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ACCELERATING GROWTH TOWARDS SDG ACCOMPLISHMENT

NOVEMBER 25, 2022



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ORGANIZED BY
NSBM GREEN UNIVERSITY, COLOMBO, SRI LANKA - NOVEMBER 25, 2022

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PREFACE

We consider it a great pleasure and a privilege for us to present the proceedings of ICOBI 2022 to the authors and delegates of the event. We believe that you will find it insightful, exciting, and inspiring.

NSBM Green University is honoured to present the International Conference on Business Innovation (ICOBI) 2022 for the fifth consecutive year. The NSBM, which commenced a new chapter in the Sri Lankan Higher Education System by being the first of its kind in South Asia, successfully held the fifth International Conference on Business Innovation (ICOBI) in 2022, attracting wide recognition in both the local and international arena.

With ICOBI 2022, NSBM takes a giant leap in the academic context by creating a platform to bring together both local and foreign research conducted despite a global pandemic that is also followed by a global economic crisis. The theme of our fifth International Conference is centered on “Accelerating Growth Towards SDG Accomplishment”, capturing the attention of a multitude of contemporary academics, researchers, and strategists.

In the year 2000, the United Nations decided on millennium development goals to be accomplished by 2015 in order to establish a sound living environment for humankind. However, in 2015, the previously framed goals were re-designed as “Sustainable Development Goals” (SDG)

or “Global Goals” to be achieved by the year 2030 via the multi-year strategy implemented by the UN Global Compact by focusing on social, economic, and environmental conditions. As SDGs act as a blueprint to achieve a better and sustainable future for humankind, they are implemented as a form of the universal call to action to end poverty and inequality and protect the planet while ensuring that humankind enjoys health, justice, and prosperity.

Therefore, accelerating growth towards accomplishing sustainable development goals is identified as a key strategy to ensure an economically, socially and environmentally peaceful living atmosphere for humankind. Sri Lanka, especially as a UN member state, thus aims to accomplish these universal goals to ensure the well-being of its population while setting an example to the whole world.

Accordingly, ICOBI 2022 aims to provide a platform to discuss the issues, challenges, and opportunities in developing SDGs locally and globally. This conference will further explore what innovations and technologies are being leveraged to accelerate the accomplishment of sustainable development goals within a limited time frame. During the ensuing discussion, speakers stressed the importance of accelerating the SDGs to Sri Lanka as well as to other foreign nations through insightful and creative recommendations. Papers and posters

presented at the conference and included in the proceedings are intended to provide further information.

In celebrating this milestone, it is our privilege to acknowledge the guidance and unwavering support extended by Prof. E. A. Weerasinghe, the Vice-Chancellor of NSBM Green University; the visionary leader behind the success of this conference; and Deputy Vice-Chancellor, Prof. Chaminda Rathnayaka, for their support and guidance throughout the process. We are also grateful for the expert input and constant guidance of Prof. J. Baratha Dodankotuwa, the Head of Academic Development and Quality Assurance; without him, the conference would not have been a success.

Finally, we would like to extend our gratitude to all the local and international presenters and participants for their contribution to the success of this conference. Moreover, we are grateful to all the reviewers who assisted us in compiling the conference proceedings and maintaining the high quality of the manuscripts. ICOBI 2022 undoubtedly creates a platform for valuable academic contributions and intellectual discourses that will enhance the quality of higher education while eventually contributing to the development of the world tomorrow. The timely theme of the conference will also contribute to creating a safer and more prosperous living ambience for the future generation in the

world. We wish all the attendees a productive and wonderful time at ICOBI 2022, organized by NSBM Green University, Sri Lanka. With your support and participation, the conference will strive towards success. Until then, we hope your experience with us remains fruitful and long-lasting.

The Conference Organizing Committee
ICOBI 2022

MESSAGE FROM VICE-CHANCELLOR



Promoting scientific culture within scholarly communities becomes instrumental for emerging economies to reach growth potential and foster development. As revealed by the strong evidence from many developed economies, research and innovation resulting from scientific culture have enormously influenced progress over a series of setbacks in different sectors. Universities, as hubs of research and innovation, have essential functions to carry out in positively accelerating a country's societal and economic growth.

In contribution to this objective, it is an absolute honour to organize the fifth consecutive International Conference on Business Innovation (ICOB I) 2022 at NSBM

Green University, which has already been acclaimed as an invaluable resource that determines effective outcomes for the country following the conclusion of four successful conferences.

The fifth International Conference on Business Innovation is unfolded amidst the country's economy demanding efforts to assist gain momentum for rapid growth. Having this in context, ICOBI 2022 with the theme of "Accelerating Growth Towards SDG Accomplishment" focuses on implementing collective efforts to create new knowledge and share insights that encourage sustainable and futuristic approaches to economic growth. Thereby I believe this international conference is timely and makes an excellent platform for multidisciplinary scholars to present their works and enable a productive discourse on varied fields.

I am confident that ICOBI 2022 will generate a great deal of value for enhancing the university's research culture as well as for the development of our nation. Hence, I make this an opportunity to extend my heartiest congratulations to the organizing committee for attracting a wide array of high-quality papers from experts in their fields.

Most of all, I express my sincere appreciation to all the presenters and delegates for enriching our annual conferences with their insightful presentations, intense discourse and collegial relationships, and I wish them a most informative and fruitful conference.

Thank You.

Prof. E. A. Weerasinghe

MESSAGE FROM DEPUTY VICE-CHANCELLOR



It is with great pleasure I pen down this message for the fifth International Conference on Business Innovation (ICOB) 2022, organized by NSBM Green University.

It is worth noting that the times we live in are overwhelming and undoubtedly call for transformation in the national economy and urge a sustainable foundation for the generations to come. NSBM Green University, being the nation's premier higher education provider, has set its mission to commit to the national demands and requirements by inspiring the current and future generations of leaders, creating new knowledge through research and innovation, and contributing to shaping the direction of the nation's economy.

With ICOB 2022 focused on the theme "Accelerating Growth Towards SDG Accomplishment", NSBM embarks on a whole new process that induces novelty and innovation over a vast area of concern. By providing a knowledge platform of such importance, we are able to inculcate and disseminate profound and thought-provoking ideologies and discourse among interested local and international academia that indeed will take the country towards a better tomorrow.

Whilst I keenly anticipate a fruitful conference of timely and informatively essential, I would like to extend my heartiest wishes to all the participants and also hope that ICOB 2022 will mark a tremendous milestone in the history of NSBM.

Thank You.

Prof. Chaminda Rathnayaka

MESSAGE FROM THE HEAD OF ACADEMIC DEVELOPMENT AND QUALITY ASSURANCE



It is my utmost pleasure and pride to extend warm greetings to the International Conference on Business Innovation (ICOBI) 2022 at NSBM Green University. Inspired by the spirit of lasting success procured with hosting four previous conferences, I sincerely hope 5th ICOBI will also imprint a more significant impact through new knowledge and strategies evolving for decisive actions.

With an impactful and societally relevant research culture embedded into the heart of university culture, NSBM has been endeavouring to tackle pressing issues at the face of communities via nurturing new and existing knowledge in various

disciplines since its onset. The university places ICOBI at the apex of such efforts, hosting a knowledge platform annually to bring together local and international experts keen on establishing discourses on critical issues that demand attention.

Taking on the responsibility of directing the nation's economic development through sustainable strategies, ICOBI 2022 is organized with the theme of "Accelerating Growth Towards SDG Accomplishment" to bring in scientific solutions to address challenges effectively while providing quantifiable real-world benefits.

I would like to express my appreciation to the Organizing Committee for the hard work they have put up in making this topical event a success. Whilst congratulating all the participants of ICOBI 2022, I hope this conference will become another rewarding endeavour that can take us closer to untangling at least some of the issues confronted by humankind.

Thank You.

Prof. J. Baratha Dodankotuwa

MESSAGE FROM THE CONFERENCE CHAIR



I am delighted and honoured to bring forth this message on behalf of the Organizing Committee of the International Conference on Business Innovation (ICOB) 2022 of NSBM Green University. The successful journey of ICOB over four consecutive years has indeed marked tremendous milestones in the history of NSBM, leaving behind discourses on a number of topics with the participation of many academics and researchers around the world.

ICOB 2022 unfolds amidst compelling circumstances driven by the demands of the nation's economy for scientific solutions and innovation

to build a prosperous future for everyone in the long run. Reflecting upon these demands, the 5th International Conference on Business Innovation conference stretches out on the timely and topical theme of "Accelerating Growth Towards SDG Accomplishment", fostering novel research, innovations and implementations on a broad spectrum of areas.

Being South Asia's first Green University Town, we at NSBM believe in sustainable development and going green as crucial factors for growth in economies and communities where significant change can impact future generations. Towards these factors, the conference provides an opportunity for undergraduates, academics, emerging researchers and experts to present findings, exchange ideas, and consider possible collaborations. The inclusion of insightful keynotes and guest speeches from prominent personnel will also present the audience with valuable perspectives on future development implementations.

As Conference Chair, it is my belief that the ultimate success of a momentous event of this sort ultimately relies upon the work and strength of many individuals who were involved in the process from the initiation. Hence, I would like to express my heartfelt gratitude to the Staff of NSBM led by the Vice

Chancellor, Prof. E. A Weerasingha, for the immense support in contribution towards the vision of enhancing the research culture at the university.

In particular, the tremendous commitment and dedication of the Organizing Committee in making ICOBI 2022 a reality should certainly be highly appreciated. On behalf of the Organizing Committee, a special note of gratitude is also extended to all the speakers, authors, and presenters for allotting their valuable time and efforts towards the success of this conference. Finally, I earnestly hope you will enjoy ICOBI 2022 to the fullest and take away many fond memories of your time with us.

Dr. Chaminda Wijesinghe

Conference Chair,

**International Conference on
Business Innovation 2022,**

NSBM Green University.

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SUSTAINABILITY

CURRENT GLOBAL STATE – OPTIONS AND INNOVATIONS

Professor Henrik Hansson, Stockholm University, Sweden



SPACESHIP EARTH

We are alone, there is no planet B, no other place to go. Our planet is one complex system, if we destroy it our life quality will decrease. It is about survival.

Apollo 8 astronaut Bill Anders took the famous “earth rise” picture when circling around the moon in 1968. He said: We came all this way to explore the Moon, and the most important thing is that we discovered the Earth (Granath, 2022).

If our ecosystems collapse, can we escape to the Moon? No, 12 people have been there¹ but it is really not a place to live for humans. Charlie Duke, an astronaut of the Apollo 16 program, was there in 1972 and just ripping the protective suit would be fatal: a clumsy fall...could have split open the only barrier between himself and the vacuum of space — which would have killed him (Mosher, 2019).

What about Venus, our neighbouring planet located closer to the Sun, can we settle there? Venus is too hot, 475 degrees Celsius. Even lead will melt at this temperature. This planet is not habitable. What about Mars then? Well, if we make it there, surviving the 3-9 months journey in space, the conditions are not easy; the average temperature is about -62°C, radiation causing cancer, toxic soil, no oxygen, no water on the surface, weak sunlight, meteorite bombardments, low gravity causing bone fragility and heart issues, no life; plants, animals etc.

If a human were dropped onto the surface of Mars right now, their saliva would boil away from their mouth. They also would not have enough oxygen to breathe. If we wanted to live there, we would have to

wear a pressurised suit...To successfully walk on the Martian surface unaided, humans would need to create an atmosphere similar in composition and thickness to that of Earth (Pavid, K, 2018). And to change the climate on Mars is not possible "It's official: we can't terraform Mars" (ibid.).

These are just some of the physical challenges, imagine the social and psychological issues of long-term space travel and isolation with a few people in a cramped technology dependent environment.

What about building space hotels? It will be extremely expensive, only an option for the super-rich and for shorter periods. Actually, the space station experiences show that astronauts face depression and many health problems by staying in cramped quarters and in low gravity for long periods of time. It will not be a place to migrate to if the earth's ecosystems collapse. Strangely one of the things space station astronauts miss are the weather..., wind, rain, sun shades, the sounds and shifting lights in nature, or maybe it is not strange at all, it is just that we take it for granted.

How about travelling to another solar system? It will take a VERY long time. If the crew even survives the journey, or rather if the crew's descendants survive the journey since it will take several generations to do this expedition. The space probes Voyager 1 and Voyager 2 have recently exited our solar system after starting their journey already 45 years ago (1977):

.... the Voyagers will be humanity's foremost representatives in interstellar

space. In about 40,000 years, Voyager 1 will get relatively close to another star in the constellation Camelopardalis, while Voyager 2 will [be] near a star in the constellation of Andromeda on its way to the giant star Sirius, which it will reach in roughly 300,000 years. (Metcalf, 2022)

If humanity survives a 40 000 – 300 000 year space journey; technically, physically, socially and psychologically, reproducing themselves and their food and water supplies, and eventually reaches another sun, they have to be lucky enough to find a planet, and that planet has to be within the habitable zone, i.e. not too close to the sun (too hot) or far away (too cold), have water and oxygen. What if there is life already there? Hostile? Diseases....

Well, let's turn back to here and now. Earth is probably our best option. There are similarities with a space journey. We have limited resources and have to reuse them in a circular fashion. Also, we live in one interdependent system; what happens in one place affects the whole system.

THE ISSUES WE FACE

Humanity has polluted its own environment with increasing speed, especially since the industrial revolution. The world population is currently reaching a new milestone of 8 billion people according to the United Nations and is forecasted to increase by 2 billion people within 30 years (UN 2022a).

It took hundreds of thousands of years for the world population to grow to 1 billion – then in just another 200 years or so, it grew sevenfold. In 2011, the global population reached the 7 billion mark, it stands at almost 7.9 billion in 2021, and

it's expected to grow to around 8.5 billion in 2030, 9.7 billion in 2050, and 10.9 billion in 2100 (UN, 2022b)

The growth is mainly taking place in the least developed countries. The earth is not growing. The pressure on our environment is tremendous; polluted air, coral reefs dying, toxic soils, polluted food and water, global warming due to the human-induced greenhouse effect, melting glaciers, rising sea water levels, islands, regions and countries will disappear under water, extinction of insects, mammals, fish, birds, loss of wildlife habitats and productive agricultural areas, increase of environmentally caused cancer, brain and cardiovascular diseases. Cities are clogged with slow traffic and waste. Increased consumption of nonrenewable resources and a throwaway culture of goods.

Do I need to add references?Really? Have you been sleeping for the last 20 years? Since you read this text, which is in alignment with world science literature, and have access to Internet validate my claims by searching "Human impacts climate change" Google search engine delivers " 894 000 000 results (0,59

seconds)" and Google Scholar will provide you with "3 390 000 results (0,11 sec)". Or if you prefer get a summary in an easy access mode, listen to the audiobook "Climate Change and Extreme Weather" (Scientific American, 2020) which summarises 900 scientific studies on climate change. NONE is denying the disastrous human impact on the environment. Science is progressing via debates and disagreements, in detail scientists do not always agree, but the fact that we destroy our planet at an unprecedented speed in the last 100 years almost all scientists agree.

John Oliver, comedian and journalist, made this even more clear. In more than 1 000 scientific papers, 97% of the scientists agree that humans are causing global warming. But still, 25% of the American public doesn't believe it. It is in fact irrelevant, they are wrong; ignorant, stupid or denying. As John Oliver says it is like asking people "Which number is bigger: 15 or 5?", or "Do owls exist: Yes/No?", or "Are there hats: Yes/No?" and he concludes "You don't need public opinion on a fact". I

n media, issues are generally debated with one person in the studio who are against and one person who are for, a 50—50 representation, which is totally misleading. The proportions are 97-3 and that's why he invited 97 scientists for and 3 against in a debate, see it here:



URL:
<https://www.youtube.com/watch?v=cjuGCJJUGsg> and read Nuccitelli, 2014.

The glaciers have been melting constantly since the first recordings at Tarfala station in north Sweden: Geodetic volume estimates of Storglaciären in Sweden suggest a 28% loss in total ice mass between 1910 and 2015 (Holmlund & Holmlund, 2019). And sure, we would not mind a warmer climate in Sweden, it would extend our agricultural season, make it habitable for more species and diminish the need for winter vacations in warmer southern Europe. However, it will be at the cost of the Netherlands, Bangladesh, Maldives, Marshall Islands, Manhattan, Florida and coastal regions worldwide etc. being submerged under water and it would force millions of people to relocate.

The warming increases by 0,5 degrees every 1 000 meters above sea level, which means that people living in high areas will face freshwater problems when glaciers melt, for instance, the populations around lake Titicaca in Peru and Bolivia at 3 712 meters above sea level.

This “development” is universal and has been going on since the industrial revolution, but now the process is accelerating and more people contribute to the destruction of our habitat. This is not new knowledge, it is strange that this development only will be emphasized when a famous person like Al Gore presents a PowerPoint a make film about what we already know (Gore, 2006), or we have to be told these basics by a child, 15-year-old Greta Thunberg (Kraemer, 2021). It resembles the long-drawn-out debate about smoking. The greedy cigarette businesses denied the obvious scientifically based studies which unequivocally related smoking to “...cancer, heart disease, stroke, lung

diseases, diabetes, and chronic obstructive pulmonary disease (COPD), which includes emphysema and chronic bronchitis. Smoking also increases the risk for tuberculosis, certain eye diseases, and problems of the immune system, including rheumatoid arthritis.” (U.S. Department of Health & Human Services, 2022). In the 17th century, smoking was a luxury for the male upper class in Europe, later associated with a sporty lifestyle, health, coolness, stress reduction, sexuality and freedom as pictured in massive advertisement campaigns brainwashing generations. Now “Over 80% of the world's 1.3 billion tobacco users live in low- and middle-income countries” (World Health Organization. (2022). They are killed because of ignorance and multinational companies' aggressive expansion to other countries after being banned by policies in the finally awakened first markets.

The denial was supported by the tobacco industry which secretly paid high-profile researchers to provide a “second opinion”. Media always want to present two sides of the problem, but there are no two sides, it is right and wrong. It is science and delusion, fraud and propaganda.

The 17 sustainability goals are interlinked. All 193 countries that are member states of the United Nations agreed in 2015 to the “New Sustainable Development Agenda Unanimously” (UN, 2015). But they have not done enough. Real-time satellite data can track CO2 emissions globally (Dijkstra, 2022). About 20-30% more CO2 emissions are released than officially reported, especially in oil and gas-producing countries. This hidden output is equivalent to USA's and India's

combined yearly emissions. It has not been so much CO₂ in the atmosphere in the last 4 million years. It is now definitely clear that the important goal to limit global warming to 1,5 degrees will not be met. It could be even worse maybe 2-5 degrees.

Even 1.5°C is likely to entail 'high multiple interrelated climate risks' for 'some vulnerable regions, including small islands and Least Developed Countries.' All of those impacts become much worse at 2°C... Severe heat events will become 2.6 times worse, plant and vertebrate species loss 2

times worse, insect species loss 3 times worse, and decline in marine fisheries 2 times worse. Rather than 70 to 90 percent of coral reefs dying, 99 percent will die. Many vulnerable and low-lying areas will become uninhabitable and refugee flows will radically increase. And so on. At 2°C, climate change will be devastating for large swathes of the globe. In short, there is no "safe" level of global warming. Climate change is not something bad that might happen, it's something bad that's happening. (Roberts, 2020)

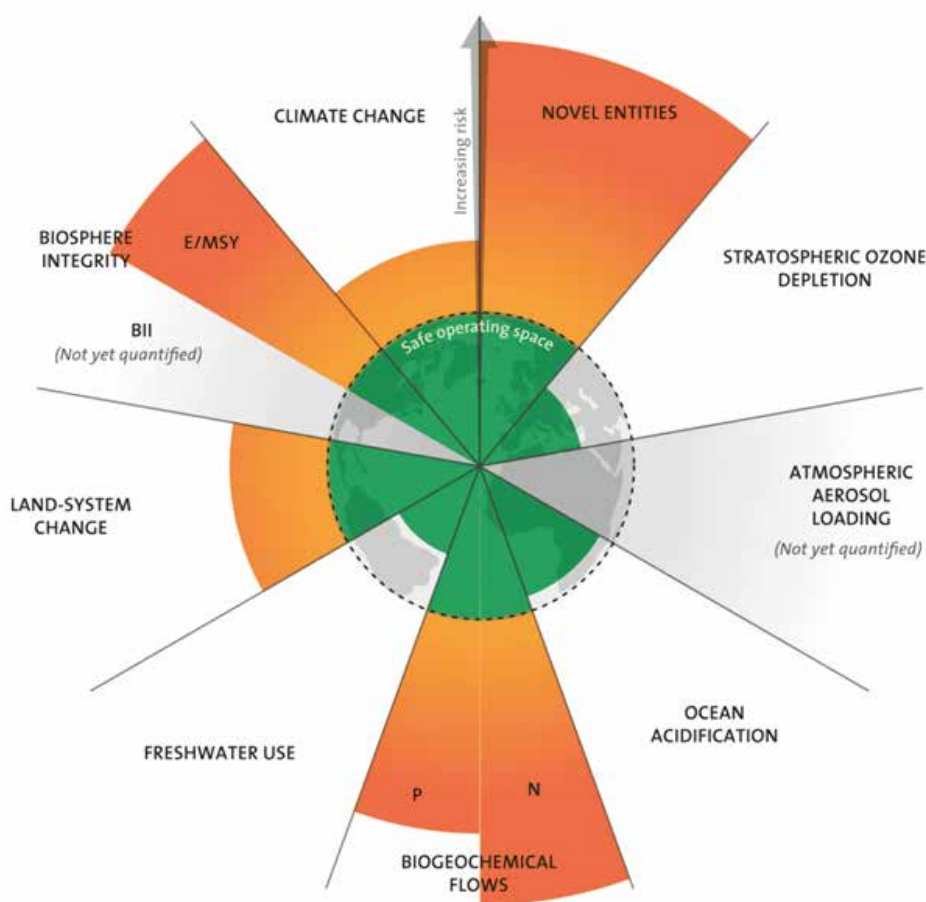


Figure. Six out of nine planetary boundaries are already crossed over (Rosane, 2022).

The last time the earth was 3 degrees warmer was 3 million years ago. Humans have never experienced this condition, homo sapiens was not yet developed.

So why is this not clearly communicated? We don't like negative information: Some scientists now suggest that public optimism about 1.5 C gives the world false hope and could even contribute to further delays in zeroing out global carbon emissions. Harvey, C (2022).

We have already crossed six out of nine planetary boundaries, see the figure below.

BEING CONSTRUCTIVE

It is clear we have huge challenges. What can we do? One talks about smartphones, smart cards, smart cities etc but seldom about smart people. It has to start there, better education for more people. And better educated leaders, maybe there should be a requirement to have a science/research education degree in order to qualify for parliament and to be a prime minister? The structure of government in different departments is to systematically work with blind-folds, in silos; finance, industry, energy, agriculture, transport, health care, education etc are all affecting sustainability and should be subordinated to sustainability policy. Industry development without sustainability concerns is destructive, agriculture also etc. Policies for digitalisation and policies for sustainability have generally been separate, but in fact, they should be interlinked. Digitalisation affects sustainability, and sustainability must be the overarching principle, see more about this in the new report "Digitalization for Sustainability: Digital Reset. Redirecting Technologies for the Deep Sustainability Transformation, 2022".

Universities are structured according to 19th-century division of intellectual labour, departments of sociology, biology, physics etc. But the sustainability challenges are multi-disciplinary and global, it requires a more holistic organisation starting with the problem and adding all relevant knowledge areas. Researchers need to work with industry more effectively and students need to learn about sustainability in their education and early on actively be involved in real-life sustainability projects.

Ranil Peiris writes in his PhD thesis "A Framework for Designing Learning Management Systems to Support Undergraduate Thesis Projects" (2022): At present, in Sri Lanka, about 41 000 undergraduate projects are conducted every year, and on average, the total time spent on the thesis projects is about 1.2 million hours. . Why not connect these mini-projects to real-life sustainability projects which could be a basis for innovation and change?

Chaminda Wijesinghe writes in his PhD thesis: Collaboration between universities and the industry has long been regarded as critical for innovation through knowledge diffusion.... university-industry collaborations in Sri Lanka are conducted primarily based on personal relationships, are short-term, and are mostly ad hoc...An ICT system can mitigate geographical distance issues and the problem of efficient collaboration and communication. (2022). Why not connect industry-students/researchers/university in Sri Lanka with an ICT-system? I will show a system we have developed with the support of Vinnova, Sweden's innovation agency.

The 17 UN Sustainable Development Goals, see figure below, all have a knowledge/education and R&D dimension and digitalisation is relevant for all. In Sweden digitalisation and sustainability have been the point of departure for many new innovative companies. You can explore 74

so-called Sustaintech companies here: <https://sting.co/companies/> And you find 978 Swedish cleantech companies here: <https://swedishcleantech.com/companies/>



Figure. The UN Sustainable Development Goals.

VitalSigns is a new company based in Stockholm focusing on SDG 3: Good health and well-being. They develop CPR-Pad - IoT for innovative societal benefit and First Aid Platform (FAP).

About the CPR-Pad. The Swedish Council for CPR (cardiopulmonary resuscitation) has the following visions:

All citizens must know CPR for adults and children

All children in primary and secondary school must undergo CPR training annually (6-19 years)

Mandatory repetition of CPR and first aid for people of working age (19-70 years)

In 2030, at least 1,000 people must be saved annually in the event of cardiac arrest outside the hospital 2030, at least 1,000 people must be saved to their lives annually in the event of cardiac arrest in hospital

In order to achieve these objectives, new approaches and products are required, which must be affordable, flexible and connected. More effective training in CPR is also a global need and there is therefore a large market for better systems. If

cardiopulmonary resuscitation is performed within minutes of cardiac arrest, the chance of survival is doubled or tripled. This means that people closest to the victim need to have the knowledge for a life-saving intervention, waiting for expertise to arrive takes too long. The pad is based on inertial sensors (MEMS IMU sensors) and can be easily distributed and used in CPR training. The pad gives feedback on how deep compressions are performed (5-6 cm is the norm) and indicates the correct pace. The sensor pad is connected to IT systems for communication, alarms and monitoring; information is transmitted to mobile phones and hospitals. With this technology, qualified training in cardiopulmonary resuscitation can take place anytime and anywhere at little cost. The pad is an IoT, a thing connected to the Internet that enables quality control, mass training and support in acute situations. CPR-pad will save more lives.

About the First Aid Platform (FAP). There is an information gap from when an accident, trauma or other medical event occurs until the ambulance arrives at the scene. This creates an information delay during the most critical period. The lack of information limits the ability for the alarm centre or nurse to triage and instruct the first responder – usually a layman or assistant nurse. This information causes problems that the First Aid Platform will solve.

The first 15 minutes of Golden Hour are lost. Prompt medical attention during the golden hour is critical for survival. Without vital parameters, it is difficult to triage and instruct laymen with high quality.

Limited First Aid knowledge from first

responders. The first responder on the scene of a medical incident is usually a layman or an elderly care assistant nurse. In both cases the knowledge of how to act properly is limited.

Inefficient use of societal resources. With the combination of limited knowledge and no technical aid for first responders, we are not optimizing our medical expertise. For example, in Sweden, 33% of all ambulance call callouts are false alarms/unneeded.

Using a combination of education, digitalized ABCDE approach and sensors the First Aid Platform give the first responder better support on how to act in the acute phase of a medical incident. It also transfers relevant data from the scene of an accident to emergency healthcare such as the alarm receiving centre, ambulance and hospital.

There is a great need to streamline emergency healthcare, both from a national and global perspective. Today, the information reporting does not take place until the patient has arrived at the emergency hospital. By collecting vital data via sensors that are applied to the person at the scene of the incident and communicating this data in real-time to recipients in the healthcare chain. Improved care can take place in the form of increased security, improved triage, improved care efforts and better resource utilization. The overall goal is that this should result in fewer deaths and a reduced number of disabilities in our society.

Every year, 2 million people need emergency medical care in Sweden. Trauma is the most common cause of death among people under the age of 45, and approxi-

mately 3 000 people die annually in Sweden as a result of trauma. Every day, an average of 440 people are treated in inpatient care for injuries caused by trauma.

FAP has many similarities with how the value chain works around defibrillators. Today there are approx. 50 000 defibrillators deployed in Sweden. FAP will be deployed in strategic places such as construction sites and heavy industry with high statistics for severe accidents, nursing homes with high statistics for acute medical events, and in a wider perspective, places where large groups of people gather such as schools, shopping malls, municipal facilities for public use, transport sector, police and fire brigade. As a service, it will also include continued education and other first aid material in multiple languages needed for the context where the FAP is placed.

FAP consists of a combination of hardware and software. The hardware consists of sensors, which measure vital parameters, such as oxygen saturation, pulse, respiration rate and body temperature. FAP also provides the option of manually supplementing data that may be relevant to the context in question, e.g. level of consciousness in the event of a fall on a construction site as well as the height from which the individual fell and what the individual landed on for support.

By following the FAP process the layman can initiate the ABCDE and connect sensors to the person who has had an accident or acute illness. FAP will collect the vital parameters in real-time and improve the information chain so that the medical teams can triage, and guide laymen and the trauma team at the hospi-

tal can be better prepared. The measurements are stored in FAP's software platform, where a trauma team can either retrieve this data directly upon arrival at the hospital or follow the patient in real-time from the time of the accident or the time of illness and all the way to arrival at the hospital. With the help of this can the trauma team get a better status of the patient's condition at an earlier stage, get a picture of the early clinical development and, on the basis of this information, optimize the resources of the hospital. Today, the majority of status checks take place when the patient has already arrived at the hospital, which means that valuable time is lost. This technology can also be used in elderly care, and substitute some of the physical follow-up meetings with doctors to check for instance physical effects of medicine or other treatments.

Solvatten is a Swedish innovation: "Solvatten is a combined portable water treatment and water heating system that has been designed for off-grid household use in the developing world. It is an easy, innovative solution that provides access to clean, hot water to people worldwide. Thanks to its durable design, Solvatten is an affordable and convenient way to get clean, hot water." It is used in 40 countries by 450 000 users. For more information see: <https://solvatten.org/>

Orbital shower is a Swedish innovation, it saves water radically "Up to 90% water saved using cutting-edge technology. Up to 80% energy saved with built-in heat correction". For more information see, <https://orbital-systems.com/> Orbital was created by a student who worked on a spaceship solution, water has to be saved

and recycled in a spaceship, but also here on earth.

Another innovative student is Abhishek Banerjee, who solved two problems, waste management and construction material by creating bricks of recycled plastic in India, read Anna Fletcher's article (2019).

The Swedish-Finnish company Stora Enso use forest-based biomaterial to substitute plastics in packages, cups, etc see their homepage for a large range of R&D-based innovative products (Stora Enso, 2022).

Finally, a Greentech giant new company in Sweden is Northvolt, or "Tesla of Europe", not making cars but batteries for the major European car manufacturers BMW, Volvo, Volkswagen etc. Green batteries for a blue planet We're in the battery business. Manufacturing with clean energy, our mission is to deliver batteries with an 80% lower carbon footprint compared to those made using coal energy. And we're building them into solutions to make the world a better, cleaner place. See their homepage for more information, Northvolt (2022).

Education, innovations, research and wiser decisions are the way forward for Spaceship Earth, or is it a rowing boat we all sit in..., who is the captain of the ship? Can we move faster? In the right direction?

REFERENCES

Digitalization for Sustainability (D4S), 2022: Digital Reset. Redirecting Technologies for the Deep Sustainability Transformation. Berlin: TU Berlin. <http://dx.doi.org/10.14279/deposition-16187>

Dijkstra, M. (2022). *Real-time space observations can now keep watch over 'super emitter'*

power plants. World Economic Forum. <https://www.weforum.org/agenda/2022/11/real-time-space-observations-power-plants/> (2022-11-13)

Fletcher, A. (2019). *Indian student creates a brick made from recycled plastic.* CNN. <https://edition.cnn.com/2019/11/25/asia/plasticube-brick-india-scn-intl-c2e/index.html> (2022-11-13)

Granath, R. (2022). *Astronaut Photograph from Space Helped "Discover the Earth".* NASA's Kennedy Space Center. <https://artsandculture.google.com/story/astronaut-photography-from-space-helped-discover-the-earth-nasa/xQXRK3svY6KQ?hl=en> (2022-11-17)

Gore, A. (2006). *An Inconvenient Truth.* Paramount Classics. Film

Harvey, C (2022). *The World Will Likely Miss 1.5 Degrees C—Why Isn't Anyone Saying So?* Scientific American. <https://www.scientificamerican.com/article/the-world-will-likely-miss-1-5-degrees-c-why-isnt-anyone-saying-so/> (2022-11-13)

Holmlund E, S, Holmlund, P.(2019). *Constraining 135 years of mass balance with historic structure-from-motion photogrammetry on Storglaciären, Sweden.* Geografiska Annaler: Series A, Physical Geography, 101:3, 195-210, -DOI:10.1080/04353676.2019.1588543

Kraemer, D. (2021). *Greta Thunberg: Who is the climate campaigner and what are her aims?* BBC News. <https://www.bbc.com/news/world-europe-49918719> (2022-11-13)

Metcalfe, T. (2022). *After 45 years in space, the Voyager probes are just starting out.* NBC News. <https://www.nbcnews.com/science/space/artemis-delay-voyager-probes-rcna44188> (2022-11-13)

Mosher, D. (2019). *An Apollo astronaut explains how he nearly killed himself 'horsing around' on the moon in 1972.* INSIDER. <https://www.businessinsider.com/apollo-astronaut-charles-duke-moon-jump-video-2019-6?r=US&IR=T> (2022-11-09)

NASA. (2022). *Who Has Walked on the Moon?*

<https://solarsystem.nasa.gov/news/890/who-has-walked-on-the-moon/> (2022-11-13)

Nuccitelli, D. (2014). John Oliver's viral video: the best climate debate you'll ever see Oliver tackles media climate false balance, the 97% expert consensus, and what a representative climate debate should look like. *The Guardian*. <https://www.theguardian.com/environment/climate-consensus-97-per-cent/2014/may/23/john-oliver-best-climate-debate-ever> (2022-11-13)

Northvolt. (2022). <https://northvolt.com/> (2022-11-13)

Oliver, J. *Climate Change Debate: Last Week Tonight with John Oliver* (HBO) - YouTube

<https://www.youtube.com/watch?v=cjuG-CJJUGsg> (2022-11-13)

Orbital Systems. (2022). <https://orbital-systems.com/> (2022-11-13)

Pavid, K. (2018). It's official: we can't terraform Mars. *The Trustees of The Natural History Museum, London*. <https://www.nhm.ac.uk/discover/news/2018/july/its-official-we-cant-terraform-mars.html> (2022-11-13)

Peiris, R. (2022). *A Framework for Designing Learning Management Systems to Support Undergraduate Thesis Projects*. PhD thesis. Stockholm: Department of Computer and Systems Sciences, Stockholm University, Sweden.

Roberts, D. (2020). The sad truth about our boldest climate target. Limiting global warming to 1.5°C is almost certainly not going to happen. Admitting that need not end hope. *Vox*. <https://www.vox.com/energy-and-environment/2020/1/3/21045263/-climate-change-1-5-degrees-celsius-target-ipcc> (2022-11-13)

Rosane, O. (2022). We Have Breached the Planetary Boundary for Plastics and Other Chemical Pollutants, Scientists Say. *EcoWatch*. <https://www.ecowatch.com/plastic-pollution-chemicals-earth-health.html> (2022-11-17)

Scientific American. (2020). Climate Change

and Extreme Weather. Audiobook – Unabridged. Coleen Marlo (Narrator), Blackstone Publishing

Stora Enso. (2022). Stora Enso's sustainability framework. <https://www.storaenso.com/en/sustainability> (2022-11-13)

Solvatten (2022). <https://solvatten.org/> (2022-11-13)

STING. (2022). 74 new companies within SustainTech. <https://sting.co/companies/> (2022-11-13)

Swedish Cleantech companies. (2022). <https://swedishcleantech.com/companies/> (2022-11-17)

UN. (2022a). Growing at a slower pace, world population is expected to reach 9.7 billion in 2050 and could peak at nearly 11 billion around 2100. <https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html> (2022-11-13)

UN. (2022b). World Population Day 11 July. <https://www.un.org/en/observances/world-population-day> (2022-11-13)

UN (2015). 193 Member States Archives - United Nations Sustainable Development. <https://www.un.org/sustainabledevelopment/blog/tag/193-member-states/> (2022-11-13)

U.S. Department of Health & Human Services. (2022). Smoking & Tobacco Use - Health Effects https://www.cdc.gov/tobacco/basic_information/health_effects/index.htm#:~:text=Smoking%20causes%20cancer%2C%20heart%20disease,immune%20system%2C%20including%20rheumatoid%20arthritis. (2022-11-13)

Wijesinghe, C. (2022). *How knowledge diffusion in University-Industry Collaboration can foster ICT innovations in Sri Lanka*. Stockholm: Department of Computer and Systems Sciences, Stockholm University, Sweden.

World Health Organization. (2022). Fact sheets – Tobacco. <https://www.who.int/news-room/fact-sheets/detail/tobacco> (2022-11-13)

COMPLEXITY, SCIENCE AND TECHNOLOGY IN SUSTAINABLE ECONOMIC DEVELOPMENT

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In developed countries, scientists and experts in different disciplines get together to solve nationally and globally important issues such as national and global economies. Ricardo Hausmann, Professor of the Practice of Economic Development at the John F. Kennedy School of Government at Harvard University, USA, and José Domínguez, Professor of Structural Engineering, School of Engineering, University of Seville, Spain, state that the application

of complexity science tools allows for the better understanding in the fields of economics that will gear a nation towards both social and technological development. The complexity can be defined as many different elements (such as specific technologies, raw materials, products, people, and organizational units) that have many different connections to one another. Based on the randomness, there are three types of complexities, viz., organized simplicity, organized complexity, and disorganized complexity. The organized simplicity involves all systems that could be described using trajectories (paths), such as the motion of a pendulum or the orbit of a planet, for example, theories of Isaac Newton and Albert Einstein. Thermodynamics and steam engines do not rely on the idea of trajectories and belong to the disorganized complexity. Science of organized complexity is the complexity we encounter in the real-world situations such as organizations and local and global economies. The economic complexity can be used to predict growth of a region, country, or the world. These are complexity matrices interacting with different

elements in a complex way such as the neural network system of our body. Therefore, the neural network-based artificial intelligence can be used to analyze science of organized complexity. When taking a decision, it is of paramount importance to investigate cause and effect relationships by solving complexity matrices using artificial intelligence or else it will lead to dramatic situations. Outright banning of all agrochemical aids is a typical example for taking ad hoc and arbitrary decisions that will ruin the economy and social wellbeing of the people as we have experienced recently. Politicians who make decisions are clueless of science or economic complexity, but they should be intelligent enough to consult right authorities before taking such drastic decisions. Today's world requires leaders who can spearhead strategic innovation while understanding the technological complexities that enable it.

The most important predictor of economic growth is not the GDP growth but the number of different products a country creates with special attention to how many of those products are unique. It is not the wealth, governance, or education that matters, it's what things a country knows how to make, i.e., converting innovations into products, devices, and technologies. According to Ricardo Hausmann who is the founder and Director of Harvard's Growth Lab and the Rafik Hariri Professor of the Practice of International Political Economy at Harvard Kennedy School, what has changed the world's history is the amount of knowledge we possess because we then know how to make things. To make a product, it requires individuals putting pieces of knowledge together (<https://ourworldinda->

[ta.org/how-and-why-econ-complexity](https://ourworldinda-ta.org/how-and-why-econ-complexity)). Moreover, once knowledge capital is considered, pure access as measured by years of schooling completed bears no relationship with long run growth. It is necessary to remember that the two main ingredients for the development of new technology are codified knowledge in the form of theories, frameworks, scientific papers, patents, recipes, protocols, routines and instruction manuals and tacit knowledge or knowhow, which is acquired through learning by doing in a long process of imitation and repetition and which exists only in brains (<https://rcc.harvard.edu/knowledge-technology-and-complexity-economic-growth>). Countries like Sri Lanka cannot be in an economic crisis given the fact that there is good education and that there are experts in developing science and technologies leading to innovations that can be directly translated to valuable products and process. Scientists and researchers in Sri Lanka do produce a great wealth of knowledge that can be adapted in local industries for manufacturing products to improve national economy. However, the question is how much of these new inventions are translated into valuable and value-added products, and unfortunately the percentage of inventions that have been translated into such products in Sri Lanka is negligibly low. There is also a competition between products that have been made from national inventions and the similar products that are imported when it comes to the commercial scenario. These countries are poor and remain to be so unless local products of high quality are developed and integrated to the economic development. The concept of importing virtually everything and any associated

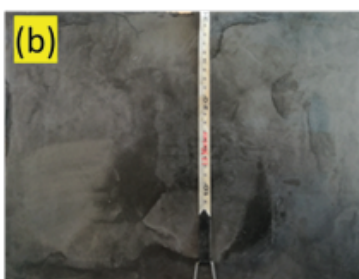
corruptions, if any, will have to be terminated to rise as a developed nation. Sri Lanka is gifted with a wealth resource of natural minerals, flora, and fauna. Scientists have worked on adding value to almost all minerals and the policy should be formed and implemented to ban exporting minerals in their raw forms or just by making smaller particles without a high value addition. Our research has led to the development of highly value-added nanomaterials from local minerals that have applications in energy conversion and storage devices, future electronics, magnetic levitation, advanced and intelligent pigments, fabrics, garments, textiles, gloves and face masks, oil recovery and oil spill cleaning. We have been successful in converting our inventions to commercial products since we collaborate with right industries for scaling up and manufacturing processes. Such a bridging of gap between the academia and industries is a must to convert inventions to marketable products. Also, the country has a rich resource of endemic and other plants from which medicinally and therapeutically important materials can be easily isolated and pharmaceutical products based on natural sources can be manufactured. When it comes to marketable products, scientists alone cannot work on doing everything, but they must get together with economists and other related professionals for market search, cost, and feasibility studies, designing of the product, and advertising, getting necessary approvals, distribution of the products, and getting the market establishment. The artificial intelligent tools described above should be used in all these steps. The keynote lecture, therefore, addresses the current economic situation of Sri Lanka and ways

and means of coming out of prevailing economic crisis. Development of local industries for manufacturing value-added products for both the local and export market is perhaps the only way forward. It is worth mentioning the policy of the CODEGEN International Pvt. Ltd. that has manufactured world's latest technology sports car-VEGA that received first place in the global latest technology inventions. Since Japan and several other countries have well established vehicle manufacturing industries, Sri Lanka is not able to compete with ordinary vehicle manufacturing, but we can certainly establish Sri Lankan brand of latest technology sport cars just like VEGA and such industries must be promoted for large scale production.

Whatever the industry or the development, it should strictly follow sustainability. The sustainable development is defined as the "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (Report of the World Commission on Environment and Development: Our Common Future, "Report of the World Commission on Environment and Development: Our Common Future; Transmitted to the General Assembly as an Annex to document A/42/427 – Development and International Co-operation: Environment; Our Common Future, Chapter 2: Towards Sustainable Development; Paragraph 1". United Nations General Assembly). The United Nations General Assembly, in 2015, adopted seventeen sustainable development goals (SDGs) addressing the global challenges, including poverty, inequality, climate change, environmental degradation, peace, and justice ("Three pillars of sustainability: in search of conceptual

origins"). The American Chemical Society (ACS) identified seven priority SDGs and five additional SDGs that are foundational to the work of the chemistry community (https://www.acs.org/content/acs/en/sustainability/chemistry-sustainable-development-goals.html#:~:text=Chemistry%20will%20help%20meet%20the,by%20advancing%20cleaner%20fuel%20technologies.)). Chemistry is central in developing technologies for addressing key issues such as zero hunger, human health and well-being, clean water

and sanitation, affordable and clean energy, industries, innovation & infrastructure, responsible consumption & production, and climate action. The keynote lecture, therefore, addresses the current economic situation of Sri Lanka and ways and means of coming out of prevailing economic crisis through sustainable development of local industries to manufacture value-added products for both the local and export markets taking examples of our own inventions.



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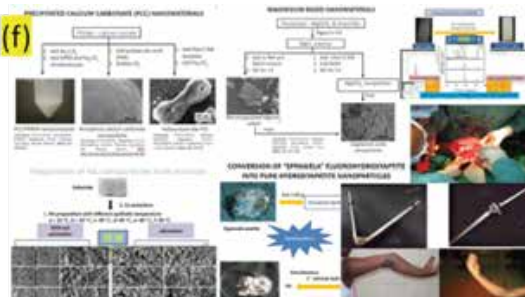
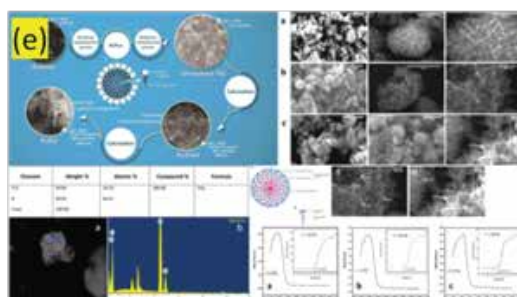


Figure 1: (a) A prototype zinc/bromine flow battery and (b) electrodes made using Sri Lankan graphite to manufacture large flow batteries, (c) high-temperature electrolyzer and (d) graphite electrodes developed at the Industrial Technology Institute (ITI) for converting quartz to solar grade silicon, (e) low-cost process developed to convert ilmenite to phase-specific titanium dioxide, iron oxide and zero-valent iron nanomaterials, and (f) custom-made prostheses developed for orthopaedic transplants starting from mundane minerals such as dolomite and apatite.

Some of the inventions that we have done that can be integrated in commercial production are shown in Figure 1. Figure 1 (a) shows a prototype zinc/bromine flow battery and (b) electrodes made using Sri Lankan graphite to manufacture large flow batteries, (c) high-temperature electrolyzer and (d) graphite electrodes developed at the Industrial Technology Institute (ITI) for converting quartz to solar grade silicon, (e) low-cost process developed to convert ilmenite to phase-specific titanium dioxide, iron oxide and zero-valent iron nanomaterials, and (f) custom-made prostheses developed for orthopaedic transplants starting from mundane minerals such as dolomite and apatite. Suitable industrial partners are required to scale up and manufacture these highly value-added products. The inventions that have been converted to commercial products are RESPIRONE NANO AV 99 face mask and industrial that is capable of filtering and destroying bacteria, viruses and fungi including SARS CoV-2 and its variants, and, antimicrobial, superhydrophobic, antipilling and antistatic garments and textile products in collaboration with relevant industries such as Sarasavi, ATG and Teejay

industries. The global Nano TiO₂ market in 2022 is USD 16.862 billion, the pigment alone market for iron oxide nanomaterials in 2021 is USD 2.3 billion, and the global market for other products is also in billions of USD. Therefore, time is ripe for scientists and industrialists to get together to develop high-quality Sri Lankan brand name based products for the overseas market comparable to those of Ceylon Tea and Sri Lankan Garment Products.

The Role of Dynamic Capabilities, Digital Capabilities and Social Capital on Resilience and Recovery of SMEs During and After Covid-19 in Sri Lanka

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ABSTRACT

SMEs account for 75% of all business entities in Sri Lanka and contribute to about 45% of total employment. Two-thirds of SMEs reported a decrease in demand for their products or services since COVID-19, and almost three-quarters reported decreased sales. The question of why some SMEs failed to withstand the COVID-19 crisis whereas some Sri Lankan SMEs survived remains unanswered. It demonstrated very clearly how frail the economy of Sri Lanka is and raised doubts about the resilience of Sri Lankan businesses. This research investigated the factors affecting the resilience of SMEs in Sri Lanka. This research used a conceptual framework comprised of Dynamic Capabilities, Social Capital, and Digital Capabilities to analyze the antecedents of resilience in SMEs in Sri Lanka. A randomly selected sample of 76 SMEs in Sri Lanka were analyzed using Partial Least Squares Structured Equation Modelling (PLS-SEM) method. Results indicate Dynamic Capabilities, Social Capital and Digital Capabilities have a significant positive influence on SME resilience. Dynamic Capabilities, Social Capital and Digital Capabilities together explained 29% of the variance in resilience of SMEs. The development of knowledge, both theoretical and empirical, has become critical in order to understand how SMEs endured the crisis, adapted to it, managed it, built resilience, and ultimately recovered from it. Such knowledge will become invaluable in future crisis situations to protect SMEs in Sri Lanka.

Keywords: *Dynamic Capabilities, Social Capital, Resilience, SME*

1. INTRODUCTION

For Sri Lankan entrepreneurs and policymakers, COVID-19 may be considered a "wake-up call." It demonstrated very clearly how frail the economy of Sri Lanka is and raised doubts about the resilience of Sri Lankan businesses. More than anything else, COVID-19 demonstrated the interdependency of business, nature, government, and society on each other for mutual survival during a crisis.

Currently, the severity of the pandemic looks to be diminishing in Sri Lanka. With a remission in sight and the optimism that new variants are less harmful due to the success of vaccination, businesses all over the world are looking forward to returning to normal. However, the post-covid period seems to be more challenging for entrepreneurs in Sri Lanka. Pessimistic views are in the air, and the economic indicators have worsened. Inflation soared to 54% in June 2022 (the highest ever recorded in Sri Lanka and the highest in South Asia) (CBSL, 2022). Foreign reserves stood at 10 million US dollars in January 2022 (the lowest ever recorded); foreign worker remittances fell to a 10-year low of 5.5 billion US dollars in 2021. GDP growth rate is predicted to be around -1.6 to 0.5 in 2022, indicating stagnant GDP. Within a decade, the Sri Lankan rupee compared to the US dollar has collapsed in a sequence of currency crises in 2012 (Rs. 131),

2016 (Rs. 151), 2018 (Rs. 182), and 2022 (Rs. 360), where parallel exchange rates are much higher than the declared rate (Wijewardena, 2022). It should be noted that recent depreciations are happening amid heavy import constraints and the selling of gold reserves. There is little argument about the fact that the business outlook is pessimistic.

Very little can be stated with confidence about the effect of COVID-19 on small business and entrepreneurs in Sri Lanka because of the lack of data released by the government. To add to this issue, the trustworthiness of the data released is questioned by many researchers. The real losses to SMEs through the loss of business hours and customers (due to lockdown, limitations in the number of customers that can be served, and other health regulations), the losses due to customers' unwillingness to visit stores due to health concerns, and the losses due to supply chain interruptions are unprecedented. Many SMEs may have been permanently closed because of the owners' inability to pay current expenses and survive the shutdown (Gourinchas, Kalemli-zcan, Pencikova, & Sander, 2020). Opportunity costs in SME sectors are also large for the Sri Lankan economy. Many people who contemplated becoming entrepreneurs gave up or postponed the transition due to a pessimistic outlook.

Few research studies and surveys have attempted to assess the impact of COVID-19 on businesses around the world. The number of business owners in the USA decreased from 15 million to 11.7 million in 2020 (Fairlie, 2020). Female entrepreneurs faced 35% higher cases of failure because women disproportionately work in industries that are more severely affected by COVID-19 (Graeber et al., 2021). The COVID-19 pandemic impact is more profound for minority community businesses (Fairlie & Foss, 2021) and for businesses in developing countries (Pereira & Patel, 2021). As a result of the COVID-19 outbreak, nearly 80% of Indian companies have gone through cash flow issues, and more than 50% of companies are confronting operations issues (Misra, 2021).

Many academic studies on the impact of COVID-19 on business are under construction,

and the results will be shared in the next few years (Alonso et al., 2021). The question of why some SMEs failed to withstand the crisis whereas others survived remains unanswered. The development of knowledge, both theoretical and empirical, in order to understand how SMEs endured the crisis, adapted, managed it, built resilience, and ultimately recovered from it has become critical. Such knowledge will become invaluable in future crisis situations to protect SMEs in the country.

In the most challenging times such as Covid-19 pandemic, resilience of SMEs are influenced by dynamic capabilities (Mansour, Holmes, Butler, & Ananthram, 2019), social capital of entrepreneurs (Al-Omouh, Simón-Moya, & Sendra-García, 2020), and the digital capabilities of the entrepreneurs (Khlystova, Kalyuzhnova, & Belitski, 2022). Therefore, these three variables, which are of contemporary interest, are selected in this research. The objective of this research is to uncover the antecedents of resilience and recovery capabilities among SMEs in Sri Lanka during and after the COVID-19 pandemic. The specific objectives are as follows:

1. To explicate the antecedents of resilience and recovery capability of SMEs in Sri Lanka in and after a crisis
2. To assess the influence of dynamic capabilities, social capital, and digital capabilities on the resilience and recovery capability of SMEs in Sri Lanka

There is no single, widely accepted definition of SMEs. The definition of an SME differs from country to country or region to region but is typically based on employment, level of assets, or a combination of the two criteria (Kumar, 2012). Many studies involving SMEs have a greater preference on using number of employees as a proxy for firm size (Troilo, 2012). This research used the guidance of Sri Lanka Standards Institution (SLSI) and defined an SME as an organization with fewer than 250 employees.

2. LITERATURE REVIEW

In a crisis situation, the most important factors for survival are the management of change and

the possession of dynamic capabilities (Mansour, Holmes, Butler, & Ananthram, 2019). Covid-19 propelled SMEs to make significant changes to their in terms of business models, product offerings and processes, customer and supplier base, reducing working hours and staff cuts, adopt to health regulations etc. within a short time. Those who possessed dynamic capabilities had the advantage of making these changes with minimum difficulty (Rashid & Ratten, 2021). Successful crisis management in SMEs is associated with directly unobservable owner and organizational factors that are deeply rooted in dynamic capabilities (Pangerl, 2013). However, the role of dynamic capabilities for the survival of SMEs in turbulent situations and crisis environments remains unanswered (Mansour, Holmes, Butler, & Ananthram, 2019).

Teece et al. (1997) argued that organizations rely on dynamic capabilities to build competitive advantage in regimes of rapid change. Teece et al. (1997, p. 516) define "dynamic capabilities" as "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments." Zahra et al. (2006) define "dynamic capabilities" as "the abilities to re-configure a firm's resources and routines in the manner envisioned and deemed appropriate by its principal decisionmaker." In this research, Teece et al.'s (1997) definition is adopted.

Teece (2007) argues that ambidexterity is a key dynamic capability. Ambidexterity is pursuit of both exploration and exploitative capabilities. In his seminal article, March (1991) presented the concepts of exploration capability (ability to innovate) and exploitative capability (taking maximum advantage of existing knowledge and assets). Iborra, Safón, and Dolz (2020) explain that SMEs attain resilience through efficiently responding to dynamic environments by developing ambidexterity and strategic consistency.

So, there is ample evidence to hypothesize that dynamic capabilities influence SME resilience and recovery.

H1: Dynamic capabilities influence resilience and recovery of SMEs

Social capital is defined as "naturally occurring relationships to promote or aid the development of valued skills or characteristics" (Loury, 1979, p. 248). In dynamic markets and turbulent times, there will be a lot of uncertainty about customer characteristics, target markets, competitor behavior, macro-economic conditions, etc. In situations where external resources are rare and difficult to obtain, entrepreneurs give up long-term strategic planning and shift their focus to maximizing the use of internal resources such as knowledge and social networks for survival (Kalinic, Sarasvathy, & Forza, 2014). Social networks support the accumulation of the knowledge required to be proactive in crisis situations and to survive in crisis where other SMEs with less networking capacity need to rely on time-consuming experimental knowledge.

Extant literature highlights the importance of social networking (social capital) for SMEs (Pinho & Prange, 2015). Social capital plays a key role in acquiring business resources such as hiring competent employees, introducing customers and suppliers, and obtaining intellectual resources and finance. Social networks both formal and informal are likely to amplify the effects of human capital (i.e. knowledge, experience etc.). According to scholars, networks contribute to indirect learning in organizations (Apaydin, Thornberry, & Sidani, 2020). Social networks facilitate SMEs to receive valuable information from sources of information quicker than their counterparts in crisis situations (Al-Omouh, Simón-Moya, & Sendra-García, 2020). Past studies recognized that formal and informal networks provide a buffer for small businesses in the face of crisis. These networks also offer opportunities for increased mobilization of knowledge, dissemination of innovative activities, which in turn increase the resilience of SMEs (Saad, Hagelaar, Velde & Omta, 2021).

So the second hypothesis can be formed as follows.

H2: Social capital influence resilience and recovery of SMEs

Sharma and Rautela (2021) note that digitalization was considered a main strategy in

the COVID-19 crisis for SMEs in India. In the past decades, SMEs have witnessed a drastic change in the technological environment, but few embraced digitalization to reach out to larger consumer groups (Perera, Mudalige, & Liyanage, 2011). In times of social distancing and quarantine due to COVID-19, such digitalization was mandatory, and those who were ready and capable of a quick digital transformation grabbed the advantage (Bloombergquint.com, 2020). With the arrival of the COVID-19 pandemic, SMEs, especially those operating globally, acknowledged the significance of digital transformation and implementing digital knowledge management (Valk & Planojevic, 2021).

However, for some SMEs where consumption of the product (mainly services such as hotel stay) is restricted to a physical place, the digitalization of value opposition is harder. Clearly, they are the hardest hit in COVID-19. Even they will need to make structural changes and adapt quickly to the new reality for their mere survival. For example, many hotels in the south of Sri Lanka have adopted booking engines, online payment gateways, digital inventory management systems, the use of crowdfunding, partnering with OTAs such as booking.com and Agoda, and using social media for marketing (GoodlifeX, 2022). All SMEs need to think about how to address consumer needs in new digital ways and how to shift to digital work processes. Digital capabilities are at the heart of such efforts (Kronblad & Pregmark, 2021).

So, the third hypothesis can be formed as follows.

H3: Digitalization capabilities influence resilience and recovery of SMEs

3. METHODOLOGY

This study is explanatory in nature, and a quantitative research approach was adopted where primary data were collected using survey questionnaires. A survey questionnaire was developed based on measures used in previous studies. Dynamic Capabilities, Social Capital, and Digital Capabilities were the independent

variables, and Resilience and Recovery of SMEs was the dependent variable.

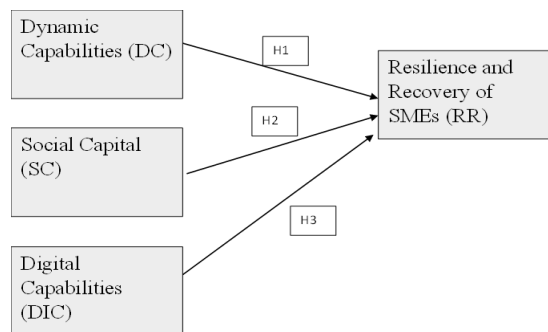


Figure 1: conceptual framework of the research

3.1. Population and Sample

Population of the study is all SMEs in Western Province, Sri Lanka. The sampling frame used for this study is the yearly registration lists maintained by the Provincial Department of Business Names Registration, Western Province. A simple random sampling method was adopted in selecting the respondent from the sample frame. 100 business organizations were randomly selected from business registrations within the time period 2015–2020. Then the criteria for a maximum of 250 employees were tested in the questionnaire. But no organization was disqualified based on that criterion. For this research, due to its limitations, the desired sample size was 100.

3.2. Questionnaire Development and Data Collection

A structured, non-disguised questionnaire was developed to test the conceptual framework. All structured questions were measured on a five-point Likert scale, similar to the original scale.

Ates and Bititci (2011) defined SME resilience as "the capacity of SMEs to survive, adapt, and grow in the face of turbulent change and crisis." The measurement of firm survival (for this research, it was assumed that survival represents resilience) and recovery was done using perceptual constructs developed by Naidoo (2010). These scales are subjective measures (perceptual constructs), and they were chosen over objective measures (financial data) given the lack of financial data and the resistance of

owners to reveal actual values in SMEs. The interest of research is also in the perception of owner of SME about survival/recovery of his/her firm in future not the actual data.

Literature indicates many different conceptualizations and scales to measure dynamic capabilities. This is usual in the initial phases of concept development. Most of these scales follow the operationalization of Teece et al. (1997) (Lin & Wu, 2014) or Teece (2007). Different scales adopt different number of dimensions of dynamic capabilities. This research used the three-dimension dynamic capability scale (i.e., sensing, learning, and transforming dimensions) suggested by Lin & Wu (2013).

A majority of social capital scales measure the strength and extent of formal and informal networks such as business partners (suppliers, customers, and distributors) and personal acquaintances. This research used the social capital measurement scale developed, validated, and tested by Che Senik et al. (2011).

Table 1 summarizes the variables and scales used for measurement.

Table 1: Scales of measurement

Variable	Scale of Measurement
Dynamic Capabilities	Lin & Wu (2013)
Social Capital	Che Senik et al. (2011).
Digital Capabilities	Naidoo (2010)
SME Resilience	Naidoo (2010)

Although the scales are selected a priori, before the actual distribution of questionnaires, a pilot study was conducted to determine the understanding of the items. Ten (10) SME owners were selected based on convenience for this pilot study. This was to ensure that the items in the questionnaire would be understood by the targeted group. After the pilot study, no major revisions to the questionnaire were made.

A total of 100 survey questionnaires were distributed using both online and physical methods. Questionnaires prepared using the Google Forms facility were distributed through email. Some questionnaires were also physically presented to the entrepreneur/owner or the SME manager. Respondents were promised anonymity for themselves and their organizations, along with a guarantee of the confidentiality of the data they provided. The final response is a total of 76 observations (a response rate of 76%). The conceptual framework and its hypotheses were tested using SPSS and SMARTPLS.

4. RESULTS

4.1. Demographic profile

There are 76 usable questionnaires from respondents for this study. The demographic characteristics were analyzed using descriptive statistics by computing the percentage of each group.

Table 2: Demographic characteristics

Variable		Percentage (%)
Gender	Male	82
	Female	18
Education Level	Passed A/L	87
	Have done a Vocational Qualification	7
	Have a Degree or Postgraduate	5
Age	20-26 years	16
	27-33 years	24

	34-40 years	36
	More than 40 years	24

Analysis of demographic characteristics indicates that male entrepreneurs outnumber female entrepreneurs easily in Sri Lanka. Majority of entrepreneurs/SME managers are from 20-40 years range. Only about 5% of the respondents had a degree or higher qualification.

4.2. Reliability Test

Table 3 below summarizes the reliability test of all measures after factor analysis has been done (Hair, Sarstedt, Hopkins, & Kuppelwieser, 2014). As shown, the Cronbach alphas of the measures were all comfortably above the lower limit of acceptability, which is $\alpha \geq .7$.

Table 3: Summary of Reliability Coefficients for All the Variables in the Study

Variables	Reliability
Dependent Variable (DV)	
• Resilience and Recovery of SMEs	.872
Independent Variables (IV)	
Dynamic Capabilities (DC)	0.711
• Social Capital (SC)	0.689
• Digital Capabilities (DIC)	0.705

The histogram plots were scrutinized, and they indicate that although the data is not normal,

there is no serious violation of the assumption of normal distribution.

Multicollinearity was tested for IVs by observing VIF values for all IVs as seen in Table 4. All VIF values are less than 5 and close to 1.

Table 4: Results of Multicollinear Test

Collinearity Statistics	
Construct	VIF
DC	1.506
SC	1.741
DIC	1.908

4.3. Analysis of Data using PLS-SEM (SMART PLS)

Minimum factor component loadings of 0.50 or higher are normally considered significant for the outer measurement model. All the indicators in the outer measurement model of this research fulfilled this criterion of a minimum of 0.5 (Hair, Sarstedt, Hopkins, & Kuppelwieser, 2014).

Fornell and Larcker (1981) stated that if the Average Variance Extracted (AVE) is greater than 0.5, that is a necessary and sufficient condition for the convergent validity of the instrument. As seen from Table 5, all AVEs are above 0.5 for the constructs.

Table 5: AVE for the construct

Variable	AVE
RR	0.5657
DC	0.7066
SC	0.8087
DIC	0.7890

The number of bootstrap samples was set to 500 to run the SMARTPLS program.

Table 6: Summary of Structural model testing

Hypotheses	Path	Path Coefficient	Standard Error	t statistics	Significance
H1	DC > RR	0.4150	0.0563	7.718	Significant
H2	SC > RR	0.4210	0.0871	4.465	Significant
H3	DIC > RR	0.4350	0.0523	7.528	Significant

R² is also called the coefficient of determination because it assesses the proportion (which is converted to a percentage by multiplying by 100) of the variance of the endogenous construct that can be explained by its predictor constructs (Hair, Sarstedt, Hopkins, & Kuppelwieser, 2014). Falk and Miller (1992) suggest 0.10 as a threshold to identify a minimum level of prediction that can have practical significance.

Table 10: Summary of coefficient of determination values for the structural model

Endogenous Latent Variable	R ²
RR	29.1

Dynamic capabilities, social capital, and digital capabilities account for 29% of the variance in resilience and recovery of SMEs. This has a substantial significance in explaining the dependent variable. Kim (2022) explains that due to the large number of variables affecting SME performance and recovery, an R² above 0.25 is of considerable significance.

5. DISCUSSION

There is a call for more comparative research on SMEs and crisis management (Alonso et al., 2021). Little resilience research has focused on the context of SMEs in developing countries. Saad et al., (2021).

Results of this research indicate that digital capabilities have a substantial role in building

resilience in SMEs. SMEs in Sri Lanka must be encouraged and supported to develop digital capabilities. Developing the digital capabilities of future entrepreneurs through a formal education system must be done as soon as possible. SMEs must embrace digital technologies to enable major business improvements such as enhancing customer experience, streamlining operations, and creating new business models, or they will face annihilation (Fitzgerald et al., 2014). Many SMEs in developed countries use AI to identify what is trending among customers, which helps the organizations customize their product offerings. For example, many retail organizations in South Korea allow persons to scan the codes of virtual groceries whilst waiting at train stations. The purchased items are delivered to the purchasers' homes even before they go home. This digital offering boosted Tesco's online sales. Such digital innovations greatly supported SMEs in developed region to overcome disadvantages in crisis situation.

This research highlights the importance of social networks in managing crisis situations in the SME sector. In the light of the above, investments in programs that would develop domestic and international networks of SMEs would be beneficial in the long run. These programs can vary from symposiums, workshops, funded foreign visits, trade fairs, and the facilitation of informal encounters between entrepreneurs. Improved informal networks can develop the confidence of international buyers and suppliers in order to overcome negative country of origin perceptions that are hindering the SME export sector amid a crisis (Francicvic & Bartlett, 2001). Given the owner-centric nature of SMEs, the development of personal networks may be the first step, and the benefits of informal acquaintances would gradually flow to the organizational level. Facilitation of industry clusters may be more useful in crisis times as SMEs become vulnerable and the confidence of suppliers and customers in individual SMEs may dwindle. Clusters can provide that additional guarantee and confidence for sustained business

as the risk of partnering with a single SME will be reduced.

Another suggestion for SMEs is to divest from unnecessarily diversified businesses as soon as possible. A substantial percentage of SMEs indicated that they are engaged in more than one core business. During COVID-19, managing a too-diversified portfolio seemed to be disadvantageous as every strategic business unit needed special attention in crisis transitions (e.g., moving to online platform from brick and motor type, layoffs to reduce cost etc.). Managing a diversified portfolio will make it more complex and difficult for an SME with an entrepreneurial-centric decision-making style. Even MNCs followed divesting strategies from 1990s. Coca Cola divested from the wine, movie, and bottled water businesses, and United Airlines divested from the hotel business (Hilton) and car rental business (Hertz). With COVID-19 crisis, fundamental changes and new challenges take place in many aspects of business including customer behavior, liquidity challenges, global supply chain management and digitalization (Accenture, 2022). Flagship products and brands need to be protected while divesting from other businesses to make sure such changes and challenges can be given adequate attention.

As per the limitations, the research sample is comparatively small because the timing of the research was very challenging. Therefore, generalizing the findings derived from this comparatively small sample should be done with caution. With the gradual return to normalcy and lifting of restrictions, future studies could seek a larger sample of SMEs. Factors such as entrepreneurial self-efficacy (i.e. self-confidence of entrepreneur about his/her own skills and knowledge) and entrepreneurial bricolage (i.e. ability to use resources in a novel way in a resource scarce condition) are also linked to SME survival recently (Alonso et al., 2020). Future studies may take these into consideration and improve the conceptual model. Longitudinal studies that investigate how SMEs develop dynamic capabilities, social capital, and digital capabilities (and, of course, other relevant factors) will become useful in policy planning

aimed at developing the resilience of SMEs. However, such studies demand long duration and research effort.

6. CONCLUSION

The question of why some SMEs failed to withstand the COVID-19 crisis whereas some Sri Lankan SMEs survived remains unanswered. It demonstrated very clearly how frail the economy of Sri Lanka is and raised doubts about the resilience of Sri Lankan businesses. This research investigated the factors affecting the resilience of SMEs in Sri Lanka. This research used a conceptual framework comprised of Dynamic Capabilities, Social Capital and Digital Capabilities to analyze the antecedents of resilience in SMEs in Sri Lanka. A randomly selected sample of 76 SMEs in Sri Lanka were analyzed using Partial Least Squares Structured Equation Modelling (PLS-SEM) method. Results indicate Dynamic Capabilities, Social Capital and Digital Capabilities have a significant positive influence on SME resilience. Dynamic Capabilities, Social Capital and Digital Capabilities together explained 29% of the variance in resilience of SMEs. The development of knowledge, both theoretical and empirical, has become critical in order to understand how SMEs endured the crisis, adapted, managed it, built resilience, and ultimately recovered from it. Such knowledge will become invaluable in future crisis situations to protect SMEs in Sri Lanka.

REFERENCES

- Al-Omoush, K. S., Simón-Moya, V., & Sendra-García, J. (2020). The impact of social capital and collaborative knowledge creation on e-business proactiveness and organizational agility in responding to the COVID-19 crisis. *Journal of Innovation & Knowledge*, 5(4), 279-288.
- Al-Omoush, K. S., Simón-Moya, V., & Sendra-García, J. (2020). The impact of social capital and collaborative knowledge creation on e-business proactiveness and organizational agility in responding to the

- COVID-19 crisis. *Journal of Innovation & Knowledge*, 5(4), 279-288.
- Apaydin, M., Thornberry, J., & Sidani, Y. M. (2020). Informal social networks as intermediaries in foreign markets. *Management and Organization Review*, 16(3), 629-656.
- Ates, A., & Bititci, U. (2011). Change process: a key enabler for building resilient SMEs. *International Journal of Production Research*, 49(18), 5601-5618.
- Central Bank of Sri Lanka (2022). NCPI based headline inflation, Press Release 2022/10/21 Retrieved from <https://www.cbsl.gov.lk/en/measures-of-consumer-price-inflation>
- Che Senik, Z., Scott-Ladd, B., Entekin, L., & Adham, K. A. (2011). Networking and internationalization of SMEs in emerging economies. *Journal of International Entrepreneurship*, 9(4), 259-281.
- Fairlie, R. W. (2020). The impact of COVID-19 on small business owners: Continued losses and the partial rebound in May 2020.
- Fitzgerald, M., Kruschwitz, N., Bonnet, D., & Welch, M. (2014). Embracing digital technology: A new strategic imperative. *MIT sloan management review*, 55(2), 1.
- Fornell, C., & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics.
- Franicevic, V., & Bartlett, W. (2001). Small firm networking and economies in transition: an overview of theories, issues and policies. *Zagreb International Review of Economics and Business*, 4(1), 63-90.
- Gourinchas, P. O., Kalemli-Özcan, S., Penciakova, V., & Sander, N. (2020). Covid-19 and SME failures. NBER Working Paper, (w27877).
- Graeber, D., Kritikos, A. S., & Seebauer, J. (2021). COVID-19: a crisis of the female self-employed. *Journal of Population Economics*, 34(4), 1141-1187.
- Hair Jr, J. F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. *European business review*.
- Iborra, M., Safón, V., & Dolz, C. (2020). What explains the resilience of SMEs? Ambidexterity capability and strategic consistency. *Long Range Planning*, 53(6), 101947.
- Kalinic, I., Sarasvathy, S. D., & Forza, C. (2014). 'Expect the unexpected': Implications of effectual logic on the internationalization process. *International Business Review*, 23(3), 635-647.
- Khlystova, O., Kalyuzhnova, Y., & Belitski, M. (2022). The impact of the COVID-19 pandemic on the creative industries: A literature review and future research agenda. *Journal of Business Research*, 139, 1192-1210.
- Kim, S. S. (2022). Influential indicators and measurements of mediating and moderating roles on SME performance. *International Journal of Knowledge Management (IJKM)*, 18(1), 1-18.
- Kronblad, C., & Pregmark, J. E. (2021). Responding to the COVID-19 crisis: the rapid turn toward digital business models. *Journal of Science and Technology Policy Management*.
- Lin, Y., & Wu, L. Y. (2014). Exploring the role of dynamic capabilities in firm performance under the resource-based

- view framework. *Journal of business research*, 67(3), 407-413.
- Loury, G. C. (1979). Market structure and innovation. *The quarterly journal of economics*, 395-410.
- Mansour, H. E., Holmes, K., Butler, B., & Ananthram, S. (2019). Developing dynamic capabilities to survive a crisis: Tourism organizations' responses to continued turbulence in Libya. *International Journal of Tourism Research*, 21(4), 493-503.
- Misra, R. (2021). <https://www.paisabazaar.com/business-loan/coronavirus-impact-on-indian-business-and-economy/>
- Naidoo, V. (2010). Firm survival through a crisis: The influence of market orientation, marketing innovation and business strategy. *Industrial marketing management*, 39(8), 1311-1320.
- Outmaneuver uncertainty: Navigating the human and business impact of Covid-19 Retrieved from <https://www.accenture.com/mu-en/about/company/coronavirus-business-economic-impact>
- Perera, H.S.C., Mudalige, D.M., & Liyanage, C. (2011). A Case Study of Technology Transfer Process in a Government Research Organization in Sri Lanka. *Wayamba Journal of Management*
- Pinho, J. C., & Prange, C. (2016). The effect of social networks and dynamic internationalization capabilities on international performance. *Journal of World Business*, 51(3), 391-403.
- Rashid, S., & Ratten, V. (2021). Entrepreneurial ecosystems during COVID-19: the survival of small businesses using dynamic capabilities. *World Journal of Entrepreneurship, Management and Sustainable Development*.
- Saad, M. H., Hagelaar, G., van der Velde, G., & Omta, S. W. F. (2021). Conceptualization of SMEs' business resilience: A systematic literature review. *Cogent Business & Management*, 8(1), 1938347.
- Sharma, S., & Rautela, S. (2021). Entrepreneurial resilience and self-efficacy during global crisis: study of small businesses in a developing economy. *Journal of Entrepreneurship in Emerging Economies*.
- Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic management journal*, 18(7), 509-533.
- Transforming The Future of Asia from Extractive to Regenerative! (2022). Retrieved from <https://www.goodlifex.com/>
- Troilo, M. L. (2012). Market orientation of SMEs in Southeast Asia: An empirical analysis. *The Copenhagen Journal of Asian Studies*, 30(1), 53-79.
- Valk, R., & Planojevic, G. (2021). Addressing the knowledge divide: digital knowledge sharing and social learning of geographically dispersed employees during the COVID-19 pandemic. *Journal of Global Mobility: The Home of Expatriate Management Research*.
- Virus Ravages Indonesia Bank's Clients Who Survived Asian Crisis (2020). Retrieved from <https://www.bloomberg.com/news/articles/2020-05-26/virus-ravages-indonesia-bank-s-clients-who-survived-asian-crisis>
- Wijewardena W.A. (2022). Collapse Of The Rupee: Is It Sudden Or Orchestrated By Central Bank?, Retrieved from <https://www.colombotelegraph.com/inde>

x.php/collapse-of-the-rupee-is-it-sudden-
or-orchestrated-by-central-bank/

Zahra, S. A., Sapienza, H. J., & Davidsson, P.
(2006). Entrepreneurship and dynamic
capabilities: A review, model and
research agenda. *Journal of Management
studies*, 43(4), 917-955.

Factors Affecting the Adoption of Digital Marketing by SMEs in the Context of Sri Lanka

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ABSTRACT

The business world's shift into the digital age has only been fast-tracked by the COVID-19 pandemic, which forced companies to conduct business via digital means, and digital marketing is one of its many latest trends. This study investigates factors that motivate SMEs to adopt digital marketing strategies, specifically social media marketing, by SMEs in Sri Lanka. The researcher has selected the TOE framework as the basis for this study. After a thorough literature review, the researcher proposes a mixed research strategy using online surveys and interviews to answer the research question. The researcher has built the research plan so that limitations are minimized.

7. INTRODUCTION

Small and Medium sized enterprises have an important part to play in an economy, in terms of job creation, innovation and economic contribution, and so often, is even a top priority for many governments, especially in developing countries (Thaha et al., 2021; Nuseir, 2018; Rasool & Dissanayake, 2019; Zhuang et al., 2017; James, 2020). Thaha et al. (2021) and Qalati et al. (2021) have found that around 90% of the world's businesses are SMEs, and also provide more than 50% of the jobs globally (these figures may be even higher as this information doesn't include informal organizations). James (2020) has discovered that two thirds of the private sector jobs in the U.S. are provided by SMEs. Further, research conducted by Adam et al. (2020) revealed that

the total number of SMEs in Indonesia amounted to 58.97 million. In the context of Sri Lanka, which is the focus of this study, SMEs amount to more than 75% of the total number of enterprises in Sri Lanka, and contributes to 52% of the total Sri Lankan GDP (Rasool and Dissanayake, 2019; Ministry of Industry and Commerce, n.d.). It is evident SMEs play an important part in a country's economy, whether it's a developing country like Sri Lanka or Indonesia, or a developed country, like the U.S.

The world has now become more and more reliant on technology, with an accelerated pace since the introduction of the Internet. The use of the Internet and browser technology to navigate the Internet has made the average consumer aware and has given them all the information they need to make an informed purchase (Suroso & Rafinda, 2021). Businesses have to take this into account when marketing their products and the use of digital marketing to have this information available for their consumer has becoming more of a necessity. In fact, Adam et al. (2020) has said that the success of a company's marketing efforts is determined by the company's website, social media, and digital advertising (all of which are included under digital marketing).

8. RESEARCH PROBLEM

Digital Marketing are an important set of tools for the running of a business, and SMEs can enjoy several benefits from the adoption of digital marketing, i.e.: reduction in cost,

attracting and engaging new customers, boosting brand awareness, improve customer satisfaction and loyalty, improving sales and performance etc. (Setkute & Dibb, 2022; Nuseir, 2018; Siraj et al., 2021). Rasool and Dissanayake (2019) state that digital technology can provide SMEs with valuable information and knowledge, increased efficiency and productivity, better connections with suppliers etc. These benefits provide SMEs with an edge over the competition, which they so desperately need as they already face a lot of barriers and constraints, such as limited resources (Setkute & Dibb, 2022), the inability to influence prices or quantity (Rasool & Dissanayake, 2019), poor infrastructure (Busaidi et al., 2019) etc.

However, SMEs are still very hesitant and slow to adopt digital marketing (Setkute & Dibb, 2022; Nuseir, 2018). Several studies discovered minimal adaption of social media marketing, and minimal investment for digital marketing efforts (Qalati et al., 2021; Michaelidou et al., 2011; Zhuang et al., 2017; Alkhater et al., 2018; Skafi et al., 2020; Gamage, 2019). This research intends to investigate this discrepancy. This study explores the following research question:

What factors exist for SMEs in Sri Lanka to adopt Digital Marketing Strategies as part of their operations?

9. RATIONALIZATION

As mentioned before, the COVID-19 pandemic has fast tracked the digitalization of businesses worldwide as employees and supervisors were forced to carry out their jobs from home via the internet. SMEs particularly suffered a great deal during the pandemic (Weeraratna et al., 2022). Hemachandra and Sharkasi (2022) have found that there has been a surge in digitalization of the business activity of Sri Lanka's retail sector during and post-pandemic, with digital marketing being a front runner in the businesses' race to digitalization. Perera et al. (2021) and Rathnaweera et al. (2021) provides further evidence through their research, where they prove that there is a positive relationship between digital marketing and the effectiveness of

tourism business activities in Sri Lanka during the post-COVID era.

As it can be seen, the move to digital business, while it began as an attempt to survive during the pandemic, has now become the new normal. A hybrid working environment is not out of the ordinary anymore. Customers today prefer getting their information via online means and find it easier to shop and buy through websites and social media (Redjeki and Affandi, 2021). It is reported that the average internet user spends up to 6hrs and 42mins online per day, and spend 2hrs and 24mins of that on social media (Redjeki and Affandi, 2021). Therefore, today, an online presence for a business is no longer a luxury but a necessity.

Social Media Marketing, which is the focus of this research, has several advantages that are very useful for the running of SMEs. SMM is known to be a very cost effective method of advertising and requires little to no additional resources, which is useful for SMEs as they have very limited access to finance and other resources. The use of SMM will provide them with very valuable information and metrics (through likes, follows, comments, shares etc.) which can be used for future marketing efforts (Zahay, 2015). SMEs, being much smaller than large multinationals and conglomerates, have the advantage of being able to react much faster to changes in customer demands and trends since they have much shorter and familiar chains of command. With the use of the information gathered from social media about their customers, SMEs will be able to react much faster to the customers' needs than large companies. Further, SMM provides SMEs with the ability to market their products abroad and break in to untapped markets. However, it is apparent from reviewing existing literature that while the theory behind the use of SMM by SMEs is sound, it isn't practiced much as it should be, thus a lot of potential revenue, productivity and marketing is lost. This paper hopes to identify the possible factors that discourage and/or encourage owner/managers of SMEs from adopting SMM and what barriers lay in between them and successful adoption of SMM for their businesses, so that SMEs can

understand the benefits of SMM and Digital Marketing and understand what needs to be done to adopt these tools and strategies.

10. RESEARCH OBJECTIVES

The objectives of this study are the following:

- a) *To identify and understand the factors that motivate SMEs to adopt digital marketing*
- b) *To understand the attitudes of SME managers towards SMM*
- c) *To understand the relationship between the identified motivational factors and Social Media Marketing (SMM).*

11. SIGNIFICANCE

Digital Marketing, although is a new concept, has been investigated and researched thoroughly. However, most of the empirical studies found on Digital Marketing are related to large businesses. This research plans to explore the relationship digital marketing has with SMEs, in which there are very few studies of. There are even fewer studies on Sri Lankan SMEs and their relationship with Digital Marketing, which is the main focus of this study. This paper hopes to contribute to filling this gap.

12. LITERATURE REVIEW

12.1. Digital Marketing and SMEs in Sri Lanka

Across various studies, Digital Marketing has been perceived and defined differently, although they all portray a similar idea. Karatum (2017) defines Digital Marketing as a branch of marketing that utilizes digital channels to market and communicate with the customer. Adam et al. (2020) cites the American Marketing Association when defining Digital Marketing as “the activity, institution and process, facilitated by the digital technology of creating, communicating and conveying value to customers and other interested parties.” Thaha et al. (2021) defines Digital Marketing as utilizing digital technology to market goods, services, information and ideas through the internet, and other electronic media.

Based on these definitions and the researcher’s own knowledge and understanding, Digital Marketing can be defined as the use of digital technologies to facilitate engagement with customers, or as Adam et al. (2020) defines it, “maintaining relationship-based interactions with the customer.” It will be an ongoing process of learning about the customers through digital marketing and sales, and using what you’ve learnt during the next marketing effort (Zahay, 2015).

Debra Zahay’s (2015) book, *‘Digital Marketing Management: A Handbook for the Current (or Future) CEO,’* states that with the as time went on marketing became less traditional and more digital, and the control of the marketing process slowly went from the company have total control of the marketing process, to the customer now holding total control of the marketing process. This is because, as Zahay (2015) put it, modern day marketing goals were not limited to just Attracting, Acquiring and Retaining, but also Engaging customers. It is the engagement that separates Digital Marketing from traditional marketing.

SMEs, in the context of Sri Lanka, are companies that employ less than 300 people and have an annual turnover of less than Rs. 750 million (Ministry of Industry and Commerce, n.d.). Medium-sized companies have an annual turnover between Rs. 251-750 million and employ around 51-300 employees, and small-sized companies have an annual turnover between Rs. 16- 250 million and employ around 1-50 employees (Ministry of Industry and Commerce, n.d.).

As stated earlier, there are a lot of benefits that SMEs could obtain through the adoption of Digital Marketing. However, there are several factors hindering the adoption of SMEs. It is stated that SMEs in Sri Lanka possess insufficient knowledge and skills (“Small and Medium Enterprises”, 2022). Insufficient information and knowledge would make owner/managers weary of going digital, because they may not understand how to fully utilize the

technology, or how to train the staff to be fully equipped to deal with the technology (“Small and Medium Enterprises”, 2022). Another problem is the lack of finance and infrastructure (Rasool & Dissanayake, 2019; Busaidi et al., 2019) which is also faced by SMEs in Sri Lanka (“Small and Medium Enterprises”, 2022). Digital Marketing, to be carried out effectively, would need a substantial budget allocation for analysing customer data, formulating marketing campaigns, hiring or outsourcing specialists etc., which SMEs may not consider as something worth spending on. There, is also a problem with the distribution of power in Sri Lankan companies where the power distance is very high (Ifiran, 2016). This means that power and control in an organization will be centralized and, in an organization, will be less control with the subordinates and more control with the owner/managers (Iran, 2016). Thus, employees going to managers and pitching new ideas are less likely due to fear of authority, leading to slower adoption of digital technology.

However, there are also certain benefits that SMEs can exploit. For example; it's not unnatural for governments to provide special attention to SMEs (Qalati et al., 2021). This is also the case for Sri Lanka where several funds have been set up for SMEs such as the Technology Transfer and Development Fund (TTDF) (Ministry of Industry and Commerce, n.d.). Further, despite Sri Lankan organizations having a centralized power system, Ifiran (2016) also found that Sri Lankan organizations are also have a collectivist culture. This means that employees and employer generally have a good relationship with each other and usually treat each other like family (Ifiran, 2016). This would encourage employee to present their ideas to management, leading better chances of the adoption of digital technology. Overall, SMEs in Sri Lanka are very diverse, and each have their own requirements and methods of carrying out their operations (“Small and Medium Enterprises”, 2022).

12.2. Social Media Marketing (SMM) and SMEs

Social Media is also known as Web 2.0 (Qalati et al., 2021; Michaelidou et al., 2011; Chatterjee & Kar, 2020). SMM is the use of social media to connect with, engage with, and understand customers with the company's marketing goals and objectives in mind (Zahay, 2015). SMM is the focus of this research is because it is a digital marketing mode that is not only available to large companies, but smaller companies as well (Qalati et al., 2021) since it enables the company to use, advertise, market and sell at much low cost (Ainin et al., 2015). Social Media platforms include Twitter, Facebook, Instagram, Snapchat, LinkedIn (especially popular with B2B companies) etc.

The active social media users around the world are estimated to be 3.96 billion (Siraj et al., 2021), which is 50.83% of the total world population. And for this reason, Social Media adoption is considered a critical factor to improve performance for both large companies and SMEs (Qalati et al., 2021). The implementation of SMM will help companies improve sales, broaden their audience to a global level, increase brand and customer loyalty, connect and engage with customers, gather important data through metrics such as number of likes, comments etc. (Qalati et al., 2021). For example, a marketing campaign on Facebook can be organized without any significant contributions in terms of resources (Ainin et al., 2015). Michaelidou et al. (2011) cites a study done by Cone (2008) who presented that 93% of social media user believe that companies should have social media as the technology can help eliminate several threats and risks for SMEs (Dahnil et al., 2014). For example: Social media marketing enables SMEs to compete with giant companies and even helps them gain awareness in foreign markets.

12.3. Theoretical Framework and Hypotheses Development

In this section of the literature review, the researcher will identify the factors that have the

power to encourage or discourage the implementation of Digital Marketing strategies by SMEs. This section will be supported through evidence obtained after examining several journal articles and empirical research and applying them in the context of Sri Lanka. This research will particularly focus on the effects of these factors on Social Media Marketing (SMM) as social media is one of the cheapest modes of digital marketing available and is more likely that such technology would be available to be used by SMEs.

12.3.1. Technology-Organization-Environment (TOE) Model

The researcher has discovered when conducting the literature review that most studies relating to the adoption of technology utilize the Technology Acceptance Model (TAM) (Chatterjee & Kar, 2020) or the Technology-Organization-Environment (TOE) model (Qalati et al., 2021). The main issue with the TAM framework is that it mainly focuses on two components when dealing with technology adoption: Perceived Usefulness and Perceived Ease of Use (Chatterjee & Kar, 2020). These two factors only relate to the particular innovation that is to be adopted. However, company technology adoption decisions have outside factors affecting them as well, such as employee skill level, top management support, competitive pressures etc.

The researcher will be using the TOE framework to understand the relationship between motivating factors and SMEs' intention for adoption of Digital Marketing. The TOE framework represents a segment of the technology adoption process of a company that showcases how the three different elements of a firm's context influences the decision to adopt and implement of an innovation (Baker, 2011). The TOE model goes beyond the TAM model's scope by analysing not just the technological factors affecting innovation adoption, but also the environmental factors and the organizational factors, and can explain adoption in industrial and national context (AlSharji et al., 2018).

Empirical evidence has been found that states that the TOE framework is the most suitable to analyse the technology-adoption by SMEs (Qalati et al., 2020; Qalati et al., 2021; Ahmad et al., 2019). TOE model is the only technology adoption model that considers the human aspect through the organizational construct, which is a necessary factor to meet this paper's research objectives and the researcher plans to investigate SMEs in Sri Lanka as whole, and therefore the researcher has deemed the TOE framework as a valid framework to utilize.

6.3.1.1. Technological Construct

Technology construct of the TOE model shows the characteristics of the technology to be adopted (Qalati et al., 2020; Samsudeen et al., 2021), which in this research, is social media. The technology factors that this study will focus on are relative advantage, compatibility, trialability, complexity, interactivity and cost-effectiveness (Qalati et al., 2021).

Relative advantage understands how much better the innovation or technology under consideration is relative to the current technology being used by the company (Ahmad et al., 2019; Qalati et al., 2021; Qalati et al., 2020). Yaseen et al. (2021) cites Oliveira et al. (2014) when explaining that there will be a stronger incentive to adopt innovations and technology when they are "simple, unambiguous benefits in terms of strategic performance and organizational efficiency." This statement is in agreement with the research by Alshamaila et al. (2013) and Samsudeen et al. (2021). Social media is proven to help organizations in rapid and clear communication with customers (Qalati et al., 2021), are cost effective (Chatterjee & Kar, 2021), help with knowledge sharing and improve the overall organizational performance (Qalati et al., 2020). Qalati et al., (2021) proved this with their study on SMEs in Pakistan which concluded that relative advantage is a strong and essential factor in determining SMEs' decision to adopt SMM. Another research on SMEs conducted in 2020, also conducted in Pakistan, displayed a positive relationship between

relative advantage the decision to adopt of SMM (Qalati et al., 2020). However, Ahmad et al. (2019) and AlSharji et al. (2018) found there was no significant relationship between relative advantages and the intention of SMEs to adopt SMM.

Gamage (2019) cites Roger (2003) when defining compatibility as the degree to which the technology or innovation match the values, behaviour, past experiences and needs of the organization. Samsudeen et al. (2021) states that the compatibility between a technology and an organization's culture, behaviour, tradition etc. has a huge impact on whether the technology will be adopted or not, and is considered an essential factor when determining if an innovation should be adopted (Ainin et al., 2015). Alshamaila et al. (2013) cites Thomg (1999) when stating that compatibility has a strong influence over the adoption of the said innovation. As SMM is low cost and easy to use (Qalati et al., 2021), it is acceptable to assume that it is compatible SMEs' tighter budgets. Ainin et al. (2015) conducted a study into Facebook marketing adoption by SMEs, which also proved that there is a positive relationship between compatibility and the adoption of Facebook marketing. Samsudeen (2021) also arrived at a similar result where compatibility has a positive relationship with the adoption of SMM. However, Ahmad et al. (2019) found no significant relationship between compatibility and the intention to adopt SMM by SMEs.

Alshamaila et al. (2013) cites Roger (2003) when defining trialability as the degree to which an innovation or technology maybe be tested out, before full adoption, for a limited period of time. Trialability helps reject or confirm any doubts that exist with the use of a particular technology and is, therefore, considered an important factor when adopting digital technology (Samsudeen et al., 2021), especially in an increasingly digital world like today. SMM is a low cost marketing method, and so having a trial run before launch is stated to be very beneficial for SMEs (Samsudeen et al., 2021) as it helps test out the

waters and expenditure won't be so high on the test run. However, Samsudeen et al. (2021) found a negative relationship between trialability and social media adoption by SMEs. Ahmad et al. (2019) also found no significant relationship between trialability and SMEs intention to adopt SMM. One reason for the negative relationship between trialability and SMM adoption may be because it's a low cost/low risk option (Ahmad et al., 2019) and therefore even SMEs may not see a need to test it out, because if the SMM attempt fails, the company won't suffer a huge loss.

Complexity refers to how easy a particular technology or innovation is to use for a business (Samsudeen et al., 2021). SMEs would be less likely to adopt an innovation or technology if they are too complex and require training to be handled, especially since SMEs would have a tighter budget than larger companies (AlSharji et al., 2018). Samsudeen et al. (2021) and Ahmad et al. (2019) have proven that the level of complexity of social media does affect SME's decision to adopt SMM. The study into Malaysian SMEs by Abbasi et al. (2022), however, showed no significant relationship between complexity and SMEs' intention to adopt SMM. This contradiction would definitely need to be investigated through this study.

Interactivity refers the degree to which companies can interact using social media (Qalati et al., 2021; Qalati et al., 2020). Social media is considered to be a highly interactive form of media as it enables two-way communication with customers via comments, direct messages, likes and mentions, unlike forms of one-way advertising such as television advertisement (Ainin et al., 2015). This would allow SMEs to learn more about the customer by interacting with them enabling them to build loyalty and customize marketing campaigns. Qalati et al. (2021) has found that interactivity has a positive relationship with SME adoption and has strong connection. Ainin et al. (2015) and Qalati et al. (2020) came to the same conclusion regarding interactivity and SME

adoption of Facebook. There are very few researches investigating interactivity and social media adoption and it is very interesting to see how this would apply in the context of Sri Lanka.

Cost-effectiveness refers to how useful and beneficial a particular innovation or technology is compared to its cost of implementing and running (Qalati et al., 2021). Other literature emphasizes the importance of cost-effectiveness in technology adoption decisions (Qalati et al., 2021; Ainin et al., 2015). Social media is definitely considered a cost-effective form of marketing compared to other forms of marketing, as it is relatively low-cost, requires little training to operate and it enables the company to reach a wider (even global) audience (Qalati et al., 2021; Ainin et al., 2015). The extensive literature review conducted by the author suggests that cost-effectiveness and SME's social media marketing adoption decisions are in sync (Qalati et al., 2021; Ainin et al., 2015; Chatterjee & Kar et al., 2020; Abbasi et al., 2022).

Based on the empirical evidence gathered above, the following hypotheses are developed:

H1a- Relative advantage has an impact on the adoption of SMM by SMEs

H1b- Compatibility has an impact on the adoption of SMM by SMEs

H1c- Trialability does not have impact on the adoption of SMM by SMEs

H1d- Complexity has an impact on the adoption of SMM by SMEs

H1e- Interactivity has an impact on the adoption of SMM by SMEs

H1f- Cost-effectiveness has an impact on the adoption of SMM by SMEs

6.3.1.2. Organizational Construct

Organization construct usually involves number of staff, revenue, extent of centralization and formalization, managerial structures, turnover, resources etc. (Samsudeen et al., 2021; Qalati et al., 2020). This research will focus on the aspects of management support (Qalati et al., 2021).

Managerial support is the consent from the manager to adopt or implement a new technology or innovation in the business (Qalati et al., 2021). The top management's support is considered to be a vital role in the adoption of technology and the reengineering of procedure (Gamage, 2019; Abdollahzadehgan et al., n.d.). Qalati et al. (2021) cites Ahani et al. (2017) when they state that IT based technology acceptance in the context of SMEs mainly rely on the top management's support for the idea. This is because the top managers are able to influence the opinions and attitudes of people at the individual and organizational level (Trawnih et al., 2021). There are several studies that show that management support has a positive relationship with SMEs' intention to adopt SMM (Ahmad et al., 2019; Abbasi et al., 2022; Qalati et al., 2020; Trawnih et al., 2021; Qalati et al., 2021). However, Samsudeen et al. (2021) rejected the hypothesis that top management support has a positive relationship with SMEs' SMM adoption.

Based on the information gathered from the literature about top management support and adoption of SMM by SMEs, the following hypothesis was formulated:

H2- Top management support has an impact on the adoption of SMM by SMEs

6.3.1.3. Environmental Construct

Environmental construct refers to the external environment in which the firm deals in (Qalati et al., 2021; Ahmad et al., 2019). The researcher focuses on the aspect of competitive pressures and the bandwagon effect (Qalati et al., 2021). Competitive pressure is the degree of rivalry presiding in an industry as the result of globalization, advancement of technology, increasing knowledge and information etc. (Samsudeen et al., 2021; Ahmad et al., 2019; Trawnih et al., 2021). Competitive pressures are stated to play a significant role in the adoption of technology (Abbasi et al., 2022). This may be because adopting new innovations help improve competitiveness in a company (Ahmad et al., 2019). During the pandemic, companies were forced to adopt technologies into their business

practices in order to survive and remain competitive in their respective industries (Trawnih et al., 2021). This is proven to be true in the case of SMM, as Qalati et al. (2021) has presented that competitive pressure have a positive relationship with SMEs' intention to adopt SMM.

Bandwagon effect (also known as the Contagion effect) is a psychological term used to explain how a company may adopt a practice, social media in the case of this study, simply because the competitor adopted it as well and not for any strategic reason (Qalati et al., 2021; AlSharji et al., 2018; Samsudeen et al., 2021; Ahmad et al., 2019). The more companies that adopt social media, the greater the pressure for the company to adopt social media (Qalati et al., 2021). The Bandwagon effect was proved to exist with SMEs in their SMM adoption decisions (Qalati et al., 2021; AlSharji et al., 2018; Samsudeen et al., 2021; Ahmad et al., 2019). The bandwagon effect on SME social media adoption has rarely been investigated and its effect on Sri Lankan SMEs would add another dimension to the existing studies.

With the following evidence gathered through reviewing existing literature, the following hypotheses were formed:

H3a- Competitive pressure impacts the adoption of SMM by SMEs

H3b- Bandwagon effect impacts the adoption of SMM by SMEs.

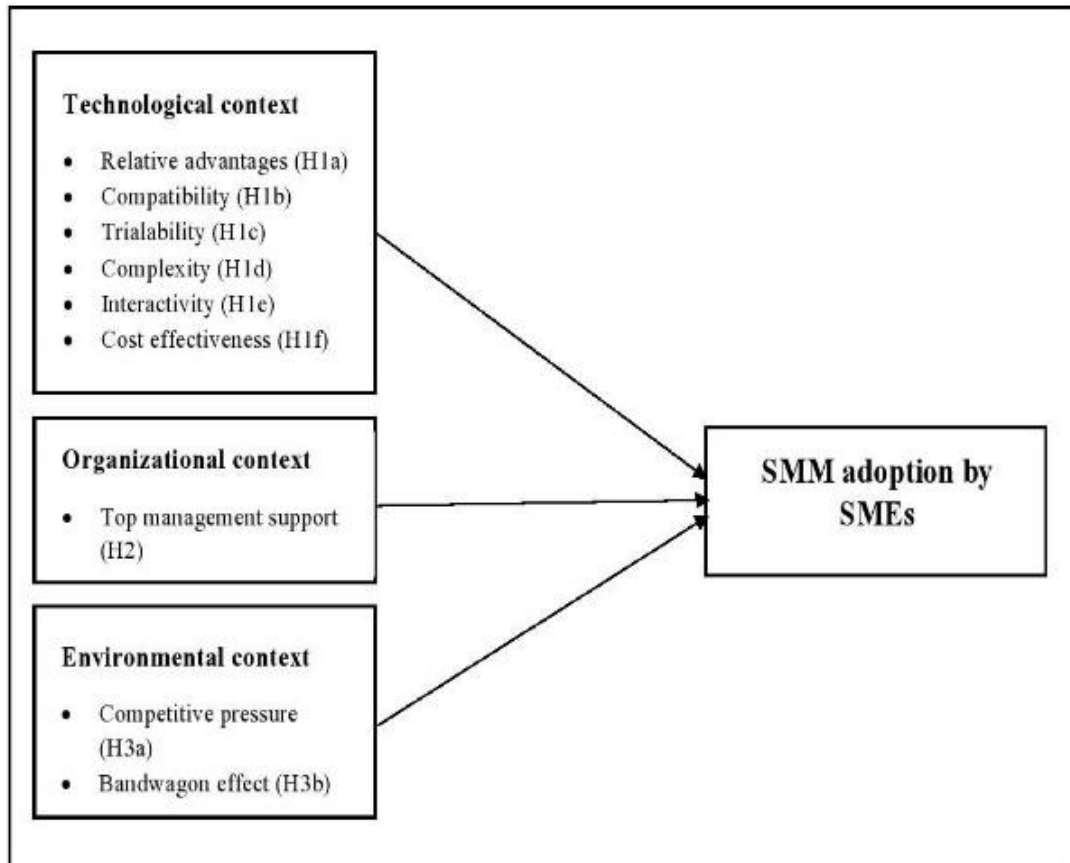
13. METHODOLOGY

13.1. Research Design and Sample

The researcher of this study proposes a mixed method of data collection and research to prove or disprove and validate the hypothesized relationships between the independent and

dependent variable. The study should employ the non-probability sampling techniques and it is recommended that a hybrid of convenience

lankayp.com. Social networking services such as LinkedIn would also be used to select a sample. It is recommended that the data collected come



sampling and snowball sampling is used for this study, as the combination would result in quick, easy, and cost-effective data collection and the use of snowball sampling would give access to a wider sample, providing more data for the hypothesis testing and validation. Purposive sampling can be used for the interviews as the researcher needs to be sure that the candidate to-be-interviewed has the right qualifications and insight to answer the questions (Bhardwaj, 2019; Qalati et al., 2021; Bafarasat, 2021). The sample of this study would include owner/managers working in SMEs in Sri Lanka and the companies would be selected through the list of companies provided by the Sri Lanka Accounting and Auditing Standards Monitoring Board websites and other websites such as

from at least 200 participants for the survey, 10 participants for the interviews, and that the sample should not be restricted to any single city or province, but consider SMEs from all over the country.

13.2. Data Collection

13.2.1. Online Surveys

Data will be collected through an online survey. The researcher finds a survey as the most suitable data collection method for this study as this study intends to examine SMEs from the entire country, and Denscombe (1998) has stated that survey is suitable to serve studies that have a wide coverage. Surveys are a cost-effective and swift data collection method which is ideal given the number of recipients expected (Denscombe,

1998). Further, survey respondents will be providing pre-coded answers which is the most suited for the data analysis required for hypothesis testing (Denscombe, 1998). The researcher has found that surveys appear to be the most popular data collection form amongst similar studies (Qalati et al., 2020; Qalati et al., 2021; Ainin et al., 2015; Chatterjee & Kar, 2020; AlSharji et al., 2018).

A problem with survey data collection is that there is a fixed set of answers. Further, there is room for bias and misunderstanding which can lead to less accurate results. The researcher will need to accept that in a survey study, data collection may not go according to plan (i.e.: incomplete submissions, delayed submissions etc.). Suitable contingencies need to be in place. To obtain the planned 200 responses, the researcher recommends contacting at least 1,000 possible survey candidates with the online survey attached.

The survey will be created using Google Forms and will be distributed via E-mail, WhatsApp, Telegram and LinkedIn. There will be a total of 40 questions in the survey, five of which are common questions to get a brief overview about the recipient, their company, and the company's SMM adoption status. The common questions will be formatted as multiple choice questions, and the questions relating to the three contexts will use the 5-point Likert scales (1= "Strongly disagree"; 5= "Strongly agree") to allow recipients to record their responses.

13.2.2. Interviews

Interviews will be the second data collection form used to collect qualitative data. The reason the researcher has incorporated interviews along with an online survey is twofold: as mentioned, survey data has several issues as such as being subjected to bias, or the participant failing to understand the question, which can lead to inaccurate results. According to Denscombe (1998), interviews are able to understand a participant's opinions, feelings and perception, and since this study focuses on SME's mindsets,

their perception of the wider environment, and how it applies to SMM adoption, it can help gain a deeper understanding as to why SMEs may feel a certain way relating one of the aforementioned factors under the TOE framework and social media, making up for the weaknesses of the survey method used (Denscombe, 1998). The researcher would not only be able to test the hypotheses, but also understand the reasoning behind the results.

Further, the accuracy of the data collected and the results of the data collected through the survey can be used to validate through the results from the interviews by matching the results from the interview with the findings from the survey (Denscombe, 1998).

The researcher recommends a semi-structured interview so that the researcher is able to get the interviews to elaborate on their answers, and respond to the answers given, to completely eliminate bias and collect as much relevant data as possible. At least 10 participants, who are owner/managers of SMEs, must be interviewed and they would need to be from different areas of the country. The recommended mode to carry out the interviews is via Zoom or Skype (internet interviews), as the interview sample is expected to be geographically widespread, and is much easier to schedule a time for the participants, and is less costly (Denscombe, 1998).

14. CONCLUSION

This study intends to understand the factors that motivate SMEs in Sri Lanka to adopt SMM technology for their businesses. The researcher conducts an extensive literature review to understand findings of similar studies and uses the TOE model to develop the hypotheses for this study. The researcher has proposed two data collection methods for the proposed research plan: online surveys and interviews. Online survey should prove useful in the hypotheses testing and the interview data would help confirming the findings from the analysed

survey data and help understand the reasoning behind the results.

REFERENCES

- Abdollahzadehgan, A., Razak, A., Hussin, C., Gohary, M. M., & Amini, M. (n.d.). *The Organizational Critical Success Factors for Adopting Cloud Computing in SMEs*. <http://ssrn.com/abstract=2333028><http://seminar.utmspace.edu.my/jisri/>
- Adam, M., Ibrahim, M., Ikramuddin., & Syahputra, H. (2020). The Role of Digital Marketing Platforms on Supply Chain Management for Customer Satisfaction and Loyalty in Small and Medium Enterprises (SMEs) at Indonesia. *International Journal of Suppl Chain Management*, 9 (3), 1210–1220. <http://excelingtech.co.uk/>
- Ainin, S., Parveen, F., Moghavvemi, S., Jaafar, N. I., & Shuib, N. L. M. (2015). Factors influencing the use of social media by SMEs and its performance outcomes. *Industrial Management and Data Systems*, 115(3), 570–588. <https://doi.org/10.1108/IMDS-07-2014-0205>
- Ali Abbasi, G., Abdul Rahim, N. F., Wu, H., Iranmanesh, M., & Keong, B. N. C. (2022). Determinants of SME's Social Media Marketing Adoption: Competitive Industry as a Moderator. *SAGE Open*, 12(1). <https://doi.org/10.1177/21582440211067220>
- Ahmad, S. Z., Abu Bakar, A. R., & Ahmad, N. (2019). Social media adoption and its impact on firm performance: the case of the UAE. *International Journal of Entrepreneurial Behaviour and Research*, 25(1), 84–111. <https://doi.org/10.1108/IJEBr-08-2017-0299>
- Alkhater, N., Walters, R., & Wills, G. (2018). An empirical study of factors influencing cloud adoption among private sector organisations. *Telematics and Informatics*, 35(1), 38–54. <https://doi.org/10.1016/j.tele.2017.09.017>
- Alshamaila, Y., Papagiannidis, S., & Li, F. (2013). Cloud computing adoption by SMEs in the north east of England: A multi-perspective framework. *Journal of Enterprise Information Management*, 26(3), 250–275. <https://doi.org/10.1108/17410391311325225>
- AlSharji, A., Ahmad, S. Z., & Abu Bakar, A. R. (2018). Understanding social media adoption in SMEs: Empirical evidence from the United Arab Emirates. *Journal of Entrepreneurship in Emerging Economies*, 10(2), 302–328. <https://doi.org/10.1108/JEEE-08-2017-0058>
- Baker, J. (2012). *The Technology–Organization–Environment Framework* (pp. 231–245). https://doi.org/10.1007/978-1-4419-6108-2_12
- Bhardwaj, P. (2019). Types of sampling in research. *Journal of the Practice of Cardiovascular Sciences*, 5(3), 157. https://doi.org/10.4103/jpcs.jpcs_62_19
- Chatterjee, S., & Kumar Kar, A. (2020). Why do small and medium enterprises use social media marketing and what is the impact: Empirical insights from India. *International Journal of Information Management*, 53. <https://doi.org/10.1016/j.ijinfomgt.2020.10.2103>
- Dahnail, M. I., Marzuki, K. M., Langgat, J., & Fabeil, N. F. (2014). Factors Influencing SMEs Adoption of Social Media Marketing. *Procedia - Social and Behavioral Sciences*, 148, 119–126. <https://doi.org/10.1016/j.sbspro.2014.07.025>
- Denscombe, M. (1998). *The Good Research Guide: for small-scale social research projects*. 4th Edition. Berkshire: Open University Press.
- Gamage, T. C. (2019). Determinants of Cloud Computing Adoption among SMEs in Sri Lanka: A Meta Theoretical Framework. *International Journal of Asian Social Science*, 9(2), 189–203. <https://doi.org/10.18488/journal.1.2019.92.189.203>
- Hemachandra, S., & Sharkasi, N. (n.d.). *The Acceleration of Digital Maturity during the*

- COVID-19 Pandemic in the Retail Industry in Sri Lanka*. www.intechopen.com
- Irfan, M.I.M. (2017). Cultural Dimensions of Hofstede and Their Impact on Organizational Performance in Sri Lanka View project Citizens' Trust View project Cultural Dimensions of Hofstede and Their Impact on Organizational Performance in Sri Lanka. *Imperial Journal of Interdisciplinary Research (IJIR)*, 2(10).
- James, L. (2020). Impact of Digital Marketing on SME Growth in South Asia: A Case Study on Faheem Haydar Dealzmag. *SA business press Journal*.
<https://ssrn.com/abstract=3758480>
- Karatum, S. (2017). THE PLACE OF DIGITAL MARKETING ON TURKISH SMALL BUSINESSES. In *Journal of International Trade, Logistics and Law* (Vol. 3, Issue 2).
<http://www.resmigazete.gov.tr/eskiler/2012/11/20121104-11.htm>
- Michaelidou, N., Siamagka, N. T., & Christodoulides, G. (2011). Usage, barriers and measurement of social media marketing: An exploratory investigation of small and medium B2B brands. *Industrial Marketing Management*, 40(7), 1153–1159.
<https://doi.org/10.1016/j.indmarman.2011.09.009>
- Ministry of Industry and Commerce. (n.d.). *National Policy Framework for Small Medium Enterprise (SME) Development*. Colombo: Department of Industries. Available at:
<https://libguides.ucd.ie/harvardstyle/harvardoffpubs#:~:text=Report%2FGovernment%20age%20publication,%5BAccessed%20Day%20Month%20Year%5D>. (Accessed June 10th 2022).
- Nuseir, M. T. (2018). Digital media impact on smes performance in the The Role of DigitalMarketing in Business Performance with the Moderating Effect of Environment Factors among SMEs of UAE View project. In *Article in Academy of Entrepreneurship Journal* (Vol. 24, Issue 2).
- <https://www.researchgate.net/publication/325393198>
- Perera, L. A. P. C., Rathnayaka, B. R. M. G. M., & Bopage, Y. W. (2021). *Effect of Digital Marketing Strategies on Destination Choice of Domestic Travelers during Post COVID 19 Waves: Special Reference to Ella, Sri Lanka*.
- Qalati, S. A., Li, W., Vela, E. G., Bux, A., Barbosa, B., & Herzallah, A. M. (2020). Effects of Technological, Organizational, and Environmental Factors on Social Media Adoption. *Journal of Asian Finance, Economics and Business*, 7(10), 989–998.
<https://doi.org/10.13106/jafeb.2020.vol7.no10.989>
- Qalati, S. A., Yuan, L. W., Khan, M. A. S., & Anwar, F. (2021). A mediated model on the adoption of social media and SMEs' performance in developing countries. *Technology in Society*, 64.
<https://doi.org/10.1016/j.techsoc.2020.101513>
- Rassool, R., & Dissanayake, R. (2019). *DIGITAL TRANSFORMATION FOR SMALL & MEDIUM ENTERPRISES (SMES): WITH SPECIAL FOCUS ON SRI LANKAN CONTEXT AS AN EMERGING ECONOMY Impact of digitalisation on business models View project Social Cohesion View project*, 7(4), 59-76.
<https://www.researchgate.net/publication/335028085>
- Rathnaweera, R.P.S.K., Dharmarathna, B.V.D.R., & Jaysekara, B.M.T.D. (2021). *Effectiveness of Digital Media Platforms in Promoting and Marketing Sri Lanka Tourism "Fostering Opportunities for Technopreneurship in the New Normal."* (2021).
- Redjeki, F., & Affandi, A. (2021). Utilization of Digital Marketing for MSME Players as Value Creation for Customers during the COVID-19 Pandemic. In *International*

- Journal of Science and Society* (Vol. 3, Issue 1). <http://ijsoc.goacademica.com>
- Saif, N., Busaidi, A., Fellow, P., Bashar, A., Phd, B., & Zulkifli, N. (2019). The Critical Review on the Adoption of ICTs in the Small and Medium Enterprises (SMEs) in the Developing Countries. *International Journal of Small and Medium Enterprises*, 2(2).
- Samsudeen, S. N., Thelijjagoda, S., & Sanjeetha, M. B. F. (2021). Social Media Adoption: Small and Medium-sized Enterprises' Perspective in Sri Lanka. *Journal of Asian Finance, Economics and Business*, 8(1), 759–766. <https://doi.org/10.13106/jafeb.2021.vol8.no1.759>
- Setkute, J., & Dibb, S. (2022). "Old boys' club": Barriers to digital marketing in small B2B firms. *Industrial Marketing Management*, 102, 266–279. <https://doi.org/10.1016/j.indmarman.2022.01.022>
- Siraj, A. S. M., Vajra, M., & Pretheeba, P. (2021). Social Media Usage and Business Performance among Small and Medium Scale Marketers in Batticaloa, Sri-Lanka. *Wayamba Journal of Management*, 12(2), 297. <https://doi.org/10.4038/wjm.v12i2.7542>
- Skafi, M., Yunis, M. M., & Zekri, A. (2020). Factors influencing SMEs' adoption of cloudcomputing services in Lebanon: An empirical analysis using TOE and contextual theory. *IEEE Access*, 8, 79169–79181. <https://doi.org/10.1109/ACCESS.2020.2987331>
- Suroso, A., & Rafina, A. (2021). Motivation of SME adopt Digital Marketing. *International Journal of Innovations, Creativity and Change*, 15(9), 696-710. www.ijicc.net
- Thaha, A. R., Maulina, E., Muftiadi, R. A., and Alexandri, M. B. (2021). "Digital Marketing and SMEs: A Systematic Mapping Study". Library Philosophy and Practice (e-journal). 5113. <https://digitalcommons.unl.edu/libphilprac/5113>
- Tawnih, A., Yaseen, H., Al-Adwan, A. S., Alsoud, A. R., & Jaber, O. A. (2021). Factors influencing social media adoption among smes during COVID-19 crisis. *Journal of Management Information and Decision Sciences*, 24(6), 1-18.
- Weeraratna, R.S., Rathnayaka, R.N.M.N., Perera, L.R.G.H., Kaluarachchi, K.R.M., Wickramasena, D.N., Arambawatta, L.V., & Wellgodapola, H.W.M.C. (2022). *The changing face of HR professionals' expectations amidst COVID-19: a comparison in between Sri Lanka and foreign context. Quality & Quantity.* <https://doi.org/10.1007/s11135-022-01533-3>
- Yaseen, H., Al-Adwan, A. S., Nofal, M., Hmoud, H., & Abujassar, R. S. (2021). Factors Influencing Cloud Computing Adoption Among SMEs: The Jordanian Context. *Information Development.* <https://doi.org/10.1177/026666669211047916>
- Zahay, D. (2015). *Digital Marketing Management: a handbook for the current (or future) CEO*. 1st Edition. New York: Business Expert Press.
- Zhuang, C., Lin, S., & Lin, F. (2017). *THE ANALYSIS OF DIGITAL MARKETING AMONG SMES IN CHAOZHOU CITY*. Advances in Economics, Business and Management Research, 37.

Exploring the Casual Shirt Preferences of Young Men in Sri Lanka

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ABSTRACT

The Menswear market has expanded worldwide as young men are becoming more conscious of the image they present to the world, which they believe should reflect their individuality, creativity, and connectivity. The casual shirt has become one of the ways of projecting these qualities, so it has now become an extensively worn item of clothing in men's wardrobes globally. Consequently, the casual shirt is currently being treated as a kind of fashion statement. The range of casual shirts available in the Sri Lankan market is wide in variety and the sales of this product have been growing exponentially over the last few years. However, to date, no research evidence is available on the preferences of young men concerning casual shirts. Hence, the research aims to thoroughly explore the preferences of young men concerning casual shirts to assess the current market gap for this item in Sri Lanka. Three data collection techniques were employed concurrently. Menswear fashion outlets in Colombo area were visited to note the styles and designs, brands, prices, fabrics, and finishing methods in respect of casual shirts. Interviews were carried out with selected young casual shirt consumers in the age group 15 to 29 when they visited the fashion outlets. Extensive in-depth information was obtained from them regarding their needs and taste in casual shirts. A questionnaire survey was also conducted with casual shirt consumers in the Colombo district to understand their preferences. It was evident that the young men in Sri Lanka wear casual shirts when attending parties and get-togethers, sports events, and other functions while going

on trips and for work. The highest priority was given to 'appearance' when selecting a new casual shirt. The findings revealed that the majority (67.8%) preferred dark colors over light colors and further, 65.2 percent were attracted to single-color shirts. As for design, the highest preference was shown for stripes. Further, it came to light that the majority of young men preferred semi-fitted cotton and linen casual shirts since they were more comfortable to wear all day long. The findings of the study will not only fill the literature gap in the area of men's casual shirts but will also benefit future studies and prove to be of value to the designers and retailers of menswear who are catering to the men's casual shirt market in Sri Lanka.

Keywords: *casual shirts, preferences, Sri Lankan market, young men*

1. INTRODUCTION

With the upsurge in the sale of men's magazines, the thoughts and lifestyles of men began to transform, and the young male started to openly take an interest in fashion (Craik, 1994). With the growth of men's engagement with fashion, the menswear market has expanded significantly around the world. Especially, the men's casual shirt has become very popular due to its versatility and the trends fueled by the marketing strategies of the world's top clothing brands and fashion designers (Elrum, 2017). The casual shirt which is acknowledged as one of the staple items of men's fashion has contributed immensely to the enhancement of men's wardrobes (Dhoker, 2017). It can be said to lead a double life (Engel, 2004) because it

works well for both formal and casual occasions and fits the requirement for whatever task due to its versatility, which can be attributed to the availability of plenty of colors, designs, and styles (Debbie & Oscar, 2016). The casual shirts offer a bigger variety of textures with bold patterns and prints that can emphasize the personality of the wearer ("The Casual Shirt," n.d.). Checks and stripes appear to be the most popular patterns for men's shirts (Engel, 2004). Lately though, an even wider selection of colors and patterns has appeared in the market for men's casual shirts (Engel, 2004).

1.1 Casual shirt preferences of men

Men always perceive their style as 'simple or casual' but that idea is more or less an old one (Elrum, 2017) that is based on the idea that *"...there is no men's fashion; men simply dress for fit and comfort, rather than for style..."* (Craik, 1994, p. 177). It suggests that *"...men do not notice clothes..."* (Craik, 1994, p. 177). Men prefer to have their clothes in simple colors; not too bright or with too many patterns because they feel more masculine in plain white or black (Elrum, 2017). Black is supposed to be *"...the symbol of propriety and masculine power..."* (Hochswender, 1998, p. 44). Therefore, it is preferred by men for most occasions because it makes them look slim, simple, and neutral. White is one of the bestselling colors for men's shirts (Engel, 2004). *"Next to white, blue is the most versatile color in the masculine shirt wardrobe"* (Hochswender, 1998, p. 70). For all occasions, it is neater and goes with any complexion or hair color (Hochswender, 1998). In addition, men prefer to wear hard, thick materials in cold weather, while in warm countries, men choose light, simple sweat-absorbing materials like cotton and linen (Wickramarachchi, n.d.).

1.1.1 Casual shirt preferences of men in Sri Lanka

Historically, the banian and cloth made up the men's national costume in Sri Lanka, and this was the most popular attire among the commoners. After the colonization by

westerners like the Portuguese, Dutch, and English, the national suit was abandoned in favor of western clothing as it proved to be more comfortable for both the factory workers who operated machinery and office workers who spent the day in enclosed environments (Fernando, 2007). During the 20th century, western clothing became widely popular, and western trends and styles were adopted in Sri Lanka by the expanding menswear industry (Wickramarachchi, n.d.). Currently, European and American fashion trends are influencing the Sri Lankan clothing industry very strongly. People are now bold enough to wear colorful and trendy designs with a fancy touch (Navaratne, 2011). Along with the growth of the world's fashion industry, international casual clothing brands have made inroads into the Sri Lankan menswear market, tempting men to buy those quality casual shirts for their wardrobes (Navaratne, 2011). Local brands and outlets are releasing products to suit local conditions, but they follow the styling trends of global brands (Navaratne, 2011). Even though Sri Lanka's local fashion market is small, it has been growing at an impressive rate over the last few years (Wattegama, 2019). However, to date, no research evidence clearly elucidates the true preferences regarding casual shirts and the changing clothing needs of men in Sri Lanka. Thus, it is essential to understand men's requirements in casual shirts and identify the current market gap in Sri Lanka to implement suitable strategies to develop local casual shirt brands and menswear fashion outlets.

1.1.2 Objective

Young Sri Lankan males who have been influenced by mass media and marketing activities to a great extent are acknowledged as being more fashionable and fashion consciousness than other age groups (Rathnayake, 2011). Therefore, young Sri Lankan males are the most important target market of fashion designers and retailers since the former's fashion involvement is appreciably high. However, there is a dearth of published studies on the preferences of young men in Sri Lanka in the realm of casual shirts.

Hence, the research aims to explore deeply the taste and preferences of young men in Sri Lanka as they relate to casual shirts. The findings will benefit the designers and retailers who are presently catering or hoping to cater in the future to the men's casual shirt market in Sri Lanka. This study can also serve as a secondary data source for researchers in the garment sector in future research undertakings.

2. METHODOLOGY

'Youth' or 'young men' is referred to in the Sri Lankan context as, *"Those within the age group of 15-29, considering the nature of the transition from dependent child to independent adult"* (National Youth Policy, 2014). Therefore, the above definition was adopted for the study. Both qualitative and quantitative methods were employed to achieve the objective of the research. That is because the mixed method approach provides greater insight into the true preferences of customers and the existing market gap while enhancing the reliability of findings (Miles and Huberman, 1994). The data collection and analysis techniques are discussed below.

2.1 Data collection

The following data collection methods have been employed concurrently within three months extending from mid-August 2021 to mid-November 2021.

- Observations at men's fashion outlets

In Sri Lanka, Colombo City and its suburbs are home to a large number of fashion outlets since they constitute an area that is highly developed commercially compared to all other places. Shop visits were made to four of these men's fashion outlets in the Colombo area. The purpose of the visits was to gain an understanding of the various products on offer in the Sri Lankan market currently. Details of the casual shirt brands, their price range, design, pattern, print, color range, and size range available at each outlet were observed and recorded. In addition, the buying behavior of customers was observed at each fashion

outlet and the relevant information was recorded.

- Semi-structured interviews with casual shirt consumers

The purpose of the semi-structured interviews with young male consumers was to understand their day-to-day shopping behavior and true needs concerning casual shirts to gain an understanding of their perceptions and construction of reality (Myer, 2009). Therefore, the interviews contained a list of questions about the respondent's perceptions regarding the appearance (print and surface decoration), fabrication, and fit of casual wear in the Sri Lankan market. Young customers who were visiting the shops were randomly selected for the interviews and their willingness to present and discuss their views on casual shirts was then confirmed. Accordingly, eight (8) customers were interviewed and the conversations were voice recorded. The details of the interviewees are given in Table 1.

Table 1 - Interviewee profile

Interviewee	Age	Residence	Occupation
Interviewee A	25	Colombo suburb	Undergraduate
Interviewee B	27	Colombo	Freelancer, Rugby player
Interviewee C	21	Colombo suburb	Undergraduate
Interviewee D	23	Colombo	Intern
Interviewee E	27	Colombo	Executive
Interviewee F	28	Colombo	Assistant Manager
Interviewee G	29	Colombo suburb	Manager
Interviewee H	26	Colombo	Photographer, Freelancer

- A questionnaire survey of casual shirt consumers

A closed-ended questionnaire survey was carried out to obtain an overall understanding of casual shirt consumers and their preferences. The questionnaire consisted of three sections. The first section focused on

demographic information and the second section was designed to examine the buying behavior of consumers. The third section contained questions about the respondents' preferences for casual shirts. To determine the sample size, the total population of young men aged between 15 and 29 was taken as 281,796 (National Youth Policy, 2014). The 'SurveyMonkey sample size calculator' was used to decide the sample size. The recommended sample size for the study was 269 at a confidence level of 90 percent and a margin of error of 5 percent. The questionnaire was revised after conducting a pilot study with 27 young males ([Sullerzor & Vuruşkan, 2017](#)). Then the questionnaire was distributed among a sample group of 269 casual shirt consumers in Colombo District through social media and personal contacts. This district was chosen because additional and supplementary education, employment, and leisure activities are heavily concentrated in the Greater Colombo area as there are a considerable number of suburbs surrounding the main city. Therefore, a diverse population of young people can be accessed in Colombo and the suburbs. Of the 269 questionnaires distributed, 227 usable questionnaires were completed and returned by the participants, showing a response rate of 84.3%. The highest number of respondents were reported from the suburbs of Colombo, making up 43.2 percent of the total sample group. Further, it was noted that participants were occupied in various fields such as banking, engineering, healthcare, apparel industry, education, and sports as executives, managers, and interns (trainees) with the rest working as freelancers or following courses as students.

2.2 Data analysis

The data collected from observations, interviews, and questionnaire survey were analyzed separately, and finally, the aggregate conclusions were drawn. Accordingly, the data collected from the shop observation were sorted based on themes, such as brands, their price range, fabrication, prints and patterns, and color range. The recorded interviews with

consumers who visited the fashion outlets were transcribed. The data were analyzed by adopting the principles of thematic analysis by identifying keywords (King, 2004). The data collected from the questionnaire survey were analyzed using Microsoft Excel to pinpoint the actual customer needs. The findings are presented in the form of pie charts and graphs.

3. FINDINGS

3.1 Sri Lankan casual shirt market

With the worldwide expansion of the fashion industry, several global clothing brands have stepped into the Sri Lankan market. Therefore, both local and international menswear brands of casual shirts were to be seen in the fashion outlets in the Greater Colombo area. Tommy Hilfiger, US Polo, Pepe Jeans, Levi's, Jack and Jones, Wyos, Dockers, Field, and Guess were identified as global clothing brands available within the Sri Lankan market. Emerald, Signature, Premium, ODEL, Boss, EKKO, Etoile, Anations, Crocodile Sri Lanka, Le Bond, Envoy, Vantage, Coco, and Giorhudson were some of the new and established menswear local brands that were marketing casual shirts under their names.

The shop observations revealed that the local casual shirt brands were also using the international sizing system and offering all sizes from S to XXL with the price range typically starting at Rs.1000. A wider range of sizes from XS to XXL were available under global casual shirt brands with the prices ranging upward from Rs.6000. Further, both local and global brands offered a variety of styles such as regular, classic, relaxed, tailored, as well as slim-fit casual shirts. Linen and cotton, as well as linen/cotton blends, were the most widely used materials for casual shirts by the local brands as they were best suited for the Sri Lankan climate. The global brands generally used cotton, polyester, flex, and an organic cotton and wool mix. In addition, many variations of prints and patterns were available, such as checks, stripes, dots, and floral and tropical designs in the local brands. The global brands too offered a range of

checks, stripes, dots and tiny prints. However, there were no significant differences between the local and global brands in terms of color range. Table 2 presents an overview of the

Table 2: Shop visit observation summary on casual shirts available in the Sri Lankan market

Outlet	Brands	Price range (Rs.)	Fabrication (Material)	Prints and patterns	Color range	Sizes
A	EKKO Anations Signature Etoile King Street	1,000-4,500	Linen Cotton Polyester	Checks Stripes Dots Floral and tropical prints	Solid colors light Solid colors dark Blue, black shades Contrasting color combinations	S-XXL
B	Tommy Hilfiger	10,000-14,000	Cotton	Checks Stripes	Blue, black shades	XS-XXL
C	Pepe Jeans Levi's Jack & Jones Wyos Dockers US Polo Field Premium Guess ODEL	3,000-16,000	Linen Cotton Polyester Flex organic cotton and wool mix	Checks Stripes Dots Tiny prints	Solid colors light Solid colors dark White, blue shades Contrasting color combinations	XS-XXL
D	Boss Emerald Signature Vantage Liberation Levi's	1,000-9,000	Linen Cotton Polyester	Checks Stripes Floral and tropical prints	Solid colors light Solid colors dark Blue shades White and black Contrasting color combinations	XS-XXL

casual shirts available in the Sri Lankan market through the observations made during the shop visits.

for practically any occasion as they were so versatile (Interviewees A, C, D, E, G, H).

3.2 The casual shirt-purchasing behavior of young males

The overall data gathered highlighted that almost all young males wear casual shirts though the occasions for which they choose to wear them would differ from person to person. According to the results of the distributed questionnaire (Figure 1), it was evident that the participants would wear casual shirts for parties and get-togethers (146), day-to-day events (145), other functions (136), trips (86), and work (84). During the interviews conducted with young male consumers, they confirmed that the casual shirts could be worn

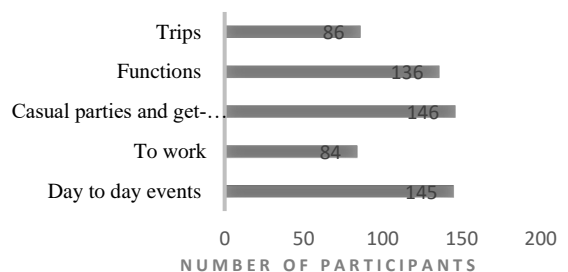


Figure 1: Occasions for which casual shirts can be worn

As shown in Figure 2, 62 percent of the sample group purchased casual shirts several times a year, whereas 17 percent purchased shirts as often as once a month from outlets in Colombo and its suburbs.

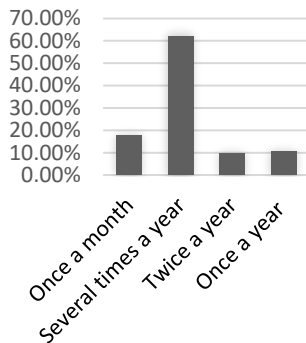


Figure 2: How often do consumers shop for casual shirts

Further, it was revealed through the questionnaire that the majority of the participants (56.8%) spent Rs.1500-3000 on a casual shirt while 19.8 percent paid less than Rs.1500 as shown in Table 3. Only 4 customers indicated that they spent more than Rs.8000 at a time on a casual shirt. Observations made during the shop visits also confirmed the customers' spending habits.

Table 3: Money spent on a casual shirt at a time

Money spent (Rs.)	# of customers	Percentage
<1500	45	19.80%
1500-3000	129	56.80%
3000-5000	37	16.30%
5000-8000	12	5.30%
>8000	4	1.80%
	227	100.00%

In addition, it was found that 77.5 percent of the participants purchased both local and international brands while 12.8 percent

purchased casual shirts only from local brands. The findings indicated that the participants were either fully satisfied (9.7%) or moderately satisfied (78.4%) with the local brands.

The survey also tested the young Sri Lankan male consumers' awareness on international trends in casual shirts. It became clear that almost 58.9 percent of the respondents were aware of international fashion trends while 10.2 percent of them appeared to have only a vague idea about this topic. However, Interviewees B, C, F, G and H stated that they were mindful about the global trends and often tried to follow them. Interviewee B stated that *"I prefer international fashion trends. I'm concerned about the costumes worn in movies and tv series like Teen Wolf. And I am following trends mostly through Facebook, Instagram, and other social media."* Interviewee C revealed that *"The freedom of (artistic) expression is high in international fashion trends and that is cool."* Further, Interviewee C observed that the casual shirts from global clothing brands available in the Sri Lankan market were narrow in variety and limited to a few styles.

3.3 Young men's preferences in casual shirts

The participants of the questionnaire survey were asked to point out the factors they considered important when selecting a new casual shirt. They gave the highest priority to 'appearance' as shown in Figure 3. Fit, fabrication, construction and quality, and price were selected as the second, third, fourth and fifth most important factors, respectively.



Figure 3: Factors considered important when choosing a casual shirt

The factors related to the preferences like appearance, fit, and fabrication were further explored and are explained below.

3.3.1 Preferences related to the appearance of casual shirt

Preferences with respect to the appearance of the casual shirt were further tested by getting the young men's views on color and surface decorations (prints and patterns). As revealed through the questionnaire (Table 4), the majority (67.8%) indicated that they prefer darker colors to lighter colors, with 65.2 percent mentioning that they favored single-color shirts. Further, it came to light that they had a partiality for blue shades. This was affirmed by the interviewees too. According to interviewee A, *"I prefer dark colors like dark blue, dark brown and dark green. I particularly like black. I think that dark colors emphasize masculinity."* Interviewee F stated that *"I think light colors are not suitable for me. They do not go well with my dark skin."*

Table 4: Preferences on color

Preferences on color	# of customers	(%)
Dark colors	154	67.8
Light colors	73	32.2
	227	100
Single color	148	65.2
Two colors	64	28.2
More than two colors	15	9.6
	227	100

Observations made during the shop visits showed that the color range of casual shirts included both dark and light single colors (Table 1). Hence, the color range of casual shirts available in the Sri Lankan market matches the consumers' preferences.

The survey findings relating to the preferences regarding surface decorations (Figure 4) show

that the highest preference was for stripes and the lowest preference was for floral prints.

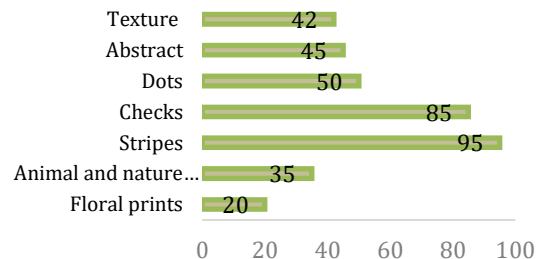


Figure 4: Preferences on surface decorations

The interviews also confirmed that most young men shied away from purchasing floral prints since they believed such decorations had an odd and feminine look (Interviewees A, D). Interviewee D mentioned that *"I have not been interested in floral prints since childhood. I believe that the 'flowers are for girls' belief has affected the mindset of most men leading them to build gender stereotypes."* They all seem to think that floral prints detract from their personality and give them an odd and feminine look (Interviewees A, D). Even though floral-print shirts are perceived as feminine, it was observed that in many Sri Lankan fashion outlets, a large selection of floral-printed casual shirts was available.

3.3.2 Preferences concerning the fit of casual shirts

According to the results of the distributed questionnaire (Figure 5), it was clear that the majority of participants preferred semi-fitted shirts since they were more comfortable for day-long wear. In addition, another reason for choosing the semi-fitted shirts was to avoid drawing attention to one's thin body. As interviewee C stated, *"I used to be worried about the fit when I picked a shirt to wear. It would usually highlight my drooping shoulders and lightweight body. So, I don't like to wear body-fitted shirts."* In contrast to this, interviewee B declared that *"I love to express*

my personality by choosing a suitable shirt for my well-built body. I want to highlight the build of my body and so I usually wear slim-fit shirts."

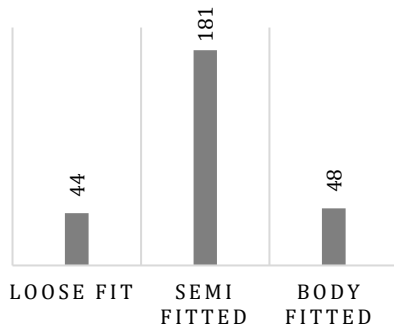


Figure 5: Preferences regarding fit

3.3.3 Preferences related to the fabrication (material) of a casual shirt

As revealed through the distributed questionnaire, young men preferred cotton and linen casual shirts as they were better suited for the weather conditions prevailing in Sri Lanka. In addition, these materials provided greater comfort too. Interviewee D stated that *"I usually consider the suitability of the fabric to the Sri Lankan climate when purchasing casual shirts since I live in a warm urban area."* During the shop visits it was observed that the local casual shirt brands mostly offered linen and cotton fabrications. However, both cotton, as well as wool mix fabrications, were available in the global brands.

4. DISCUSSION AND CONCLUSION

It has become quite clear that the young men in Sri Lanka wear casual shirts for parties and get-togethers, day-to-day events, other functions, trips and work; further, 58.9 percent of them were quite aware of international fashion trends. The results of the study indicated that 90.3 (77.5 + 12.8) percent of the young men purchased local brands even though international menswear casual shirt brands were also available in the fashion outlets of Greater Colombo. The main reason for this is

because the price range of local casual shirt brands starts at Rs.1000 whereas the price of global brands starts at Rs.6000. The findings confirmed that the young men were either fully satisfied (9.7%) or moderately satisfied (78.4%) with the local brands.

Based on these results, it can be concluded that 'appearance' is the major concern of young men in Sri Lanka when buying a new casual shirt. The majority prefer darker colors to lighter colors, and are attracted to single color shirts, particularly those of a blue shade. As for decoration, the highest preference was shown for stripes. Further, it was noticed that the majority preferred semi-fitted, cotton and linen casual shirts due to their comfort and suitability for day-long wear.

The findings highlighted the fact that the retailers and apparel producers in Sri Lanka need to re-evaluate their products and identify suitable design solutions to upgrade the appearance of casual shirts in order to cater more effectively to this Sri Lankan niche market segment. This would help to minimize the current problems and give a boost to local production. Accordingly, adding a wider selection of darker colors and more blue shades, both singly and as combinations, would meet the local demands better. Designs with stripes and checks of different sizes to cater to different tastes will also expand the market for casual shirts. However, the best results can be obtained only by extending this study across the whole country to arrive at a robust conclusion since the current study covered only the Greater Colombo area. It is suggested that scholars and researchers conduct further research in the other areas, like men's preferences concerning appearance, colors and prints while also exploring the possibilities for other menswear categories.

REFERENCES

- Craik, J. (1994), *The face of fashion: cultural studies in fashion*. London, Routledge,
Debbie and Oscar. (2016), Men's 1950s Clothing History: Casual Fashion'. Retrieved from

- <https://vintagedancer.com/1950s/mens-1950s-clothinghistory-casual/>
- Dhoker, A. N. (2017), '10 Best Casual Shirts Brands that No Man dare to Skip'. Retrieved from <https://www.looksgud.in/blog/best-casual-shirts-brands-men-india-buy-online/>
- Engel, B. (2004), *The 24-hour Dress Code for Men*. Germany: Feierabend.
- Elrum, K. (2017), *Masculinity and fashion consumption*, Master's Thesis. available at: https://projekter.aau.dk/projekter/files/261962114/Kristina_Elrum_Thesis.pdf
- Fernando, L. (2007), 'National Dress suits our country, climate and culture. Retrieved from <https://archives.dailynews.lk/2007/01/17/fea02.asp>
- Hochswender, W. (1998), *Men's wardrobe*. New York : Alfred Knopf.
- King, N. (2004), 'Using Templates in the Thematic Analysis of Text'. In *Essential Guide to Qualitative Methods in Organizational Research*, edited by C. Cassell and G. Symon, 259–270. London: Sage.
- Miles, M. B., and Huberman, A. M. (1994), *Qualitative Data Analysis: An Expanded Source Book*. London: Sage.
- Myers, M.(2009), *Qualitative research in Business & Management*, Sage Publications
- Navaratne, N. (2011), 'Sri Lankan Fashion Design Industry'. *Lifestyle*. Retrieved from <https://www.slideshare.net/nrnslideshare/sri-lankan-fashion-design-industry10088717>
- National Youth Policy, (2014) Retrieved from https://www.youthpolicy.org/national/SriLanka_2014_National_Youth_Policy.pdf
- Rathnayake, C.V. (2011), 'An empirical investigation of fashion consciousness of young fashion consumers in Sri Lanka', *Young consumers*, Vol. 12. No. 2
- Suller zor, B. and Vuruşkan, A. (2017), 'Survey Study for Detection of Problems in Plus-Size Women's Clothing in Turkey' , *Tekstil ve Mühendis*, Vol 24: 107, pp. 203-212, Retrieved from <https://doi.org/10.7216/1300759920172410709>
- Wattegama, C. (2019), 'Lanka's Fashion Market in Turbulent Times: A Positive Outlook'. Retrieved from <http://www.dailymirror.lk/features/Sri-Lankas-fashion-market-in-turbulent-times-A-positive-outlook/185-166738>
- Wickramarachchi, P. (n.d.), 'A study on the social meaning of "Clothes" in Sri Lanka'. Retrieved from https://www.academia.edu/10010445/A_study_on_social_meaning_of_Clothes_in_Sri_Lanka
- The Casual Shirt. (n.d.), Retrieved from <https://abbieandrose.com/gb/content/13-casual-shirt>

Reversible Jacquard Knitted Fabrications: Perceptions of Sri Lankan Customers

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ABSTRACT

Slow fashion appears to be the new trend that is emerging as a solution to garment industry pollution. Weft-knit reversible fabrics made using the Jacquard technique are being promoted as a product that would be effective at reducing pollution. Even though reversible Jacquard knit fabrics are available in Sri Lanka, there is a lack of published research evidence regarding its place in the market. Therefore, the goal of this study is to assess Sri Lankan customers' perceptions and attitude towards reversible jacquard knitted fabrics. The primary data collection method of this study was a questionnaire survey. Participants for the questionnaire survey were selected based on the random sampling technique. The 105 completed questionnaires were subjected to data analysis by using Microsoft Excel. According to the survey results, 58.1 percent of respondents were unaware, while 41.9 percent were aware of reversible jacquard knit technology. 41.7 percent of respondents had heard about jacquard knit technology through social media, while 28.3 percent learned about it through showrooms, magazines, and word of mouth. However, even 91.4 percent of the respondents who were aware of this fabric had never used it. The findings showed that 90 percent of respondents supported the concept of 'reversible' jacquard knitted fabrications. Reversible jacquard knitted fabrications were deemed fashionable by 63.9 percent of participants while 21.3 percent of participants thought they were aesthetically appealing. 38.7 percent of respondents preferred outerwear with reversible jacquard knitted fabrications. These findings will be useful to the knitwear designers and manufacturers in Sri Lanka as it will guide them to upgrade their

existing products and find bigger markets for them.

Keywords: *Customer, Jacquard, Knit, Reversible, Sri Lanka*

1. INTRODUCTION

Over the last 15 years, the textile industry doubled its production of textiles but most of the clothing made from the fabrics were discarded long before they reached the end of their useful life. Fully 73% of the clothing including fashion attire and apparel was burned or buried in landfills, producing 991 million tons of waste over that period (Council, 2019). The emergence of slow fashion for long term clothing appeared to be a new trend that evolved as a solution to minimize pollution from the garment industry. According to Power (2008), this innovation was based on weft-knit reversible fabrics, leading to the emergence of new methods of producing them. This contributed to save money and reduce the number of garments, including unsold garments, going to waste.

Weft-knit reversible jacquard fabric has gained enormous popularity as it offers structural patterning using different colors and with different appearance on the front surface and the rear surface (Power, 2008). Globally, weft-knit reversible jacquard fabrics are being marketed by different brands and designers such as Missoni, Macqueen, Pendleton, Beams plus, St. John Collection, Nordstrom, GUCCI, PRADA, PROMO Brand-London, Milly Brand and Nike (WGSN, 2021).

1.1 Objective of the study

Manufacturers in Sri Lanka are also intent on meeting the local market demand for knitwear by coming up with new innovations (fibre2fashion, 2014). Even though manufacturers in Sri Lanka produce reversible knit fabrics, there is a lack of published research evidence of this. Therefore, it is essential to assess the awareness, understanding and the perception of Sri Lankan customers towards reversible knitted fabrications.

Thus, the main objective of this research is to assess the Sri Lankan consumers' awareness and perception of reversible jacquard knitted fabrics.

2. LITERATURE REVIEW

Weft knitting or filling is a type of knitting where the yarn stitches run horizontally across the fabric (Power, 2008). Making vertical strips is not possible with weft knitting. Therefore, the use of jacquard, intarsia or plating techniques are introduced as solutions (Textileschool, 2019). Table 1 shows the different types of weft-knit structures, their properties, and end uses.

2.1 Reversible Weft-Knitted Jacquard






Jacquard is an additional attachment used to create more complex color patterns in textiles (Jacquard fabric, 2016). Reversible jacquard is manufactured in single and double plates, both on flatbed and circular knitting machines (Jacquard fabric, 2016). Two or more yarns with different properties can be used, one for the front surface and the other for the rear surface. Double-layered fabric can be made of different types of yarns that satisfy the different demands made on functionality. Table 2 shows the different types of reversible jacquard knitting techniques and their properties.

Table 1: Weft-knitting techniques (Cassidy, 2018)

Structure	Type	Properties	End uses
Single Knits	<ul style="list-style-type: none"> • Single Jersey • Lacoste 	<ul style="list-style-type: none"> • Very elastic • Warm to wear 	<ul style="list-style-type: none"> • Underwear • Hosiery • T-Shirts • Sportswear • Baby Clothes • Jumpers • Scarves • Hats • Gloves
Double knit	<ul style="list-style-type: none"> • Rib Knit • Purl Knit • Interlock Knit • Cable Fabric • Bird's Eye • Cardigans • Milano Ribs • Pointelle 	<ul style="list-style-type: none"> • Comfortable • Shrinks easily • Different properties can be achieved depending on the yarns used • Can stretch out of shape easily 	
Specialized Weft Knits	<ul style="list-style-type: none"> • Intarsia • Jacquard Jerseys • Knitted Terry • Knitted Velour • Sliver Knit • Fleece • French Terry 	<ul style="list-style-type: none"> • Does not fray • Unravels when cut • Curls up at the edges • Various colors/ patterns can be achieved • Good insulator • Good stretch 	

Table 2: Structure types of reversible Jacquard techniques (Cassidy, 2018)

through the questions in the second section. The third section of the questionnaire focused on evaluating the

Technique	Fabric	No. of beds	Description	Advantages & Disadvantages	Properties
Float Jacquard		1 front	Maximum length of the float <1"	Low weight & Cannot make high density patterns e.g., Fair Isle pattern	Can do different types of patterns
Tubular Jacquard		2	Each color knitted separately on front and back bed	Fine and reversible & Only two colors can be used	Can easily use long repeats Can replace print design patterns using dyed yarns
Bird's eye Jacquard		1 back	Can use multiple colors and virtually any pattern	Can knit with a greater number of colors & Heaviest Jacquard type	Can use multiple yarns in one repeat Can achieve designs as in woven fabric
Ladder-back Jacquard		1	Lightweight and multi-colored design	Can knit a greater number of colors, and any pattern is possible & Heavier than float Jacquard	Can make picture patterns on fabric
Following is the most suitable technique for reversible and colorful Jacquard design patterns					
Intarsia Jacquard		1	combination of jacquard plus intarsia that combines the benefits of both	Lightweight and Block/ Multi-color design possible e.g., Argyle patterns	Can use for making light weight fabrications of two or more colors

3. METHODOLOGY

The questionnaire survey intended to assess the customer awareness and perception regarding various aspects of reversible knitted fabrications. The questionnaire consisted of four sections. The first section focused on the demographic information of the respondents. Customer purchasing habits were determined

customer awareness on reversible knitted fabrications. Customers' perceptions of the concept of 'reversible jacquard knitted fabrications' were assessed through the questions in the fourth section.

Women between the ages of 20 and 35 were considered for the study. Assuming the population size as 200,000, margin of error as

5% and confidence level as 95%, sample size for the questionnaire survey was determined using Raosoft sample size calculator (n.d.). The recommended sample size was 105. Questionnaire survey was administered online as well as physically. The data gathered through the questionnaire were analyzed using Microsoft Excel.

4. DATA ANALYSIS

4.1 Overview of the questionnaire respondents

Out of the 105 questionnaire respondents, 88.6 percent were between the ages of 20 and 25. 9.5 percent were between the ages of 26 and 35, with the remainder being under 20. Majority of respondents were females, who accounted for 63.8 percent of the total. Further analysis showed that 68.6 percent of respondents were from the Western Province. The second highest number was from the Southern Province, amounting to 12.4 percent. According to the findings, most of the respondents to the questionnaire were females between the ages of 20 and 25 based in the Western Province.

4.2 Customer purchasing habits

According to the survey results on customer purchasing behavior, 55.2 percent of respondents go shopping every three months. 18.1 percent of respondents shop twice a year and 13.3 percent of respondents do their shopping (for clothes) once a year. Further investigation into spending habits revealed that 64.8 percent of participants tended to spend Rs. 1000-2500 for a garment, while 28.6 percent would pay Rs. 2500-3500. None of the respondents wanted to spend more than Rs. 4500 on a garment.

When purchasing clothing, 90.5 percent of respondents consider the fit and the design. Price is more important to 66.7 percent of respondents, while durability is given priority by 53.3 percent of respondents. 30.5 percent of respondents take into consideration the brand of the garment. 25.7 percent of customers are more concerned about the cloth's washability.

The analysis of color preferences when purchasing clothing revealed that 40% of survey participants prefer light and dark color combinations. 33.3 percent prefer darker colors, while 17.1 percent prefer lighter neutral colors when choosing a garment. 49.5 percent of the respondents prefer 100% cotton fabrics while 48.6 percent prefer cotton/ synthetic blends.

Figure 1 depicts the main design preferences. According to this, most customers want unique, customized designs (63.8 percent). 28.6 percent of participants prefer floral patterns.

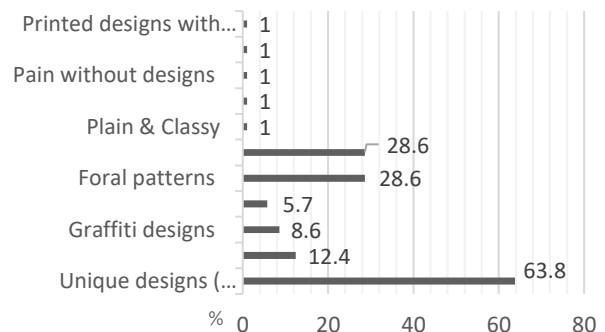


Figure 11: Design preferences

The majority (87.6 percent) of respondents, particularly females, were interested in new fashion trends that keep changing from time to time. However, 12.4 percent of participants seemed to be indifferent to fashion trends.

4.3 Consumer awareness of reversible jacquard knitted fabrics or garments

According to the findings, 58.1 percent of the respondents were unaware of reversible jacquard knit technology. However, the results show that 41.9 percent of participants (44) were aware of this technology. Respondents who claimed to know about reversible jacquard knit were asked to identify the media sources that helped them learn about it. Out of the 44 respondents, 41.7 percent said they learned about jacquard knit technology from

social media, while 28.3 percent learned about it through showrooms, magazines, and word of mouth.

Respondents who knew about reversible jacquard knit were further questioned to determine whether they had personally used the fabrics/ textiles or garments. Inquiring into their knowledge and experience of reversible jacquard knit textiles or garments revealed that 91.4 percent of respondents had never used them before, while 8.6 percent had worn reversible knit fabrications or garments marketed under different brand names, such as JEEZA and PUMA.

4.4 Consumer preferences on reversible jacquard knitted fabrics or garments

Customers' perceptions of the concept of "reversible jacquard knitted fabrications" were assessed because this unique production process allows customers to purchase two garments for the price of one. According to Figure 2, 41.9 percent of respondents were very interested in the concept, while 37.1 percent were interested. 11.4 percent believed it would be better for them. Thus, the findings show that 90 percent of respondents support the concept of "reversible jacquard knitted fabrications."

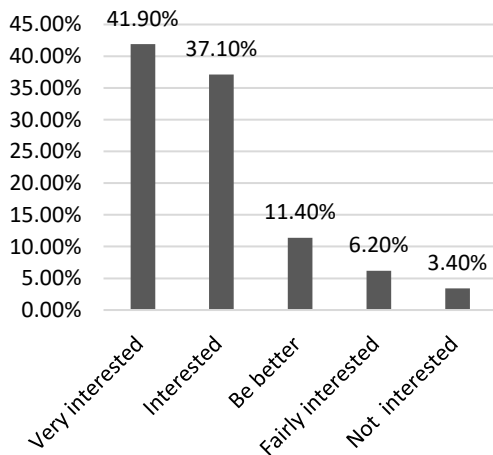


Figure 2: Consumer perception of the concept of "reversible jacquard knitted fabrications"

The expected benefits of using reversible jacquard knitted fabrications were investigated and the findings are presented in Figure 3. The findings reveal that 63.9 percent of participants used reversible jacquard knitted fabrications to appear fashionable. Due to their aesthetic appeal, reversible jacquard knit garments were desired by 21.3 percent of participants.

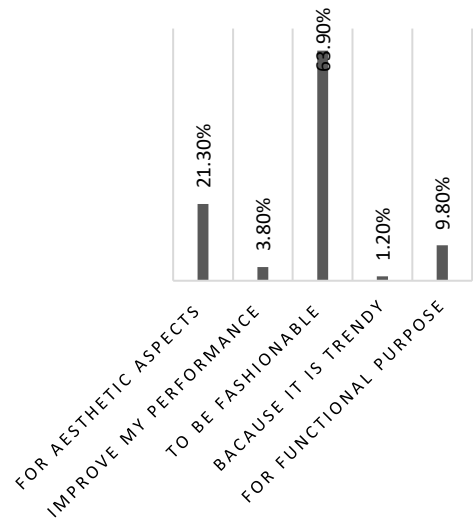


Figure 3: Perceived benefits of using reversible jacquard knitted fabrications

Figure 4 shows the popularity of products categorized as reversible jacquard knitted fabrications. These fabrications are preferred by 38.7 percent of respondents for outerwear and other fabric design/ textile applications. Reversible jacquard is preferred by 11.3 percent of participants for sportswear and by 9.7 percent for intimates.

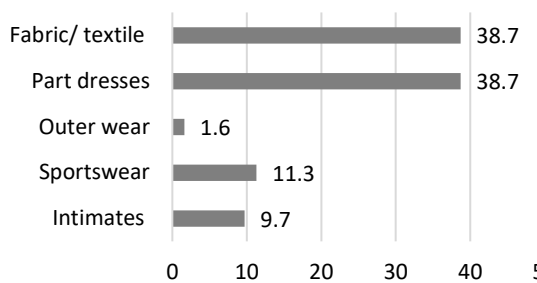


Figure 4: Customer preferences by product category

According to the results, 23.5 percent of participants were willing to buy reversible jacquard knit garments of any brand available in the Sri Lankan market. Nike was preferred by 17.6 percent of participants, while roughly equal numbers (5.9 percent) preferred BOSS, JEEZA, Levi's, ODEL, Puma, and L brands.

5. CONCLUSION

The study concludes that 41.9 percent of women in the Western Province between the ages of 20 and 25 were aware of reversible jacquard knit technology. Of them, 91.4 percent had never worn reversible jacquard knitted garments. However, 90 percent of respondents supported the concept of "reversible jacquard knitted fabrications." That is because, it is fashionable and aesthetically attractive. 38.7 percent of respondents prefer outerwear with reversible jacquard knitted fabrications. This indicates there is a market potential for knitted garments made using this technique in Sri Lanka. Therefore, the findings of this research will be useful for the knitwear manufacturers in Sri Lanka who wish to upgrade their existing products. Academics will also be benefitted since there is no research evidence on customer perception of reversible jacquard knitted fabrications in Sri Lanka.

To achieve more reliable results, the same research can be conducted across the whole country since 88.6 percent of the women involved in the survey were from the Western Province of Sri Lanka. Further research can be conducted to assess customer preferences on

other aspects of reversible jacquard knit structures too, such as colors, compositions, etc.

REFERENCES

- Cassidy, T. D. (2018). *Knitwear Design and Technology*. CRC Press
- Council, A. F. (2019). Pulse of the Fashion Industry 2019 Update. Retrieved from: <http://www.sustainabilityportal.net/blog/pulse-of-the-fashion-industry-2019-update-released>
- Fibre2fashion. (2014). Sri Lankan Textile Sector - fiber to fashion - The changing dimensions of Sri Lankan textile. Retrieved from: <https://www.fibre2fashion.com/industry-article/7384/the-changing-dimensionsof-sri-lankan-textile>
- Jacquard fabric, (2016). Jintian Textile. Retrieved from: <https://www.slideshare.net/jintiantextile>
- Power, E. J. (2008). *Developments in apparel knitting technology*. In: *Advances in Apparel Production*. London, UK. Woodhead Publishing.
- Raosoftware (n.d.) Sample size calculator. Retrieved from: <http://www.raosoftware.com/samplesize.html>
- Textileschool. (2019). Knitting Design Technology - Design variation using colour - unit 2. Retrieved from: <https://www.textileschool.com/251/knitted-fabrics-and-types/>
- WGSN, (2021), Textile sourcing Guide S/S 21: Menswear - WGSN Fashion. Retrieved from: https://www.wgsn.com/fashion/article/86446#page_9

Evaluation of Challenges and Opportunities in Application of Green Practices to Shipping Firms in Sri Lanka

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ABSTRACT

Sri Lanka is a global pioneer in maritime industry due its strategic location in the mid of busiest shipping routes. Therefore, shipping industry becomes prominent and shipping agents who provide wide range of services to the vessels arriving at ports plays a vital role in economic and environmental sustainability. The purpose of this study is to identify the existing green practices, influencing factors, challenges and opportunities when applying green practices to Sri Lankan shipping firms. This is primary research conducted using sample of 64 shipping companies registered under Ceylon Association of Ship Agents (CASA). Collected data was analyzed using quantitative and qualitative mixed method including descriptive statistics and regression analysis by SPSS. Based on literature,

21 green practices under four categories; company policy and procedure, office work and documentation, shipping equipment and materials and shipping design for compliance were considered in here. To identify the influencing factors for shipping firms when applying green concept 18 reasons were categorized into 5 factors: rules and regulations, industrial norms, customer request, pressure from competitors and company strategy.

Regression analysis conclude that Sri Lankan shipping firms are following green practices at moderate level and driven by industrial norm, customer request and company strategy. As per the categorical distributions 71.88% of companies follow green practices at some level and 90.63% of companies believe adapting to green practices add value to their company. Knowledge, technical and financial barriers found to be more common challenges and employees' motivation and positive mindset can be utilized as an opportunity.

1. INTRODUCTION

Sri Lanka is a potential maritime and logistic hub with the strategic location in the Indian Ocean. Being the most connected point of international shipping routes in South Asia, Sri Lanka ranked 25th in maritime economies making the shipping services industry prominent (UNCTAD, 2019). On average above 4000 vessels arrive at Colombo port annually and these vessels request for different services from Sri Lanka. To provide services to the vessels shipping agencies and freight forwarders together established as a logistics industry and nowadays it has become a highly competitive industry with over 500 companies including shipping agencies, freight

forwarders and clearing agencies. As per the records of Ceylon Association of Ship Agents (CASA) there are 137 registered ship agents who provides wide range of services including ship repairs, crew management, logistics and freight forwarding, shipping agency work and ship supplies (Ceylon Association of Ship Agents, 2019). Usually in Sri Lanka, most of these companies work with the primary objective of profit maximization and very few companies focus on sustainability of the business due to the high competition within the market. Green practices, which are environmentally friendly actions are vital for a business in moving towards sustainability specially for shipping services as it is one of the fields which involve with massive documentation work, packaging, transportation, labor works and it is a leading contributor for environmental pollution (UNCTAD, 2011). Therefore, this study aims to investigate the existing green practices, challenges, and opportunities available in ancillary services in maritime industry within Sri Lanka.

In 2018 Sung-Ho Shin et.al analyzed maritime literature studies related to sustainability and according to his findings there are very few research targeting maritime logistics with compared to shipping and ports (Shin et al., 2018). Young-Tae Chang and Denise Danao conducted research to identify the factors influencing shipping firms to adopt to green shipping practices and their findings were industrial norms and customer demand for environmental friendliness (Chang & Danao, 2017). This paper highly influenced corresponding author to conduct a study using ancillary service providers out of ports to identify challenges and opportunities in green practices.

In the Sri Lankan context few studies carried out on green practices in different fields (Indrasiri, 2015) but only one related to shipping industry and it is narrowed to transshipment terminal operations (Chandrakumar et al., 2016). Therefore, this study will be a novel contribution to shipping literature in global and Sri Lankan context as it specifically targets the green

practices in shipping firms which provides ancillary services in maritime industry.

2. LITERATURE REVIEW

2.1 Theory Overview

Theoretical aspect of this research is basically combination of maritime industry; specifically, maritime logistics and sustainability; specifically, environmental aspect. It is applying green practices to shipping firms which provides ancillary services. The below figure shows the theoretical foundation of the study.



Figure 1: Theoretical Foundation

2.2 Maritime Industry

Maritime industry is a global industry where all the countries connected each other and share resources and perform wide range of activities over the sea. According to Maritime Economics, maritime industry divides into five groups; vessel operations, shipbuilding, and marine engineering; marine resources, marine fisheries, and other marine activities, mainly tourism and services. Out of the above merchant shipping, where cargo and passenger transportation occur account for one third of the maritime activities and raise highest turnover (Stopford, 2010). In here major role is performed by the ports and several other services and businesses are emerged with the aim of supporting port operations.

Another classification of players in maritime industry are suppliers, ship owners and ship management companies, intermediaries such as ship agents, ship brokers, freight forwarders, customers, port authorities, customs, stevedores, class and survey institutions, insurance companies, and banks (Caliskan and Ozturkoglu, 2016). By considering both the classifications it can be observed that all the stakeholders can be

separate into three, ship owners and ship management, port operations and other services.

In maritime industry maritime transportation differ from maritime logistics where maritime transportation is directly involved with carrying cargo from port to port. Maritime Logistics is defined as "The process of planning, implementing and managing the movement of goods and information involved in the ocean carriage." (Lee, Nam and Song, 2012).

2.3 Maritime Logistics in Sri Lanka

Sri Lanka plays a vital role in global maritime industry with its strategic location and improvements in logistics infrastructure. Central positioning of the island facilitate trade between East and West making a stopover point of international shipping routes (Sri Lanka Ports Authority, no date).

Due to this strategic location, Colombo port ranked 11th in Global container port connectivity index score in 2018 (Ministry of Ports & Shipping, 2018).

Colombo port is the only deep-water commercial port in South Asia which can handle larger vessels in the world. In 2019 7.2 million Twenty-foot Equivalent Units (TEUs) handled in Colombo port (Shipping, 2019). Over the time Sri Lanka has become south Asia's leading maritime logistics and distribution hub considering the productivity of the terminal. In Colombo port there are three terminals and South Asia Gateway Terminal (SAGT) which is the first private terminal remarks productivity of 113 containers moves per hour (Ministry of Foreign Affairs, 2016). With the new improvements in infrastructure by 2018 Colombo port has ranked as the worlds' fastest growing port with 15.6% growth rate (PORT OF COLOMBO RANKED WORLD'S NO.01 | LMD, no date).

In Sri Lanka there are three government institutions related to maritime industry; Sri Lanka ports Authority, which is responsible for the port operations, Ceylon Shipping Corporation Limited which is responsible for

shipping and logistics facility and Merchant Shipping Secretariat (MSS) which is responsible for shipping administration which has the licensing authority for third party service providers (private) such as shipping agents, freight forwarders, container terminal operators etc. Also, they are responsible for setting rules and regulations for shipping industry in accordance with the International Maritime Organization (IMO) conventions (Shipping, 2019). There are national and multinational shipping companies, and all are registered under MSS. There are 130 plus shipping agencies which are organized under Ceylon Association of Ship Agents (CASA) and 120 plus freight forwarders in association with the Sri Lanka Freight Forwarders Association (SLFFA). Including clearing agents there are above 500 companies in the maritime logistics industry in Sri Lanka.

2.4 Sustainability

The modern world values a business not only by profit but also the concern towards people and planet. According to Bromley, sustainability is the potential for long term maintenance of wellbeing which depends on the natural world and natural resources (Bromley, 2008). However, sustainability concept comes into business processes with the aim of maintaining the triple bottom line, Profit, People and Planet. Sustainability in business management is an integration of core business of a firm with the social and environmental matters (Schaltegger & Wagner, 2006). Sustainability is developed on top of the four pillars: Human, Social, Economic and Environmental concerns. Out of the above four dimensions, Environment sustainability attracts people attention than others. Businesses follow an Environmental Management System (EMS) to address environmental issues in holistic manner to become sustainable and competitive in the market.

According to the review study of sustainability literature in maritime industry done by Shin et al., (2018) it can be seen that, although sustainability in ports and shipping operations were discussed since 1990's, maritime logistics incorporated with sustainability only after 2011

and very few research works carried out so far. It also shows that environmental and economy aspects in sustainability is comparatively frequently addressed than the social aspect. Further, main sustainability issues for ports and shipping were found as carbon emission, climate change and region-specific environmental regulations.

2.5 Application of Green Practices to Shipping Industry

In the global context application of green shipping practices (GSP) has been a trending topic due to its impact and value addition to operations. According to literature, a survey was carried out using 107 shipping firms in Hong Kong. Lai et al., (2013) aim was to define measurement scale to evaluate GSP. After a review study they categorized 31 green practices into six dimensions: company policy and procedure, shipping documentation, shipping equipment, shipper cooperation, shipping materials, and shipping design for compliance. Excepts the measure of eco-design for cargo transportation all the others were found to be correlated and both the models they have developed found to be significant and recommended for shipping firms to use this six-dimensional model for self-evaluation. However, based on the above framework Chang and Danao (2017) narrowed down the above 6 dimensions into four; Company policy and procedure, Shipping documentation, Shipping Equipment and shipping design for compliance and developed a structural equation to identify the factors affecting GSP implementation in shipping Firms.

Company Policy and Procedure is to measure whether environmental concern is addressed in the vision of the company and top management support for an eco- friendly business process and influence employees to behave environmentally friendly manner. Reassuring that Norton, Zacher and Ashkanasy (2014) conducted research with 168 employees and showed that Green work climate perception can explain that there is a positive relationship between presence of an organizational sustainability policies and employee's green behavior. However, in the study carried out by Montabon, Sroufe and

Narasimhan, (2007) except the "surveillance of market" none of the strategic initiatives have no significant relationship with the firm's performance.

The processes and procedures in the shipping industry are heavily involved with documentation and paperwork. The reason is the process involve with many parties and approval process is critical as any kind of error in documentation will lead to legal issues at port and incur high cost for the shipper. In order to become environmentally sustainable and reduce the supply chain cost, paperwork can be eliminated. This can be achieved by working all the parties involved in the process in a same platform; as an example, automating the system.

Shipping Equipment are eco-friendly machineries and products in the supply chain process. Shipper corporation refer to the working with customers while maintaining environmental objectives. Shipping materials are the packages and cartons which can be recycled or re-use. This involves with having a proper waste disposal method in the company. Shipping design and compliance is minimizing the damage to environment throughout the shipping activities by compliance with the regulations. This can be achieved by incorporating waste management, energy conservation, optimization concept and lean concept to the process. However, according to the study of Montabon, Sroufe and Narasimhan, (2007) packaging and energy initiatives doesn't show any significant impact on firm's performance.

However, Tippayawong et al., (2016) conducted a study in a different perspective and thereby showed that green procurement, green transportation, and green manufacturing; reverse logistics and eco-design; and reuse and recycle of manufacturing affect the performance of green supply chain. The basis for this was Five R analysis which is a tool used to test whether the company policies include efficient use of materials, waste, energy, human resource and time in an environmentally friendly manner. This concept was developed by Daniel C. Esty and Andrew S. Winston and the 5 R's represent for Recycle, Reuse, Reduce, Re-design and Re-imagine (Esty and Winston, 2009).

3. METHODOLOGY

This study addresses the research question; What are the existing green practices, influencing factors, challenges, and opportunities in applying green practices to shipping firms. In this case study deductive approach is used where hypothesis is developed to test whether the factors which were found from literature does really affect the Sri Lankan shipping companies to adopt with green practices. based on the literature following conceptual framework was developed.

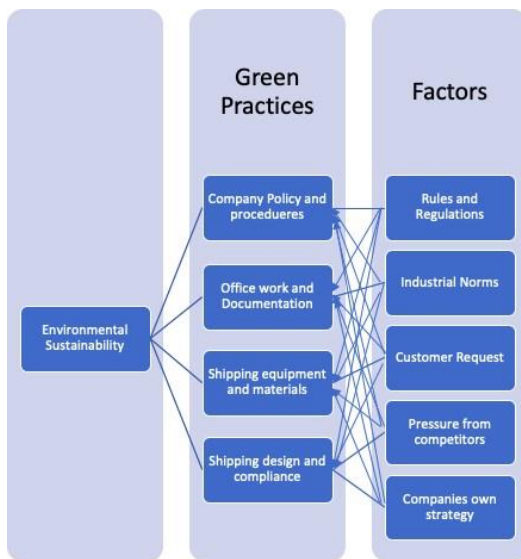


Figure 2: Theoretical Framework Accordingly,

the below theory is put forward

“Environmental performance of the company is affected by the factors rules and regulations, Industrial norms, customer request, pressure from competitors and companies’ own strategy”

Then the hypotheses were deduced from the literature and tested by collecting data and analyzing them. The target population of this study was all the 137 registered shipping companies listed in CASA. Non-probability volunteer Self-selection method used in sampling and out of 137 companies 60 companies responded to the questionnaire. Descriptive statistics is used to describe the basic features of the data set and environmental performance is

calculated for each company by taking the mean value of measurement items in green practices and it was used to identify the existing green practices in Sri Lankan Shipping firms. One of the objectives of this research is to identify the factors affecting adaption of green practices. By considering literature five factors were chosen and to assess them 18 possible reasons were questioned. Mean score of each factor was calculated by taking the mean value given for each reason for adapting to green practices. Then the regression analysis was performed in SPSS by considering Environmental performance (EP) as dependent variable and above 5 factors as independent variables.

4. RESULTS

4.1 Categorical Analysis

The categorical data analysis shows that there are 4.69% of large companies with no. of employees more than 100. 20.31% of companies have 20-50 no. of employees and 15.63% of companies have 50-100 employees. Most of the companies have less than 20 employees which amount to 59.38%.

According to the age wise categorization 43.75% are matured companies which were operated for 20-50 years. Secondly most no. of companies (26.13%) have operated for 10-20 years which are in the growth stage and 18.75% of the companies startups with less than 5 years. Least of the companies 4.69% operated for 5-10 years and same number of companies operated for more than 50 years.

When the status of green practices analyzed most of the companies (71.88%) already follow green practices at some level and 25% are willing to follow them. Only very few 3.13% of the companies are new to the green concept.

Out of all, most of the companies provide Ship chandelling service. Crew management, logistics and freight forwarding, and agency works are

provided respectively. Few companies provide all the services or multiple services.

It can be assumed that when the company becomes larger and becomes stable in the industry by the time more reluctant to adapt green practices. In this study number of employees used as the variable to define the size of the company and age of the company to define the stability of the company. Age and the no. of employees are ordinal variables while environmental performance is a continuous variable. Spearman correlation coefficient is used to assess the relationship between environmental performance (EP), No. of employees (EMP) and age of the company (AGE) as follows.

Correlations				
		EMP	AGE	EP
Spearman's rho	EMP	1.000	.137	-.180
	Sig. (2-tailed)		.280	.155
	N	64	64	64
AGE	Correlation Coefficient	.137	1.000	.232
	Sig. (2-tailed)	.280		.065
	N	64	64	64
EP	Correlation Coefficient	-.180	.232	1.000
	Sig. (2-tailed)	.155	.065	
	N	64	64	64

Figure 3: Spearman Correlation Coefficient

According to the above table, spearman correlation coefficient between No. of employees and environmental performance is -0.180 which is close to 0. It means there is no significant relationship between no. of employees and the environmental performance Spearman correlation coefficient between age is no significant relationship between age of the company and environmental performance.

4.2 Descriptive Analysis

By considering the mean values obtained for the level of green practices followed in Sri Lankan

shipping companies existing level was determined as follows.

Dimension	Measurement Item	Existing Level
Company Policy and Procedure (CPP)	CPP1 Top Management provide necessary support	High
	CPP2 Staff training and guidance for green concept is given	Moderate
	CPP3 Financially Invest on green practices	Moderate
	CPP4 Follow Environmental Management System / ISO 14000 certified	Moderate
	CPP5 Environmental performance reporting/evaluating / auditing	Moderate
Office Work & Documentation (OWD)	OWD1 Use of emails in business operations	Very High
	OWD2 Approval process within the company done electronically	High
	OWD3 Financial documents (Ex: invoice, payment receipts) are handled electronically	Moderate
	OWD4 Customer documents (ex: BL's, Purchase orders, inquiries and quotations) are handled electronically	Moderate
	OWD5 Handling shipping documents electronically outside the office (Ports Authority, Customs and related departments)	Moderate
Shipping Equipment & Materials	SEM2 Eco- friendly warehouses and stock handling ex: CFC free refrigeration	Moderate
	SEM2 Eco - friendly packaging	Moderate
	SEM3 Eco - friendly cargo handling (cartons, Pallets, containers)	Moderate
	SEM4 Eco- friendly delivery and transportation	Moderate
	SEM5 Corporation with environmentally sustainable suppliers of materials	Moderate
Shipping Design for Compliance	SDC1 Use energy saving mechanism	Moderate
	SDC2 Use of Waste disposal method	Moderate
	SDC3 Recycling and recovery of waste	Moderate
	SDC4 Reuse shipping materials ex: packaging	Moderate
	SDC5 Reduce use of resources ex: water, transportation	Moderate
	SDC6 Eco- friendly set up in the building	Moderate

Figure 4: Summary of Descriptive Statistics

4.3 Reliability test

In this study Environmental Performance is calculated by taking the mean value of all the measurement items (green practices). Measurement items are in the five-point Likert scale, and it is required to test whether the scale is reliable. The most common measure of reliability is Cronbach's alpha value. The outcome of the reliability test performed using 21 variables (measurement items) in SPSS. When OWD2 which is "approval process within the company done electronically" is removed Cronbach's alpha value increases by a small

amount to 0.954 which assure that scale is highly reliable.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.954	.957	19

Figure 5: Reliability Statistic after removing OWD2

4.4 Multiple Linear Regression

One of the objectives of this research is to identify the factors affecting adaption of green practices. By considering literature five factors were chosen and to assess them 18 possible reasons were questioned. Mean score of each factor was calculated by taking the mean value given for each reason for adapting to green practices. Then the regression analysis was performed in SPSS by considering Environmental performance (EP) as dependent variable and above 5 factors in the theoretical framework as independent variables. Outcome is as follows.

Coefficients ^a											
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	1.263	.170		7.438	.000					
	RR	-.061	.096	-.091	-.641	.524	.757	-.084	-.041	.197	5.066
	IN	.281	.129	.432	2.178	.034	.846	.275	.138	.102	9.815
	CR	.292	.139	.441	2.106	.040	.853	.267	.133	.091	10.948
	PC	-.003	.101	-.004	-.028	.977	.781	-.004	-.002	.191	5.226
	CS	.115	.056	.168	2.065	.043	.586	.262	.131	.601	1.663
2	(Constant)	1.263	.168		7.520	.000					
	RR	-.061	.095	-.091	-.646	.521	.757	-.084	-.041	.198	5.060
	IN	.279	.110	.429	2.546	.014	.846	.315	.160	.139	7.209
	CR	.292	.137	.440	2.133	.037	.853	.268	.134	.092	10.821
	CS	.114	.054	.168	2.133	.037	.586	.268	.134	.635	1.575
3	(Constant)	1.238	.162		7.618	.000					
	IN	.275	.109	.422	2.521	.014	.846	.309	.157	.139	7.178
	CR	.246	.117	.372	2.110	.039	.853	.263	.132	.126	7.966
	CS	.107	.052	.157	2.054	.044	.586	.256	.128	.664	1.507

a. Dependent Variable: EP

Figure 6: Regression Analysis

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17.794	5	3.559	38.363	.000 ^b
	Residual	5.381	58	.093		
	Total	23.175	63			
2	Regression	17.794	4	4.449	48.779	.000 ^c
	Residual	5.381	59	.091		
	Total	23.175	63			
3	Regression	17.756	3	5.919	65.536	.000 ^d
	Residual	5.419	60	.090		
	Total	23.175	63			

a. Dependent Variable: EP

b. Predictors: (Constant), CS, IN, RR, PC, CR

c. Predictors: (Constant), CS, IN, RR, CR

d. Predictors: (Constant), CS, IN, CR

Figure 7: ANOVA Table

When observing the ANOVA table, it can be observed that Model 3 has significance value 0 which is less than 0.05. It can be stated that overall model is significant at 95% level of confidence.

Model Summary ^d				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.876 ^a	.768	.748	.30458
2	.876 ^b	.768	.752	.30199
3	.875 ^c	.766	.754	.30052

a. Predictors: (Constant), CS, IN, RR, PC, CR

b. Predictors: (Constant), CS, IN, RR, CR

c. Predictors: (Constant), CS, IN, CR

d. Dependent Variable: EP

Figure 8: Model Summary

According to the model summary final model (Model 3) has three predictor variables, CS, IN and CR. Model 3 has 0.766 R² value which is a good value meaning 76.6% of the variance in EP can be explained by CS, IN and CR.

In a regression model it is required to test whether the fitted model is adequate for applications. The residual plot exhibits random pattern so that it can be stated that the assumptions related to error terms which are linearity and constant variance are satisfied. The Normal PP plot is nearly linear which suggest that error distribution is normal.

4.5 Challenges faced by Shipping Firms and employee's perspective on green practices

Table 1: Challenges & Frequency

Challenge	Frequency
Lack of knowledge on green practices	12
Not having common system for communication	9
High investment cost	5
Lack of storage and warehouse facilities	2
Government regulations	1
Lack of management support	1
Other	6

90.63% of the respondents have stated that adapting to green practices add value to their companies and 4.69% of respondents have neutral or negative perspective on this regard.

5. DISCUSSION

According to the graphical analysis there are 4.69% of large companies such as Maersk Lanka, CMA CGM and MSC with no. of employees more than 100 and majority Most of the companies have less than 20 employees. When considering the age of companies, 43.75% were operated for 20-50 years. Remarkably most of the companies (71.88%) already follow green practices at some level and 25% are willing to follow them. Only very few 3.13% of the companies are new to the green concept.

Chang and Danao, (2017) considered firm size and the market coverage as control variables for adaption of green practices assuming when the

company becomes large in size and scope more focus will be given for sustainability concept. However, Spearman correlation coefficient values which are close to zero suggested that there is no significant relationship between no. of employees and age of the company with the environmental performance.

One of the objectives in this study was to identify the existing green practices in Sri Lankan shipping firms. According to the mean values obtained in descriptive statistics, all the green practices are followed at moderate level but not in a considerable level. However, the companies have already taken measures to reduce the paperwork where this was proven by the fact that office work and documentation measures are followed at high level compared to other dimensions.

In regression analysis significance of the coefficients is tested which imply the relationship between EP and other predictor variables. Assume the model as

$$EP = \beta_0 + \beta_1 RR + \beta_2 IN + \beta_3 CR + \beta_4 PC + \beta_5 CS \quad (1)$$

This is a positive significance test where null hypothesis $H_0: \beta_j = 0$ Against the alternative hypothesis $H_1: \beta_j > 0$

Model 3 include three variables, and coefficients all the variables are positive and significant at 95% level of confidence. Therefore, null hypotheses can be rejected which means

“Industrial norms (IN), Customers’ requirements (CR) of environmentally sustainable service and Companies own strategies (CS) on environmental sustainability in Sri Lankan shipping industry are positively related with the

environmental performance (EP) of the company.”

Thus, model obtained from Backward elimination method is

$$EP = 1.238 + 0.275 IN + 0.246 CR + 0.107 CS \quad (2)$$

ANOVA table suggest that overall model (model3) is significant at 95% level of confidence. According to the model summary final model (Model 3) has three predictor variables, CS, IN and CR. Model 3 has 0.766 R² value which is a good value meaning 76.6% of the variance in EP can be explained by CS, IN and CR. The aim of identifying existing green practices and influencing factors is to evaluate the challenges and opportunities in adaption of green practices to shipping firms. As the result of the open-ended question regarding challenges, lack of knowledge on green practices, not having a common system to work with customs and port authority were stated as the common barriers. Despite the challenges 90.63% of the respondents have stated that adapting to green practices add value to their companies and 4.69% of respondents have neutral or negative perspective on this regard.

6. CONCLUSION

In this study 21 green practices were tested and according to descriptive statistics all the practices were found to be followed at moderate level. However, more focus is towards reduction of paperwork by using emails for communication and approval processes within the company are done electronically. According to the outcome of the regression analysis, rules and regulations and pressure from competitors does not affect to environmental performance. However industrial norms, customer request and company strategy have positive influence on environmental performance. Despite the literature, Spearman Correlation coefficients suggest that no. of employees and age of the company are insignificant which means no effect to the environmental performance. This study found that lack of knowledge on green practices, not

having common platform to communicate with customs, port authority and other parties, high investment cost, less storage and warehouse facilities as key challenges when adapting to green practices. Therefore, it is recommended that by giving proper training, technological development and top management and support can overcome these barriers. It is a responsibility of government, regulatory bodies, trade unions to provide sufficient knowledge and motivation for employees to follow green practices and impose rules and regulations on environmental sustainability. The main limitation of this study was not having enough literature based on Sri Lanka related to green practices in shipping industry to refer and companies not responding to the questionnaire. If the sample size can be increased by taking contribution from more companies, better analysis can be performed and achieve reliable conclusions. However, this study and its findings will be a novel contribution to the Sri Lankan maritime literature and sustainability development.

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REFERENCES

- Caliskan, A. and Ozturkoglu, Y. (2016) Maritime logistics, Handbook of Research on Military, Aeronautical, and Maritime Logistics and Operations. doi: 10.4018/978-1-4666-9779-9.ch019.
- Ceylon Association of Ship Agents (2019) CASA, Ceylon Association of ship Agents. Available at: <https://www.casa.lk/members/> (Accessed: 10 October 2020).
- Chandrakumar, C. et al. (2016) ‘Incorporate LEAN and Green Concepts to Enhance the Productivity of Transshipment Terminal Operations’, *Procedia CIRP*, 40, pp. 301–306. doi: 10.1016/j.procir.2016.01.042.
- Chang, Y. T. and Danao, D. (2017) ‘Green shipping practices of shipping firms’,

- Sustainability (Switzerland), 9(5). doi: 10.3390/su9050829.
- Esty, D. and Winston, A. (2009) *Green to Gold; How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage*. New Haven: Yale University Press.
- Indrasiri, R. (2015) 'Analysis of Green Warehouse Practices in Sri Lanka', in 8th International Research Conference, KDU, pp. 197–203.
- Lai, K. H. et al. (2013) 'Measures for evaluating green shipping practices Implementation', *International Journal of Shipping and Transport Logistics*, 5(2), pp. 217–235. doi: 10.1504/IJSTL.2013.053251.
- Lee, E.-S., Nam, H. and Song, D.-W. (2012) 'Defining maritime logistics and its value', in.
- Ministry of Foreign Affairs (2016) 'Sri Lanka: A Maritime & Logistics Hub', (June), p. 12. Available at: <http://www.slpa.lk/location.asp?chk=1>.
- Ministry of Ports & Shipping (2018) *Performance Report-2018*.
- Montabon, F., Sroufe, R. and Narasimhan, R. (2007) 'An examination of corporate reporting, environmental management practices and firm performance', *Journal of Operations Management*, 25(5), pp. 998–1014. doi: 10.1016/j.jom.2006.10.003.
- Norton, T. A., Zacher, H. and Ashkanasy, N. M. (2014) 'Organisational sustainability policies and employee green behaviour: The mediating role of work climate perceptions', *Journal of Environmental Psychology*, 38, pp. 49–54. doi: 10.1016/j.jenvp.2013.12.008.
- PORT OF COLOMBO RANKED WORLD'S NO.01 | LMD (no date). Available at: <https://lmd.lk/port-of-colombo-ranked-worlds-no-01/> (Accessed: 14 December 2020).
- Shin, S. H. et al. (2018) 'Analyzing sustainability literature in maritime studies with text mining', *Sustainability (Switzerland)*, 10(10). doi: 10.3390/su10103522.
- Shipping, M. of P. & (2019) 'Performance report 2019'.
- Sri Lanka Ports Authority (no date). Available at: <https://www.slpa.lk/> (Accessed: 11 December 2020).
- Stopford, M. (2010) *Maritime economics*, *Choice Reviews Online*. doi: 10.5860/choice.47-3934.
- Tippayawong, K. Y. et al. (2016) 'Factors affecting green supply chain operational performance of the Thai auto parts industry', *Sustainability (Switzerland)*, 8(11). doi: 10.3390/su8111161.
- UNCTAD (2011) *Review of Maritime Transport*. New York.
- UNCTAD (2019) *Review of Maritime Transport 2019*. New York.

Sustainable development on tea estates of Welimada: sustainable practices for the increase of brand recognition

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ABSTRACT

The paper is based on sustainability and all the sources used are secondary sources that are used to analyze the course concepts and to provide recommendations. The course concepts used are Carbon Neutrality, Triple Bottom Line, and Corporate Environmental Responsibility. Carbon neutrality explains how Welimada Tea Estates reduced carbon footprint where they are known as “uncompensated” tea. Triple Bottom Line looks into people, planet, and profit whereas the paper brings out the sustainable practices undertaken from the organization to the estate people. Corporate Environmental Responsibility uses natural resources to reduce negative environmental impacts and costs by focusing on waste management, sustainable events, etc. As recommended in Welimada Tea Estate can use natural resources such as fertilizers, cost-efficient methods such as water management, hydro energy, solar energy, thermal power, wind energy, and more cost-efficient methods that benefit the organization as well as the environment. The company can move into the green concept and use decomposable products that will be less harmful to the environment. Welimada Tea Estates can make better efforts to use sustainable practices for the organization that will increase brand recognition as well as the incremental betterment of the environment as well.

Key Keywords: *Sustainability, Carbon Neutrality, Triple Bottom Line CER*

1. GENERAL GUIDELINES

Sustainability can be defined as the development that meets the needed of the present without compromising the ability of the future generations to meet their own needs”. The concept enables to

provide relevant priority to poor people who need help and the limitations which are brought up in society and technology as well as in the environment (Bruntland, 1987).

Welimada is located 1017m above mean sea level in the up-country intermediate zone. Welimada tea estates date back to the 1860s to the British Colonial and have been fertile in tea plantations. The tea estates in Welimada have played a major role in tea manufacturing and marketing by being one of the highest contributors to society as well as the government. This research aims to identify how to improve the sustainability of tea estates in Welimada and how to improve sustainable practices to increase brand recognition.

This research brings out the complex interactions between sustainable development and the environment concerning ways and means of achieving sustainable development.

Sustainability relates to the economic systems and human quality of life which address powerful approaches for examining issues related to global water needs, changes in global climate, and energy demands. Sustainability is a conceptual framework that has a desirable healthy, dynamic balance of humans and systems of policies, beliefs, and practices that will protect diversity, and ecosystems (Duomin, Yubin, Zuoji Dong, & Yiqi, 2022). Sustainability elements which are economic, financial, and environmental that improve the solutions to the challenges that will help benefit triple the bottom line. Sustainable development involves the pursuit of environmental quality, economic prosperity, and social equity which aims for sustainability to enrich environmental performance. It will help in

improving the social and environmental performance of generations (Coronato, 2020).

Sustainability is important in developing economies which are linked to humans as a reflection of freedom. With the recent economic crisis, there have been so many issues arising in the tea industry with exporting, but it also affects the well-being of the employees who work in tea estates. This research was undertaken to concern the well-being of the tea estate community along with developing sustainability. As a resident in the Badulla province my hometown being in welimada, I have seen the beauty and sustainability of Welimada tea estates.

This research was conducted through mixed method field surveys; the information was collected through extensive research of more than thirty estates. "Sri Lanka's geographic location and topography define the climatic and agro-ecological framework, within which the potential tea growing areas are situated. Practically the whole wet zone as well as a considerable portion of the intermediate zone, especially in the Uva basin and eastern Badulla District, is suitable for the successful cultivation of tea"(Humbel, 1991).

As the climate is favorable in the Welimada area, it has provided the opportunity for human labor. This research will discuss the sustainable methods employed by tea estates, how sustainability will improve brand recognition, and the initiatives taken to improve the triple bottom line, CER, and zero carbon emissions.

Hence this research will bring out the opportunities and knowledge for society to maintain a fulfilling productive life by replenishing social, economic, and philanthropic systems to prepare for a better future.

2. LITERATURE REVIEW

2.1. Sustainable Development

As Alam, (2021) mentions human needs are satisfied with the conflicting environment which is presented through the sustainability triangle of the three pillars which are society, environment, and economy. Sustainable development can be defined as a practice of using the three elements social, economic, and environmental. This

process enables in reduction of many environmental issues.

Bruntland Comission (1987) demonstrated sustainable development as "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs" Sustainable development can support a certain system that projects the well-being of natural work and its use of resources. It supports the promotion of alternative energy sources that can be used, it can improve the planet and the population (Sustainable Development Goals and our Sustainability Commitments). It was reinforced by environmental and international legislation that sustainable development contributes to any nation's economic growth. Sustainable development as explained by

Hammer & Pivo (2016) is a multidimensional achievement to achieve more opportunities for people. Social, economic, and environmental development is the reinforcing components of sustainable development. It incorporates thinking towards the future by taking approaches toward a better sustainable world. As proved by Pope & Saunders (2004) sustainable development can be prioritized by reducing emissions that are beneficial for the environment.

2.2. Carbon Neutrality

Carbon neutrality can help balance carbon emissions through the absorption to reduce emissions, in economic development, and to enhance carbon sequestrations which will show many alterations in natural and human systems (Sun, Wu, & Qi, 2020). As it is seen carbon neutrality is a global challenge that is offset to generate carbon dioxide (CO₂) through carbon capture to achieve zero emission of greenhouse gases (Overcoming Barriers to Carbon Neutrality, 2017). Promoting the carbon neutrality process in society will help in reducing carbon emissions constantly and it will decrease the concentration of air pollution and improve air quality (Becker, 2020). With the right opportunities and efforts to achieve carbon neutrality, it will mitigate climate change, thus a society with low carbon will show great significance. Society can take steps to develop strategies for low carbon neutrality such as low carbon transition, industrial restructuring,

energy conservation, improving efficiency to utilize clean energy, develop a circular economy. Christensen & Olhoff, (2019) emphasized how achieving global net zero carbon

emissions/carbon neutrality can control global warming by 1.5 °C. Harness renewable energy- With the ongoing electricity issue there have been severe problems in the tea industry, and the tea estate community, and as citizens of a technological era, many opportunities can be undertaken to sort out the problem.

Gossling (2009) explains carbon neutrality as “a company, service or product that causes carbon emissions to be balanced by funding an equal amount of carbon in the world”. Sullivan (2015) furthermore argues on how this concept was generated through renewable energy and the activities that can be taken to benefit the society in developing countries and to reduce greenhouse gas emissions. Many measures can be taken to reduce energy consumption and emissions and with prior steps taken society can use energy efficient processes, low carbon technology innovations, and renewable electricity with wind, hydro, solar, and thermal (DAS, 2012). Carbon neutrality is a means of producing, where the total output of carbon dioxide during production is neutral or equal to zero, where the emissions are counterbalanced (ROADMAP FOR CARBON NEUTRALITY 2050, 2019).

2.3. Triple Bottom Line

Ramakrishna (2018) mentions triple bottom line is also called the three “p’s”: people, planet, and profit. It captures the beauty and essence of sustainability through the measurement by impacting an organization's activity that has profitability on social, human, and environmental. As mentioned it is an agreement between a community regards societal, ecological, and environment (Kingsley, 2013). TBL is a brilliant and far-reaching metaphor for the three main focuses: people, planet, and profit which focus the effort to incorporate economic, environmental, and social considerations. The economic line of TBL will have an impact on practices an economic system can take to survive and evolve into the future to support future generations (Hammer & Pivo, 2016). The economic line draws

the capacity of growth of an organization and how well it can support the surrounding systems to prosper and support future generations.

John Elkington 1994 introduced the triple bottom line which defines how a business or managers make profits while incorporating environmental and social factors. Slaper (2011) argues how the broad concept brings values to a business through social and environmental activities and how organizations can impact people and the earth through CSR aspects. Coca-Cola (2018) has social aspects which ensure a triple bottom line through providing safe work environments and health benefits for communities who need health and education. As coca-cola has sustainable development goals to undertake programs to have a world without waste in 2030 and to reduce its carbon footprint (Sustainable Development Goals and our Sustainability Commitments). As Elkington projects the triple bottom line will enable environmental advantages as well as for society.

Planet- Environmental measures are projected by natural resources which reflect potential influences regarding its viability. It incorporates the quality of air and water, energy consumption, and natural resources.

Environment practices can be taken for efficient use of energy resources, reducing greenhouse gas emissions, minimize the ecological footprint.

People- Social measures refer to the dimensions of a community to improve education, health, and wellbeing. Social development includes dimensions of a firm, community, region, and measurement of education, social resources health, and wellbeing.

Profit- Economic development can be seen as a dimension of business climate and diversity factors. When conducting or taking measures to increase the profit of an organization it refers to conducting beneficial as well as fair business practices in terms of human, labor, and community.

2.4. Corporate Environmental Responsibility

Corporate environmental sustainability adopts a sustainability model that will ensure the availability of resources for future generations

with minimum use of natural resources and with a reduction of pollution (Alam, 2021). As Busch & Schwarzkopf (2013) mentions CER includes infrastructure activities for the creation of drinking water supply, sanitization, health, education, drainage systems, solar power system, and awareness program for farmers, harvesting with rain water, community plantation programs. As proved by Siegel & Orlitzky (2014) corporate environmental responsibility enables the inculcation of a corporate culture with the essentials of sustainability which motivates the community to reduce its carbon footprint and regulate emissions. With a globally faced challenge of battling the climate crisis, corporate environmental responsibility has made a niche by the measures to control pollution along with environmental protection and conservation (Carroll, 2009).

Environmental development can be undertaken under corporate environmental responsibility to adopt natural resources and reflect potential natural resources and reflect influences on viability. It incorporates quality water and air, energy consumption, and natural resources. Garriga & Mele (2004) project and argues corporate environmental responsibility as a practice that will benefit the environment and the actions undertaken to mitigate adverse actions of business on the environment. Corporate environmental responsibility can also be defined as “Green corporate environmental responsibility” which refers to reducing or eliminating negative impacts on the environment. Under corporate environmental responsibility, there are many quantifiable indicators in the CSR spectrum by undertaking social performance to focus on the issues prevailing such as CO₂ emissions, hazardous materials, etc.

Ganescu & Dindire (2014) mentions the different aspects of CSR which brings out the aspects where organizations take measures on environmental issues to eliminate emissions waste. It will help in reducing negative environmental impacts by using natural resources and costs to focus on waste management and more sustainable activities. Corporate social responsibility is connected to corporate environmental responsibility as both influences

the environmental protection within the corporate. As Montiel (2008) projects corporate environmental responsibility is the relationship between economic, social, and environmental. Some organizations use corporate environmental responsibility such as KMPG which prepares ISO 14001 which has environmental standards and they ensure that the company ensures sustainability through areas such as water, paper, energy, and waste. Levis is another company that involves sustainable environmental approaches where their main approach is to reduce environmental footprint through many campaigns for water manufacturing products, to ensure they save one billion liters of water and hope to improve it by 2030 (Sun, Wu, & Qi, 2020).

Sustainability is the integration of environmental, health, social equity, and economic vitality to create thriving healthy and diverse communities for future generations. Sustainability practices recognize how issues are interconnected and require systems to approach complex issues (Munasinghe, Deraniyagala, & Dasanayake, 2013). Sustainable practices will acknowledge ecological, human, economic, health and vitality

3. METHODOLOGY

The research philosophy used for the research is positivism where as Ipogah, B., & Svensson, (2014) explain positivism as working with social reliability which is observable and at the end of the research there will be a law-like generalization that will be similar to philosophical stances. Gill & Johnson (2002) mentions a positivist researcher will have a highly facilitated methodology to facilitate replication. Positivism is a research paradigm with has a significant influence on the methodology to be used in research. The methodological implications that a positivistic researcher use in a paradigm will infuse specific research questions, choice of respondents, data collection tools, collection procedures, and analysis. A positivist will focus on scientific empiricists that will gather data that are not biased (Saunders, Lewis, & Thornhill, 2016). As this research uses a positivism philosophy, it will promote ideas that will be used to experiment and used to prove hypotheses.

The research approach that will be used is a deductive approach where theory is developed and a framework is developed to test collected data. A deductive approach will be used by literature theories and a theoretical framework will be developed to analyze collected data. There are six steps mentioned by Gill and Johnson (2002): first, deduce a hypothesis where a relationship can be seen between variables. The second step is expressing concepts or variables which are measured. The third step is testing the hypothesis. The fourth step is to examine the theory or the measures to be taken for modification. The deductive theory has a process of finding theories. The research strategy that will be used is a survey that will be done through a Google survey that which be sent to the population.

The researcher used a qualitative as well as a quantitative study. Which has enabled the collection of data through surveys as well as interviews. The research method were questionnaire as well as interviews. Qualitative data instruments observation, open-ended questions, in-depth interviews, and field notes are used to collect data from participants. The participant's observation and focused group nature of qualitative research will bring a wide understanding of behavior. The researcher constructs and reconstructs theories where necessary which are based on data generated. The quantitative approach in research emphasizes numbers and figures in the collection and analysis of data. It can be seen as being scientific.

A sample of 80 was collected through interviews and a survey. Simple random sampling is the method used for the research. Probability sampling is every item in the population has an equal chance of being included in sampling (Cooper & Schindler, 2014). Gill & Johnson (2002) mentions that simple random sampling can be free from bias and will be more costly regarding time and energy. The research conducted is done through the use of mixed data collection techniques. Morgan table was used for the selection of the population of 102 and a sample of 80 was collected from the tea estate community.

Accordingly the following hypothesis was used.

H1 There is a positive relationship between sustainable development and carbon neutrality

H2 There is a positive relationship between sustainable development and Triple bottom line

H3 There is a positive relationship between sustainable development and corporate environmental responsibility

4. DATA ANALYSIS

Analysis was conducted from the data collected through a sample of 80, the reliability was analyzed based on Cronbach's Alpha value. This analysis was done by the complete data collected from the questionnaire and the interviews. Reliability can be mentioned as the consistent measure of a test that is undertaken which is reliable that will have the same result and conditions. Cronbach Alpha values will enable in measuring the internal consistency of the likert scale. It will bring out the high internal consistency and the high reliability.

The recommended Cronbach's Alpha value should be above 0.7 and if so, it is considered reliable. The Cronbach alpha for the independent variables which are carbon neutrality (3 items) is .744, triple bottom line (3 items) : .713, corporate environmental responsibility (3 items) : .642. All independent variables have a strong reliability since the values are between 0.4 to 0.7 which ensures the items are reliable and acceptable for further statistical analysis. The Cronbach alpha value for the dependent variable sustainable development (2 items) is .612 which is also between 0.4 to 0.7 which is reliable and acceptable for further analysis.

The research have analyzed the data collected from the respondents by using another analyzing method known as Pearson correlation coefficient and regression analysis. Both analyses will enable in depicting strengths of the dependent and independent variable. Correlation coefficient analysis ranges between -1 and +1. And 0.05 can be mentioned as the significant level to accept hypotheses.

Correlation coefficient between sustainable development and carbon neutrality is .324. The

correlation coefficient value is between .000 which is less than 0.01. As the value is .324 it lays 0.25 and 0.50 it depicts a low degree of correlation between sustainable development and carbon neutrality. The correlation coefficient of triple bottom line is 5.12 and corporate environment responsibility which depicts increase in the increment of sustainable development. The correlation value .512 and .519 shows a moderate positive correlation between triple bottom line and sustainable development : corporate environment responsibility and sustainable development .

Liu & Kuang (2003) explained ANOVA model is used to identify the significance of research. The significance level must be less than 1% of sample error ,then there is a chance of model being accepted. The significance value is 0.000 which is less than 0.01 ,where the model and can be accepted and depicts that sustainable development has an influence on sustainable activities. Multiple regression coefficients consider all independent variables that can be used to identify the relationship with the dependent variable which is sustainable development.

The standard beta value of coefficient for independent variables will prove whether there is a positive impact of sustainable development on the sustainable activities in Welimada tea estates. The hypotheses was tested using linear multiple regression which determined the independent variable has a positive impact on sustainable development. The hypotheses with be accepted or rejected based on standardized beta and the significance value projected in the regression analysis and the significance value must be less than 0.05 and standardized beta must be positive.

H1- There is a significant relationship between sustainable development and carbon neutrality According to the statistical analysis done , the standard beta coefficient between sustainable development and carbon neutrality was generated through multiple regression with a value of .701 with a significance value of .485 which confirms a positive relationship between the two variables. Hence the researcher accept H1 and reject H1₀.

H2- There is a significant relationship between sustainable development and triple bottom line. Standard beta coefficient between sustainable development and triple bottom line was generated through multiple regression which shows a result of .207 with a significance value of .091 ,where the researcher accept H2 and reject H2₀.

H3- There is a significant relationship between sustainable development and corporate environmental responsibility. The result generated through multiple regression shows a value of .433 with a significance value of .001, where the association between the two variables is significant. There for the researcher accept H3 and reject H3₀. Furthermore, it is proved in the empirical studies that sustainable development have significant relationship with the three variables.

After testing hypotheses the researcher have accepted all three variables to have significant influence on sustainable development. Hence the researcher use previous literature sources to bring put previous discussions which have proved that carbon neutrality, triple bottom line and corporate environmental responsibility have a positive influence on sustainable development .

To have minimized environmental impacts many environmental friendly alternatives are tested for methyl bromide including soil solarization, use of methane sodium dazomet and different concentrations (Duomin , Yubin , Zuoji Dong , & Yiqi , 2022).

Gunawardena (2011) projects on how Sri Lanka is the first tea growing country which has phased out the use of methyl bromide and earned ozone friendly label. Use of mana (cymbopogon confertiflorum) can be used in replanting to control nematode infestation without using chemicals. Cracknell & Njoroge (2014) explain that organic cultivation will increase soil carbon pool, by reducing atmosphere CO₂ concentration and to mitigate climate change. Addition of organic fertilizers helps in reduced soil erosion. A well-managed tea estate has a good canopy cover which will protect the land by reducing splash erosion. When Agro forestry is achieved in large scale it has positive impacts on tea, because it will

improve micro-climate surrounding tea bushes. It is further proved by Wijeratne, De Costa, & Wijeratne (2015) that tea plantations with shade have comparable carbon sequestration potentials to agroforestry systems, which will help in reducing carbon footprint of tea.

If hydro power is used to generate electricity, the environmental impact could be reduced compared to electricity generated using coal and fossil oils. Electricity wastage especially in tea manufacturing process are addressed using on-site electricity with using many techniques such as mini hydropower stations. In that method energy wastage from electricity generation for consumption can be reduced enormously. New energy efficient technologies can be adopted by using energy saving stoves, energy efficient boiler and replacing LED bulbs (Christensen & Olhoff, 2019).

In the life cycle of tea, the highest energy used is in consumption stage, alternate tea which uses cold water instead of boiling water which help in using energy efficient kettles and to reduce carbon footprint of tea (Sauer, 2009). Another highlighting factor in sustainability is the soil respiration of the growing tea. Soil respiration can be defined as CO₂ production in soils that result from respiration of soil organisms and roots. It is mentioned as a function in terrestrial ecosystems which contribute to global carbon cycling and climate change. As mentioned by the total global emission of CO₂ from soil has a flux on global carbon cycle and changes in magnitude of CSR have an affect on concentration of CO₂ in atmosphere. As tea or *Camellia Sinesis* it is the most important plantation crop grown in Sri Lanka which is important to get CO₂ emissions from tea lands to remain profitable (Saikia, Sarma, Dutta, & Baruah, 2011). In some areas in Welimada the working conditions for pickers are poor with low wages, low job and income security, discrimination along with ethnic and gender lives, lack of protective gear and inadequate basic facilities such as housing, food and water. But sometime their working conditions don't improve because of trade unions being ineffective or absent or won't represent them. The sectors environment can be considered through reduced biodiversity with resulting of habitat

conversion and high energy consumption (Munasinghe, Deraniyagala, & Dasanayake, 2013).

5. CONCLUSION

This research provides contributions to literature on sustainability and broad set of practices which emerge ranging from carbon footprint reductions in carbon emission offsetting. And triple bottom line which was address in the literature review projects the social, environmental and economic issues that are raised in the struggle to retain resources for future generations while utilizing enough to survive today. Sustainability will boost brand awareness by the demonstration of sustainability, in legal and ethical best practices.

When organizations adapt to the sustainable practices of going green, it will reduce overall cost. For example, tea factories can switch to energy efficient smart LED lights that can help save money. Green initiatives can be taken to reduce amount of waste the business generate and can reduce the expenditure on waste disposal system. Sustainable development is a broad, dialectical concept that balance need for economic growth by protecting society as well as the environment. WCED (1987) mentions that sustainable development as the development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.

Brand recognition is how a consumer recognize and discriminate a brand through how its shown. A brand is purchased by how it influences a consumer and how strong the brand is recognized again. Green sustainable marketing can bring recognition by addressing issues such as air, water pollution, and climate change. A green brand describes as a brand where environmental values constitute brand essence. When brand use priority the natural resources, environmental protection programs, community CSR program, it will increase brand recognition. As there is a global demand for natural products, organizations have made positive green credentials. Sustainability can be used as a brand for differentiation. With the recent changes in the country due to COVID-19, it has raised serious concerns regarding sustainability in a long term perspectives. There

are ecological indicators related to the environmental activities which include economic, social and sustainability parameters. The community can be acknowledged with the quality of work and life through the spheres of air, land and water. When organizations practice sustainability as a culture, it will help in developing new marketing opportunities. Welimada tea estates can improve green marketing to execute sustainable business practices, to demonstrate social responsibility to highlight awareness of a green environment.

REFERENCES

- Alam, S. (2021). Examining the role of environmental corporate social responsibility in building green corporate image and green competitive advantage. *International Journal of Corporate Social Responsibility*.
- Christensen, M. J., & Olhoff. (2019). Emissions Gap Report. UNEP (United Nations Environment Programme).
- Duomin, W., Yubin, H., Zuoji Dong, & Yiqi, D. (2022). Research Hotspots and Evolution Trends of Carbon Neutrality—Visual Analysis of Bibliometrics Based on CiteSpace. *Sustainability*.
- Darlington, B. (2016). Benefacto. Retrieved from <https://benefacto.org/what-is-corporate-volunteering/>
- Hammer, J., & Pivo, G. (2016). The Triple Bottom Line and Sustainable Economic Development Theory and Practice.
- Hanks, G. (n.d.). Small Business. Retrieved from <https://smallbusiness.chron.com/maximizing-profits-theory-social-responsibility-business-65231.html>
- Hilal, M. (2020). Sri Lanka's Tea Economy: Issues and Strategies. *Journal of Politics and Law*.
- Kamalakkannan, S., Kulatunga, A., & Kassel, N. (2020). Environmental and social sustainability of the tea industry in the wake of global market challenges: a case study in Sri Lanka. *International Journal of Sustainable Manufacturing*.
- Powe, N. (2020). Sustainable development, sustainability and research within the Journal of Environmental Planning and Management. *Journal of Environmental Planning and Management*.
- Slaper, T., & Hal, T. (n.d.). The Triple Bottom Line: What Is It and How Does It Work? Overcoming Barriers to Carbon Neutrality. (2017). A Report of the Carbon Neutrality Finance and Management Task Force.
- ROADMAP FOR CARBON NEUTRALITY 2050. (2019).
- Becker, S. (2020). The carbon neutrality principle: A case study in the French spirits sector. *Journal of Cleaner Production*.
- Bliss, R. T. (2015). cfo.com. Retrieved from <https://www.cfo.com/risk-management/2015/02/shareholder-value-csr-friends-foes/>
- British, T. (n.d.). Environmental management. Retrieved from <https://www.bat.com/environment>
- Brundtland. (1987). The Brundtland Report 'Our Common Future. Sustainable Development.
- Bryman, A. (2012). *Social Research Methods*. 4th edition. New York: Oxford University Press.
- Busch, T., & Schwarzkopf, J. (2013). Carbon management strategies - A quest for corporate competitiveness. *Progress in Industrial Ecology An International Journal*.
- Ceylon Tobacco Company, C. T. (n.d.). Ceylon Tobacco Company. Retrieved July 29, 2019, from http://www.ceylontobaccocompany.com/group/sites/SRI_9PMJN9.nsf/vwPagesWebLive/DO9PMKL5
- CocaCola. (2018). Business & Sustainability Report.
- Cooper, D., & Schindler, P. (2014). *Business research methods*.
- Coronato, M. (2020). The Sustainability Dimensions: A Territorialized Approach to.
- Creswell, J. W. (2009). *Research Design Qualitative, Quantitative and Mixed Methods Approach*. London: SAGE Publication.
- CTC Annual Report 2013, C. A. (2013). CTC Annual Report 2013. Ceylon Tobacco Company.
- Cycyota, C. S. (2016). Science Direct. Retrieved from

- <https://www.sciencedirect.com/science/article/pii/S0007681316000057>
- Cracknell, R., & Njoroge, B. (2014). , B. (2014). Mitigating Climate Change in the Tea Sector. International Trade entre.
- DAS, S. (2012). Achieving Carbon Neutrality in the Global Aluminum Industry.
- EFC Member Achievement - Bogawantalawa achieves Carbon Neutral Certification. (n.d.). Retrieved December 5, 2019, from <http://www.employers.lk/estate-labour-indian/638-efc-member-achievement-bogawantalawa-achieves-carbon-neutral-certification->
- Freeman, E., & Dmytryiev, S. (2017). Corporate Social Responsibility and Stakeholder Theory.
- Freeman, E., & Velamuri, R. (n.d.). A New Approach to CSR: Company Stakeholder Responsibility.
- Gaffney, O. (2014). Sustainable Development Goals Improving human and planetary wellbeing. Global change.
- Gunawardena, N. (2011). Ozone friendly pure Ceylon tea. Retrieved January 19, 2022, from <http://www.businesstoday>.
- Ganescu, C., & Dindire, L. (2014). Corporate environmental responsibility – a key determinant of corporate reputation.
- Garriga, E., & Mele, D. (2004). Corporate Social Responsibility. *Journal of Business Ethics*, 51–71.
- Gil, R. B. (2007). Family as a source of consumer-based brand equity. *Journal of Product and Brand Management*, 188–99.
- Gill, , J., & Johnson, , P. (2002). *Research Methods for Managers*. London: Sage Publications.
- Gossling, S. (2009). Carbon neutral destinations: a conceptual analysis. *Journal of Sustainable Tourism*, 17-37.
- Griggs, D. (2013). Sustainable development goals for people and planet.
- Ipogah, , B., B., , A., & Svensson, , M. (2014). A Study to Indicate the iBuss Management. 29-39.
- Kates, R. (2000). SUSTAINABILITY SCIENCE.
- Kates, R., & Parris, T. (2014). What is sustainable development? goals , indicators, values and practice.
- KENTON , W. (2019). Investopedia. Retrieved from <https://www.investopedia.com/terms/t/triple-bottom-line.asp>
- Kingsley, O. (2013). Triple Bottom Line Accounting: A Conceptual Expose. *Journal of Business and Management*, PP 30-36.
- Liu a, R., & Kuang b, J. (2003). Principal component regression analysis with SPSS. *Computer Methods and Programs in Biomedicine*.
- MacDonald, C., & Norman, W. (2004). Getting to the Bottom of “Triple Bottom Line”. *Business Ethics Quarterly*, 243 - 262.
- Maines, L., & Sprinkle, G. (2010). The benefits and costs of corporate social responsibility. 445—453.
- Munasinghe , M., Deraniyagala, Y., & Dasanayake, N. (2013). Economic, social and environmental impacts and overall sustainability of the tea manufacturing industry in Sri Lanka. . *SCI Research Study Report*. Munasinghe Institute for development.
- McGUIRE, J. (1988). CORPORATE SOCIAL RESPONSIBILITY AND EIRM EINANCIAL PEREORMANCE. *Academy o/ Monogement /oumal*, 854-872.
- MCWILLIAMS, A., & SIEGEL, D. (2001). CORPORATE SOCIAL RESPONSIBILITY: CORPORATE SOCIAL RESPONSIBILITY:. *Academy of Management Review*, 117-127.
- Montiel, I. (2008). Corporate Social Responsibility and Corporate Sustainability. *Organization & Environment*, 245-269.
- Moon, J., Mattenw, D., & Muthuri, J. (2009). Employee Volunteering and Social Capital ; Contributions to Corporate Social Responsibility. *British Journal of Management*, 75-89.
- Naeem , M., & Sami, A. (2020). Product Brand Loyalty and Purchase Decision. *International Journal of Entrepreneurial Research*, 76-87.
- Nike. (n.d.). Renewable Energy. Retrieved from <https://purpose.nike.com/renewable-energy>
- OECD. (2002). *Frascati Manual: proposed standard practice for surveys on research and experimental development*.

- Parkhurst, M. (2017). Renewable Energy World. Retrieved from <https://www.renewableenergyworld.com/ugc/articles/2017/05/23/corporate-social-responsibility--how-renewables-have-expanded-the-field.html>
- Patten, B., & Costanza, R. (1995). Defining and predicting sustainability. *Ecological Economics*, 193-196.
- Peattie, K. (1992). *green marketing*. Pitman.
- Pope, J., & Saunders, A. M. (2004). Conceptualising sustainability assessment. *Environmental Impact Assessment Review*, 595-616.
- Rahman, S. (2011). Evaluation of Definitions: Ten Dimensions of Corporate Social Responsibility.
- Ramakrishna, V. (2018). TRIPPLE BOTTOM LINE OF SUSTAINABILITY.
- Sachs, J. (2012). From Millennium Development Goals to Sustainable.
- Samanga, R., & Sachitra, V. (2017). IMPACT OF FACTORY MODEL CULTIVATION ON TEA INPUT AND OUTPUT QUALITY: A STUDY IN SELECTED TEA FACTORIES IN RUHUNU REGION, SRI LANKA. *European Journal of Economic and Financial Research*.
- Schooley, S. (2019). *businessnewsdaily.com*. Retrieved July 29, 2019, from businessnewsdaily.com/4679-corporate-social-responsibility.html
- Sharma, V., Kaushal, A., & Tripathi, D. (2013). Reality of Triple Bottom Line. *Global Journal of Management and Business Studies*, 153-158.
- Siegel, D., & Orlitzky, M. (2014). Strategic Corporate Social Responsibility and Environmental Sustainability. 6-27.
- Saikia, D. N., Sarma, J., Dutta, P. K., & Baruah, D. K. (2011). Sustainable productivity of tea through conservation of bio-mass, addition of bio-fertilizers and reduction of inorganic fertilizer. *Two and a Bud*. 109-17.
- Sauer, J. L. (2009). Tea's carbon footprint. Retrieved January 20, 2022, from <http://www.samovartea.com/teas-carboncarbonfootprint/>
- Slaper, T. (2011). *The Triple Bottom Line: What Is It and How*.
- Sullivan, F. &. (2015). Benefits of Carbon Neutrality in a Rapidly Changing Business Environment.
- Sustainable Development Goals and our Sustainability Commitments. (n.d.). Sustainable Development Goals.
- Sun, L., Wu, L., & Qi, P. (2020). Global characteristics and trends of research on industrial structure and carbon emissions: A bibliometric analysis. *Environ. Sci. Pollut. Res.*, 44892-44905.
- Unilever. (n.d.). Retrieved from <https://www.unilever.com.lk/sustainable-living/sri-lanka-sustainability-initiatives/unilever-s-project-arunella-works-with-communities-on-sustainable-waste-management/>
- Wndungu, C. (n.d.). Course Hero. Retrieved from <https://www.coursehero.com/file/p79sfof/T-RIPPLE-BOTTOM-LINE-3-Coca-Cola-Company-addresses-social-aspect-of-the-triple/>
- Wijeratne, T. (2018). Assessing and reducing the environmental impact of tea cultivation.
- Wijeratne, T., De Costa, J., & Wijeratne, M. (2015). Carbon sequestration of tea plantations as an adaptation for climate change. Abstract presented at the 4th International Conference on . 41.
- Xianhua Wu, Zhiqing Tian, & Ji Guoab. (2022). A review of the theoretical research and practical progress of carbon neutrality. *Sustainable Operations and Computers*, 54-66.
- Chen, W., (1991). *Nonlinear Analysis of Electronic Prognostics*. Doctoral dissertation. The Technical University of Napoli, Napoli, Italy.
- Ferrell, B. L. (1999), JSF Prognostics and Health Management. *Proceedings of IEEE Aerospace Conference*. March 6-13, Big Sky, MO. doi: 10.1109/AERO.1999.793190
- Hyndman, R. J., & Koehler, A. B. (2006). Another look at measures of forecast accuracy. *International Journal of Forecasting*, vol. 22, pp. 679-688. doi:10.1016/j.ijforecast.2006.03.001
- International Standards Organization (ISO) (2004). Condition Monitoring and

Diagnostics of Machines - Prognostics part 1: General Guidelines. In ISO, *ISO13381-1:2004(e)*. vol. *ISO/IEC Directives Part 2, I. O. f. S.* (ISO), (p. 14). Genève, Switzerland: International Standards Organization.

Schwabacher, M., & Goebel, K. F. (2007). A survey of artificial intelligence for prognostics. *Proceedings of AAAI Fall Symposium*, November 9–11, Arlington, VA. www.aaai.org/Library/Symposia/Fall/2007/f07-02-016.php

Vachtsevanos, G., Lewis, F. L., Roemer, M., Hess, A., & Wu, B. (2006). *Intelligent fault diagnosis and prognosis for engineering system*. Hoboken, NJ: John Wiley & Sons, Inc

Influence of Brand Equity on Purchase Intention for Natural Handworks

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ABSTRACT

This research aims to identify how brand equity influences the purchase intention of natural handworks. Haritha Design uses the brand equity variables to evaluate how they influence purchase intention. Purchase Intention was identified as the dependent variable which is used to evaluate the relationship between brand equity and its variables. The independent variables are brand equity, brand loyalty, perceived quality, brand awareness, brand association, and the independent variable purchase intention, which are analyzed and evaluated using previous literature. Haritha design customers were used as the target population to collect data. The sampling method used was a simple random sampling method and 340 respondents participated in this study. Data were gathered by Haritha Design consumers as a primary data collection method using a questionnaire which was distributed as a Google form. SPSS was the data analytic tool used to further the analysis process. The reliability of the variables was analyzed using Cronbach Alpha Value and all 6 variables were considered to be reliable. The correlation Coefficient was used to measure the strength of the variables which all dependent variables confirmed to influence Purchase Intention. The adjusted R showed a value above 50%. Hypotheses were tested and five variables were accepted. Finally, the research reached its conclusions by deriving the summary of all chapters.

1. INTRODUCTION

Brand equity is defined as the added value of a product or service which reflects in the way consumers think, feel or react concerning the price, market, and profitability of the firm (Singh & Banerjee, 2021). Haritha Design is an

enterprise taken for the research which is an entrepreneurial business of natural handworks. This enterprise is located in Badulla district in Sri Lanka. As a researcher, this research uses the brand name “Haritha” and the product marketed is natural handworks where this study explores the influence of brand equity on the purchase intention for natural handworks. In today’s society brands are driven to develop distinctive images to sustain their competitive advantage. Hence consumer-based brand equity is important, which assesses brand performance, differentiates brands, and gains an advantage in the market (Ashmond, 2021). Enterprises that use brand equity for their performance achieve positive results and benefits. Purchase intention is reflected as the outcome of brand equity whereas this research will explore the influence of brand equity on the purchase intention of natural handworks. Haritha Design is an enterprise established in 2015 as a unique business to provide customers with unique and different handwork which is valuable due to its ingredients such as wildflowers, paddy, leaves, rare bonsai trees, etc. With society focusing on technology, this company will help the individual by providing a piece of art that will provide beauty, artistic, valuable, and rare handworks. Since the COVID situation, there has been a fluctuation in the purchasing of Haritha design handwork. It has shown that there’s less profit compared to last year, which is why the enterprise can use brand equity to influence the purchase intention of natural handworks. When a brand is successful it helps in triggering brand equity, it helps to focus on developing and maintaining new marketing strategies (Atilgan, Aksoy, & Akinc, 2005).

This research is important academically because this research brings out updated information on brand equity, its dimensions, and purchase

intention. Wenyan (2019) mentions when building a brand, brand equity is important because high equity brand levels lead to high purchase intentions. Kumar, Shekhar, Dash, & Purwar (2013) projects brand equity can be explained as assets and liabilities that are linked with brand, name, symbol, and the value which is provided by product/service to the prior customer. This study is important from a business perspective due to the ability to satisfy customers according to their taste in handwork whereas Kumar & Rekhi (2017) mentions that for a brand to be successful it must develop a distinctive personality to gain competitive advantage. As a researcher, this research uses the brand name "Haritha" and the product marketed is natural handworks where this study explores the influence of brand equity on the purchase intention for natural handworks. Pinar, Trapp, & Girard (2014) project that positive feelings about a brand create purchase intention for customers.

This study is important personally as an entrepreneur to incorporate values and expertise that shape organizations structure and strategy by making natural handworks that are creative and differentiate one another by flowers and leaves. I get to do my own business by providing customers with what they like whereas Aaker (1991) mentions one's future is shaped when one works on things that are of interest to them and attract customers. Entrepreneurs incorporate values and expertise that shape organizations' structure and strategy. Keller (1993) mentions when building a brand, brand equity is important because high equity brand levels lead to high purchase intentions. Forbes (2017) project that Professor Kevin Keller brings out that to build brand equity a firm has to shape how consumers think and feel about the product.

And this topic is significant to the firm because brand equity can be achieved to influence purchase intention when consumers recognize the brand. Çifci, Ekinci, Whyatt, & Japutra (2016) mentions that customer satisfaction can be projected as a barometer that will predict future customer behavior. Haritha design has implemented brand equity practices which helped the company to achieve higher productivity

hence; it will have a positive impact on the performance of the company.

Aims and Objectives

Aim- The main aim of this research is to identify how brand equity influences purchase intention for natural handwork

This research has 3 main questions which will help in understanding the significance of the topic

- a) What are the Brand Equity dimensions?
- b) How do brand equity dimensions affect the purchase intention of natural handworks?
- c) What are the recommendations to increase purchase intention of natural handworks based on the brand equity dimensions?

Objectives

- a) To examine the dimensions of brand equity
- b) To examine how brand equity dimensions affect the purchase intention of natural handwork
- c) To provide recommendations to increase purchase intention of natural handworks based on the brand equity dimensions.

2. LITERATURE REVIEW

2.1. Brand equity

Brand equity is defined by Keller (1993) as "the added value which is endowed on products and services. It may be reflected in the way consumers think, feel and act concerning the brand, as well as the prices, market share and profitability the brand commands for the firm". Shahin, Kazemi, & Mahyari (2012) argue that a product has high brand equity when a product in a certain brand has an advantage over its competitors and is bought more frequently. Su (2016) depicts that brand equity can be explained as assets and liabilities that are linked with brand, name, symbol, and the value which is provided by product or service to the prior customer. Brand equity is important in the marketing field where most studies include the brand equity ten-element model of Aaker (1991), four element model of Aaker (1996), pyramid model of Keller (1993), and three-dimension models of Yoo & Donthu (2002). Aaker's brand equity framework is known to influence scale

developments whereas Yoo & Donthu (2000) use this model to assess brand equity. Yoo & Donthu (2000) developed a multi-dimensional scale to measure brand equity which is claimed to be reliable and valid. Malik, Ghafar, Iqbal, & Riaz (2013) mention that brand loyalty, brand awareness, brand association, and perceived quality were found as dimensions of brand equity. Yoo & Donthu (2000) developed a multi-dimensional scale to measure customer-based brand equity.

2.2. Brand loyalty

Customer loyalty leads to profitability as customers can be the main force for growth and it can be considered from many different aspects (Alhaddad, The effect of brand image and brand loyalty on brand equity, 2014). Rshidi & Rahmani (2013) explains such aspects are loyal to products, services, etc. Kanwal & Hameed (2018) depict that to satisfy a need or want a loyal customer will pay extra whereas Sally & Francisco (2016) mentions that when customers make decisions brand loyalty becomes an important factor. It's an important dimension because if it is established then brand equity will be the result (Gil, 2007). Monalisa (2020) explained brand loyalty as the tendency of consumers to purchase one brand over another. Chierici (2019) measures brand loyalty through the repeating purchase or the consumer's approach toward a brand. Organizations can reduce the cost of marketing (Foroudi, Jin, Z, Gupta, & Foroudi, 2018).

2.3. Perceived quality

Vo & Nguyen (2015) mentions a crucial determinant that perceived quality can be a factor that affects purchase intention. It was proved by (Saleem, Ghafar, Ibrahim, & Yousuf, 2015) that when a customer has a positive perspective regarding a certain product then it will influence purchase intention. It is mentioned by Calvo-Porrall & Lévy-Mangin (2017) that it is a reason why customers differentiate a brand from another.

As Saleem, Ghafar, Ibrahim, & Yousuf (2015) prove perceived quality is a component of brand equity that can measure brand equity. Perceived quality helps to judge the overall excellence of a product (Braun, 2020). Perceived quality is mentioned as the "core/primary" facet of the

CBBE framework (Calvo-Porrall & Lévy-Mangin, 2017).

Perceived quality is the customer's perception of the product quality of a brand (Calvo-Porrall & Lévy-Mangin, 2017). Chaudhuri (1997) mentions in their research that perceived quality has a positive effect on purchase intention. Das (2015) projects on how consumers have personal experiences with a product which will also the quality of the product. When a brand is differentiated and the quality is a component of brand value, it will be purchased by consumers which will lead to high brand equity (Prados-Pe & Barrio-García, 2021).

2.4. Brand awareness

Chierici (2019) project the ability of a brand to appear in consumers' mind when they remind a product. Brondoni (2001) also believes important point in showing the difference between a brand and its competitors. Ipogah & Svensson (2014) argues that brand awareness can be measured through brand recognition such as through logo, slogan, tagline, advertising, etc. When a brand comes to consumers' minds it can be explained as brand awareness (Surucu, Ozturk, Okumus, & Bilgihan, 2019). Calvo-Porrall & Lévy-Mangin (2017) explains it as the customer's views on how they look at a brand's perceived strength. Brand awareness represents a strong identity of a brand that is apparent in the consumer's mind. It includes the roles in the process of customer decision-making (Anas & Sohail, 2021) (Vanitha & Subramanian, 2020).

It has inadequate to influence a consumer to purchase or make a decision to use a service (Shahid & Tehmeena, 2017). It's essential in brand equity as it is the precondition for brand and customer-based equity (Romaniuk, Wight, & Faulkner, 2017). Astrid (2020) explains that brand awareness has a positive effect on purchase intention. When a brand includes high brand equity and has a high level of brand awareness it will have an impact on purchase intention (Hayes, 2008), whereas Cho, Fiore, & Russell (2015) argues that brand awareness is a salient tool and a fundamental component which will help in developing brand equity.

2.5. Brand association

It is a method that when consumers know products that relate to brand association it will pave the way to build brand equity (Susanti, Sumarwan, & Simanjuntak, 2019). Severi, Ling, & Nasermoadeli (2014) mentions that brand associations are the linkage between the product and the consumer through its brand, name, price, and characteristics. Clave(2020) depicts how brands (private) have more importance to quality than price. When manufacturer brands are compared with private brands, the latter has a reputation due to its advertising (Samudroa, 2020). Mohsan & Nighat (2017) depicts perceived quality can be the outcome of consumer judgment and perceptions of a product or service. It can provide differentiation; self-confidence and a sense of comfort to buy (Grigaliūnaitė & Pilelienė, 2017). Susanti, Sumarwan, & Simanjuntak (2019) explain that it brings out the information in customers' minds regarding the brand that is linked to the memory. It is grouped into product-related attributes like brand performance and non-product attributes like brand personality and organization (Susilowati, 2020). Grigaliūnaitė & Pilelienė (2017) conducted research on brand association which proves that it influences purchase intention. The four dimensions are found to have positive effects on overall brand equity Alnsour (2018). Shariq (2018) mentioned that for purchase intention to be established brand equity dimensions are needed to maintain causal relationships. A proposed model for brand equity was brought out with the four dimensions of brand loyalty, brand awareness, brand association, and perceived quality whereas Martinez & Chernatony (2013) argues that brand equity and its dimensions are interlinked with one another. Saleem et al (2015) depict in their research that perceived quality has a positive relationship with purchase intention which is also proved by

Das (2015). Singh & Banerjee (2021) mentions that purchase intention can be explained as a situation where a consumer tends to buy a product in a certain condition. Purchase intention determines the purchasing behavior of potential customers and it is considered the willingness of a buyer to buy a product or service (Aquini & Soliha, 2020).

Kanwal & Hameed (2018) mention there are three indicators or aspects that show the customer retention to buy. It involves the study of the behavior, perception, and attitudes of consumers (Ariesta & Ruswanti, 2017). Aaker (1991) reinforced that brand equity has a positive impact on consumers' purchase intention.

Brand loyalty will make consumers have attachments with the brand which will affect purchase intention, but it is also a fact that brand loyalty cannot happen without purchasing behavior (Aaker D. A., 1991). Alnsour (2018) that brand awareness increases consumers' familiarity with a product and is very crucial towards purchase intention. Kumar & Rekhi (2017) explains that brand associations help customers to differentiate a brand, gain information, convince them to buy a brand, and have a positive attitude towards the brand. Chen et al (2020) depict perceived quality to deliver the value of differentiation as well as uniqueness and is very crucial for purchase intention as it will determine the importance of how customers value the brand and the willingness to purchase. Vinh, Nga, & Nguyen (2017) define purchase intention as when a consumer buys a product the probability of it happening. When they are exposed to the brand it will be the first step in building brand equity (Su, 2016). When a consumer expresses their decision to buy a product, the process is influenced by attitude and belief (Naeem & Sami, 2020). There have been successful investigations into brand equity, its dimensions, and purchase intention and its relationship (Vinh & Huy, The relationships among brand equity, brand preference and purchase intention, 2016). Purchase intention is the probability of a customer buying a product or brand where brand equity is considered to affect purchase intention (Carrubi & Martínez, 2019). Jeon (2017) proved by several studies that a positive relationship exists between brand equity and purchase intention. Bashir (2019) reveals that in many studies it is indicated that purchase intention is impacted by the influence of brand equity and also has a positive impact on consumers' purchase intention.

3. METHODOLOGY

3.1. Research Philosophy

Positivism, as explained by Ipogah, B., & Svensson (2014), is working with observable social reliability where the end product of the research is law-like generalizations that are similar to the physical and natural scientist philosophical stances. A positivist researcher depicts and uses a highly structured methodology to facilitate replication (Gill & Johnson, 2002). Saunders, Lewis, & Thornhill (2016) mentions that positivism is to be focused on the methods of scientific empiricism which will be used to gather data that are not biased or misinterpreted. Positivism promotes ideas that are from experimentation and used to prove hypotheses. Positivist research is objective because the statements will be seen as a proper domain for scientists.

3.2. Research Approach

The research takes a deductive approach where a theory is developed with a framework that will help to test prior collected data. A deductive approach is undertaken by using literature theories and ideas that can be used for data. A theoretical or conceptual framework will be developed to test the data. This involves developing a theory that is subjected to a rigorous test. The research takes a deductive approach where a theory is developed with a framework that will help to test prior collected data. Gill & Johnson (2002) explains the six-step of how the deductive approach progress. Bryman (2012) argues that deductive theory has a process of finding a theory, making predictions, and hypotheses, observing and experimenting, and at last proving it or disproving it. Leedy & Ormrod (2010) provides information that positivism adopts a deductive approach. A deductive approach is undertaken by using literature theories and ideas that can be used for data. A theoretical or conceptual framework will be developed to test the data. This involves developing a theory that is subjected to a rigorous test. Collis & Hussey (2003) mentions deduction theory as the dominant research approaches in natural sciences, where laws are presently based on the explanation, it allows anticipate of

phenomena and to predict occurrence. Robson (2002) lists stages in which deductive research will progress step by step.

The first step is to deduce a hypothesis where a testable proposition, where there can be seen a relationship between variables. The second step is to express concepts or variables which are to be measured. The third step is to test the operational hypothesis. The fourth step is to examine the specific outcome of the inquiry which will tend to confirm the theory or take measures for its modification. The deduction approach, first, explains the causal relationship between variables.

3.3. Research Strategy

The research strategy is a survey that will be done using a Google form which will be circulated among a sample of the population. OECD (2002) defines survey research as the “collection of certain information from a sample of individuals through their responses to questions”. According to survey research, it is mentioned that the use of sampling method by designing a questionnaire to measure a population, characteristics through utilizing statistical methods (Sukamolson, 2007).

3.4. Research to generate

The research will be a quantitative study. Quantitative research undertakes a problem statement, then generates a hypothesis by reviewing the literature (Bryman, 2012). Creswell (2009) further proves the above statement by remarks that quantitative research brings strategies to inquire surveys and experiments which will enable collecting data to yield statistical data.

The researcher uses quantitative methods by emphasizing measuring and using factor analysis. The collection of quantitative data is a characteristic used to utilize to test a hypothesis. The deduction of the concepts is operationalized in a way that can be measured quantitatively. Quantitative research explains an issue by gathering data and involves statistical techniques to answer questions. The data for this research will be gathered to find how brand equity influences purchase intention for handworks by using primary data quantitative methods. Primary

data are originated by a researcher for the specific purpose of addressing the problem at hand. Since data is original and relevant to the topic the accuracy is high. It is up-to-date and is known to be relevant to the problem. It comprises the advantage to cover a larger population and wider geographical coverage and the reliability is high.

3.5. Research method

The research method used is a questionnaire. An online questionnaire was used to analyze data to identify purchase intention toward handwork. A questionnaire can be defined as “a list of mimeographed or printed questions that are completed by or for a respondent to give his opinion” (Roopa & Rani, 2012). It is the main means to collect quantitative primary data. This will enable quantitatively collect standard data that is consistent and coherent for analysis. The questionnaire is developed based on the dimensions of brand equity by Keller and Aaker. The questionnaire was developed based on the dimensions of brand equity. The questionnaire is adopted from Yoo & Donthu's (2002) and Chang & Liu's (2009) research paper due to its reliability. The questionnaire is designed on par with the literature review, which was operationalized using the Likert scale. The questionnaire is divided into two parts. The first includes the demographic and the second is the 4 variables of brand equity and purchase intention. A Likert scale of 1-5 is adopted with anchors of strongly disagree-strongly agree.

3.6. Sampling

The sampling method used for the research is probability sampling –simple random sampling. Cooper & Schindler (2014) mentions that probability sampling can be defined as every item in the population will have equal chances of being included in the sampling. Random sampling is free from bias and will include the most costly sampling when it comes to time and energy (Gill & Johnson, 2002). Hammersley (2012) argues that simple random sampling deals with every population having equal chances of probability of being included.

As Cooper & Schindler (2014) mentions when simple random sampling is used the data collected from questionnaires can be objective, due to the

data source is primary data which is gathered from the respondent. . Since the research conducted is done by collecting data using single data collection techniques, it can be mentioned as a mono method. According to the Morgan table, population of 370 who are customers that buy natural handworks were sent the questionnaire and a sample of 340 was collected.

3.7. Data Analysis

To facilitate data preparation SPSS (Statistical Package for the Social Sciences) was used. Data analysis was carried out by SPSS. Multi varied techniques, multiple regressions, and correlation coefficients will be used.

3.8. Ethics

When doing research the researcher must proceed with ethical practices by taking privacy and confidentiality into consideration. During the research when participants filled out the questionnaire, it provided the purpose of the research, aim, and significance. Anonymity was guaranteed by the researcher so that the participant won't face any issues.

3.9. Time Scale

The research undertakes a cross-sectional study to collect data from a population at one specific point in time which allows the researcher to look at numerous characteristics such as age, income, gender, etc. Its main advantage is allowing researchers to collect data quickly. The time horizon used for the research is a Cross-sectional design where 340 samples of respondents are drawn from the target population and the information is also obtained once.

4. DATA ANALYSIS

Before any analysis is conducted on the data collected, the reliability of the data was analyzed based on Cronbach's Alpha value. The reliability analysis was performed by using the complete data set of the questionnaire. As Liu & Kuang (2003) mentions reliability can be considered as the degree of consistency of a measure and a test

undertaken that is reliable and will have the same results and same conditions.

Table 1: Reliability Analysis

Variable	Cronbach Alpha Value	Items	Reliability Range	Reliability
Brand Equity (IV)	0.827	4	Above 0.7	Reliable
Brand Loyalty (IV)	0.893	3	Above 0.7	Reliable
Perceived Quality (IV)	0.786	3	Above 0.7	Reliable
Brand Awareness (IV)	0.882	3	Above 0.7	Reliable
Brand Association (IV)	0.786	3	Above 0.7	Reliable
Purchase Intention(DV)	0.894	4	Above 0.7	Reliable

Most frequently the statistics used to measure the internal consistency of the Likert scale is Cronbach's coefficient alpha. It indicates the value that high internal consistency and high reliability. And the recommendation for Cronbach's alpha should be above 0.7 and if it is

Model Summary ¹				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.855 ^a	.732	.728	1.56467

above 0.7 the scale can be considered reliable if all variables are between 0.4 and 0.7 we can come to a conclusion variables are reliable and acceptable for further statistical analysis.

Data was collected through a closed-ended questionnaire with a five-point Likert scale Which are: 5- Strongly Agree, 4- Agree, 3- Neutral, 2- Disagree, 1- Strongly Disagree. Mean

values for Brand equity, brand loyalty, perceived quality, brand awareness, brand association, and purchase intention can be rounded off to value 4 and according to the Likert scale value, 4 is "agree where customers of Haritha design agree to the measurement items.

A correlation coefficient can be defined as a statistical method used to analyze the strength of a relationship between two variables. The correlation is measured by the correlation coefficient which ranges between -1 and + 1. 0.05 is the maximum significance level to accept hypotheses.

Table 2: Correlation Analysis

Independent Variables	Correlation Coefficient between the independent variables and dependent variable (purchase intention)	Significance (2-tailed)
Brand Equity (IV)	.639	.000
Brand Loyalty (IV)	.639	.000
Perceived Quality (IV)	.614	.000
Brand Awareness (IV)	.638	.000
Brand Association (IV)	.550	.000

Coefficient between independent variables brands equity, brand loyalty, perceived quality, brand awareness brand association, and dependent variables purchase intention. The correlation coefficient test's significant values are .639, .639, .614, .638, and .550 which are between the variables is .000 which is less than 0.01: which shows a positive correlation between brand equity and purchase intention.

Table 3: ANOVA

This test can be used to explain the relationship among variables to predict the actual outcome. In this research, regression analysis was used to determine the influence of brand equity on purchase intention. In Regression analysis, the Adjusted R square depicts the overall explanation of the independent variable. The adjusted R-value for the model summary is .732. The value is greater than 0.5 which validates the model for the

analysis of purchase intention and 50.1 % of purchase intention is impacted by brand equity variables.

4.1. ANOVA Test

This is used to identify the significance of the research. If the significance value is less than 1% of the sampling error, then there is a chance of the model being accepted (Liu a & Kuang b, 2003). The significance of the model represents the ANOVA which is the overall significance of the conceptual model. The significance value is 0.000 which is less than 0.01 where the model is accepted and depicts that brand equity influences purchase intention. The conceptual framework is assumed as significant if the result value of the significance of ANOVA is less than 0.05.

4.2. Regression Analysis

Multi regression test examines how variables respond to each other. Multiple regression coefficients consider all the independent variables that are used to identify the relationship with the dependent variable: purchase intention. The standard beta value of a coefficient for the independent variables proves whether there is a positive impact of brand equity variables on purchase intention.

Hypotheses were tested using linear multiple regression analysis to determine how independent variables have a positive effect on purchase intention. Hypothesis testing can be tested by Regression analysis and had the results of the independent variables having significant positive relationships with purchase intention. It is decided based on the standardized Beta and Significance values that were generated in regression analysis. Hence the hypotheses to be accepted the significance value should be less than 0.05 and the standardized Beta value must be positive.

Table 4: hypothesis testing

Model	Unstandardized Coefficients		Standardized Coefficients			Accepted/ Rejected
	B	Std. Error	Beta	t	Sig.	
Constant	0.031	0.313		0.098	0.922	
Brand Equity	0.385	0.118	0.269	3.27	0.002	Accepted
Brand Loyalty	0.721	0.104	0.619	6.957	0.000	Accepted
Perceived Quality	0.275	0.110	0.236	2.508	0.014	Accepted
Brand Awareness	0.381	0.094	0.370	4.067	0.000	Accepted
Brand Association	0.188	0.133	0.128	1.419	0.160	Accepted

H1- There is a significant relationship between brand equity and purchase intention.

The standard beta coefficient between brand equity and purchase intention is 0.269 which is less than 0.05 and the significant value is .002 which confirms that the association between the two variables is significant. Therefore the researcher accepted H1 and reject H1o.

H2- There is a significant relationship between brand loyalty and purchase intention.

The standard beta coefficient between brand loyalty and purchase intention is 0.619 which is higher than 0.05 and the significant value is .002 which confirms that the association between the two variables is significant. Therefore the researcher accepted H2 and reject H2o.

H3- There is a significant relationship between perceived quality and purchase intention.

The standard beta coefficient between perceived quality and purchase intention is 0.236 which is less than 0.5 and the significant value is .014 which confirms that the association between the two variables is significant. Therefore the researcher accepted H3 and reject H3o.

H4- There is a significant relationship between brand awareness and purchase intention.

The standard beta coefficient between brand awareness and purchase intention is 0.370 which is less than 0.5 and the significant value is .000 which confirms that the association between the two variables is significant. Therefore the researcher accepted H4 and reject H4_o.

H5- There is a significant relationship between the brand association and purchase intention.

The standard beta coefficient between brand association and purchase intention is 0.128 which is less than 0.5 and the significant value is .160 which confirms that the association between the two variables is significant. Therefore the researcher accepted H5 and reject H5_o.

In the present study on regression, the analysis suggests that brand equity can have a significant value which has a positive influence on purchase intention. The research aims to identify the extent of brand equity for the purchase intention of natural handworks. As David Aaker mentions brand equity has four main variables which are brand loyalty, perceived quality, brand awareness, and brand association Aaker(1991) whereas proves by mentioning in his research that brand equity has the same four dimensions. The impact of the independent variables on purchase intention is recognized using primary data which is collected through the research.

The company comprises the brand equity dimensions that help in influencing purchase intentions for competitiveness in the market. As Aaker and Keller propose the brand equity model, Prados-Pe & Barrio-García (2021) considers consumer-based brand equity to be a multidimensional concept that includes several dimensions. Brand equity explained by Han et al (2021) is a tool used to analyze the relationship between a brand and a consumer. Brand equity can add value to a product which will create meaning for the consumers that will result in purchase intention. RUNGSRISAWAT & SIRINAPATPOKIN (2019) mentions in their research that the beta coefficient of brand equity is .072 which increases brand awareness and can predict the increment of purchase intention when other variables are constant.

As per the research findings and the results of descriptive statistics of purchase intentions the mean value is 3.76 which are close to the value of 4. The aggregate median value and mode value depicted in SPSS of the variable purchase intention is and which can be proved as a close value to 4. In the Likert scale in the questionnaire “4” the value stands for “Agree” which proves when analyzed that the customers or the respondents agree that Haritha design agrees that the company has a positive impact on brand equity to purchase intention.

Brand loyalty has a positive attitude from its consumers when a brand is regularly purchased (Barrio-García, 2020). When marketing strategies and research are undertaken brand loyalty becomes an essential factor for succeeding through its behavioral and attitudinal components.

Abdillah (2017) mentions in his research that the correlation coefficient between brand loyalty and purchase intention is 0.728 which proved that there's a positive relationship between the two variables. There are many studies done on brand loyalty and purchase intention which have resulted in showing a positive relationship between the two variables. RUNGSRISAWAT & SIRINAPATPOKIN (2019) mentions in their research that the beta coefficient of brand loyalty is .049 which increases brand awareness and can predict the increment of purchase intention when other variables are constant. According to (DEVENDRA & PERERA, 2018), in their research the correlation analysis between brand loyalty and purchase intention is 0.807 with a significance level of 0.000. (Naeem & Sami, 2020) explain that in their data analysis, brand loyalty and purchase intention has a correlation coefficient of 0.434 with a significance value of .000 and a beta coefficient value of .231, and a significance value of .000. Irshad (2012) in his research depicts in

The data analysis that the Cronbach alpha value of brand loyalty is .772 which is a positive value that can be used for further statistics.

As per the research findings and the results of descriptive statistics on brand loyalty the mean value is 3.93 which is close to the value of 4. The aggregate median value and mode value depicted

in SPSS of the variable brand loyalty is and which can be proved as a close value to 4. In the Likert scale in the questionnaire “4” the value stands for “Agree” which proves when analyzed that the customers or the respondents agree that Haritha design agrees that the company has a positive impact on brand loyalty to purchase intention.

Perceived quality can be explained as the customer consumption experience and evaluation of the product. Studies developed by Chinomona & Maziriri (2017) have proved that perceived quality has a positive influence on purchase intention. It can be referred to the consumers assessing the product's superiority in the market (Braun, 2020).

As Kaldeen (2020) mentions in his research, it proved that perceived quality has a correlation of 0.810 with its dependent variable purchase intention. The beta coefficient is proved to have a significant relationship with a value of 0.387 with a significant value of 0.001. (Kahimpong & Tielung, 2016) Investigated that perceived quality had a positive effect on purchase intention.

Kaldeen (2020) explains that in his research the dependent variable is purchase intention and has a moderate coefficient correlation value with perceived quality where the value is 0.387 with a significance value of 0.001. Naeem & Sami (2020) depicts that in the correlation coefficient of their research, there is a value of .526 with a significance value of .000 between perceived quality and purchase intention which again is proved in the hypothesis that the beta coefficient between the two is .148 with a significance value of .002. Irshad(2012) in his research depicts in the data analysis that the Cronbach alpha value of perceived quality is .854 which is a positive value that can be used for further statistics.

As per the research findings and the results of descriptive statistics of perceived quality the mean value is 3.93 which is close to the value of 4. The aggregate median value and mode value depicted in SPSS of the variable perceived quality is and which can be proved as a close value to 4. In the Likert scale in the questionnaire “4” the value stands for “Agree” which proves when analyzed that the customers or the respondents agree that Haritha's design agrees that the

company has a positive impact on perceived quality to purchase intention.

Brand awareness can be projected as a mediating dimension that has a positive effect on purchase intention. The attribute that generates consumers' recognition of a brand (A.P. Graciola et al., 2020). Brand awareness shows a positive relationship with purchase intention.

Dabbous & Barakat (2020) mention that it plays an important role in the decision-making process in purchase intention. When there is a brand with high awareness, there's a positive impact on purchase intention. It can be identified due to the customer behavior on how they recognize a brand or a product.

The research undertaken by Abdillah (2017) proves that brand awareness and brand loyalty have a correlation coefficient of 0.683 which shows a positive relationship between the two variables. Most research has proved that brand awareness has a positive influence on purchase intention which leads to more customers. RUNGSRISAWAT & SIRINAPATPOKIN (2019) mentions in their research that the beta coefficient of brand awareness is .052 which increases brand awareness and can predict the increment of purchase intention when other variables are constant. Gunawardane (2015) depicts in his research how brand awareness and purchase intention have a positive relationship with the correlation coefficient of .413 and a beta value of .462 and a significance value of .000, where the research shows that the hypotheses are accepted.

As per the research findings and the results of descriptive statistics of brand awareness the mean value is 4.17 which is close to the value of 4. The aggregate median value and mode value depicted in SPSS of the variable brand awareness is and which can be proved as a close value to 4. In the Likert scale in the questionnaire “4” the value stands for “Agree” which proves when analyzed that the customers or the respondents agree that Haritha design agrees that the company has a positive impact on brand awareness to purchase intention.

The brand association explained by Erdil (2015) is that an image of a product is the overall link to

consumers' memory. It concerns both perceptions of the brand and consumer benefits. Brand associations are deemed as a strong variable as it is mainly based on experiences that will pave way for high brand awareness. Brand association can be mentioned as a complex idea that is linked to one another which will establish a network with brand awareness. Brand associations can be related to memory, idea, recognition, and experience that can be attached to the consumer.

According to Abdillah (2017), it has been proved in his research that there's a positive relationship between brand association and purchase intention with a correlation coefficient of 0.643. RUNGSRISAWAT & SIRINAPATPOKIN (2019) mentions in their research that the beta coefficient of brand association is .0165 which increases brand awareness and can predict the increment of purchase intention when other variables are constant. Santoso & Cahyadi (2014) depicts in their research conducted on brand equity dimensions and purchase intention that brand association has a beta coefficient of .294 and a significance value of .010 which proves the hypothesis of that variable is accepted. Gunawardane (2015) depicts in his research how brand awareness and purchase intention have a positive relationship with a correlation coefficient of .242 and a beta value of .360 and a significance value of .000, where the research shows that the hypotheses are accepted.

As per the research findings and the results of descriptive statistics of brand association the mean value is 3.93 which is close to the value of 4. The aggregate median value and mode value depicted in SPSS of the variable brand association is and which can be proved as a close value to 4. In the Likert scale in the questionnaire "4" the value stands for "Agree" which proves when analyzed that the customers or the respondents agree that Haritha design agrees that the company has a positive impact on the brand association to purchase intention.

Naeem & Sami (2020) mentions that it is the result of a consumer's experience in purchasing which brings out an understanding of a brand's attributes which are perceived by a customer. Purchase intention can be defined as the consumer's interest in a product which is strongly

related to the attitude and preference. High brand equity has a strong and positive influence on the product and conveys the idea of how the dimensions will increase the purchase intention of the product.

There are many researchers conducted on brand equity and purchase intention. When the dependent variable is purchase intention, it will be used to see the relationship between the independent variables. As RUNGSRISAWAT & SIRINAPATPOKIN (2019) depicts the results of the data analysis of their research done on the impact of brand equity on purchase intention, they have an R-value of .6859 and an Adjusted R square of .456. Irshad (2012) in his research depicts in the data analysis that the Cronbach alpha value of purchase intention is .802 which is a positive value that can be used for further statistics. Based on the research conducted by Santoso I & Cahyadi (2014) the adjusted R is 41, 9% of the purchase intention of the product which was explained by the variance of brand equity dimensions.

Objective 1 of this research is "what are the brand equity dimensions". As brand equity is comprised to have 4 dimensions brand loyalty, perceived quality, brand awareness, and brand association have been proven in both empirical studies and data analysis results to have a positive influence on purchase intention. Brand equity retains in the existing market by adding value to products and services and it reflects the way consumers think, feel, and act which the output is the profitability to the firm. The four dimensions are found to have a positive effect on overall brand equity.

The second objective of this study is to examine how brand equity dimensions affect the purchase intention of natural handworks. There have been several studies that prove that brand equity dimensions have a positive influence on purchase intention. Aaker has proved in his studies and by many other types of research that purchase intention is impacted by the influence of brand equity and its dimensions to have a positive impact on consumers' purchase intention (Aaker D. A., 1991). Empirical evidence was brought up to explain that brand equity influences purchase intention.

The third objective provides recommendations to increase purchase intention of natural handworks. Haritha design can use brand equity as a measurement tool to develop marketing activities to increase competition and to develop the product with the growing demand in the market. The company can use the marketing mix with aspects such as prices, distributions, and advertising which contributes to brand equity. Using the 4p's, Haritha design will be able to build more effective marketing plans. And promotions can be undertaken to solidify and build brand equity for a marketing plan. With a new marketing plan, the company can be positively related to brand equity and its dimensions for more favorable purchases of the product. Hence to increase purchase intention, brand equity can be used to exploit marketing efforts along with its dimensions.

5. CONCLUSION

With globalization, increased living standards, and the competitive market industry there's a need for new products and services. With almost every company and organization contributing to enhancing their services, it's necessary to help consumers to make purchase decisions of products/services. Even though brand equity includes many theories it can be the committed factor that supports repurchasing of a brand. When a customer self-identifies as a brand, it is due to the memory and emotional connection that arises through the evaluation of a product's image, quality, and service which is derived through brand equity dimensions. Effect brand equity can be used as a competitive tool that establishes a positive and desirable mindset for consumers which increases purchase intention. Aaker has proved in his studies and by many other types of research that purchase intention is impacted by the influence of brand equity and its dimensions to have a positive impact on consumers' purchase intention. Empirical evidence was brought up to explain that brand equity influences purchase intention. The company can use the marketing mix with aspects such as prices, distributions, and advertising which contributes to brand equity. Using the 4p's, Haritha design will be able to build more effective marketing plans. And promotions can be undertaken to solidify and

build brand equity for a marketing plan. With a new marketing plan, the company can be positively related to brand equity and its dimensions for more favorable purchases of the product. Hence to increase purchase intention, brand equity can be used to exploit marketing efforts along with its dimensions.

REFERENCES

- Abdillah, F. (2017). THE CORRELATION ANALYSIS BETWEEN BRAND EQUITY AND THE CUSTOMER DECISION BUYING. *The Management Journal of BINANIAGA*.
- Alhaddad, A. (2014). The effect of brand image and brand loyalty on brand equity. *International Journal of Business Management*, 28-32.
- Alnsour, M. (2018). Impact of brand elements on brand equity. *African Journal of Marketing Management*.
- Ashmond, A.-A. (2021). The influence of social media on purchase intention: The mediating role of brand equity. *Cogent Business & Management*.
- A. Saleem et al. (2015). Product perceived quality and purchase intention with consumer satisfaction. *Global Journal of Management and Business Research*, 21-27.
- A.P. Graciola et al. (2020). Mediated-moderated effects: High and low store image, brand awareness, a perceived value from mini and supermarkets retail stores. *Journal of Retailing and Consumer Services*.
- Aaker, D. (1996). Measuring brand equity across products and markets. *California Management Review*, 102-120.
- Aaker, D. A. (1991). *Managing brand equity: Capitalizing on the value of a brand name*. New York: The Free Press.
- Aquinia, A., & Soliha, E. (2020). The effect of brand equity dimensions on repurchase intention. *International Journal of Business*, 97-103.
- Astrid, P. (2020). Social Media Marketing and Brand Loyalty: The Role of Brand Trust. *The Journal of Asian Finance, Economics ,and Business*, 951-958.

- Braun, A. (2020). Cognitive quality; An unexplored perceived quality.
- Bryman, A. (2012). *Social Research Methods*. 4th edition. New York: Oxford University Press.
- Barrio-García, S. (2020). How does parent heritage brand preference affect brand extension loyalty? *Tourism Management Perspectives*.
- Bashir, M. A. (2019). Impact of Brand Equity on Consumer Brand Preference and Brand Purchase Intention. *Journal of Business Studies*.
- Cho, E., Fiore, A., & Russell, D. (2015). Validation of a fashion brand image scale capturing cognitive, sensory and affective associations: Testing its role in an extended brand equity model. *Journal of Psychology*, 32: 28-48.
- Carrubi, D. B., & Martínez, J. M. (2019, November 8). How brand equity affects firm productivity: The role of R&D and human capital. Retrieved January 13, 2021, from Taylor and Francis Online: <https://www.tandfonline.com/doi/full/10.1080/01331677X.2019.1686045>
- Chang, H., & Liu, Y. (2009). The impact of brand equity on brand preference and purchase intentions in the service industries. *The Service Industries Journal*.
- Chaudhuri, A. (1997). Product class effects on perceived risk: The role of emotion. *Intern. J. of Research in Marketing*, 15, 157-168.
- Chen et al, Z. (2020). Enhancing Consumer Online Purchase Intention Through Gamification in China: Perspective of Cognitive Evaluation Theory.
- Chierici, R. (2019). Enhancing Brand Awareness, Reputation and Loyalty. *International Journal of Business, and Management*.
- CLAVE, P. (2020). MEASURING BRAND EQUITY WITH SOCIAL MEDIA.
- Collis, J., & Hussey, R. (2003). *Business Research: A Practical Guide for Undergraduate and Postgraduate Students*. Basingstoke: Palgrave Macmillan.
- Creswell, J. W. (2009). *Research Design Qualitative, Quantitative, and Mixed Methods Approach*. London: SAGE Publication.
- Dabbous, A., & Barakat, K. A. (2020). Bridging the online-offline gap: Assessing the impact of brands' social network content quality on brand awareness and purchase intention. *Journal of Retailing and Consumer Services*.
- DEVENDRA, S., & PERERA, A. (2018). INFLUENCE OF BRAND LOYALTY ON PURCHASE INTENTION TOWARDS SOFT DRINK INDUSTRY. *International Journal of Entrepreneurship and Development Studies*, 188-199.
- Das, G. (2015). Linkages between self-congruity, brand familiarity, perceived quality, and purchase intention. A study of fashion retail brands. *Journal of Global Fashion Marketing*, 180-193.
- Ekinci, Y., & Whyatt, G. (2016). A cross validation of Consumer-Based Brand Equity models: Driving customer equity in retail brands. *Journal of Business Research*, 3740-3747.
- Forbes. (2017, July 8th). Building Brand Equity. Retrieved november 3rd, 2020, from <https://www.forbes.com/sites/propointgraphics/2017/07/08/building-brand-equity/?sh=49bd886e8f85>
- Gil, R. B. (2007). Family as a source of consumer-based brand equity. *Journal of Product and Brand Management*, 188-99.
- Gill, J., & Johnson, P. (2002). *Research Methods for Managers*. London: Sage Publications.
- Hammersley, M. (2012). *Methodological Paradigms in Educational Research*. British Educational Research.
- Ipogah, B., B., A., & Svensson, M. (2014). A Study to Indicate the iBuss Management. 29-39.
- Jeon, J.-E. (2017). The impact of brand concept on brand equity. *Asia Pacific Journal of Innovation and Entrepreneurship*.
- Kumar, P., & Rekhi, S. (2017). The Impact of Brand equity on Business and customer perception. *International Research Journal of Management and Commerce*.
- Liu a, R., & Kuang b, J. (2003). Principal component regression analysis with SPSS. *Computer Methods and Programs in Biomedicine*.
- Martinez, B., & Chernatony, L. D. (2013). The influence of brand equity on consumer responses. *Journal of consumer market*, 62-74.
- Nguyn, G. (2020). The relationship between brand equity and intention to buy: the case of

- convenience stores. *Independent Journal of Management & Production*.
- Kahimpong, I., & Tielung, M. (2016). The influence of consumer perception on purchase intention of using indihome product in Manado city.
- Kaldeen , M. (2020). AN ANALYSIS OF FACTORS IMPACTING CONSUMER PURCHASE INTENTION ON HERBAL PRODUCTS. *Journal of Marketing*, 41-50.
- Kanwal, M., & Hameed, S. (2018). Effect of brand loyalty on purchase intention in cosmetics industry. *Research in Business and Management*, 25-35.
- Keller, K. (1993). Conceptualizing, Measuring and Managing Customer-Based Brand Equity. *Journal of Marketing*, 1-22.
- Keller, K., & Lehmann, D. R. (2003). How do brands create value? . *Marketing Management*, 26-31.
- Kumar, Shekhar, R., Dash, S., & Purwar, P. (2013). The Nature and Antecedents of Brand Equity and its Dimensions. *Marketing Intelligence and Planning*, 141–159.
- Leedy, P. D., & Ormrod, J. E. (2010). *Practical Research: Planning and Design*. Boston: Pearson Educational International.
- Malik, M., Ghafoor, M., Iqbal, H., & Riaz, N. (2013). Importance of brand awareness and brand loyalty in assessing purchase intentions. *International Journal of Business*, 167-171.
- Mohsan , K., & Nighat, F. (2017). Identifying the Key Dimensions of Consumer-based Brand Equity Model: A Multivariate Approach. *Asian Journal of Marketing*.
- Monalisa , D. (2020). DETERMINANT OF BRAND LOYALTY WITH COMMITMENT AS A MEDIATION. *International Journal of Business Management and Economic Review*.
- Naeem , M., & Sami, A. (2020). Product Brand Loyalty and Purchase Decision. *International Journal of Entrepreneurial Research*, 76-87.
- Pinar, M., Trapp, P., & Girard, T. (2014). University Brand Equity: an empirical investigation of its dimensions. *Journal of Educational Management*, 616–634.
- Prados-Pe , M., & Barrio-García, S. (2021). Key antecedents of brand equity in heritage brand extensions:. *European research on management and business economic*.
- RUNGSRISAWAT, S., & SIRINAPATPOKIN, S. (2019). Impact of brand equity on consumer purchase intent.
- Romaniuk, J., Wight, S., & Faulkner, M. (2017). Brand awareness: revisiting an old metric for a new world. *Journal of Product & Brand Management*, 469-476.
- Roopa , S., & Rani, M. (2012). Questionnaire Designing for a Survey. *The Journal of Indian Orthodontic Society*, 273-277.
- Rshidi, h., & Rahmani , z. (2013). Brand and it's effect on brand loyalty. *Economic Journal* , 65-80.
- Santoso i, C., & Cahyadi, T. (2014). Analyzing the Impact of Brand Equity towards Purchase Intention in Automotive Industry. *iBuss Management*, 29-39.
- Shahid, Z., & Tehmeena, H. (2017). The Impact of Brand Awareness on The consumers' Purchase Intention. *Journal of Marketing and Consumer Research An International Peer-reviewed Journal*, Vol.33.
- Shariq, M. (2018). BRAND EQUITY DIMENSIONS – A LITERATURE REVIEW. *International Research Journal of Management and Commerce*.
- Susilowati, E. (2020). The influence of brand awareness, brand association, and perceived quality toward consumers' purchase intention. *Independent Journal of Management & Production*.
- Saleem, A., Ghafar, A., Ibrahim, M., & Yousuf, M. (2015). Product Perceived Quality and Purchase Intention with Consumer Satisfaction. *Global Journal of Management and Business Research*.
- Sally, B., & Francisco , G. (2016). Consumer-based brand equity.
- Samudroa, A. (2020). Assessing the effects of perceived quality and perceived value on customer satisfaction.
- Saunders, M., Lewis, P., & Thornhill, A. (2016). *Research Methods*. Harlow: Pearson Education Limited.
- Severi, E., & Ling, K. C. (2013). The mediating effects of brand association, brand loyalty, brand image and perceived quality on brand equity. *Asian Social Science*.

- Sukamolson, S. (2007). Fundamentals of quantitative research. Language Institute Chulalongkorn University.
- Surucu, O., Ozturk, Y., Okumus, F., & Bilgihan, A. (2019). Brand awareness, image, physical quality and employee behavior as building blocks of customer-based brand equity. 114–124.
- Susanti, V., Sumarwan, U., & Simanjuntak, M. (2019). How to manage customer satisfaction through brand association and perceived value strategy. *Journal of Management and Marketing Review*, 184–193.
- Vinh , T., Nga, V., & Nguyen, N. (2017). The causal relationships between components of customer-based brand equity. *Asian Economics finance review*.
- Vanitha , P., & Subramanian, S. (2020). A Study on Brand Awareness and Customer Engagement. *Indian Journal of Public Health Research & Development*.
- Wenyuan, L. (2019). Influence of Brand Equity on Brand Performance: Role of Brand Reputation and Social Media. *International Journal of Research and Review*.
- Yoo, B., & Donthu, N. (2000). An examination of selected marketing mix elements and brand equity. *Journal of the Academy of Marketing Science*, 195-211 .

The Impact of Waste Management Practice Initiatives on the Sustainability of commercial banks in Sri Lanka

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ABSTRACT

One of the major issues confronting the banking sector is a lack of knowledge and awareness about waste management and sustainability. Herein, the social, economic, environmental and philanthropic responsibility falls on the shoulders of top management, who is responsible for managing business practices including waste management practices by fostering trust and effective communication. As a result of globalization, digitalization, and the Covid -19 pandemic period, waste minimization and sustainability have been significant banking and finance constructs in recent years, notably in relationship management in the service industry. Therefore, this research is conducted to examine the impact of Waste Management Practice Initiatives on the Sustainability of commercial banks in Sri Lanka. This study has been conducted using Legitimacy Theory. The research is conducted under the quantitative method where data from 370 respondents (Management Level employees of the Commercial Banks in Colombo District) were collected through Emails and WhatsApp by a Google questionnaire. The data analysis was conducted through SmartPLS 3.0 and SPSS 25 software. The key research finding is that there is a positive association between Waste Management Practice Initiatives and Commercial Bank Sustainability in Sri Lanka. The main research limitations are that the sample is limited to the Colombo District and that the survey was conducted online only with managerial-level personnel. Future studies should broaden the sample and focus more on mixed method and qualitative methodologies with middle and operational

level staff. In terms of managerial impact, top managers, commercial banks, employees, and the

government would be beneficial. Future studies could examine further supporting virtues for the Legitimacy Theory as well as other useful considerations for future mechanisms to promote waste management practice initiatives, which would increase Commercial Banks' long-term sustainability.

Keywords: *Waste Management Practice Initiatives, Sustainability, Commercial Banks*

1. INTRODUCTION AND PURPOSE OF THE STUDY

Academics and professionals have come to realize over the past few years that green and waste management practices projects are a source of competitive advantage as well as an innovative and dynamic strategy to be used in the current circumstances in the global setting. Due to the significant influence of the Gross Domestic Product in the local context, most people believe that the manufacturing sector is the one that disposes of enormous volumes of garbage (GDP). According to the Annual Report of Central Bank of Sri Lanka 2019/2020 However, it is important to highlight that although contributing around 50% of the GDP, the service industry is still underappreciated, as demonstrated by the recent instances of Meethotamulla, Bluemandal, and Rathupaswala. The banking industry contributes about 8%. Therein, it is important to note that although the service sector contributes more to waste disposal than the manufacturing sector does, it will be crucial to study this because high output production can lead to high waste disposal in the economy. Because the banking industry is one of the sectors that dispose of the most trash for the economy, it will be important to understand how the banking sector was chosen for this study in light of the local environment. Additionally, according to the

Central Environment Authority in 2020/2021, 7,000 MT of solid and liquid wastes are produced per day, 60% of which come from the Western Province and 30% to 40% of which are related to banks. Meanwhile, around 40% of paper waste and 1% to 3% of gas emissions, which nearly amount to 1GT, can be observed at present. The risk and uncertainty surrounding banking institutions will harm both the environment and the viability of the banks. To promote green banking and maintain not only environmental sustainability but also economic and social sustainability in this setting, it is therefore, crucial to investigate the waste management practice efforts implemented by Sri Lankan banks (Arulrajah, 2017).

2. LITERATURE REVIEW

Legitimacy theory simply elaborates that companies report social responsibility information to portray a socially responsible image and legitimize their behavior to their stakeholder groups. Additionally, it describes how businesses, particularly banks, behave while adopting and developing voluntary disclosure of social and environmental information to uphold their social contract, which enables them to recognize their objectives and survive in a volatile environment (Burlea-schiopoiu & Popa, 2013).

3. METHODOLOGY OF THE STUDY

The influence of waste management practice initiatives on the viability of commercial banks in Sri Lanka was assessed using a quantitative study methodology and a deductive approach.

The Colombo district's managerial level personnel who work in commercial banks are considered by the study. The population of this study in 2022 consisted of about 22,500 managers at the 25 commercial banks in Sri Lanka's Western Province that were officially registered. The population of this study is founded on the supposition that their capacity for making decisions and familiarity with programs for waste management, as well as the sustainability of the banks, are more tailored to and focused on them.

379 workers of commercial banks in Western Province's Colombo district who were managers underwent this survey. Here, the sample was

selected using a range of sample sizes suggested by Krejcie and Morgan (Krejcie & Morgan, 1970), with a 95 percent and a 5-point confidence interval.

The sample is chosen using the Simple Random Sampling technique. These sample approaches were chosen for the study because they were straightforward, simple to comprehend, and straightforward to conduct and analyze. This is also highly beneficial for the study's hypothesis-generation process. To cover all the bases, this study uses both primary and secondary sources of information. For the study, the researcher employed questionnaires as the primary data and annual reports of banks, websites, and other publications such as CBSL reports. The survey was divided into three components. The questions in Section A pertain to the respondents' personal information, such as the bank they worked for, their position and work history according to the number of years spent working there, as well as their age and gender.

Section B includes questions relevant to waste management practice initiatives (liquid, solid and paper sewage management practices and energy waste initiatives) which are under the independent variable as waste management practice initiatives become one of the main concepts in this study.

Questions related to sustainability (environmental, economic and social sustainability) which is in section C, which is the dependent variable of the study. Sections B and C of the questionnaire are measured with five-point Likert scale.

4. RESEARCH FINDINGS

The overall dependability data (Table 01) show that Cronbach's alpha value was 0.926, which is good compared to the required value of 0.7. As a result, a definitive conclusion can be made because the variables utilized in the study have strong internal consistency, and the questionnaire is regarded as reliable. The analysis explains that the Composite Reliability and Cronbach's Alpha values fall within the desired range, and the table expresses that all of the variables' Composite Reliabilities are greater than 0.6 and all are around 0.9, indicating that all of the measures of each variable construct used in this research are reliable.

In addition, all the AVE values are significantly higher than the benchmark of 0.7, which measures

the amount of variance that is captured by a construct concerning the amount of variance due to measurement error. Values around 0.8 indicate that the study is within the allowed range and that the internal consistency is suitable for this investigation. The discriminant validity (Table 02) of this AVE was also evaluated.

The PLS Algorithm is used to generate the mean values in Table 03, which only employs standardized data with a mean value of zero. The statistics shown in the table show that the average value of all the variables is zero (zero), which almost qualifies as an agreement. The researcher uses the standard deviation to assess the variance of the variables Solid, Liquid, and Paper Sewage, Energy Waste, Environment Sustainability, Economic Sustainability (EC), and Social Sustainability (SS) and finds that the variance for each of these variables is, on average, 1.000. It suggests that there were no greater departures from the mean value for any of the constructs.

The normalcy of the data distribution is described using the skewness (Table 03). Skewness is often acknowledged to range from -2 to 2. Therefore, for construct measurements, all skewness values should be greater than -2 and lower than 2. The investigated statistics show that the skewness for the SLP, EW, EnvS, ES, and SC variables is, respectively, -0.646, -0.556, -0.792, -0.602, and -0.557. As a result, it is possible to describe the data gathered from the respondent as regularly distributed.

With the use of Kurtosis analysis, (Table 03) the normality of the data should be between -1 to +1 of skewness. However, this data represents the skewness, 3 times more than the standard error which is approximately from 3.258 to 3.499. It expresses the values 3.279, 3.258, 3.311, 3.499, 3.396 respectively. Since all values are higher than the three times of standard error, it can be concluded that the data cannot be considered normally distributed.

The association between the aqua, solid, and paper sewage management practice initiatives and sustainability is positively and significantly correlated, as shown by the T value (Table 04) between the initiatives and sustainability being

43.285 and the P-value being 0.000. As a result, it supported hypotheses H1, H2, and H3, which state that there is a substantial correlation between the initiatives for aqua, solid, and paper sewage treatment practices and the sustainability of the environment, economy, and society.

The positive and significant association between energy waste management practice initiatives and sustainability is shown by the T value (Table 04) between these two variables, which is 4.113, while the P-value is 0.000. As a result, it backed the H4 and H5, which basically state that there is a major connection between energy waste management practice initiatives and the sustainability of the environment and the economy. H6, the hypothesis, does not, however, support the model or the results of the study, which have values of 0.106 P and 1.630 T.

Table 01: Reliability, AVE

Description	Composite Reliability	Cronbach's Alpha	Average Variance Extracted
Aqua, Liquid and Paper Sewage	0.964	0.955	0.817
Energy Waste	0.961	0.949	0.830
Environmental Sustainability	0.932	0.903	0.775
Economical Sustainability	0.941	0.906	0.841
Social Sustainability	0.949	0.919	0.860

Table 02: Discriminant Validity

	ASP	ES	EW	EnvS	SS
ASP	0.904				
ES	0.894	0.917			
EW	0.911	0.865	0.911		
EnvS	0.885	0.865	0.892	0.881	
SS	0.874	0.891	0.855	0.86	0.928

Table 03: Descriptive Statistics

	Mean	Standard Deviation	Kurtosis	Skewness
Aqua, Liquid and Paper Sewage	-0.000	1.000	3.279	-0.646
Economic Sustainability	-0.000	1.000	3.258	-0.556
Energy Waste	0.000	1.000	3.311	-0.792
Environment Sustainability	-0.000	1.000	3.499	-0.602
Social Sustainability	0.000	1.000	3.396	-0.557

Table 04: Coefficients

Hypothesis	Variables	Path Coefficient	T statistics	Status
H1	ASP – EnvS	0.402	4.254	Supported
H2	ASP – ES	0.602	4.857	Supported
H3	ASP – SS	0.574	3.169	Supported
H4	EW – EnvS	0.524	5.663	Supported
H5	EW – ES	0.318	2.563	Supported
H6	EW – SS	0.324	1.630	Not Supported

5. CONCLUSION

When considering the effect of waste practice initiatives on the sustainability of commercial banks in Sri Lanka, there is a considerable positive relationship between the variables, with a value of 61.585. It can be accepted in cases where the bootstrap T values are higher than the benchmark because it is within the acceptable range at a 5% significance level (0.05). ($T > 1.96$)

Recommendations

It is important to note that, according to this study's findings, Sri Lanka's banking industry is only just beginning to implement waste management programs.

Additionally, to improve their interaction with staff, service centers might implement effective communication techniques. In the meanwhile, the bank can run internal awareness campaigns to help staff members fully comprehend waste management practices initiatives and how they will affect the banks' sustainability. Additionally, if the banks can implement initiatives such as green building adaptation, switching to paperless banking through online banking and mobile banking in addition to having a high level of security, mass-transit systems, starting investments in low carbon producing technology, and developing new sustainable development initiatives to lessen the carbon footprint from the environment, this will be a benefit to the commercial banks.

Limitations

According to the study's population, it was particularly challenging to conclude about the entire business in the Western Province given that the sample of commercial banks only includes the Colombo District. The poll was conducted online and only included employees at the managerial level; hence, it is unclear whether the employees' perceptions and accuracy are accurate.

Future Research Areas

In light of this, it will be advantageous for the banks if future studies can specifically pinpoint and talk about different collecting systems for recyclable sewage, such as solid, liquid, and paper waste. Future researchers can also look at the growth in awareness among banks. The environment can be improved through better management, and the bank's operating activities can be optimized under the 3R idea by using a Mini Inclinator to burn trash plastic crusher, producing liquid fertilizer.

REFERENCES

- Ahmad, I. (2020). *Waste Management Analysis From Economic- Environment Sustainability Perspective*. May.
- Ahmed, T. (n.d.). *Corporate Social Responsibility Practices of Commercial Banks in Bangladesh : A Case Study on Southeast Bank Ltd.*
- Hoshsein, M. S., Hasan, M. N., Mamun, S. H. M. A. Al, Mannan, A., & Mamun, D. M. A. Al. (2017). Green Financing: An Emerging Form of Sustainable Development in Bangladesh. *Journal of Business and Management (IOSR-*

JBM), 19(12 Ver. VII), 24–30.
<https://doi.org/10.9790/487X-1912072430>

Lebbe, A., Shameem, M. A., & Haleem, A. (2021).
A Study On Green Banking Practices In
Banking Industry: Sri Lankan Context.
*Journal of Contemporary Issues in Business
and Government*, 27(1), 2021.
<https://cibg.org.au/490>

Putra, H. P., Damanhuri, E., & Sembiring, E.
(2019). *identification of factors affecting the
performance of waste bank in waste
management system in the " kartamantul "*
*territory identification of factors affecting the
performance of waste bank in waste
management system in the " kartamantul "*
territory (y. may.

Social Media Organic Promotions for Online Entrepreneurs

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ABSTRACT

As the theory of marketing has expanded and new methods of market orientation have arisen, marketers have been increasingly focusing on identifying their customers. This has assisted in the collection of massive quantities of data for businesses to improve the efficiency of their Facebook marketing. The purpose of this study is to examine the factors impacting the effectiveness of Facebook organic promotions. Organic promotions are effective when marketers follow best practices. Therefore, this research focused on the techniques and skill sets that should be practiced by Sri Lankan Facebook entrepreneurs to maximize the reach of their Facebook business pages. The sample of this research is Facebook users, with a total of 384, and the research has used the convenience sampling technique. This research has used primary data collection, which has been gathered via questionnaires. This research has used the multiple linear regression analytical technique.

Key words: caption, content, effectiveness of Facebook organic performance

1. INTRODUCTION

Businesses go along with new trends, allowing the internet to create new opportunities for businesses (Wielki, 2010). It all began with a desire to remain in a digital environment. Social media has grown so fast with the number of users, and the speed of the growth can still be seen around the world. Because of this factor, there has been an increase in the

influence of the social media ecosystem, but its relevance stems from the fact that it connects the economy's online and offline parts, either directly or indirectly (Harun and Lily, 2018). The purpose of this research is to evaluate the factors that make unpaid promotions effective in world markets the best approaches and methods for achieving the greatest, and the reasons for various sorts of activities, that internet entrepreneurs should be applied by Sri Lankan entrepreneurs by identifying practices done by internationally with comparing to Sri Lankan online business environment. According to past research, this research has two independent and one dependent variable, which are Caption, Content, and Effectiveness of Facebook Organic Promotions. These research objectives are to evaluate how captions influence the effectiveness of organic promotions on Facebook and to evaluate how content can create effectiveness in organic promotions on Facebook. Social media has increased in popularity in parallel with the growing number of users, and there is still a significant increase in social media users around the globe.

Most Facebook brands function under the "Pay-to-Play" model, which explains why organic promotion reach floats around 5% for entertainment and 2% for news content for online brands on Facebook, which is in practice. If there are 100 online customers, the post will reach only for 2 customers which are at a very below average. It is obvious that the main goal of online entrepreneurs is to reach their target market or spread their brand on Facebook (Mohenesh, C., 2021). Therefore, with the techniques used by international entrepreneurs, there is a practice gap in Sri Lankan Facebook organic promotion marketing. Therefore, this research will focus on the techniques and skill sets that should be

practiced by Sri Lankan Facebook entrepreneurs to maximize the reach of their Facebook business pages.

The remaining sections of the paper are organized as follows: Section two is a conceptual framework, Section three is the hypothesis, Section four is the literature review, Section five is the methodology and data analysis, Section six is the results and discussion, Section seven is the conclusion, and Section eight is the limitations and recommendations for further research.

2. LITERATURE REVIEW

Several factors that influence the success of organic Facebook promotions in Sri Lanka have been identified. However, it is unclear how much these factors influence the success of organic Facebook promotions, and no prior research study has been done to assess how much these factors influence the success of unpaid promotions in Sri Lanka. The literature thus tries to determine the extent to which the listed criteria have an impact on the efficacy of organic promotions in Sri Lanka. Depending on the speaker's aim and the social and cultural context, language can have a broad range of meanings as a medium of communication (Yunita Sari, 2022). The caption ought to be appropriate for the audience to understand it. Only by examining the sort of content that goes with the text can you determine how rich the content connected with a post is. (such as a graphic, a moving image, or a webpage link) (F et al., 2014). Even though more men than women use Facebook, recent data indicates that there are more male users in Sri Lanka than female users (Rathnayake and Rathnayake, 2018). Online business owners should think of developing relevant advertising methods to use on social media, notably Facebook, as the younger generation spends more time there. Technological developments have given rise to social media platforms that enable users to exchange material in a range of formats, including text, photographs, audiovisuals, and online links (Chawla and Chodak 2021).

2.1. Effectiveness of Facebook organic promotions in Sri Lanka

The ISO 9000:2005 standard defines communication effectiveness as the extent to which intended objectives are achieved. The term "effectiveness" refers to the praxeology technique or theory of effective action (Chodak et al., 2019). In a world where one individual may discuss products, companies, or brands with hundreds or even thousands of peers, the value of consumer engagement has significantly grown (Liu et al., 2018). In social media communication studies, it is usual to neglect the efficacy of communication over a wide range of material, degrees of participation, and posting times (Lamberton and Stephen, 2016). Depending on how easy it is to interact with a post, it may be viewed and receive a response in the form of likes, comments, or shares (Sally and Wickramasinghe, 2020).

2.2. Captions of Facebook Promotions

A caption is a summary or heading for a picture. According to the study, captions are useful for marketing and education since they enhance everyone's user experience, not only people with impairments. Facebook post captions may provide a personal touch to news (B et al., 2022). The caption may include notifications, information about events, or emotional responses, depending on its purpose. Facebook is used as a medium for communication (Yunita Sari, 2022).

Any symbols or acronyms used in the figures should also be defined, and if symbols are required in the titles of the axes, make sure to explain them in the caption as color-coded caption identification is frequently ineffective due to color variations between displays and printers. Therefore, it's crucial to use the proper color coding, and before submitting, make sure the caption description corresponds to the visual (M and V, 2019). The caption may include notifications, information about events, or emotional responses, depending on its purpose. Facebook is used as a medium for communication (Yunita Sari, 2022). Results of word recognition were modified by risk status: those at risk benefited from captions, whereas those not at risk identified more words when there

were no captions (Linebarger and Piotrowski, 2010). Because they allow viewers to see a word in print, hear it represented acoustically, and interpret a term's meaning in light of its broadcast portrayal, captions have a direct influence on viewers' ability to decipher code (Molina. et al., 2020). As a result, it can be shown that captions do affect how successful Facebook promotions are.

Based on the above, we expect a positive relationship between captions and the effectiveness of organic Facebook promotions in Sri Lanka, whereas the better the content, the higher the effectiveness becomes.

2.3. Content of Facebook Promotions.

Facebook contents are outward messages posted to a user's profile page or their whole Facebook audience (or "wall"). Businesses utilize posts to be visible to their audience constantly and possibly get new followers. The term "message content" refers to the essential data that is included in the message (Niu et al., 2015). The role of content in fostering consumer engagement in social media is investigated in a real-world setting, and it is established that content is crucial. It was found that postings featuring videos or contests received more likes than other posts, while those with questions attracted more comments (KimSpiller and Hettche, 2014).

Therefore, it's intriguing to study what characteristics this online content should have to allow for consumer distribution without any prices or limits, since people enjoy sharing content with their peers in a chic but direct and personalized way (Sabate et al., 2014). Both the message style and content should be properly developed to raise the receiver's incentive to engage with the promotion favorably and increase communication effectiveness. What should be posted? Each post in message content typically contains a variety of themes, and these themes are crucial predictors of message effectiveness (Niu et al., 2015).

Feasible photographs should be used when communicating with clients since both format and content are crucial to message strategy (Molina. et al., 2020). Several studies have demonstrated the

influence of user-generated content on consumers' propensity to buy. Content is the tool that encourages engagement. There are a few key aspects of message content that must be taken into account. A key component is an interaction, which contains a call to action. An effective social media strategy will lead to interaction between brands and their customers on a two-way basis (VriesGensler and Leeflang, 2012). It's important to remember that marketing effectiveness indicators like shares, likes, and comments are all influenced by the message's content (KanjeCharles and Tumsifu, 2020).

Based on the above, we expect a positive relationship between content and the effectiveness of organic promotion in Sri Lanka. As long as there is better content, it leads to an increase in the effectiveness of the promotions.

3. CONCEPTUAL FRAMEWORK

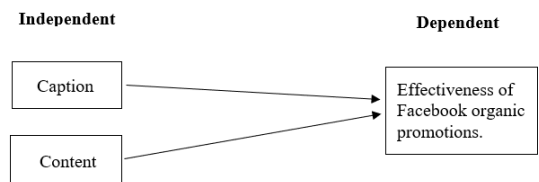


Figure 1: Conceptual framework (Compiled by authors)

H1: There is a positive significant impact of Caption on Facebook organic promotions in Sri Lanka.

H2: There is a positive significant impact of Content on Facebook organic promotions in Sri Lanka.

4. METHODOLOGY

4.1. Data

This research has used positivism because it is quantitative. This study will use a deductive approach because it will use a developed hypothesis based on an issue. This research is deductive research that had a prior identified theory. This research will use primary data collection, which will be gathered via

questionnaires. This research collected primary data through a questionnaire using the five Likert scales, using our two independent variables. Each variable is divided into 4 questions and altogether which will contain 8 questions. The purpose of this study is to examine the factors that influence the effectiveness of Facebook organic promotions for online entrepreneurs. This research will use the convenience sampling technique. because the questionnaire data was collected by Facebook users, and because this research will have more than one variable. In this research, the population is 4.5 million (Hewage and Weerasekera, 2018), and according to Morgan's table, the sample size is 384. The analysis of this research will use multiple linear regression analytical techniques. This research will use the SPSS software program for the purpose of cleansing and storing facts.

4.2. Questionnaire style.

The questionnaire was divided into two pieces. The first section will be divided into five general questions: age, which province you live in, and which promotion you use when using Facebook promotions. The idea about the Facebook population in Sri Lanka when compared to Instagram and the average time that a Sri Lankan citizen spends on Facebook. The second section will be divided by using over two independent variables and a dependent variable: content, content, caption, and effectiveness of Facebook organic promotions. Each variable had four multiple-choice questions. The multiple choice questions answers are Disagree, Strong Disagree, Neither agree nor disagree, Agree and Strong Agree.

5. RESULTS

The data of this research is gathered via questionnaires by using the 5 Likert scales, using variables caption and content. The following is the description of the characteristic of the respondents.

5.1. Reliability Statistics.

Cronbach's alpha is a measurement of a scale's internal consistency. Internal consistency is stated to be excellent if the Cronbach alpha value is equal to or more than 0.7, and unacceptable if it is less than 0.5. In this study overall reliability is .992.

Table 1: Reliability Test

Cronbach's Alpha	Cronbach's Alpha Base on Standardized items	N of Items
.992	.992	8

Source: Compiled by Authors

5.2. ANOVA.

This table shows what percentage of the variability in the Dependent Variable is accounted for by all of the Independent Variables.

Table 2: ANOVA output

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	286.979	4	71.745	1013.899	.000b
Residual	26.536	375	.071		
Total	313.515	379			

Source: Compiled by Authors

5.3. Coefficients.

This table shows the multiple linear regression analysis outputs of two variables Content and Caption, as results of the 384 responses of social media users. The following explanations present the results of the analysis.

Table 3: coefficients of output

Model	Unstandardized Coefficients B	Standardized Coefficients Beta	T	Sig.
(Constant)	.268	.070	3.854	.000
Content	.216	.050	4.307	.000
Caption	.013	.053	.013	.804

As mentioned before, the COVID-19 pandemic

Source: Compiled by Authors

6. DISCUSSION

The data of this research is gathered via questionnaires by using the 5 Likert scales, using variables Caption and Content. The following is a description of the characteristics of the respondents. In this research, the first hypothesis was to demonstrate that there is a positive and

significant impact of captions on Facebook organic promotions in Sri Lanka. The collected data clearly showed that there is a positive significant impact of captions on the unpaid Facebook promotions. The representation of a person's private state—their opinion, mood, or point of view—through the use of subjective language, with a bias toward positive valence, was said to be a crucial component of sharing news on social media (Welbers and Opgenhaffen, 2018). In connection, the positive captions frequently provide clarifications. As an illustration, consider the sentence from a PTV story that reads, "House Speaker Alan Peter Cayetano thinks President Rodrigo Duterte intends to do everything to safeguard the public despite his shoot-to-kill stance." (Rodriguez et al., 2020)

The next hypothesis that was expected is that there is a positive and significant impact of content on Facebook organic promotions in Sri Lanka. Contrary to what the aforementioned writers claim, we discover that the addition of images and interesting text (written in an expressive tone) increases the number of likes. Similar to this, we discover that a post's success in terms of comments depends less on the quantity of material and more on the originality of that content (Camarero et al., 2018). In order to understand the significance of format, content, and the moderating effect of appeal in messages to promote advertisements and campaigns, a total of three hypotheses were tested on Facebook based on the drivers and moderating variables that determine brand posts and, subsequently, marketing effectiveness (Molina et al., 2020).

7. CONCLUSION

The objective of this study was to measure the effectiveness of captions and content on Facebook organic promotions. This study provides a clear idea of the measure of the effectiveness of the two variables; i.e. captions and content for the organic Facebook promotions. The findings can be useful in identifying the positive impact of captions and content on the effectiveness of unpaid Facebook promotion. As per the information gathered via providing questionnaires to online business entrepreneurs, it was able to identify that both captions and content have a positive impact on the

effectiveness of organic promotions on Facebook. Furthermore, the study reveals that using good captions, especially trending ones, helps to grab the attention of the consumers. Having a meaningful, relevant, and good font uplifts the quality of the caption. Even though the content is less effective than the captions, it also plays a major role when creating organic Facebook promotions. Good content helps to increase its reach among consumers. Attractive images, colors, symbols, etc. can be used to increase the effectiveness of promotions on Facebook. Therefore, it can be concluded that using both captions and content and designing them in an attractive and relatable manner helps to have a positive impact on organic promotions on Facebook.

REFERENCES

- Constance. M.B. & Prashant V. K. (2019). Ten Tips for Capturing Figures with Captions. ACS Publications, Available at: <https://scihub.hkvisi.net/10.1021/acsenergylett.9b00253> [14th April 2022: 14th April 2022]
- Chloe, Therese B.R., Mary, Cielou.B.G, Loïc, A., Pazcoguin., D, S., Faith. & C, S., Luise, Gayle. (202). "Shoot them dead": Influence of the headlines and captions of online news articles towards comments on Facebook. Available at: https://www.researchgate.net/profile/Chloe_Rodriguez4/publication/357092024_Shoot_them_dead_Influence_of_the_headlines_and_captions_of_online_news_articles_towards_comments_on_Facebook/links/61bb3ac9a6251b553ac07858/Shoot-them-dead-Influence-of-the-headlines-and-captions-of-online-news-articles-towards-comments-on-Facebook.pdf [14th April 2022: 14th April 2022]
- Chawla, Y. & Chodak, G. (2021). Social media marketing for businesses: Organic promotions of web-links on Facebook Journal of Business Research, 49-65 Available at: <https://www.sciencedirect.com/science/article/pii/S014829632100432X> [14th April 2022: 14th April 2022]

- Chodak, G., Chawla, Y., Dzidowski, A. & Ludwikowska, K. (2019). The effectiveness of marketing communication in social media. *ACADEMIA*, Available at: https://dl1wqtxts1x7le7.cloudfront.net/60277297/Paper_-_ECSM_-_Full-with-cover-page-v2.pdf?Expires=1650644929&Signature=XYr-wiJW1iEc4gAVgZqPHVw5BIsgOP69WUvKjW1mYva2ONFSCx3~2BSK5j4zwsxT~rTnO7qPsVbELGaeLJx7OYtoL6IjD7liGBwoOCA~rZ2dC8HxsuHTrH5nA65whYNF4aAhmtaLUBzy-NBRSTQLMS7NFFbW3qZzjZqXUjoishFePjZoEXbGxxBqL23Scb5du7vDvDLG7MONIx bMS16Fn4aCBogawG9M5y2ZiPfKmE5JS1o keJzAv9nuT8A7GuHsmP32tr7ymX33KwdOEZtBILuApi5NZoGG65u5EHbEu0D5X1Y61I5ao-dEiDk5wEJk8-EjzQjZj-xMmT7vbX~w__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA [14th April 2022: 14th April 2022]
- Harun, A. & Lily, J. (2018). Benefits of Facebook fan/brand page marketing and its influence on relationship commitment among Generation Y: Empirical evidence from Malaysia. 35(7), 1980-1993 Available at: <https://doi.org/10.1016/j.tele.2018.07.002> [14th August 2022: 14th August 2022]
- Hewage, K. & Weerasekera, H. (2018) Social Media for Business: An Initial Scoping Exercise for Sri Lanka. Available at: <https://www.ips.lk/wp-content/uploads/2020/02/Social-Media-for-Business.pdf> [15th April 2022]
- Kanje, P., Charles, G. & Tumsifu, E. (2020). Customer engagement and eWOM in tourism. *Journal of Hospitality and Tourism Insights*
- Kim, D.-H., Spiller, L. & Hettche, M. (2014). Analyzing media types and content orientations in Facebook for global brands. *Journal of Research in Interactive Marketing*, 9(1), 4 - 30 Available at: <https://www.emerald.com/insight/content/doi/10.1108/JRIM-05-2014-0023/full/html> [14th April 2022: 14th April 2022]
- Lamberton, C. & Stephen, A., T. (2016). A Thematic Exploration of Digital, Social Media, and Mobile Marketing: Research Evolution from 2000 to 2015 and an Agenda for Future Inquiry. *Journal of Marketing: AMA/MSI* 80(146-172 Available at: https://ora.ox.ac.uk/catalog/uuid:f6995406-9460-40b8-8743-857c8610139a/download_file?file_format=pdf&safe_filename=thematic-exploration-of-digital-social-media-and-mobile-marketing.pdf&type_of_work=Journal+article [14th April 2022: 14th April 2022]
- Linebarger, D. & Piotrowski, J., Taylor. (2010). On-screen print: the role of captions as a supplemental literacy tool. *Journal of Research in Reading*, 33(2), 148-167 Available at: https://www.researchgate.net/profile/Deborah-Nichols-2/publication/227793136_On-screen_print_The_role_of_captions_as_a_supplemental_literacy_tool/links/5b7db5f14585151fd127c52d/On-screen-print-The-role-of-captions-as-a-supplemental-literacy-tool.pdf [14th April 2022: 14th April 2022]
- Liu, L., Lee, M., K.O., Liu, R. & Chen, J. (2018). Trust transfer in social media brand communities: The role of consumer engagement. *International Journal of Information Management*, 41(1-13 Available at: <https://www.sciencedirect.com/science/article/abs/pii/S0268401217302359> [14th April 2022: 14th April 2022]
- Mirabent F.S. , Cañabate B., & Lebherz P.R. (2014). Factors influencing popularity of branded content in Facebook fan pages. Available at: https://www.researchgate.net/profile/Antonio-Cañabate-Carmona/publication/266079275_Facebook_popularity_factors/links/542465710cf238c6ea6ebe26/Facebook-popularity-factors.pdf [14th April 2022: 14th April 2022]

- Rathnayake, T. & Rathnayake, D. (2018). Facebook Usage of Sri Lankan Consumers: Consumption Perspective of Social Media. *Arts and Social Sciences Journal*, 9(4), 9-44 Available at: https://strathprints.strath.ac.uk/71160/1/Rathnayake_Rathnayake_ASSJ_2018_Facebook_usage_of_Sri_Lankan_consumers.pdf [14th April 2022: 14th April 2022]
- Sabate, F., Mirabent, J. B., Cañabate, A. & Lebherz, P. R. (2014). Factors influencing popularity of branded content in Facebook fan pages. *European Management Journal*,
- Sally, M. S. & Wickramasinghe, M. I. E. (2020). A Trend Analysis on Sri Lankan Politics based on Facebook User Reactions. *Journal Pre-proof*, Available at: <https://www.sciencedirect.com/science/article/abs/pii/S0160791X19306256> [14th April 2022: 14th April 2022]
- Yunita Sari, D. A. (2022). AN ANALYSIS OF JACINDA ARDERN'S INTERPERSONAL MEANING THROUGH HER FACEBOOK CAPTIONS. Available at: http://digilib.uinsby.ac.id/52581/3/Della%20Ariyanti%20Yunita%20Sari_A03217012.pdf [10th April 2022: 10th April 2022]
- Wielki, J. (2010). The impact Of the Internet On The Development Of Web-Based Business Models. *Journal of Internet Banking and Commerce*, Available at: <https://www.icommercecentral.com/open-access/the-impact-of-the-internet-on-the-development-of-webbased-business-models.php?aid=38465> [14th August 2022: 14th August 2022]

A Study of Factors Associated with Realistic Design Innovations to Develop & Enhance the Apparel Industry of Sri Lanka

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winning & widening the international market share horizons of apparel industry.

ABSTRACT

The main objective of this research is to study & identify the factors associated with realistic design innovations to win the global customer's mind & develop the business to Sri Lanka. For this study, the researcher has selected as the model a well-established business unit in apparel manufacturing & exporting company. This synopsis has been tested with 200 randomly selected employees in different career categories under the development & research center of the organization. A survey was developed & utilized to gather data regarding the factors that significantly associated with realistic design innovations to develop & enhance the apparel industry of Sri Lanka. The data gathered was statistically analyzed in order to support or reject the research hypothesis. The findings of the research had been indicated that there were significant impacts to develop & enhance the apparel industry of Sri Lanka by using sustainable raw material for design concepts in various initiatives for garment manufacturing – such as using natural raw material for knitting structures, using recycle raw material which had been used already as industry waste & brand promotions with organizations sustainable projects & initiatives which are purely designed for developments of the garment concepts. According to the historical records & past sales records it is evident that present day majority of the consumers are looking for greener, sustainable brands with new initiatives. Through this study, the researcher suggests strategies to be coordinated by all relevant parties to optimize & succeed the targeted goal of

Keywords: *Design innovations, Sustainable apparel industry, Apparel industry development*

1. INTRODUCTION

The sustainable development goals, known as the Global goals which was accepted, established & adopted by the United Nations in the year 2015. These goals have been decided as a universal call to end up the poverty, protect the planet to ensure all the people in globe will enjoy peace & prosperity by the year 2030.

When it applies to design innovations for industry development, here the researcher is focusing to the Apparel industry which is the main dollar income to Sri Lanka even though during this prevailing economic situation facing.

As top seven global sustainable apparel innovations can be categorized as below in few which is identified as Innovation snapshots.

Seven innovations showcasing how the style and sustainability can be similar. Throughout 2020, the COVID-19 pandemic ensured that a lot of global shopping was directed online, which is not the most sustainable option in terms of shipping and delivery.

However, before, during and after the coronavirus hit, designers and innovators across the world were thinking of ways to align the fashion industry with a more natural approach, in order to protect both planet and the quality and variety of fashion that have grown from a flower- stuffed puff jacket to COVID-protective clothing made from recycled plastic. Here are seven of our best-spotted fashion innovations from 2020 in records.

Manufacturing sustainable clothing for reducing the waste.

The researcher reveals about a Nigerian-born designer called Lola Faturoti is known for her colourful, African- inspired designs. She had long wanted to produce denim clothing but was put off by the large order sizes needed, and the huge amounts of waste involved in printing on denim. Now, she is partnering with Resonance, a garment manufacturing company that is working to eliminate inventory in fashion, creating only the pieces that will be purchased. Faturoti uses Resonance's cloud- based platform to print her designs on organic and biodegradable denim, using 40% less ink and 50% less water than conventional methods. Savings are made from the item being produced only after a customer has placed an order, eliminating the manufacturing of items that never sell.

Using the platform, Faturoti produces one sample of each of her designs, then manufactures them as they're purchased. By eliminating minimum orders, it is also very easy to ditch designs that are not selling without generating excess garments and waste. It also speeds up the design process, allowing designers to tinker with different colours and patterns in order to see what sells. In addition to digital printing, Resonance also laser cuts all materials and uses only organic fibres.

Plant based (Natural) clothing designs.

Another example that author takes your attention to a London-based clothing startup Vollebak has designed a hoodie from eucalyptus trees that is fully biodegradable and compostable within eight weeks. Made from pulped eucalyptus and beech wood that has been sourced from sustainably managed forests, the plant-based jumper achieves a mossy hue from being dyed with pomegranate peel.

Vollebak, that Steve Tidball established on 2015 with his twin brother Nick, calculates that it will completely break down within 12 weeks if buried in soil, or eight weeks in a home compost heap, and even faster in an industrial composting facility. The hoodie also decomposes at different rates depending on the climate with bacteria-filled environments breaking down the material quicker.

According to Tidball, making biodegradable clothing was not a challenge, but rather creating something that could be manufactured in a sustainable way. Vollebak made the hoodie from eucalyptus and beech using a closed-loop production process, where over 99% of the

water and solvent used to turn the pulp into fibre was recycled and reused.

Fashionable clothing designs with zero- waste.

Royal College of Art graduate Danielle Elsener has created a toolkit for more efficient pattern cutting. The project, which was recently declared the winner of the Evian-Virgil Abloh's sustainable design programme, aims to eliminate the 15% of material wasted in the production of an average garment. For this, the A020 system of tools (also known as DECODE) is based on a series of pattern masters that aim to help designers to approach a piece of fabric like a puzzle, in which any empty space can serve a purpose within the finished garment.

Coded messages within the garments also aim to ignite a sense of discovery for the customer, as well as fostering more in-depth explorations around the idea of zero-waste design. Around these tools, Elsener created a series of educational workshops for designers to learn about the methodology and collect feedback on how the system could be improved. This feedback loop, she explained, is fundamental to helping factories transition their existing workflows into zero-waste ones.

Protective fashionable clothing with recycle (upcycle) plastic.

Colombian clothes brand Maaji is selling fashionable virus protective clothing made from recycled plastic.

Since sisters Manuela and Amalia Sierra founded the brand in 2002, Maaji has been dedicated to leveraging the latest research to produce eco-friendly materials, fabrics and printing processes. In addition to this, they have planted over 100,000 trees and continue to lead beach clean-up efforts.

Items for sale include a protective hoodie mask and a long jacket with face protection. The fabrics and protective layers of the garments are knitted with premium post-consumer recycled yarn, from plastic recovered bottles. They also use an Eco

Digital printing process that reduces water usage by 98 per cent, meaning that the overall production process produces 80 per cent less CO₂.

A better future for fashion industry.

Algiknit – which is producing textile fibres extruded from kelp, a variety of seaweed. The extrusion process turns the biopolymer mixture into kelp-based thread that can be knitted or 3D printed to minimize waste. The final knitwear is biodegradable and can be dyed with natural pigments in a closed loop cycle. BioGlitz. This company produces the world's first biodegradable glitter. Based on a unique biodegradable formula made from eucalyptus tree extract, the eco-glitter is fully biodegradable, compostable and allows for the sustainable consumption of glitter without the environmental damage associated with micro plastics.

When it comes to circular fashion, it has created a software that interconnects circular design, circular retail models and closed loop recycling technologies enables fashion brands to design circular garments. Circular clothes are attributed an identification tag that orchestrates a reverse supply chain network of consumers, sorting and recycling companies to close the loop to regenerated textiles.

Remeant innovative textile- Remeant is a fascinating material made from single use plastic. Based on innovative technology they have created textiles from non-recycled and unconventional materials. Remeant patented process of manufacturing ensures its qualities, making it highly durable, waterproof, easy to clean & lightweight.

Flocus. The company produces natural yarns, fillings and fabrics made from kapok fibres. The kapok tree can be naturally grown without the use of pesticides and insecticide in arid soil not suitable for agricultural farming, offering a sustainable alternative to high water consumption natural fibre crops such as cotton.

Frumat. The brand uses apples to create a leather-like material. Apple pectin is an industrial waste product which can be used to create sustainable materials that are totally compostable whilst still being durable enough to create luxury accessories. The leathers can be dyed naturally and tanned without chemically intensive techniques.

Good on You. This mobile app provides ethical ratings for about 1,000 fashion brands rated on their impact on people, the planet and animals. It is built on a robust brand rating system which aggregates standards, certifications and publically available data sources into a simple, accessible 5-point score to promote transparency across the fashion industry and to allow customers to make conscious purchasing decisions.

Mango Materials. The company produces biodegradable bio-polyester that can be used as a sustainable alternative to the present polyester utilized in the fashion industry. Micro-fibres produced from the bio-polyester can biodegrade in many environments, including landfills, wastewater treatment plants, and the oceans helping to prevent microfibre pollution and contributing to a closed-loop bio economy for the fashion industry.

Nano Textile. It offers a sustainable alternative to binder chemicals normally used to attach finishes onto a fabric. Its technology embeds fabric finishes directly into fabric using a process called Cavitation and can apply to a range of products such as antibacterial & antiodor finishes or water repellency. This protects the end-user and the environment from the leaking of hazardous chemicals. Orange Fiber. This Italian company manufactures natural fabrics from citrus by-products. Orange Fiber is made by extracting the cellulose from the fibres that are discarded from the industrial pressing and processing of oranges. The fibre, through nanotechnology techniques, is enriched with citrus fruit essential oils, creating a unique and sustainable fabric.

PAPTIC- which manufactures bio-based alternative packaging materials that are made from sustainably sourced wood fibres. The material has the unique properties of paper and plastic commonly used in the retail sector, but with a much higher tear resistance than paper. The material can be recycled alongside cardboard.

Planet Care- which has developed a micro-fibre filter to be integrated in washing machines, that can capture microplastics before they are released in wastewater. The system works on the microfiltration of water based on electrically charged fibres and membrane nanotechnology.

This technology contributes to reducing microplastics pollution ending up in the ocean.

Provenance Biofabrics. Provenance bio-engineers offer a true leather equivalent by programming the self-assembly of collagen molecules the building blocks of leather. This next generation fabric delivers a more efficient and sustainable alternative to leather without harming animals. **Reverse Resources.** This platform enables fashion brands and garment manufacturers to address pre-consumer waste for industrial upcycling. The Software as a Service (SaaS) platform allows fabric and garment factories to map and measure leftover fabrics and scraps so that these become traceable through their following life cycles. By mapping the waste material in the factory, these resources can eventually be reintroduced into the supply chain, limiting the use of virgin materials.

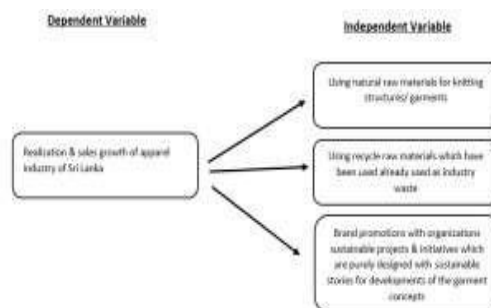
Scalable Garment Technologies Inc. SGTI has built a robotic knitting machine linked with 3D modelling software to make custom seamless knit garments. This new knitting technology enables digitization of the entire production process and on-demand manufacturing of custom seamless knit garments. This allows responsiveness to consumer demand while reducing waste.

Style Lend. It is a fashion rental marketplace. AI and machine learning is used to match users based on fit, as well as style. By renting out garments consumers can extend the life cycle of clothing and delay it from going into landfills.

2. SIGNIFICANCE OF THE STUDY

The researcher explains, multiple design concepts which are innovative to the apparel industry. First concept is “Using natural raw materials (Mainly plant based materials) for knitting structures /garments.” In modern apparel industry, leading fashion brands are more focusing on sustainable, reliable brands. By considering their interests, this first concept goes in sustainable manner by using natural raw materials such as 100% Cotton, 100% Linen, Cashmere, 100% Merino wool, Bamboo etc. Because by using the natural yarns, it look & feel good, in lustre effect that are having light weight in garment form. Also the main good thing that the researcher explains that by producing more & more these kinds of sustainable trendy wear using natural yarns , the impact for the external environment is not harmful at all as those are all in

to natural & super natural raw material base which are bio degradable.



Secondly, using recycle materials which are already used as industrial waste. Mostly these recycle yarns are referring to synthetic yarns that categorized under man made yarns. In order to reduce the production of these synthetic man-made yarns, using these same yarns after processing can be identified as recycle yarns. In apparel industry most of the time these types of raw materials are using in the base of “Recycled Polyester” & “Recycled Nylon” versions. These days customers / brands are much interested in such concepts & garments with recycle blended base, so they are aware it’s purely for a sustainable future.

Bran promotions with organizations sustainable projects & initiatives which are purely designed with sustainable stories for the developments of the sustainable stories. Not only the product with a suitable, innovative & creative concept, the organization, the people behind this product creation , should also be a part of this same concept. So from the organization perspective there are certain initiatives have been taken in place in long term & short term basis for brand promotional sustainable projects. These projects are covering the two main arms of environmental sustainability & human sustainability.

These projects are called CSR projects such as tree planting projects, re-forestation projects, riverbank developments, seeds distributions through in built garment fabrics / tags & protecting the work force & related families & their children around the organization with welfare projects.

By all these initiatives, it helps to make a creative sustainable product to improve the sales of the global apparel industry by improving the hit rate of brand selections of the initial concepts while making the human capital of the organization &

around it protected while making their economical stability in long term.

3. CONCEPTUAL FRAMEWORK

Variable	Valid	Min	Mean	Std. Dev.	Skewness
Using natural raw materials for knitting structures/ garments	200	0	3.86	0.737	-0.413
Using recycle raw materials which have been used already used as industry waste	200	0	3.94	0.713	-0.478
Brand promotions with organizations sustainable projects & initiatives which are purely designed with sustainable stories for developments of the garment concepts	200	0	3.92	0.617	-0.330
Realization & sales growth of apparel industry of Sri Lanka	200	0	3.97	0.670	-0.077

As shown in the following figure, in this research “Realistic design innovations to develop & enhance sales growth of apparel industry of Sri Lanka” is the dependent variable & there are three independent variables such as “using natural raw materials for knitting structures”, “using recycle raw materials which have been used already used as industry waste” & the third independent variable is “brand promotions with organizations sustainable projects & initiatives which are purely designed with sustainable stories for developments of the garment concepts”.

Figure 1: Conceptual framework

4. DEVELOPMENT OF HYPOTHESIS

Under each category it is assumed that the hypothesis relevant to each measurement in modern design innovations have an impact over the realization & sales growth of apparel industry to world market from Sri Lanka. The primary objective of this study is to prove the hypothesis.

H1 – There is an impact between using natural raw materials for knitting structures/ garments & the realization & sales growth of apparel industry.

H2 – There is an impact between using recycle raw materials which have been used already as an industrial waste & the realization & sales growth of apparel industry.

H3 -There is an impact between brand promotions with organizations sustainable projects & initiatives which are purely designed with sustainable stories for developments of the garment

concepts & the realization & sales growth of apparel industry.

5. DATA ANALYSIS STRATEGIES

This section discusses the analytical strategies used in the study to achieve its objective method of analysis includes a statistical of information collected using bar charts.

However, as a data analysis tool the author is going to use SPSS. The SPSS table is a summary table of descriptive statistics that gives figures for all the measures & it uses graphical options to make comparisons between the variables simpler.

Table 1: Descriptive statistics

Researcher has analyzed the level of responses regarding the independent variables with the dependent variable of realization & sales growth of apparel industry of Sri Lanka by applying statistics. Mean, Standard Deviation & Coefficient of skewness have been used to test the responses. According to descriptive statistics, all the mean values of variables are very close to the Likert scale 4. This says that response, with regarding the variables are in agreeable level.

Highest standard deviation is 0.73 & it belongs to “using natural raw materials for knitting structures /garments”. This says that, “using natural raw materials for knitting structures / garments has comparatively higher variance. Minimum variance belongs to the “Brand promotions with organizations sustainable projects & initiatives which are purely designed with sustainable stories for developments of the garment concepts”, of as the minimum standard deviation is 0.61. This indicates that comparatively Realization & sales growth of apparel industry of Sri Lanka has minimum variance. All the coefficients of skewness are between -1 & +1

Table 2: Correlation Analysis

According to the correlation analysis, the probabilities of “using natural raw materials for knitting structures / garments” & “using recycle raw materials which have been used already as an industrial waste” are highly significant between the “Realization & sales growth of apparel industry of Sri Lanka” (Endogenous variable) & other mentioned factors (Exogenous variables)

Brand promotions with organizations sustainable projects & initiatives which are purely designed with sustainable stories for developments of the garment concepts is significant with the realization & growth of apparel industry of Sri Lanka. Coefficient of correlation between them are positive.

Their value is more than 0.6. this means that all the actions taken as independent variables are having strong positive association with realization & the growth of apparel industry of Sri Lanka.

Table 3: Regression Analysis

Model	Sum of Squares	Mean Square	F	Sig.
1 Regression	24.710	8.237	86.658	.000 ^b
Residual	6.273	.095		
Total	30.983			

Table 4: Individual effect

Model	Unstandardized Coefficient		Standardized Coefficient		t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta				Tolerance	VIF
1 (Constant)	1.023	.241			2.599	.000		
Using natural raw materials for knitting structures/ garments	.240	.103	.305		1.033	.000	.258	3.81
Using recycle raw materials which have been used already used as industry waste	.732	.078	.809		9.623	.000	.434	2.31
Brand promotions with organizations sustainable projects & initiatives which are purely designed with sustainable stories for developments of the garment concepts	.234	.121	.216		1.926	.000	.345	4.01

Probability of F test statistics of the regression ANOVA is highly significant as the P value is 0.000. This means that the model is jointly significant, & the measures of traditional indigenous medicine jointly influence on the realization & sales growth of apparel industry of Sri Lanka. The model is appropriate, & individual effect has been analyzed above. Probability of

innovative & sustainable design concepts are

Independent Variables		Pearson	
Using natural raw materials for knitting structures/ garments		Correlation	.656**
		Sig. (2-tailed)	.000
		N	70
Using recycle raw materials which have been used already as an industrial waste		Pearson	.732**
		Correlation	
		Sig. (2-tailed)	.000
		N	70
Brand promotions with organizations sustainable projects & initiatives which are purely designed with sustainable stories for developments of the garment concepts		Pearson	.648**
		Correlation	
		Sig. (2-tailed)	.000
		N	70

highly significant with positive beta values. Their probabilities are less than

0.01. This says that they significantly influence positively on realization & sales growth of apparel industry of Sri Lanka. These assumptions have been tested & diagnostic tests to decide the validity of regression results. In the model summary, D-W test is in the accepted level & residuals are independent. All the variance inflation factors (VIF) are less than 10 & it indicates that independent factors are not highly & perfectly correlated. Therefore, no multicollinearity problem in the regression model. Accordingly, regression model is highly valid.

6. DISCUSSION

When the researcher considers the hypothesis made during this study, the hypothesis no 01, using natural raw materials for knitting structures/ garments has a positive impact or relationship with realization & sales growth of apparel industry of Sri Lanka. According to the correlation analysis the probability of using natural raw materials for knitting structures/ garments is 0.886 the standard must be 0.7. Therefore, there is significant between use of natural raw materials for knitting structures/ garments & realization & sales growth of apparel industry of Sri Lanka. According to the regression analysis the probability of using natural raw materials for knitting structures/ garments is highly significant with positive beta value.

Their probability is less than 0.01. This says that this significantly influence positively on realization & sales growth assumptions have been

tested as diagnostic tests to decide the validity of regression results. Accordingly, regression model is highly valid Hypothesis no 03, Brand promotions with organizations sustainable projects & initiatives which are purely designed with sustainable stories for developments of the garment concepts has a positive impact or relationship with realization & sales growth of apparel industry of Sri Lanka, according to the correlation analysis, the probability of Brand promotions with organizations sustainable projects & initiatives which are purely designed with sustainable stories for developments of the garment concepts is 0.649 & therefore there is highly significant between Brand promotions with organizations sustainable projects & initiatives which are purely designed with sustainable stories for developments of the garment concepts with realization & sales growth of apparel industry of Sri Lanka.

7. CONCLUSION

According to the statistics shown throughout in the research by the researcher & the analysis revealed the positive impacts of sustainable design innovations to realization & sales growth of apparel industry of Sri Lanka, the regulators & the policy makers need to take necessary steps making the innovations of research level concepts for further developments to as a great opportunity to promote our Sri Lanka capabilities in apparel industry in the global market. In this scenario the avenues to be designed & implemented by the collective efforts of the organizational leaders to utilize resources as Ministry of Export Development Board & Trade Ministry. Researcher suggests the motivation of organizational leaders in Sri Lanka by the Export development board to arrange necessary standards & certifications from standardizing institutions & universities to the level of acceptance in the international market. Trade ministry & the foreign ministry could take the leadership providing more & more improved opportunity to Sri Lankan manufactures to explore market outside Sri

Lanka. The author believes this as a golden opportunity & Sri Lanka will win global market through promoting our Sri Lankan Sustainable realistic design concepts to global market & reaping unbelievable harvest of foreign income in apparel industry.

of apparel industry of Sri Lanka. These assumptions have been tested as diagnostic tests to decide the validity of regression results. Accordingly, regression model is highly valid.

When it comes to hypothesis no 02, using recycle raw materials which have been used already used as industry waste, according to the correlation analysis, the probability of use recycle raw materials which have been used already used as industry waste is 0.713 & therefore there is a high significant between with use recycle raw materials which have been used already used as industry waste & realization & sales growth of apparel industry of Sri Lanka. Accordingly, Correlation model is highly valid. According to the regression analysis Probability of using recycle raw materials which have been used already used as industry waste is highly significant with positive beta value. Their probability is less than 0.01. This says that they significantly influence positively on realization & sales growth of apparel industry of Sri Lanka. These

REFERENCES

- BAILEY, T.H.O.M.A.S. (1993) "Organizational innovation in the apparel industry," *Industrial Relations: A Journal of Economy and Society*, 32(1), pp. 30–48. Available at: <https://doi.org/10.1111/j.1468-232x.1993.tb01017.x>.
- Doeringer, P. and Crean, S. (2006) "Can fast fashion save the US apparel industry?," *Socio-Economic Review*, 4(3), pp. 353–377. Available at: <https://doi.org/10.1093/ser/mwl014>.
- Home (2022) Natural Yarns. Available at: <https://naturalyarns.co.za/> (Accessed: August 6, 2021).
- King, S. (2022) 16 Zero Waste Clothing Brands for a sustainable closet, *Sustainably Chic*. Sustainably Chic. Available at: <https://www.sustainably->

chic.com/blog/zero-waste-clothing-brands

(Accessed: November 16, 2021).

McBee-Black, K. (2022) "A case study exploring adaptive apparel design innovations as key competitive resource for the Adaptive Apparel Market," Breaking Boundaries [Preprint]. Available at: <https://doi.org/10.31274/itaa.13288>.

The Systematic Review Method: Adaptation of Innovative Products by Technicians in the Automotive after Marketer Business

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ABSTRACT

In the Sri Lankan context, owning a vehicle has its limitation, especially for the individual owners mainly due to the high-cost involvement and limited access to funds for a certain segment of the population. With the rapid development of highways and roads, the need to move from one point to another has become a necessity owing to the residence, work or visit to a place of interest. The country relies entirely on the importation of required vehicles. The current system of the importation and aftersales mostly depends on individual importers rather than the dealership network of the brand of vehicles; due to this model practised on vehicle imports technicians and workshops involved in the aftersales maintenance of vehicles are of paramount importance to customers who rely on the maintenance of their vehicles. In order to have the vehicles maintained as per the manufactures specifications. Technicians and workshops have to update their capability to meet the maintenance and repair standards as per the manufacturer. Adaptation to innovation by the technicians required to meet the maintenance process and attract entrepreneurs, to set up workshops. The workshops should be able to handle the new models of vehicles and introduce the modern compatible maintenance process and equipment to meet the standards as well as to improve the knowledge and innovative approach by the technicians to meet the expectations of the customers.

Keywords: *Innovation, Entrepreneur, Technician, Workshop, Maintenance, Vehicle*

1. INTRODUCTION

The vehicle maintenance business consists of car care; which relates to day-to-day maintenance of the vehicle, mechanical maintenance and collision repair. The study is to find the vehicle maintenance technician's adaptability to innovation in products required for vehicle maintenance in meeting the manufacturer's recommended process in maintenance and repair and the entrepreneurial approach in setting up business opportunities in meeting the vehicle maintenance requirement.

1.1. Literacy rate in Sri Lanka

A study conducted in Sri Lanka (Chandrakumara & Budwar ,2005) states; the literacy rate of the population stands at 92%(CBSL,2005); which is in accordance with the developed countries. The development of a country is supported by human capital; which plays a crucial role in the development process (Psacharopoulos and Patrinos, 2002; Becker, 1964; Shultz, 1961). For a country's development it is important how the income of people is met in terms of personnel revenue and having a dialogue with others, which will help to have a healthier human capital; to achieve this education is a source of bridging for a human capital formation (World Bank,2005).

1.2. Customer purchase decision on Vehicles

A study by (Brito et al., 2007). Customer satisfaction with the maintenance of a vehicle is one of the buying preferences. Focusing more on service quality and the preference of the customer to purchase the vehicle (Croninet et al.,2000). The quality of the service provided to car owners is still debated according to the study, using the service quality literature may help to understand the purchase intention of the customer based on service operations. Research by (Cronin et al., 1992) established that service quality directly influenced

the customer on the purchase decision and customer satisfaction held a more influence on the purchase decision. The development of a customer-centric approach to building the trust of the vehicle owners.

1.3. Innovation and Entrepreneurship

Innovation to help meet customer expectations on vehicle maintenance requirements, (Drucker, 1994) explains innovation as need not be technical; it can be in the form of social as well as economic innovations. In other terms, the shortest term for innovation is invention. A combination of theory or design ideas that provides a new method is innovation (Sundbo, 1998; Bright, 1969). The act of creative seen as entrepreneurship and innovation entrepreneurship generating somewhat that never existed (Johnson, 2001). Teams led by people to announce innovations are entrepreneurs. Opportunities: are sought by entrepreneurs and succeeded by way of innovations (Legge and Hidle, 1997). Market requirements are met by innovations while entrepreneurship focuses on the commercial aspects (Zhao, 2001). The primary cause of innovation and entrepreneurship is seen as culture (Herbig et al., 1994). Ideas get converted to services and products and taken to market in entrepreneurship (Johnson, 2001, p.138)

1.4. Knowledge

Knowledge has been characterised as tacit and explicit (Polyani, 1967). The formal knowledge structure refers to the explicit and the informal structure refers to the tacit knowledge (Nonaka and Takeuchi 1995; Polyani, 1967). Knowledge gained through the non-conscious refers to tacit knowledge (Hasher & Zacks, 1984). Tacit knowledge is gained through the involvement of an activity other than formal instructions (Schutz and Luckmann, 1973; Scribner, 1986). Knowledge transfer of explicit is easier than tacit (Polanyi, 1967).

2. METHODOLOGY

A philosophical approach was to identify the technician's view of adapting to innovation apart from the current practice of attending to the maintenance process. The search was carried out on philosophical domains to identify the suitable for the research; the outcome was the Realism view

(Saunders et al. 2011), which was found more suitable to work on the research area of adaptability of innovation by the technicians. From a philosophical positioning, realism is the reality of the truth of the human mind and is a division of epistemology. The world we live in is heavily concerned with research conducted for business and management (Saunders et al. 2011). In direct realism, we get what we see and in critical realism; the experience is the perception. In understanding critical realism, Bhaskar, 1989 relates; we will be able to understand what is going around the social world; if sensations could be able to recognize the theoretical and practical process of social science will not be able to identify. In understanding direct realism; it has the capacity to change the world with the research lessons but will not differ from the business background it works on.

The four philosophical research approaches namely Positivism, Realism, Interpretivism, and Pragmatism; are based on the study to understand the technician's ability to change to accept innovation. Ontology would be critical realism and Epistemology will fall into direct realism. Quantitative and Qualitative are both used in realism philosophy for data collection techniques. To understand the technicians to adapt to innovation quantitative method was selected based on the study by (Saunders et al. 2011); which mentions the application of Deduction, Induction and a combination of both and deduction was the selected method to conduct the primary research. Utilizing the deductions theory, the researcher positioned independently to get the inputs quantitatively.

3. RESULT AND DISCUSSION

Technicians working in maintenance workshops lack the knowledge and innovative approach to attending to the work, which results in poor workmanship of the maintenance and repair. The education systems with higher literacy rates fail to improve the knowledge of apprentices as well the job seekers on innovation. The limitation to produce apprentices to the demand required by the workshops does not tally with the intake of apprentices and the demand required by the workshops. Development of the workshops and the technician's educational requirements will support

the roadworthiness of the vehicles as per the manufacturer's expectations and customer happiness.

4. CONCLUSION

Asian countries compared to the western and developed countries lack the ability to adapt to innovations in their lifestyle, with high literacy rates recorded in many of the countries with the support of free education by the respective governments of the country. It is important for Sri Lanka to be competitive with the developed countries to attract innovation to the available population with high literacy, which will help especially the youth be on par with the other developed countries' requirements that can support employees as well to develop the entrepreneur-based development in the vehicle maintenance industry.

REFERENCES

- Audretsch, D. (2012). Entrepreneurship research. In *Management Decision* (Vol. 50, Issue 5, pp. 755–764). <https://doi.org/10.1108/00251741211227384>
- Baniak, A., & Dubina, I. (2012). "Innovation analysis and game theory: a review", *Innovation: Management, Policy*.
- Chandrakumara, D. P. S. (n.d.). *ACHIEVEMENTS IN HUMAN CAPITAL FORMATION IN SRI LANKA*. Entrepreneurship.
- Chandrakumara, A. (2007). Does HRM fit really matter to citizenship and task performance?: Sri Lankan manufacturing sector experience. *Employee Relations*, 29(6), 611–639. <https://doi.org/10.1108/01425450710826113>
- Chen, L., Hsieh, J. J. P.-A., & Rai, A. (2022). How Does Intelligent System Knowledge Empowerment Yield Payoffs? Uncovering the Adaptation Mechanisms and Contingency Role of Work Experience. *Information Systems Research*. <https://doi.org/10.1287/isre.2021.1097>
- Chilton, M. A., & Bloodgood, J. M. (2010). Adaption-innovation theory and knowledge use in organizations. *Management Decision*, 48(8), 1159–1180. <https://doi.org/10.1108/00251741011076726>
- Dhall, R., & Solanki, V. K. (2017). An IoT Based Predictive Connected Car Maintenance Approach. *International Journal of Interactive Multimedia and Artificial Intelligence*, 4(3), 16. <https://doi.org/10.9781/ijimai.2017.433>
- Dollinger, M. J. (2008). *Entrepreneurship: strategies and resources*. Marsh Publications.
- Edquist, C. (2009). Systems of Innovation: Perspectives and Challenges. In *The Oxford Handbook of Innovation*. Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780199286805.003.0007>
- McFadzean, E., O'Loughlin, A., & Shaw, E. (2005). Corporate entrepreneurship and innovation part 1: The missing link. In *European Journal of Innovation Management* (Vol. 8, Issue 3, pp. 350–372). <https://doi.org/10.1108/14601060510610207>
- Jiang, S., Wang, F., Fan, R., & Liu, L. (2018). The Research and Practice of the Training and Innovation of the Professional Skills and Cultivation of Talents.
- Psacharopoulos, G., & Patrinos, H. A. (2018). Returns to investment in education: a decennial review of the global literature. *Education Economics*, 26(5), 445–458. <https://doi.org/10.1080/09645292.2018.1484426>
- Gedeon, S. (n.d.). What is
- Psacharopoulos, G., & Patrinos, H. A. (2018). Returns to investment in education: a decennial review of the global literature. *Education Economics*, 26(5), 445–458. <https://doi.org/10.1080/09645292.2018.1484426>
- rito, E. P. Z., Aguilar, R. L. B., & Brito, L. A. L. (2007). Customer choice of a car maintenance service provider: A model to

identify the service attributes that determine choice. *International Journal of Operations and Production Management*, 27(5), 464–481.
<https://doi.org/10.1108/01443570710742366>

Smith, W. S., Coleman, S., Bacardit, J., & Coxon, S. (2019). Insight from data analytics with an automotive aftermarket SME. *Quality and Reliability Engineering International*, 35(5), 1396–1407.
<https://doi.org/10.1002/qre.2529>

Smit, B., Burton, I., Klein, R. J. T., & Street, R. (n.d.). THE SCIENCE OF ADAPTATION: A FRAMEWORK FOR ASSESSMENT.

Zhao, F. (2005). Exploring the synergy between entrepreneurship and innovation. *International Journal of Entrepreneurial Behaviour and Research*, 11(1), 25–41.
<https://doi.org/10.1108/13552550510580825>

Influencer Marketing and Electronic Word of Mouth: A Methodological Review

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ABSTRACT

Influencer marketing has gained immense popularity over the past years. Many organizations rely on social media influencers to promote their brands and reach out to target consumers. Academic research on influencer marketing is expanding rapidly and provides a greater understanding of how influencer marketing influences customers and thereby facilitate electronic word of mouth. Given the importance of social media influencers in the marketing literature and the fact that this study area is continuously evolving, a detailed and critical review of existing research on this issue is much needed. The main objective of the present study is to perform a methodological review on influencer marketing and electronic word of mouth. The review has been undertaken from the period of 2010 to 2022 based on 47 articles retrieved from the Scopus database. Descriptive analysis was carried out in order to get insights on the background of the studies in the sample. The study deploys coding process pertaining to methodological choices giving emphasis on, research design, sampling techniques, data collection methods, variable measurements, validity and reliability measures, and data analysis techniques. Conclusively, recommendations for future research are provided to shed light on unexplored realms pertaining to context and methodology on influencer marketing.

1. INTRODUCTION

In the recent times, one of the profound consequences of social media is the impact it has created on business organizations. Virtual marketplace is enjoyed by large variety of

organizations as opposed to traditional marketplace. In an era where consumers are attracted to various social media networks, this has become a point of paramount significance to brands in devoting their marketing strategies towards this domain where vast audience can be reached (Campbell & Lawrence, 2015). As defined by Kaplan and Haenlein (2010), social media is internet-based applications built on Web 2.0 technology that allows participants to create and share user-generated content. Modern businesses largely consider social media as a promising platform of conducting their promotional activities that allow effective communication with target customers (Popp & Woratschek, 2016; Harrigan et al., 2017). Hence, social media is deemed to be possibly heralding a paradigm shift in marketing (Hanna et al., 2011).

Social media platforms offer various ways for the organizations to connect with their customers which does not require greater financial investment (Michaelidou et al., 2011). Consumers are able to navigate through social media in order to browse for products and go through reviews before stepping into the physical store. By the time consumers reach the post-purchase stage, they have acquired their own experience after having completed the consumption (Carù & Cova, 2003). Before the existence of social media, post-purchase behavior of consumers was shared with limited circles. Anderson (1998) studied the word-of-mouth behavior of consumers between private parties among the people known to them. Findings revealed that word of mouth behavior of extremely dissatisfied customers is greater than highly satisfied customers. Accordingly, word of mouth communication allows customers to exchange information and opinions that steer other potential customers

towards or away from brands (Hawkins et al., 2004).

Customers can evangelize their own experience to more and more customers by using various social media platforms (Hudson et al., 2016). Seminal work of Fournier (1998) influenced marketing literature to examine the bond between consumers and their brands. Ghani & Tuhin, (2018) reviewed the evolution of consumer brand relationship research. The authors pointed out that brand evangelism as a relatively new construct that has been employed to study consumer brand relationship. Fan pages in different social media networks enable the community members to share their ideas and express themselves freely. Hence, organizations focus on rewarding and praising such fans to further promote interactions (Hsu, 2019). To exploit this to a greater potential, nowadays brands tend to join hands with social media influencers (SMI) to promote and review products (Evans et al., 2017).

SMIs represent a new type of independent third-party endorser who shape audience attitudes through blogs, tweets, and the use of other social media" (Freberg et al., 2011, p.90). Influencers form deeper psychological attachments with their followers by sharing content that may seem personal and predominantly revolves around their interests and life styles mainly in terms of beauty, fashion and travel (Audrezet et al., 2020; Ki et al., 2020; Tafesse & Wood, 2021). Influencers are more likely to be micro-celebrities who may involve in advocating products and services through paid sponsorships by collaborating with various brands, providing opinion (Senft, 2008 as cited in Martínez-López et al., 2020). SMIs being opinion leaders must ideally upload original content in order to be perceived as distinct by their current and potential followers (Casaló et al., 2020). Accordingly, SMIs' narrative strategies would enable eWOM in online platforms where customers too can interact sharing their ideas and opinions (Zhou et al., 2021a).

Over the recent years, both conceptual and empirical studies have contributed to influencer

marketing literature. However, studies on SMIs predominantly focusing on systematic literature review came into light in 2019. Sundermann and Raabe (2019) reviewed literature on SMIs for strategic communication considering the research papers published between 2011 – 2018, which gave many insights to subsequent studies. This was further comprehended by De Veirman et al. (2019) where the focus was on how influencer marketing targets young children. Influencer endorsement in travel and tourism sector was undertaken by Nafi and Ahmed (2019) and Sesar et al. (2021). Moreover, Hudders et al. (2021) searched the Scopus database from 2018-2022 and opened up future research directions on strategic use of social media influencers. Many other scholarly work on bibliographic review pertaining to influencer marketing give insights to the value and the use of influencer endorsement (De Veirman et al., 2019; Abhishek & Srivastava, 2021; Vrontis et al., 2021; Ye et al., 2021; Kanaveedu & Kalapurackal, 2022; Tanwar et al., 2022). The purpose of the current study is to extend the knowledge on methodological discussion via systematic literature review in order to offer a glimpse of how prior research studies in the field of influencer marketing have progressed. Particularly, the present study aims to explore the scientific research papers published focusing on the research question, "what is the impact of influencer marketing on electronic word of mouth?", since the earlier reviews seldomly focused this research area.

2. METHODOLOGY

The present study followed the procedure proposed by Parahoo (2006) as cited in Dakduk & González (2018). In developing the search string, edited checklist of O'Brien and McGuckin, (2016) was followed. Pertaining to the research question, search string was developed. Initially focused the key word, "social media influencers" and then identified the mostly used synonyms. Subsequently, focused on the other part of the research question, "electronic word of mouth" and related terms were identified. BOOLEAN operators OR was used to separating the keywords while AND was used

to combine the search string. The following search string was developed accordingly.

("Influencer" OR "Influencer marketing" OR "Social media influencers" OR "Influencer endorsement") AND ("Electronic word of mouth" OR "Word of mouth" OR "Brand evangelism")

2.1. Inclusion and Exclusion Criteria

The search was performed in Scopus database available in the Plymouth University library, using the search string developed. Previous review papers in the area of influencer marketing included only the research papers of indexed journals (Vrontis et al., 2021; Kanaveedu & Kalapurackal, 2022). Hence, the present study also limited the review to the journal articles listed in Scopus database. The initial results generated 147 articles. Inclusion and exclusion criteria were included to obtain the most relevant articles. The articles published between 2010-2022 were given prominence as prior researchers too have established that most of the research based on influencer marketing came into light after 2010 (Vrontis et al., 2021; Tanwar et al., 2022). Among the search results generated in Scopus database, 9 articles were

published prior to 2010 were removed, narrowing down to 138 articles.

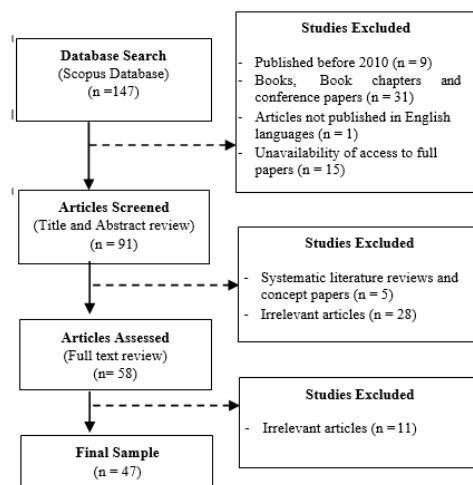


Figure 1: search strategy (Source :Author)

The database results were further delimited using exclusion criteria. Only the reviewed journal papers were considered excluding books, book chapters and conference papers. Review papers and conceptual papers were excluded since the present study is a methodological review, thus giving emphasis on empirical research. Exclusion criteria based on language were also applied such that only those journal papers published in English language were considered. After incorporating the inclusion and exclusion criteria, 47 were included as the final number of articles (AlFarraj et al., 2021; AlRabiah et al., 2022; Arenas-Márquez et al., 2021; Azim & Nair, 2021; Barbe et al., 2019; Bergel & Brock, 2019; Casais & Gomes, 2022; Chen et al., 2017; Chopra et al., 2021; Dalla-Pria & Rodríguez-de-Dios, 2022; Dwidienawati et al., 2020; García-de-Frutos & Estrella- Ramón, 2021; Gkritzali et al., 2020; Grigsby & Skiba, 2022; Han, 2019; Hess et al., 2022; Iacobucci & De Cicco, 2020; Jiang & Park, 2021; Jiménez-Castillo & Sánchez- Fernández, 2019; Ki & Kim, 2019; Konstantopoulou et al., 2019; Kristensen, 2021; Le et al., 2018; Lee et al., 2022; Liu et al., 2022; López et al., 2022; Lou et al., 2020; Loureiro et al., 2021; Morton, 2020; Muda & Hamzah, 2021; Oraedu et al., 2021; Petrescu et al., 2018;

Pornsrimate & Khamwon, 2021; Pozharliev et al., 2022; Sánchez-Fernández & Jiménez-Castillo, 2021; Rosara & Luthfia., 2020; Sands et al., 2022; Saville et al., 2020; Schwemmer & Ziewiecki, 2018; Silva & Campos, 2019; Sharma & Bumb, 2022; Shen, 2021; Simay et al., 2022; Taillon et al., 2020; Verma, 2013; Wang et al., 2022). Search strategy results with inclusion and exclusion criteria being applied are summarized in Figure 1.

3. ANALYSIS AND RESULTS

3.1. Descriptive analysis

It is crucial to map the literature on SMIs using descriptive analysis in order to capture patterns, strengths and shortcomings of previous studies (Vrontis et al., 2021; Ye et al., 2021; Kanaveedu & Kalapurackal, 2022). Hence, the descriptive analysis was carried out in order to obtain an overall picture on the selected articles for the methodological review. Accordingly, data in terms of year of publication, journal in which the article has been published, number of citations, geographic coverage, social media platforms studied were presented descriptively.

3.1.1. Year of Publication

In conformance with prior studies (Kanaveedu & Kalapurackal, 2022; Vrontis et al., 2021), search results of the present study too depict that greater majority of articles have been published after 2017 giving evidence to the novelty of the research area. Accordingly, 62% (n=29) of the research publications in the sample out of the



total of 147 articles, have been published in 2021

Figure 2: Publications based on the year Source: Author

and 2022. Figure 2 illustrates the number of articles based on the year of publication.

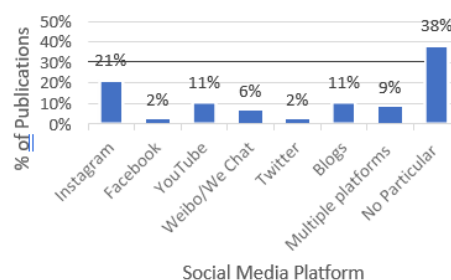


Figure 3: Social media platform

3.1.2. List of Journals

In order to obtain a clear picture of the journals on which the selected articles have been published, the information is summarized in Appendix 1. Majority of the articles have been published in the marketing related journals (51%, n=24). In addition, remaining articles in the final sample are from journals in the fields of information management, general management, logistics and psychology. Moreover, few articles have been published in tourism related journals. Hence, the empirical studies on social media influencers are not confined only to marketing literature rather deemed attractive across many disciplines.

3.1.3. Social media platforms

Since influencer marketing takes place on social media, the type of social media platform considered by prior researchers is worth analyzing. In the current sample of articles, 38% (n=18) have not relied on a specific social media platform as such. However, (n=10) of the articles have studied Instagram whereas similar

results were also revealed in previous bibliographic reviews in the area of influencer marketing (Vrontis et al., 2021; Kanaveedu & Kalapurackal, 2022). Instagram is identified as one of the most popular networking sites when it comes to social media marketing as it largely facilitates electronic word of mouth, thus widely being used by influencers as well (De Veirman et al., 2017). Among the articles studied influencer endorsement through blogs. Multiple platforms have been considered 9%

(n=4). Analysis also revealed that, Weibo and WeChat were the social media platforms that were

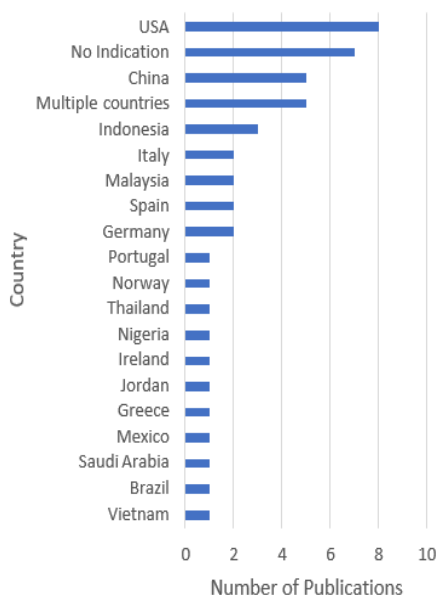
widely taken into consideration in the research conducted in China. Figure 3 graphically

represents the various social media platforms being studied in research papers under consideration.

considered for the review 11% (n=5) have considered YouTube and similar number has

3.1.4. Country

In terms of the geographic coverage of the studies in the sample, the United States of



America (USA) has been mostly examined. In seven studies, the country is not specified, whereas five studies focused on multiple countries. One such study includes USA and India, which is the only considered in the empirical studies in the sample are shown in Figure 4. study being conducted in

South Asian context. Detailed description on different countries

3.2. Content Analysis and coding

The content analysis and coding process was adopted to facilitate the methodological review. Due to inadequate methodological reviews available among the extant literature in the area of influencer marketing, content analysis and the coding process stated by De Alwis and Hernwall (2021) was followed as it was a methodological paper which gave valuable insights to the process. Accordingly, coding process was carried out giving emphasis on research design, sampling techniques, methods of data collection, variable measurement, validity and reliability, and data analysis methods.

3.2.1. Research design

The research design lays down the blueprint of concerning data collection, measurement and analysis to answer the research questions (Sekaran & Bougie, 2016). Present study undertakes the review pertaining to the research design based on the research onion introduced by Saunders et al. (2019). First and foremost, the methodological choice of the research studies was coded as qualitative, quantitative or mixed methods. Among the review articles of this study 32 out of 47 articles (68%) have employed quantitative approach while 23% (n=11) have used qualitative approach in their research design. Moreover, 9% (4 articles) have used mixed methods as the methodological choice.

Secondly, research strategy employed in the selected research papers was identified and

coded. Such strategies can be mainly identified as experiment, survey, archival and documentary research, case study, ethnography, action research, grounded theory and narrative inquiry (Saunders et al., 2019). The research strategy, survey method is not confined only to structured questionnaires but may also include other survey instruments such as interviews and structured observations (Sekaran & Bougie, 2016). The majority of the research articles being reviewed for the present study have undertaken surveys as the research strategy (45%, n=21).

Experimental design has been undertaken by 12 articles (26%). Among the articles in the sample, two papers specifically mentioned as exploratory studies. Moreover, case study research strategy has been adopted by one article while mixed strategies were followed by three research papers (6%). One of the articles that used mixed research strategies relied on both grounded theory and survey while other two papers followed survey and analysis on blog posts. In addition, six other articles (13%) also focused on such various social media platforms' content, which is likely to have adopted archival and documentary research strategy. Among the articles under consideration, two papers have stated that the authors adopted netnography. According to Saunders et al. (2019), ethnographic approach which studies people in online or virtual communities is known as netnography or online ethnography. As far as the time horizon is concerned, almost all the papers in the sample have used cross-sectional approach.

3.2.2. Sampling Techniques

Sample is vital to draw conclusions that are generalizable to population (Sekaran & Bougie, 2016). In the present methodological review, coding process revealed that both probability and non-probability sampling methods were employed by the authors of the articles. Most of the reviewed studies have not mentioned any sampling technique followed (43%, n=20). Purposive sampling has been used in 32% of the articles (n=15). Four research papers (9%) have

mentioned that the authors used convenient sampling. Two papers reported having employed snowball sampling technique out of which one study is a quantitative study. Moreover, only four studies appear to have used probability sampling methods. Such methods include systematic random sampling, stratified random sampling and simple random sampling. Three studies have mentioned multiple sampling techniques. One such study is a mixed method study that used convenient sampling and snowball sampling. The other two research papers mentioned purposive and snowball sampling.

3.2.3. Data Collection Methods

Based on the data collection techniques, studies are broadly categorized into mono method quantitative study, multi- method quantitative study, mono method qualitative study and multi-method qualitative study (Saunders et al., 2019).

30 research papers in the sample (64%) have used questionnaires to collect data which is mono method quantitative while 6% (n=3) employed semi-structured interviews to collect data. Further, nine studies (19%) collected data from social media content. In addition, five studies employed mix methods in data collection. Such mixed methods include, text collection through grounded research and questionnaire, social media content and interviews, social media content and questionnaire, interview and observations depicting the variety of mix methods have been employed in data collection.

3.2.4. Variable measurements

Researchers use a set of measurements or rating questions in order to infer the presence of a construct, which are then merged into a scale that measures the construct (Saunders et al., 2019). In line with De Alwis and Hernwall (2021), following codes were adapted to analyze the variable measurements incorporated in the studies under consideration: existing scales, existing scales adapted and new scales developed. All the 30 studies which collected

data via questionnaires have adapted existing scales. In addition, two more studies which used mixed method research design that contain questionnaires too have adapted existing scales. Accordingly, 32 (68%) studies in total have

adapted existing scales. None of the studies in the sample focused on scale development.

3.2.5. Validity and Reliability

Validity of the questionnaire is vital as it ensures that the data is collected accurately which would actually measure the concepts that are intended to be collected by the researcher. Moreover, reliability refers to the consistency, meaning whether the respondents would consistently interpret questions in a similar way (Saunders et al., 2019). Among the studies in the sample, 49% (23 articles) have stated validity measures whereas 51% (24 articles) have not mentioned any information regarding validity tests being carried out. As for the reliability tests, 55% (n=26) have reported reliability tests being conducted prior to proceeding with other analysis methods, whereas 45% (n=21) have not reported any reliability tests.

Cronbach's alpha is a popular internal reliability test. It computes the average of all potential split-half reliability coefficients (Bryman, 2012). Analysis revealed that 21 studies out of the 32 quantitative studies in the sample (66%) have undertaken Cronbach's alpha as the reliability test. 16 studies have used composite reliability (CR) along with Cronbach's alpha in terms of presenting reliability results, whereas one study has tested composite reliability alone.

Majority of the quantitative studies (17 out of 32) which accounts to 53% have undertaken convergent validity and discriminant validity in order to validate the scale. Moreover, seven studies have incorporated Confirmatory Factor Analysis (CFA) to further test the validity. These seven studies have employed covariance

based structural equation modelling (SEM) as the data analysis technique.

3.2.6. Data Analysis

Coding was undertaken for different data analysis techniques employed by the studies in the sample. As for the quantitative studies, 16 out of 47 articles (34%) have employed structural equation modelling. Predominantly the studies which have adopted experimental research design have used analysis techniques in terms of ANOVA, ANCOVA, MANOVA and MANCOVA. Specifically, 9% (n=4) of the studies have used ANOVA, while other three techniques (ANCOVA, MANOVA and MANCOVA) have been employed by one study each. Moreover, three studies (6%) have employed multiple regression analysis, while two studies have used t-test. In addition, one study each have reported to analyze data using Chi-Square, Sentiment analysis and path analysis.

As for the analysis techniques of qualitative studies, majority of articles revealed content analysis as the data analysis technique (n=4, 9%). Moreover, three articles (6%) have employed thematic analysis while one study has used matrix approach. Furthermore, three studies have used multiple analysis techniques which include: content analysis and discourse analysis, semiotic analysis and rhetorical analysis, thematic analysis and content analysis. The four studies which used mixed method as the research design employed mix of qualitative and quantitative analysis techniques. Accordingly, one study used ANCOVA and thematic analysis, another study used fuzzy-set qualitative comparative analysis and configuration analysis, another study employed content analysis and path analysis while the other mixed method study used content analysis and inferential statistics as the analysis techniques.

4. DISCUSSION

In terms of the research design, methodological choices of the articles were studied. Findings

revealed that most of the studies on influencer marketing reported to have followed quantitative research designs, which is consistent with previous systematic literature reviews in the area of influencer marketing (Kanaveedu & Kalapurackal, 2022; Vrontis et al., 2021). Hence, it is apparent that previous researchers have given more emphasis on theory testing rather than focusing on theory building via qualitative approaches.

4.1. Quantitative designs

Findings revealed that the majority of the studies in the sample have undertaken surveys as the research strategy. This particular strategy is often used in business research, as it enables the researchers to collect both quantitative and qualitative data over many types of research questions (Sekaran & Bougie, 2016). According to the findings, most commonly used survey strategy is questionnaires. As the study area is into social media marketing, mainly online surveys have been used in data collection. Out of the quantitative studies, only two studies followed different methods to collect data apart from questionnaires. One such study conducted by Arenas-Márquez et al., (2021) employed behaviour approach and peer-nominated approach on the website content. Moreover, another quantitative study authored by García-de-Frutos and Estrella-Ramón, (2021) collected data from YouTube content (number of subscribers, number of videos and number of views). The studies which have employed questionnaires to collect data have adapted existing scales while giving due credits to the original authors. Process of scale development is surely time consuming. Rather than developing own scales researchers often adapt existing scales unless and otherwise research objective is to develop a scale (Saunders et al., 2019).

Interestingly, 12 articles in the review have followed experimental research design (AlRabiah et al., 2022; Hess et al., 2022; Dalla-Pria & Rodríguez-de-Dios, 2022; Sands et al., 2022; Pozharliev et al., 2022; Grigsby & Skiba, 2022; Lee et al., 2022; López et al., 2022; Jiang

& Park, 2021; Lou et al., 2020; Dwidienawati et al., 2020; Iacobucci & De Cicco, 2020). Among these experimental studies in the sample, 11 articles are quantitative studies while one article has been carried out as a mixed method research. True experiments are not really common in sociology, although they are used in allied fields of study such as psychology and organizational studies. Experimental research is widely used as a yardstick because it instills confidence in the robustness and dependability of its results and is high in terms of internal validity (Bryman, 2012). Most of the studies included in the review developed fictitious brands or social media pages and posts for the experimental purpose. Kanaveedu & Kalapurackal (2022), stated that influencer marketing literature would benefit from more experimental studies ideally embedding real world scenarios of influencers and the content posted by them.

As per the review results, cross-sectional research design is commonly followed as the time-horizon where data collection is limited to a single point in time. This is in conformance with previous reviews in the area of influencer marketing (Kanaveedu & Kalapurackal, 2022; Vrontis et al., 2021). Authors further stated that longitudinal studies are important because they may follow consumer behaviour when exposed to influencer marketing at various times and trace the many stages that the connection between influencers and audiences go through over time. Nevertheless, longitudinal studies are more time consuming compared to cross-sectional studies, well-planned longitudinal studies would enable to identify cause-and-effect relationships in before and after scenarios (Sekaran & Bougie, 2016).

The extent to which the sample represents the population, and the generalizability is a concern in research whereas positivistic research views this as a strength in quantitative studies. However, majority of the studies in the sample have used convenience sampling technique which is a non- probability sampling method. However, non-probability sampling is often criticized for elements not having equal chance

of being selected for the sample and high degree of biasness. Nevertheless, criticisms associated with non-probability sampling techniques, non-availability of proper databases lead to continuing use of these techniques. When using convenience sampling in such circumstances, researchers should take attempts to make the sample representative as much as possible (Edgar & Manz, 2017).

Given the fact that, most of the questionnaires have adapted existing scales when developing the questionnaires, ensuring validity and reliability is vital to further ensure that questionnaire fits into the context. Almost half of the research studies considered in the sample have clearly stated validity and reliability tests being undertaken. Most commonly used reliability test is the Cronbach's alpha while Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) have widely been employed as the validity tests. Analysis also revealed that articles which have employed structural equation modelling have tested the validity and reliability of the constructs. In terms of data analysis, various quantitative methods have been employed. ANOVA, ANCOVA, MANOVA, MANCOVA are commonly used analysis techniques in studies with experimental research designs. Interestingly, SEM is also being given prominence among the studies being reviewed. Among the 16 articles that employed SEM, 10 studies have used Covariance based SEM using AMOS software while six studies have used PLS-SEM using Smart PLS. These studies have mostly included mediator and moderator variables in conceptual framework thus, used SEM as it facilitates examining multiple relations.

4.2. Qualitative designs

The findings of the current review revealed that 11 out of 47 studies have employed qualitative research design. Qualitative studies often related to interpretivism approach as it requires the researchers to make sense of the subjective and socially created interpretations on the phenomenon (Saunders et al., 2019). Certain

qualitative studies have focused on survey as research strategy in which the data collection is based on interviews. Among the qualitative studies in the sample, three studies have mentioned netnography as research strategy (Casais & Gomes, 2022; Silva & Campos, 2019; Zhou et al., 2021). The ethnographic approach when related to online context is termed as netnography and this is also used along other synonyms in terms of, online ethnography, webethnography, virtual ethnography and mobile ethnography (Bryman, 2012). Accordingly, Casais and Gomes (2022) mentioned that netnographic method is more appropriate when undertaking studies concerning deep analysis on online context. The authors also studied the bloggers based on blog post content.

Most of the qualitative studies in the review have followed purposive sampling alone or combined with another sampling technique such as snowball sampling. Purposive sampling is used by researchers when the information has to be obtained from specific target groups rather than from those respondents convenient to the researchers (Sekaran & Bougie, 2016). In terms of data collection, qualitative studies commonly depended on semi-structured interviews other than the netnographic research studies which were predominantly focusing on social media content.

Validity and reliability are widely considered in quantitative studies. However, the qualitative study of Zhou et al. (2021) stated validity and reliability measures. Accordingly, authors have ensured intra-coder reliability and as for validity of dimensions, descriptive validity, interpretive validity and theoretical validity were undertaken. Moreover, analysis of the qualitative studies was enriched by thematic analysis, content analysis and discourse analysis.

4.3. Mixed methods design

Nevertheless, the novelty of the research area, inductive studies remain scarce to date. Moreover, studies which conducted mixed

methods approach were seldomly found within the sample of articles, whereas only five studies have carried out mixed methods research design. However, mixed methods research is becoming more popular and acceptable means of doing social research (Bryman, 2012). Further confirming this, Abhishek and Srivastava (2021) stated that there is a need to carry out mixed method research in the area of influencer marketing. Embedding both qualitative and quantitative would enable to gain more detailed insights and generalizations (Vrontis et al., 2021).

5. CONCLUSION

Popularity of influencer marketing has drawn the attraction of organizations, customers as well as the academia. The present study provides an overview on methodological review of previous literature in the area of influencer marketing and electronic word of mouth. Findings reveal methodological gaps and provide directions to the future research. Extant studies are predominantly based on deductive research approach whereas theory building can be undertaken in the area influencer marketing given the novelty of the research area. Moreover, studies can embed mixed methods employing both quantitative and qualitative methods.

Future qualitative studies may focus on grounded theory, which was seldomly used in the sample of articles, whereas content analysis was commonly used. Netnographic research design is another emerging area which can be used in further research. The review also revealed that quantitative studies based on questionnaires adapted existing scales, thereby drawing attention to the need to develop more scales in the context of influencer marketing.

The use of more rigorous sampling techniques should be given attention by the future researchers as vast majority of quantitative studies have relied on convenience sampling technique. Findings also revealed the inadequacy of longitudinal studies being carried out related to influencer marketing. Future

research specially undertaking experimental research may rather focus on longitudinal time horizons rather than cross-sectional.

Moreover, it was also revealed that research on influencer marketing is mostly centered in developed countries. Minimum number of studies have been conducted in South Asian context, which is another eye opener to expand the geographical coverage of influencer marketing research.

The present systematic review possesses some limitations. The study was limited only to the Scopus database and excluded books, book chapters and conference proceedings. Language concern is another limitation, whereas only the articles published in English language were taken into consideration. Nevertheless, the present study provides some valuable insights and directions towards further research in influencer marketing literature.

REFERENCES

- Abhishek, & Srivastava, M. (2021). Mapping the influence of influencer marketing: a bibliometric analysis. *Marketing Intelligence and Planning*, 39(7), 979–1003. <https://doi.org/10.1108/MIP-03-2021-0085>
- AlFarraj, O., Alalwan, A. A., Obeidat, Z. M., Baabdullah, A., Aldmour, R., & Al-Haddad, S. (2021). Examining the impact of influencers' credibility dimensions: attractiveness, trustworthiness and expertise on the purchase intention in the aesthetic dermatology industry. *Review of International Business and Strategy*, 31(3), 355–374. <https://doi.org/10.1108/RIBS-07-2020-0089>
- AlRabiah, S., Marder, B., Marshall, D., & Angell, R. (2022). Too much information: An examination of the effects of social self-disclosure embedded within influencer eWOM campaigns. *Journal of Business Research*, 152, 93–105. <https://doi.org/10.1016/j.jbusres.2022.07.029>

- Anderson, E. W. (1998). Customer satisfaction and word of mouth. *Journal of Service Research*, 1(1), 5–17. <https://doi.org/10.1177/109467059800100102>
- Arenas-Márquez, F. J., Martínez-Torres, M. R., & Toral, S. L. (2021). How can trustworthy influencers be identified in electronic word-of-mouth communities? *Technological Forecasting and Social Change*, 166. <https://doi.org/10.1016/j.techfore.2021.120596>
- Audrezet, A., de Kerviler, G., & Guidry Moulard, J. (2020). Authenticity under threat: When social media influencers need to go beyond self-presentation. *Journal of Business Research*, 117, 557–569. <https://doi.org/10.1016/j.jbusres.2018.07.008>
- Azim, R., & Nair, P. B. (2021). Social Media Influencers and Electronic Word of Mouth: the Communication Impact on Restaurant Patronizing. *Journal of Content, Community and Communication*, 14(7), 46–56. <https://doi.org/10.31620/JCCC.12.21/05>
- Bergel, M., & Brock, C. (2019). Visitors' loyalty and price perceptions: the role of customer engagement. *Service Industries Journal*, 39(7–8), 575–589. <https://doi.org/10.1080/02642069.2019.1579798>
- Bryman, A. (2012). *Social Research Methods* (4th ed.). Oxford University Press.
- Campbell, C., & Lawrence, J. M. (2015). Good native advertising isn't a secret. *Business Horizons*, 58(6), 599–606. <https://doi.org/10.1016/j.bushor.2015.06.003>
- Carù, A., & Cova, B. (2003). Revisiting consumption experience: A more humble but complete view of the concept. *Marketing Theory*, 3(2), 267–286. <https://doi.org/10.1177/14705931030032004>
- Casais, B., & Gomes, L. R. (2022). Fashion bloggers' discourse on brands under corporate crisis: a netnographic research in Portugal. *Journal of Fashion Marketing and Management*, 26(3), 420–435. <https://doi.org/10.1108/JFMM-09-2020-0206>
- Casaló, L. V., Flavián, C., & Ibáñez-Sánchez, S. (2020). Influencers on Instagram: Antecedents and consequences of opinion leadership. *Journal of Business Research*, 117, 510–519. <https://doi.org/10.1016/j.jbusres.2018.07.005>
- Chopra, A., Avhad, V., & Jaju, S. (2021). Influencer Marketing: An Exploratory Study to Identify Antecedents of Consumer Behaviour of Millennials. *Business Persepective and Research*, 9(1), 77–91. <https://doi.org/https://doi.org/10.1177/2278533720923486>
- Dakduk, A. S., & González, Á. M. (2018). Analyzing Academic Performance Using Systematic Literature Review. *SAGE Research Methods Cases*. <https://doi.org/https://dx.doi.org/10.4135/9781526447340>
- Dalla-Pria, L., & Rodríguez-de-Dios, I. (2022). CSR communication on social media: the impact of source and framing on message credibility, corporate reputation and WOM. *Corporate Communications*, 27(3), 543–557. <https://doi.org/10.1108/CCIJ-09-2021-0097>
- De Alwis, S., & Hernwall, P. (2021). A Review of Methodological Choices Relating to Work-Life Boundary Research. *Managing Global Transitions*, 19(1), 73–101. <https://doi.org/10.26493/1854-6935.19.73-101>
- De Veirman, M., Cauberghe, V., & Hudders, L. (2017). Marketing through instagram influencers: The impact of number of followers and product divergence on brand attitude. *International Journal of Advertising*, 36(5), 798–828. <https://doi.org/10.1080/02650487.2017.1348035>
- De Veirman, M., Hudders, L., & Nelson, M. R. (2019). What Is Influencer Marketing and How Does It Target Children? A Review and Direction for Future Research. *Frontiers in Psychology*, 10. <https://doi.org/10.3389/fpsyg.2019.02685>

- Dwidienawati, D., Tjahjana, D., Abdinagoro, S. B., Gandasari, D., & Munawaroh. (2020). Customer review or influencer endorsement: which one influences purchase intention more? *Heliyon*, 6(11). <https://doi.org/10.1016/j.heliyon.2020.e05543>
- Edgar, T. W., & Manz, D. O. (2017). Exploratory Study. *Research Methods for Cyber Security*, 95–130. <https://doi.org/10.1016/B978-0-12-805349-2.00004-2>
- Evans, N. J., Phua, J., Lim, J., & Jun, H. (2017). Disclosing Instagram Influencer Advertising: The Effects of Disclosure Language on Advertising Recognition, Attitudes, and Behavioral Intent. *Journal of Interactive Advertising*, 17(2), 138–149. <https://doi.org/10.1080/15252019.2017.1366885>
- Fournier, S. (1998). Consumers and Their Brands Developing. *Journal of Consumer Research*, 24(4), 343–353.
- Freberg, K., Graham, K., McGaughey, K., & Freberg, L. A. (2011). Who are the social media influencers? A study of public perceptions of personality. *Public Relations Review*, 37(1), 90–92. <https://doi.org/10.1016/j.pubrev.2010.11.001>
- García-de-Frutos, N., & Estrella-Ramón, A. (2021). You absolutely (don't) need this!examining differences on customer engagement components for (anti)haul youtubers' videos. *Journal of Research in Interactive Marketing*, 15(1), 86–103. <https://doi.org/10.1108/JRIM-11-2019-0181>
- Ghani, N. H. A., & Tuhin, K. W. (2018). Evolution of consumer brand relationship research. *Academy of Strategic Management Journal*, 17(1), 1–9.
- Grigsby, J. L., & Skiba, J. (2022). Using Influencers to Build Self-Brand Connections: The Impact of Influencer Presence, Ad Source, and Consumer Age. *Journal of Interactive Advertising*, 1–16. <https://doi.org/10.1080/15252019.2022.2096157>
- Hanna, R., Rohm, A., & Crittenden, V. L. (2011). We're all connected: The power of the social media ecosystem. *Business Horizons*, 54(3), 265–273. <https://doi.org/10.1016/j.bushor.2011.01.007>
- Harrigan, P., Evers, U., Miles, M., & Daly, T. (2017). Customer engagement with tourism social media brands. *Tourism Management*, 59, 597–609. <https://doi.org/10.1016/j.tourman.2016.09.015>
- Hawkins, D. I., Best, R., & Coney, K. A. (2004). *Building marketing strategy* (9th ed.). McGraw-Hill, Boston.
- Hess, A., Dodds, S., & Rahman, N. (2022). The development of reputational capital - How social media influencers differ from traditional celebrities. *Journal of Consumer Behaviour*, 1236–1252. <https://doi.org/10.1002/cb.2074>
- Hsu, L. C. (2019). Investigating the brand evangelism effect of community fans on social networking sites: Perspectives on value congruity. *Online Information Review*, 43(5), 842–866. <https://doi.org/10.1108/OIR-06-2017-0187>
- Hudders, L., De Jans, S., & De Veirman, M. (2021). The commercialization of social media stars: a literature review and conceptual framework on the strategic use of social media influencers. *International Journal of Advertising*, 40(3), 327–375. <https://doi.org/10.1080/02650487.2020.1836925>
- Hudson, S., Huang, L., Roth, M. S., & Madden, T. J. (2016). The influence of social media interactions on consumer-brand relationships: A three-country study of brand perceptions and marketing behaviors. *International Journal of Research in Marketing*, 33(1), 27–41. <https://doi.org/10.1016/j.ijresmar.2015.06.004>
- Iacobucci, S., & De Cicco, R. (2020). Users awareness of native advertising from Instagram media publishers: The effects of Instagram's branded content tool on attitudes and behavioural intent. *International Journal of Internet Marketing and Advertising*, 14(1), 71–90.

- <https://doi.org/10.1504/IJIMA.2020.106046>
- Jiang, Y., & Park, H. (2021). The effects of CSR appeals and message sources on consumer responses to branded content on Instagram. *Journal of Interactive Advertising*, 21(3), 209–224.
<https://doi.org/https://doi.org/10.1080/15252019.2021.1973930>
- Kanaveedu, A., & Kalapurackal, J. J. (2022). Influencer Marketing and Consumer Behaviour: A Systematic Literature Review. *Vision*, 1–20.
<https://doi.org/10.1177/09722629221114607>
- Kaplan, A. M., & Haenlein, M. (2010). Users of the world, unite! The challenges and opportunities of Social Media. *Business Horizons*, 53(1), 59–68.
<https://doi.org/10.1016/j.bushor.2009.09.003>
- Ki, C. W. 'Chloe,' Cuevas, L. M., Chong, S. M., & Lim, H. (2020). Influencer marketing: Social media influencers as human brands attaching to followers and yielding positive marketing results by fulfilling needs. *Journal of Retailing and Consumer Services*, 55.
<https://doi.org/10.1016/j.jretconser.2020.102133>
- Ki, C. W. 'Chloe,' & Kim, Y. K. (2019). The mechanism by which social media influencers persuade consumers: The role of consumers' desire to mimic. *Psychology and Marketing*, 36(10), 905–922.
<https://doi.org/10.1002/mar.21244>
- Kristensen, L. B. K. (2021). Leveraging Blogger Influence in the Launch of Storytel. *Publishing Research Quarterly*, 37(2), 183–199. <https://doi.org/10.1007/s12109-021-09803-y>
- Lee, S. S., Chen, H., & Lee, Y. H. (2022). How endorser-product congruity and self-expressiveness affect Instagram micro-celebrities' native advertising effectiveness. *Journal of Product and Brand Management*, 31(1), 149–162.
<https://doi.org/10.1108/JPBM-02-2020-2757>
- Liu, Z., Yu, S., Cheng, F., & Waheed, R. (2022). Assessing the Influencing Factors of Electronic Word-of-Mouth on CSR Issues. A Case of Hospitality Service Industry of China. *Frontiers in Psychology*, 13(June), 1–13.
<https://doi.org/10.3389/fpsyg.2022.924779>
- López, M., Sicilia, M., & Verlegh, P. W. J. (2022). How to motivate opinion leaders to spread e-WoM on social media: monetary vs non-monetary incentives. *Journal of Research in Interactive Marketing*, 16(1), 154–171. <https://doi.org/10.1108/JRIM-03-2020-0059>
- Lou, C., Ma, W., & Feng, Y. (2020). A Sponsorship Disclosure is Not Enough? How Advertising Literacy Intervention Affects Consumer Reactions to Sponsored Influencer Posts. *Journal of Promotion Management*, 27(2), 278–305.
<https://doi.org/10.1080/10496491.2020.1829771>
- Martínez-López, F. J., Anaya-Sánchez, R., Fernández Giordano, M., & Lopez-Lopez, D. (2020). Behind influencer marketing: key marketing decisions and their effects on followers' responses. *Journal of Marketing Management*, 36(7–8), 579–607.
<https://doi.org/10.1080/0267257X.2020.1738525>
- Michaelidou, N., Siamagka, N. T., & Christodoulides, G. (2011). Usage, barriers and measurement of social media marketing: An exploratory investigation of small and medium B2B brands. *Industrial Marketing Management*, 40(7), 1153–1159.
<https://doi.org/http://dx.doi.org/10.1016/j.indmarman.2011.09.009>
- Muda, M., & Hamzah, M. I. (2021). Should I suggest this YouTube clip? The impact of UGC source credibility on eWOM and purchase intention. *Journal of Research in Interactive Marketing*, 15(3), 441–459.
<https://doi.org/10.1108/JRIM-04-2020-0072>
- Nafi, S. M., & Ahmed, T. (2019). The ethical standpoint of social influencers on hotel E services cape: A theoretical perspective on the existing literature. *African Journal of Hospitality, Tourism and Leisure*, 8(1), 1–15.

- O'Brien, A. M., & Mc Guckin, C. (2016). The Systematic Literature Review Method: Trials and Tribulations of Electronic Database Searching at Doctoral Level. *SAGE Research Methods Cases*, 1–13. <https://doi.org/10.4135/978144627305015595381>
- Oraedu, C., Izogo, E. E., Nnabuko, J., & Ogba, I. E. (2021). Understanding electronic and face-to-face word-of-mouth influencers: an emerging market perspective. *Management Research Review*, 44(1), 112–132. <https://doi.org/10.1108/MRR-02-2020-0066>
- Parahoo, K. (2006). *Nursing Research: Principles, Process and Issues* (2nd ed.). Palgrave Macmillan.
- Popp, B., & Woratschek, H. (2016). Introducing branded communities in sport for building strong brand relations in social media. *Sport Management Review*, 19(2), 183–197. <https://doi.org/10.1016/j.smr.2015.06.001>
- Pornsrimate, K., & Khamwon, A. (2021). How to convert Millennial consumers to brand evangelists through social media micro-influencers. *Innovative Marketing*, 17(2 May 2021), 18–32. [https://doi.org/10.21511/im.17\(2\).2021.03](https://doi.org/10.21511/im.17(2).2021.03)
- Pozharliev, R., Rossi, D., & De Angelis, M. (2022). Consumers' self-reported and brain responses to advertising post on Instagram: the effect of number of followers and argument quality. *European Journal of Marketing*, 56(3), 922–948. <https://doi.org/10.1108/EJM-09-2020-0719>
- Sánchez-Fernández, R., & Jiménez-Castillo, D. (2021). How social media influencers affect behavioural intentions towards recommended brands: the role of emotional attachment and information value. *Journal of Marketing Management*, 37(11–12), 1123–1147. <https://doi.org/10.1080/0267257X.2020.1866648>
- Sands, S., Campbell, C. L., Plangger, K., & Ferraro, C. (2022). Unreal influence: leveraging AI in influencer marketing. *European Journal of Marketing*, 56(6), 1721–1747. <https://doi.org/10.1108/EJM-12-2019-0949>
- Saunders, M. N. K., Lewis, P., & Thornhill, A. (2019). *Research Methods for Business Students* (8th ed.). Pearson Education.
- Sekaran, U., & Bougie, R. (2016). *Research Methods for Business: A Skill-Building Approach* (7th ed.). John Wiley and Sons Ltd. <https://doi.org/10.1108/lodj-06-2013-0079>
- Senft, T. M. (2008). *Camgirls: Celebrity and Community in the Age of Social Networks*. Peter Lang Inc.
- Sesar, V., Hunjet, A., & Koznia, G. (2021). Influencer marketing in travel and tourism: Literature review. 73rd International Scientific Conference on Economic and Social Development - “Sustainable Tourism in Post-Pandemic World,” 147–156.
- Sharma, S., & Bumb, A. (2022). Femluencing: Integration of Femvertising and Influencer Marketing on Social Media. *Journal of Interactive Advertising*, 22(1), 95–111. <https://doi.org/10.1080/15252019.2022.2032493>
- Shen, Z. (2021). A persuasive eWOM model for increasing consumer engagement on social media: evidence from Irish fashion micro-influencers. *Journal of Research in Interactive Marketing*, 15(2), 181–199. <https://doi.org/10.1108/JRIM-10-2019-0161>
- Silva, N. D., & Campos, R. D. (2019). The 2.0 Critic: Blended Discourses in Blogging. *Latin American Business Review*, 20(2), 109–133. <https://doi.org/10.1080/10978526.2019.1578178>
- Simay, A. E., Wei, Y., Gyulavári, T., Syahrivar, J., Gaczek, P., & Hofmeister-Tóth, Á. (2022). The e-WOM intention of artificial intelligence (AI) color cosmetics among Chinese social media influencers. *Asia Pacific Journal of Marketing and Logistics*. <https://doi.org/10.1108/apjml-04-2022-0352>
- Sundermann, G., & Raabe, T. (2019). *Strategic Communication through Social Media*

- Influencers: Current State of Research and Desiderata. *International Journal of Strategic Communication*, 13(4), 278–300. <https://doi.org/10.1080/1553118X.2019.1618306>
- Tafesse, W., & Wood, B. P. (2021). Followers' engagement with instagram influencers: The role of influencers' content and engagement strategy. *Journal of Retailing and Consumer Services*, 58(July 2020), 102303. <https://doi.org/10.1016/j.jretconser.2020.102303>
- Tanwar, A. S., Chaudhry, H., & Srivastava, M. K. (2022). Trends in Influencer Marketing: A Review and Bibliometric Analysis. *Journal of Interactive Advertising*, 22(1), 1–27. <https://doi.org/10.1080/15252019.2021.2007822>
- Vrontis, D., Makrides, A., Christofi, M., & Thrassou, A. (2021). Social media influencer marketing: A systematic review, integrative framework and future research agenda. *International Journal of Consumer Studies*, August 2020, 1–28. <https://doi.org/10.1111/ijcs.12647>
- Wang, L., Wang, Z., Wang, X., & Zhao, Y. (2022). h ASD, BFEWQCAssessing word-of-mouth reputation of influencers on B2C live streaming platforms: the role of the characteristics of information source. *Asia Pacific Journal of Marketing and Logistics*, 34(7), 1544–1570. <https://doi.org/10.1108/APJML-03-2021-0197>
- Ye, G., Hudders, L., De Jans, S., & De Veirman, M. (2021). The Value of Influencer Marketing for Business: A Bibliometric Analysis and Managerial Implications. *Journal of Advertising*, 50(2), 160–178. <https://doi.org/10.1080/00913367.2020.1857888>
- Zhou, S., Barnes, L., McCormick, H., & Blazquez Cano, M. (2021a). Social media influencers' narrative strategies to create eWOM: A theoretical contribution. *International Journal of Information Management*, 59. <https://doi.org/10.1016/j.jinfomgt.2020.102293>
- Zhou, S., Barnes, L., McCormick, H., & Blazquez Cano, M. (2021b). Social media influencers' narrative strategies to create eWOM: A theoretical contribution. *International Journal of Information Management*, 59(November 2020), 102293. <https://doi.org/10.1016/j.jinfomgt.2020.102293>

Leveraging Green Thinking as a Motivator to Influence Consumer Purchasing Intention

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ABSTRACT

Over the past few years, ‘going green’ as a concept has garnered significant attention from both an academic and practical perspective. However, whilst a plethora of research has been conducted in line with the ‘green’ concept a significant knowledge gap continues to persist in the paradigm of what influences green thinking in consumers’ minds. Therefore, this paper primarily intends to utilize insights from self-determination theory to assess the relationship between green thinking and green intrinsic and extrinsic motivation. This research further contributes to the existing literature by critically evaluating the concept of ‘going green’ and ‘green purchasing intention’ from both an academic and practical perspective

1. INTRODUCTION

The organizations in the world are more focusing on discovering new ideas, new methods and planning new approaches to place the product branding in the consumer’s mind. In the present era positioning the green branding in the consumer’s mind will help the business entities to stay in the market competition which will support in achieving the sustainability and also it will be improving the market space in the long term. Sustainability is a concept that is widely addressed and practically implemented by the companies in accomplishing the business objectives effectively and efficiently while paying more attention to the environmental impacts creating by the business activities.

Marketing discipline has consumer centric approach therefore this creates an uncontrollable resource consumption (Aleksandar & Milovanov, 2016), that we need to tackle through sustainable initiatives. According to (Grant, 2008) a green brand can be identified as “a brand that offers a significant eco-advantage over the rivals and which hence appeals to those who are willing to making green a high priority. There are strong green brands targeting both retail consumers and also B2B customers”. Green marketplaces are developing across the globe which will facilitate products to the “green consumers” a separate target group who concentrate about mitigating the environmental effects through their buying decisions (Hartmann & Apaolaza Ibáñez, 2006). As mentioned in (Norazah and Norbayah, 2015b, cited in Norazah Mohd Suki, 2016) a green customer is an individual who spends money to purchase green products and besides is concerned of the environmental impacts. According to Marcus and Fremeth, (2009) some organizations such as Honda, Toyota, GM etc. in the automobile industry take real efforts in conserving the environment by instigating green technologies such as reducing of greenhouse emissions, conserving of raw materials. NSBM Green University is also an educational organization which paves the way for environmental sustainability.

1.1 Performance Gap

Environmental pollution has led many consumers to rethink their buying choices today. For example, in Europe and Asia, consumers label buying as contributing to environmental

hazards due to pollution caused by the mass production of non-green products (Sanchez & Sabaté, 2019). For “green” consumers, although environmental protection and waste reduction are major concerns (Wu et al., 2018b) and consider adopting green products (Panda et al., 2020).

Further in sustainable goals, it is evidently identified the importance of decreasing carbon footprint, reduce electronic wastage, development of renewable energy and continuation of searching substitutes for fossil fuel etc. Even though institutions have identified the policies and other eco-friendly measures to ensure the reduction of environmental pollution, there is still a doubt whether people actually follow the rules and regulations of government institutions. Hence, this study critically focuses on how an individual is motivated to use green products.

1.2 Behavior of the Problem; Empirical and Theoretical Gaps

Empirically, it is evident that prior scholars have identified the how green purchasing behavior is vital to discuss as it has become a critical topic in the current context. Looking further into the internal mechanism, cognitive and affective factors such as evaluation of, and attachment with, green products can deliver lasting effects on consumers’ purchase behavior (Bosque & Martín, 2008) than those of external factors such as price discounts and appreciation from social actors (Wenjing et al., 2020). Therefore, it would be insightful to further understand the intrinsic mechanism of consumer behavior in this context. To serve this objective, the current research focuses on the internal makeup of consumers and investigates how green thinking as a cognitive antecedent

In further explaining why consumers are still reluctant to purchase green products. Within the setting of mobile payment literature, self-determination theory is a human motivation-related theory that is also identified as a macro theory in the literature. The theory deliberates intrinsic motivation and extrinsic motivation compliance with intention. However, the theory fails to discuss how consumers develop their

thinking to motivate themselves that directs a relationship towards the green purchase intention. Therefore, the researcher proposes a further explanation to self-determination theory by explaining intrinsic and extrinsic motivations with the help of green thinking and thereby on the green purchase intention through the lens of cognitive affective behavioral model.

Self-determination theory has been identified as a theory of human motivation that also discusses the origins and outcomes of human actions (Deci & Ryan, 1980; Weiner, 1990). Even though most of the theories deploy motivation as a unitary concept, Self-determination theory differentiates motivation under autonomous and controlled (Deci & Ryan, 2008; Vansteenkiste & Ryan, 2013). The theory discusses intrinsic motivation, extrinsic motivation along with intention and this theory has been acknowledged in many prior studies concerning mobile payments. Thus, it proves that self-determination theory can be incorporated in identifying the motivation on intention to use mobile payments.

Cognitive affective behavior model has been identified to explore in-depth the cognitive and affective psychological process of an individual in shaping the consumer behavior. Further, it highlights how the consumer thinking and feeling leads towards the intention and thereby the human behavior (Bosque & Martín, 2008). According to the cognitive-affective behavior model, consumers’ decision making begins with cognitions such as perceptions, thoughts, beliefs, and meanings about certain objects or issues. Morel and Pruyn (2003) witnessed that consumers’ cognitive confidence indicates favorable product judgment that leads to purchasing decisions. Likewise, Hughner et al. (2007) found that positive thinking about green labels creates a positive evaluation of green products. Consumers tend to see intellectually how the perceived benefits of green products match their motives when deciding to purchase green products (Hahnel et al., 2014).

1.3 Research Questions

RQ1: What are the possible motivational factors driving the green purchase intention?

RQ2: Does intrinsic motivation affect the relationship between green thinking and green purchase intention?

1.4 Research Objectives

RO1: To identify the possible motivational factors driving the green purchase intention.

RO2: To examine whether there is a mediating impact of intrinsic motivation on the relationship between green thinking and green purchase intention.

2. LITERATURE REVIEW

2.1 Going Green

When considering from a historical perspective, up until late 20th century most organizations across a wide array of industries focused on being environmentally friendly purely as a balancing act to offset any negative impacts that their respective businesses may have had whilst pursuing their organizational and shareholder objectives (Gifford, 1997). Nonetheless, over the last few decades, businesses worldwide have demonstrated a growing awareness of the widespread environmental degradation caused by many organizations as a result of their sole focus being aligned with the economic bottom line of their businesses (Grove, Fisk, Pickett, & Kangun, 1996). As a result, the concept of going green has started to gain significant traction from a both academic and industry perspective.

The growing trend of businesses going green has been led from both demand and supply viewpoints. On one hand, organizations have been inspired to go 'green' in the recent times due to the rise of green/ conscious consumerism with more and more consumers opting to align themselves with brands that actively promote less or no environmental degradation through their business operations (Santhi, Jerinabi, & Gandhi, 2007). As elaborated by (Chang, 2011; Wang, et al., 2018) modern consumers share common concerns on environmental issues with the vast majority being considerate towards

maintaining and uplifting environmental quality as well.

On the other hand, the concept of going green has been a business led movement with environmental conservation becoming a central theme in the global business arena (Kabiraj, Topkar, & Walke, 2010). Businesses have increasingly identified the detrimental effects issues such as pollution, overpopulation and uncontrolled depletion of non-renewable resources has had on the overall environment and has thereby called for increased urgency in motivating people to engage in a pro-environmental manner (Griskevicius, Tybur, & Van den Bergh, 2010). Moreover, this green movement has not only helped increase consumer awareness on environmental issues, but it has also propelled development of novel products with low environmental impacts as well (Marcus & Jean, 2009). Therefore, many organizations continue to perceive that the adoption of a green concept in their business operations to be a viable option to promote their respective products which in turn will result in increasing the demand for their products amongst green-savvy consumers (Raska & Shaw, 2012). However, regardless of the motives behind the inception and growth of the going green concept, most consumers today have chosen to practice green thinking prior to making prominent purchase decisions across a wide variety of products and services.

2.2 Green Purchasing Intention

Purchase intention typically refers to the preference of consumers to buy a specific product or service (Younus, Rasheed, & Zia, 2015). Green purchase intention on the other hand refers to a consumer's willingness to purchase an environmentally friendly product once becoming aware of its green attributes (Oliver & Lee, 2010). Despite the relative novelty of the concept, a significant number of researchers have conducted studies pertaining to factors influencing green purchase intention. For an instance (Zhuang, Luo, & Riaz, 2021) in their study identified a direct positive correlation between green purchase intention and variables such as green perceived value, green attitude, and green trust. On the other

hand, (D'Souza, Taghian, & Khosla, 2007) argues that green purchase intention is predominantly dependent on the two dimensions of price and quality of the green product under consideration. Moreover, (Wang, Ma, & Bai, 2019) in their research identified that green product knowledge plays a pivotal role in influencing a potential consumer's green purchase intention. Regardless of all these considerations, businesses that align their operations with that of the green concept must focus on translating green purchase intention to actual purchasing behaviour if they are to maintain their businesses whilst being considerate about societal sustainability (Lasuin & Ng, 2014).

2.3 Green Intrinsic Motivation

According to (Li et al.,) 2020, Green motivation is a driving factor that can support and motivate people to engage in specific environmental protection activities based on predetermined environmental protection objectives or goals and it is said that it could be divided mainly into the following types: green intrinsic motivation and green extrinsic motivation. When people are motivated by their love and passion for the job at hand rather than by external rewards or benefits, this is known as intrinsic motivation (Deci and Ryan, 1985). Amabile et al. (1994) found that individuals who are intrinsically motivated are more enthusiastic, inquisitive, and curious, as well as more engaged and pleased at what they do. For instance, a lot of people enjoy golf and gardening because they are intrinsically motivated to do them.

Based on a finding of Moon and Kim (2001), people typically gravitate toward things that are fascinating and pleasurable. Wenjing et al., (2020), with regards to a context of electronic products has mentioned that, because of the consumers innate attachment to the environment, those who are intrinsically motivated to live in a greener way may plan to purchase green electronic products.

As per Deci & Ryan (1985), according to the self-determination theory individual intrinsic motivation can be increased when the external

environment offers informative factors; yet it can be decreased when the external environment offers controlling factors. We can use the cognitive-affective behavior model to further understand our knowledge of intrinsic motivation. According to this theory, both thinking and feeling have an impact on how people behave (Bosque & Martin, 2008). As such, the current study may help to thoroughly analyze the cognitive and affective psychological processes that a specific customer goes through while determining whether to purchase green products.

2.4 Green Extrinsic Motivation

Green extrinsic motivation is the propensity for people to act sustainably in response to rewards from the external world, such as savings, admiration, or popularity. (Wenjing et al., 2020). For example, customers are extrinsically motivated when they plan to purchase green electronic products due to discounts and/or recommendations from others. (Huang et al., 2016). According to the literature, extrinsic motivation tends to lessen people's intrinsic motivation to engage in eco-friendly practices (Huang et al., 2016). It was further supported by Moser (2015) in one of his findings that people were less likely to voluntarily engage in green measures when bonuses and prizes were provided to them than when they were naturally driven to do so without receiving them.

Additionally, from the findings of Davis et al. (1992), we can derive that consumers' motivation to develop purchase intentions for green products is likely to be influenced by both green intrinsic variables, such as a natural affinity for the environment, and green extrinsic factors, such as positive environmental outcomes.

2.5 Green Thinking

Green thinking is a cognitive process that motivates people to take action in favor of the environment (Ali, F. et al., 2020). Individuals with a green mindset demonstrate love and passion for saving and caring for the natural environment through activities like planting seeds, gardening, and golfing, which are distinguishing characteristics of environmental

greening. (Caldera et al., 2019). By purchasing, reusing, and recycling green items, green thinkers, according to Biswas and Roy (2015), contribute to the development of ideas and methods that reduce energy consumption per unit. Jones (2019) stated that people who are ecologically conscious favor using green products over nongreen products. Particularly, Chinese consumers are more likely to start green initiatives for environmental welfare by greening their societies, enterprises, and productions (Zhang et al., 2018). Green thinking is therefore regarded as a key factor in determining whether to support and promote green initiatives (Jacobs et al., 2018).

Chen (2008) claims that people are now concerned about safeguarding their communities and the environment, which is pressuring the corporate sector to adhere to environmental protection policies and regulations. Similarly, organizations are guided by their values and beliefs, and incorporating the directive to "do no harm to the environment" into corporate culture encourages the development of green ideas (Caldera et al., 2019).

3. CONCEPTUALIZATIONS

3.1 Green Thinking and Green Purchase Intention

Green purchase intention has been discussed widely in sustainable marketing and green marketing. Green purchase intention has been defined as the purpose of purchasing green brands/products and the intention to involve social and community activities to protect the environment. According to the cognitive-affective behavioral model, consumers start their decision-making with their perceptions, beliefs, and meanings (Morel & Pruyn, 2003). Also, a study related to green purchase intention shows that environmental opinions were found to have a positive relationship with purchase intention. According to the above arguments below hypothesis has been derived.

H1: Green thinking will impact the purchase intention

3.2 Green Thinking and Green Intrinsic Motivation

Self-determination theory discusses intrinsic motivation as a factor affecting intention. According to the theory, intrinsic motivation is defined as how users/consumers perceive their pleasure and satisfaction (Vallerand & Blssonnette, 1992; Chiu & Li, 2015; Van Yperen et al., 2016; Ifinedo, 2017). Green thinking possess that consumers are having sufficient awareness and knowledge of environmental problems. According to the previous scholars' arguments, there is a significant relationship between green thinking and green intrinsic motivation. Supporting the above-mentioned relationship between green thinking and green intrinsic motivation, a study on green intention to purchase electronic products have been discussed a positive relationship between green thinking and green intrinsic motivation (Ali et al., 2020). According to the above arguments below hypothesis has been derived.

H2: Green thinking will impact the green intrinsic motivation

3.3 Green Intrinsic Motivation and Green Purchase Intention

Individuals are oriented to things and objects that are enjoyable and satisfying (Moon & Kim, 2001). As per the previous studies, it is noteworthy that individuals with in-born attachments to environmentally friendly products are always motivated internally in purchasing green/sustainable products (Ali et al., 2020). For example, a study about green consumption behavior revealed that consumers who take pleasure in activities are more constructive for environmentally friendly products (Bailey et al., 2016). Furthermore, in the discussion of motivation theory, it is identified that green motivation could enhance green purchase intention. According to the above arguments below hypothesis has been derived.

H3: Green Intrinsic motivation will impact the purchase intention

3.4 Extrinsic motivation and green purchase intention

Extrinsic motivation has been also identified as a direct determinant of human motivation (Deci & Ryan, 1985; Koo et al., 2015). Also, it is noteworthy that if consumers get rewards for using a product/service will intend to purchase the product. Most importantly economic rewards can be pointed out as one of the main factors that show satisfaction among individuals. If consumers are subjected to economic rewards, they could motivate to create intention (Tang et al., 2016). According to previous studies conducted in developing countries, higher extrinsic motivation will influence to formation of an attitude to use and thereby increase the intention (Chiou & Shen, 2012). According to the above arguments below hypothesis has been derived.

H4: Green Extrinsic motivation will impact the purchase intention

3.5 Green Thinking on Green Purchase Intention Mediates by Green Intrinsic Motivation

As per the previous studies, it has been found that green thinking provides the first cognitive signal to generate green intrinsic motivation which eventually leads the purchase intention (Ali et al., 2020). Furthermore, individuals with more concern and consideration towards the environment attach themselves to shopping for green products (Huang et al., 2016).

Supporting the above, a study relating to the intention to purchase green products states that there is a partial mediation of green intrinsic motivation on the relationship between green thinking and green purchase intention (Ali et al., 2020).

H5: Green Intrinsic motivation will impact the relationship between green thinking and purchase intention.

4. CONCEPTUAL FRAMEWORK

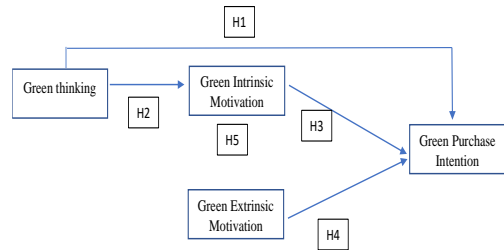


Figure 1: Conceptual Diagram

REFERENCES

- Abbas, Z. et al. (2020). Green human resource management as a way to support sustainability. In DOKBAT 2020 - 16th Annual International Bata Conference for Ph.D. Students and Young Researchers (Vol. 16). Zlín: Tomas Bata University in Zlín, Faculty of Management and Economics. Retrieved from <http://dokbat.utb.cz/conference-proceedings/>. ISBN: 978-80-7454-935-9.
- Ali, F. et al. (2020) "How 'green' thinking and altruism translate into purchasing intentions for electronics products: The intrinsic-extrinsic motivation mechanism," *Sustainable Production and Consumption*, 24, pp. 281–291. Available at: <https://doi.org/10.1016/j.spc.2020.07.013>.
- Amabile, T. M. (1997). Motivating creativity in organizations: On Doing What You Love and Loving What You Do. *California Management Review*, 40(1), 39-58. doi: 10.2307/41165921
- Amabile, T. M., Hill, K. G., Hennessey, B. A., & Tighe, E. M. (1994). The Work Preference Inventory: Assessing Intrinsic and Extrinsic Motivational Orientations. *Journal of Personality and Social Psychology*, 66(5), 950-967. doi: 10.1037//0022-3514.66.5.950
- Biswas, A., & Roy, M. (2015). Green products: An exploratory study on the consumer behaviour in emerging economies of the East. *Journal of Cleaner Production*, 87, 463–468.
- Caldera, H. T. S., Desha, C., & Dawes, L. (2019). Transforming manufacturing to be 'good for planet and people', through

- enabling lean and green thinking in small and medium-sized enterprises. *Sustainable Earth*, 2(1), 4. <https://doi-org.plymouth.idm.oclc.org/10.1186/s42055-019-0011-z>
- Chang, C. (2011). Feeling ambivalent about going green. *Journal of Advertising*, 40(4), 19-32.
- Chen, Y.-S. (2008). The driver of green innovation and green image--green core competence. *Journal of Business Ethics*, 81(3), 531–543.
- D'Souza, C., Taghian, M., & Khosla, R. (2007). Examination of environmental beliefs and its impact on the influence of price, quality and demographic characteristics with respect to green purchase intention. *Journal of targeting, measurement and analysis*.
- Deci, E. L., & Ryan, R. M. (2010). Intrinsic Motivation. *The Corsini Encyclopedia of Psychology*, 1-2. doi: 10.1002/9780470479216.corpsy
- Deci, E.L., Ryan, R.M., 1985. Conceptualizations of intrinsic motivation and self-determination. In: *Intrinsic Motivation and Self-Determination in Human Behavior*, pp. 11e40. https://doi.org/10.1007/978-1-4899-2271-7_2
- Del Bosque, I.R., San Martín, H., 2008. Tourist satisfaction a cognitive-affective model. *Ann. Tour. Res.* 35 (2), 551–573
- Gifford, D. (1997). The value of going green. *Harvard Business Review*, 75(5), 11-13.
- Griskevicius, V., Tybur, J. M., & Van den Bergh, B. (2010). Going green to be seen: status, reputation, and conspicuous conservation. *Journal of personality and social psychology*, 98(3), 392.
- Grove, S. J., Fisk, R. P., Pickett, G. M., & Kangun. (1996). Going green in the service sector: Social responsibility issues, implications and implementation. *European journal of marketing*, 30(5), 56-66.
- Huang, Y.-C., Yang, M.-L., Wong, Y.-J., 2016. The effect of internal factors and family influence on firms' adoption of green product innovation. *Manag. Res. Rev.* 39 (10), 1167–1198. doi:10.1108/mrr-02-2015-0031.
- Jacobs, K., Petersen, L., Hörisch, J., & Battenfeld, D. (2018). Green thinking but thoughtless buying? An empirical extension of the value-attitude-behaviour hierarchy in sustainable clothing. *Journal of Cleaner Production*, 203, 1155–1169.
- Jones, E. (2019). Rethinking greenwashing: Corporate discourse, unethical practice, and the unmet potential of ethical consumerism. *Sociological Perspectives*, 62(5), 728–754.
- Kabiraj, S., Topkar, V., & Walke, R. C. (2010). Going green: a holistic approach to transform business. *International Journal of Managing Information Technology*, 2(3).
- Lasuin, C. A., & Ng, Y. C. (2014). Factors influencing green purchase intention among university students. *Malaysian Journal of Business and Economics (MJBE)*.
- Marcus, A., & Jean, J. (2009). Going green at home: the green machine. *Information Design Journal*, 17(3), 235-243.
- Moon, J.-W., Kim, Y.-G., 2001. Extending the TAM for a world-wide-web context. *Inf. Manag.* 38 (4), 217–230.
- Moser, A. K. (2015). Thinking green, buying green? Drivers of pro - Environmental purchasing behavior. *Journal of Consumer Marketing*, 32(3), 167–175. <https://doi.org/10.1108/JCM-10-2014-1179>
- Moser, A.K., 2015. Thinking green, buying green? Drivers of pro-environmental purchasing behavior. *J. Consum. Market.* 32 (3), 167–175. doi:10.1108/ jcm-10-2014-1179.
- Oliver, J. D., & Lee, S. H. (2010). Hybrid car purchase intentions: a cross-cultural analysis. *Journal of Consumer Marketing*, 27(2), 96-103.
- Raska, D., & Shaw, D. (2012). When is going green good for company image? *Management Research Review*, 35(3/4), 326-346.
- Santhi, P., Jerinabi, U., & Gandhi, N. M. (2007). Green Consumerism-Issues and Implications. *Indian Journal of Marketing*, 37(1).
- Sreen, N., Purbey, S., & Sadarangani, P. (2018). Impact of culture, behavior and gender on

- green purchase intention. *Journal of retailing and consumer services*, 177-189.
- Wang, H., Ma, B., & Bai, R. (2019). How does green product knowledge effectively promote green purchase intention? *Sustainability*, 1193.
- Wang, X., Sun, C., Wang, S., Zhang, Z., & Zou, W. (2018). Going green or going away? A spatial empirical examination of the relationship between environmental regulations, biased technological progress, and green total factor productivity. *International Journal of Environmental Research and Public Health*, 15(9), 1917.
- Wenjing, L., Bhutto, T.A., Xuhui, W., Maitlo, Q., Zafar, A.U., Bhutto, N., 2020. Unlocking employees' green creativity: the effects of green transformational leadership, green intrinsic, and extrinsic motivation. *J. Clean. Prod.*, 120229. <https://doi.org/10.1016/j.jclepro.2020.120229>.
- Younus, S., Rasheed, F., & Zia, A. (2015). Identifying the factors affecting customer purchase intention. *Global Journal of Management and Business Research*.
- Zhang, L., Li, D., Cao, C., & Huang, S. (2018). The influence of greenwashing perception on green purchasing intentions: The mediating role of green word-of-mouth and moderating role of green concern. *Journal of Cleaner Production*, 187, 740–750.
- Zhuang, W., Luo, X., & Riaz, M. U. (2021). On the factors influencing green purchase intention: A meta-analysis approach. *Frontiers in Psychology*, 644020.
- Chen, W., (1991). *Nonlinear Analysis of Electronic Prognostics*. Doctoral dissertation. The Technical University of Napoli, Napoli, Italy.
- Ferrell, B. L. (1999), JSF Prognostics and Health Management. *Proceedings of IEEE Aerospace Conference*. March 6-13, Big Sky, MO. doi: 10.1109/AERO.1999.793190
- Hyndman, R. J., & Koehler, A. B. (2006). Another look at measures of forecast accuracy. *International Journal of Forecasting*, vol. 22, pp. 679-688. doi:10.1016/j.ijforecast.2006.03.001
- International Standards Organization (ISO) (2004). Condition Monitoring and Diagnostics of Machines - Prognostics part 1: General Guidelines. In ISO, *ISO13381-1:2004(e)*. vol. *ISO/IEC Directives Part 2, I. O. f. S. (ISO)*, (p. 14). Genève, Switzerland: International Standards Organization.
- Schwabacher, M., & Goebel, K. F. (2007). A survey of artificial intelligence for prognostics. *Proceedings of AAAI Fall Symposium*, November 9–11, Arlington, VA. www.aaai.org/Library/Symposia/Fall/2007/fs07-02-016.php
- Vachtsevanos, G., Lewis, F. L., Roemer, M., Hess, A., & Wu, B. (2006). *Intelligent fault diagnosis and prognosis for engineering system*. Hoboken, NJ: John Wiley & Sons, Inc

Impact of Family-Centered Life and Work-Centered Life on Employee Performance with Special Reference to Telecommunication Industry in Sri Lanka

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performance, particularly in the telecommunication industry of Sri Lanka.

ABSTRACT

In the current business world, work-life balance and employee performance is a widely discussed phenomenon. Family-centred life and work-centred life are two recent concepts that have emerged from this global discussion on work-life balance. Hence, the focus of this study was to determine the impact of family-centred life and work-centred life on employee performance. The research is conducted using a cross-sectional survey research design. For this study, a sample of 180 employees from the telecommunication industry of Sri Lanka was chosen. It was used to determine whether or not there is a significant relationship between the two independent variables of family-centred life and work-centred life. The findings show that both spheres of work-life balance; family-centred life and work-centred life have a positive impact on employee performance. The current study also emphasizes the importance of understanding the challenges faced by employees in terms of their family-centred life and work-centred life that has an impact on employee performance. Family-centred life and work-centred life is yet a novel concept in economically growing countries, and more research is needed to identify sustainability issues and assess the effects of employee

Keywords: *work-life balance, family-centred life, work-centred life, employee performance*

1. INTRODUCTION

Many people struggle to balance work and family life in today's ever-demanding work climate. Work-life balance (WLB) does not imply an equal distribution of obligations rather, it refers to changing work schedules to allow individuals to balance work with other responsibilities such as caring for sick and elderly people or children (Weerakkody & Mendis, 2017). As stated by Guest (2001) inability to balance between work and family can affect both the employee and the employer impacting the sustainable competitive advantage of the whole organization because consequences can have a detrimental impact on an employee's work and life satisfaction, mental and physical health, and individual performance in the workplace.

According to Amoro (2021) WLB can be divided into two main areas as work-centred life and family-centred life. Work-centred life is when people give more importance to their profession than their family and personal purposes. Family-centred life, on the other hand, is when people give more importance to their families than their profession. This causes work-to-family conflicts and family-to-work conflicts to occur accordingly.

It is reported that one person out of every eight has a mental disorder (World Health Organization, 2017) and the report says one of the reasons for it may be the inability of the individuals to maintain a balance between personal life and work life. Out of the many industries in Sri Lanka, the telecommunication industry is one of the country's most dynamic industries, contributing significantly, both directly and indirectly, to investment, employment, productivity, innovation, and overall economic growth (International Trade Administration, 2021). Hence, requiring employees in this industry to work around the clock.

Many scholars have conducted studies on WLB and employee performance in Sri Lanka and the western world. However, fewer studies have been conducted on WLB zooming into family-centred life and work-centred life impacting employee performance in the Sri Lankan telecommunication industry. Hence, this research gap will be primarily addressed in this study.

The significance of this study is twofold, first, to the best of the author's knowledge this study brings together family-centred life and work-centred life for the first time to understand its impact on employee performance in the Sri Lankan telecommunication industry. Second, the study will provide practitioners with strategies to be used in organizations to improve employee performance by concentrating on family-centred life and work-centred life of employees.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1. Family-centred life and employee performance

Family-centred life means that people give more priority to their personal life responsibilities than their professional requirements. This causes to occur family-to-work conflicts. Most probably family-centred life occurs due to reasons such as primary responsibility for children, elder care responsibilities, interpersonal conflict within the family unit, and

unsupportive family members (American Psychological Association, 2022). Family-centred life is one complex aspect of work-life balance, since it does not only relate to challenges that are faced by parents with children, but it concerns every employee whose environment requires special care, and assistance for the elderly, and the sick (Amoro, 2021). Employee performance is highly influenced by employees' family responsibilities this shows that consideration of family responsibility characteristic of an employee can hugely improve employee performance (Mungania, 2016).

Family roles such as financial provider and caregiver, may impact employee performance, cause absenteeism, or may affect life satisfaction (Boyar et al, 2016). According to the study of Gragnano, Simbula, and Miglioretti (2020), family-centred life is one complex aspect of work-life balance, since it does not focus only on challenges that are faced by parents with children, but also concerns every employee whose environment needs special care, and assistance for the elderly, and the sick people in their family life. A study by Sirgy and Lee (2018) reveals that most parents wish to look after their children, especially after childbirth. The key challenge to an organization therefore would be to facilitate these kinds of family-centred preferences because employees are increasingly faced with difficulties in balancing career, and family responsibilities, especially for individuals who are entering a family life at a later age, as some of the employees may choose to temporarily stop work, and attend to family responsibilities. Accordingly, the first hypothesis of this study is developed as follows,

H1- There is a significant impact of family-centred life on employee performance.

2.2. Work-centred life and employee performance

Work-centred life means that people give high priority to their career responsibilities than their personal life requirements. This will cause to occur work-to-family conflicts. Most probably work-centred life occurs due to reasons such as

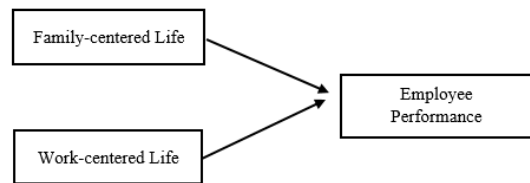
interpersonal conflict at work, inflexible work hours, unsupportive supervisor, and work overload (Karatepe, 2007). Work-centred life can be a state period or duration one spends in an organization compared with the amount of time an employee spends with their family or free time (Amoro, 2021). Stress at the workplace affects employee performance and it is recommended that organizations should give opportunities to burn out sessions for its staff and provide reasonable time for them to fulfill family responsibility easily by being with their people (Awadh, Gichinga, & Ahmed, 2015).

Time management, work culture, work schedule, and working hours are some other aspects of work-centred life. According to Riley (2012) work is an important aspect of human life, and it provides several advantages for employees such as establishing social identity, it is an avenue for social interaction that surpass work-related activities, it also empowers relationships, as well as encourages engagement, and finally gives a purpose and meaning in individuals lives as the source of income, and status in the community. Work is an activity that provides employees with resources that they need to live, and the concept of work includes social contribution, personal growth, and a feeling of belonging that are central to a sense of well-being (Gragnano, Simbula, & Miglioretti, 2020).

The most important aspect of work-centred life is working conditions and workplace options for employees; these include flexible working conditions such as part-time work, career breaks, unpaid leave, parental leave, compressed working weeks, staggered hours or rota working, and teleworking among others. Employees are also affected by workplace stress that is associated with workplace harassment, management bullying, high extensive long working hours, difficult relationships with fellow staff; the toxic working environment can lead to compromised health of employees impacting their performance at work in the long run (Ntombizakithi & Govender, 2015). Accordingly, the second hypothesis of this study is developed as follows,

H2- There is a significant impact of work-centred life on employee performance.

Based on the aforementioned literature and



hypothesis the following conceptual framework is proposed.

Figure 1: conceptual framework

3. METHODOLOGY

According to the research techniques and data analysis method, this research is related to the positivism approach. To conduct this research a deductive approach was selected because here the research problem is to identify the impact of family-centred life and work-centred life on employee performance. The survey method was chosen for this study because they provide standardized data from a sample population for easy comparison. Due to the specific timeframe, a cross-sectional was carried out and data collection took place through Google forms. The population of this study was the executive-level employees who are working in the telecommunication industry of Sri Lanka with an approximate sample size of 180 employees. Under the sampling procedure, convenient sampling was used in this study for easy access to get the data gathered for the questionnaire designed. The SPSS 24 software was used for statistical analysis by evaluating the quantitative data obtained.

4. DATA ANALYSIS

The raw data was initially reviewed for any missing values after being entered into the SPSS 24. Following that, the measuring scales' validity and reliability were evaluated, and the sample's demographic composition was examined. The data was used for the performance of parametric tests of reliability, correlation, and regression to understand the level of impact and to evaluate the hypothesis

after testing for the multivariate assumptions of normality and linearity. The summary of the study's response rate is illustrated in Table 1.

Table 1: Response Rate

Number of Google forms distributed	Number of responses received	Response Rate %
180	154	85.5%

(Source: Survey Data, 2022)

The composition of the sample is analyzed through every variable included in the questionnaire namely; gender, age, marital status, and education using descriptive statistics using frequency tables. The frequency tables are further illustrated.

Table 2: Gender composition

Sex	Response	Percentage (%)
Male	46	29.9
Female	108	70.1
Total	154	100.0

(Source: Survey Data, 2022)

As per the Table 2, it indicates that the sample consists of 108 female respondents (70.1%) whilst male respondents amount to 46(29.9%). Hence it can be concluded that the responsiveness of females is higher than that of males.

Table 3: Age composition

Age	Responses	Percentage (%)
20 – 29	137	89.0
30 – 39	14	9.1
Above 40	3	1.9
Total	154	100.0

(Source: Survey Data, 2022)

Table 3 shows 137 respondents (89%) fall between the ages of 20-29, 14 (9.1%) fall between the ages of 30-39, and 3 (1.9%) fall

above 40. It is evident that ages 20-29 constitute the largest percentage.

Table 4. Marital Status

Marital Status	Response	Percentage (%)
Single	125	81.2
Married	28	18.2
Prefer not to say	1	.6
Total	154	100.0

(Source: Survey Data, 2022)

As per the Table 4, it indicates that the sample consist of 125 single respondents (81.2%) whilst married respondents are amounting to 28(18.2%). And 1 respondent preferred not to say it. Hence it can be concluded that the responsiveness of singles is higher than that of married ones.

Table 5 highlights that 113 (73.4%) have their Bachelor's, 21 (13.6%) have a Master's Degree and 7 (4.5%) have PHD and the rest of the 13 (8.4%) respondents have other qualifications. Hence, Bachelor's constitutes the largest percentage.

Table 5. Educational Qualification

Qualification	Response	(%)
Bachelor's	113	73.4
Master	21	13.6
PhD	7	4.5
Other	13	8.4
Total	154	100.0

(Source: Survey Data, 2022)

Table 6. Reliability test

Variables	No. of items	Cronbach's Alpha
Family-centred	05	0.760
Work-centred	06	0.774
Employee Performance	04	0.730

(Source: Survey Data, 2022)

Cronbach's Alpha levels between 0.60 and 0.80 are considered as moderate and appropriate. Cronbach's alpha is considered to be extremely good if it is between 0.80 and 1.00. Table 6 highlights that Cronbach's Alpha for the three variables are 0.7. Hence, it indicates all the questions are highly reliable to analysis and acceptable.

Table 7. Correlation Coefficient

Variable	Family-centred life	Work-centred life
Correlation Coefficient	0.376	0.415
Sig value	0.000	0.000

(Source: Survey Data, 2022)

Based on Table 7, indicates that at a 95% confidence level the relationship between the family-centred life and work-centred life is positive and significant.

Table 8. Hypothesis Testing Table

Hypothesis	Beta Value	Sig Value	Accept/Reject
H1: Family-centred life has an impact on employee performance.	0.379	0.000	Accept
H1: Work-centred life has an impact on employee performance.	0.472	0.000	Accept

(Source: Survey Data, 2022)

Based on Table 8, all the hypotheses are accepted. It could be seen based on the statistics the impact of all the independent variables (family-centred life, work-centred life) on the dependent variable (employee performance) is positive and significant.

5. DISCUSSION AND CONCLUSION

The first objective of the study was to identify how family-centred life impacted on employee performance in the Sri Lankan telecommunication industry. Based on the result of the survey data, it was discovered that family-centred life has a significant impact on employee performance in the Sri Lanka Telecommunication industry. According to the coefficients sig value 0.000. Sig value is equal to P value because this is a two-tailed test. At the 95% confidence level, Sig value is less than

0.05. This finding aligns with the study of Sirgy & Lee (2018), if an organization facilitates family-centred preferences it will allow the employees to manage family-centred life between professional performances while also helping the organization to maintain the human capital so that employees are able to happily engage in long, fulfilling careers.

The second objective of the study was to identify how work-centred life impact on employee performance in the Sri Lankan telecommunication industry. According to the data interpretation, sigma value is 0.000. At the 95% confidence level, Sig value is less than 0.05. This shows a significant impact of work-centred life on employee performance. This finding aligns with the finding of Human Resource Management International Digest (2004) as reducing stress and absence through work flexibility results in a more satisfied and more productive workforce and also has an effect of improved recruitment and retention in human resources.

With the revelations of the study, practitioners must take into account that providing proper training and development programs will enhance the effectiveness of employee performance. The training program can be planned by considering the employee and organizational requirements. Training such as personal and professional development training courses, life management training courses, effective workload management will help employees to balance family and work sphere needs and it will improve their performance. Moreover, providing stress management services could reduce employee absenteeism, and allowing employees to work in flex-work schedules with specified regulations will be an opportunity for the employees to plan their workday by considering professional responsibilities and personal requirements. Thus, it is the employer's responsibility to ensure such practices are available within the workplace as it impacts employee performance positively.

Conclusively, the main aim of this study was to look into the impact of family-centred life and work-centred life on employee performance in Sri Lanka's Telecommunication industry. The study found how well the two key factors have a significant impact on employee performance. The results of this study thus add a thorough understanding of how employee performance gets a positive and negative impact through family-centred life and work-centred life which are part of work-life balance. Hence, the study recommends practitioners to take maximum advantage from employees' work-life balance where managers must first pay attention to using different techniques that help to fulfill employees' professional requirements in work-centred life and personal responsibilities in family-centred life to enhance the employee performance within an organization.

REFERENCES

- American Psychological Association. (2022). Parents and Caregivers Are Essential to Children's Healthy Development. Retrieved from <https://www.apa.org/pi/families/resources/parents-caregivers>
- Amoro, E. (2021). Work-life balance and employee performance at geothermal development company in Nairobi city county, Kenya. Master's Research Project. Kenyatta University, Nairobi, Kenya.
- Awadh, I. M., Gichinga, L., & Ahmed, A. H. (2015). Effects of Workplace Stress on Employee Performance in the County Governments in Kenya: A case study of Kilifi County Government. *International Journal of Scientific and Research Publications*, Vol 5(10), pp. 1-8.
- Boyar, S. L., Wagner, T. A., Petzinger, A., & McKinley, R. B. (2016). The impact of family roles on employee's attitudes and behaviors. *Journal of Management Development*, Vol. 35(5), pp. 623-635.
- Gragnano, A., Simbula, S., & Miglioretti, M. (2020). Work-Life Balance: Weighing the Importance of Work Family and Work Health Balance. *International Journal of Environmental Research and Public Health*, vol. 17, pp. 1-20.

- Guest, D.E. (2001). Perspectives on the study of work life balance. Social Science Information <http://www.ucm.es/info>.
- Human Resources Management International Digest, (2004). Leeds lists the benefits of better work life balance: Councils reap the rewards of family friendly policies.
- International Trade Administration. (2021). Sri Lanka - Telecommunications and Information Technology. Retrieved from <https://www.trade.gov/country-commercial-guides/sri-lanka-telecommunications-and-information-technology>
- Karatepe, O. (2007). Relationships with supervisor support and conflicts in the work-family interface with selected job outcomes of frontline employees. *Tourism Management*, vol. 28, pp. 238-252
- Mendis, M. D., & Weerakkody, W. S. (2017). The impact of work-life balance on employee performance in Sri Lanka Telecommunication industry. *Kelaniya Journal of Human Resource Management* vol. 12(1), pp. 72-100.
- Mungania, A. K. (2016). Influence of family responsibilities on the performance of the banking industry in Kenya. *International Journal of Advanced Multidisciplinary Research*, vol.3(8), pp. 6-13.
- Ntombizakithi, R. B., & Govender, P. (2015). Employee assistance programs: tools for quality of work-life. *Problems and Perspectives in Management*, Vol. 13(2), pp. 506-514.
- Riley, D. (2012). Work And Family interface: Wellbeing and the role of resilience and work-life balance.
- Sirgy, M., & Lee, D. (2018). Work-Life Balance: An Integrative Review. *Applied Research Quality Life* vol. 13, pp. 229–254.
- World Health Organization. (2017). Depression. Retrieved from <https://www.who.int/news-room/fact-sheets/detail/depression>

Aligning Student Behavior, Pedagogy, and Academic Performance Thorough Learning Analytics: A systematic Methodological review

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ABSTRACT

This article focuses on a systematic review of literature in reviewing methodologies related to the key concept of Learning Analytics (LA) along with the concepts of pedagogy, student behavior and academic performance. The Higher Education (HE) setting has faced rapid change, with respect to the massive changes taken place in technology. Teacher-centered learning methodology is converted to learner and learning-centered, while promoting active learning over passive learning, through technology. 16 extracted articles that are published within the time span of 2010 to 2018 have been reviewed and a descriptive discussion on the methodological implications of these papers was conducted in terms of research approach, research design, sampling strategy, collection of data, data analysis, reliability, and validity measurements. Findings of the study highlighted the use of a variety of methodologies in the context and the quantitative approach has been emphasized in majority of the papers. Most of the papers have utilized the quantitative approach to understand the students' engagement and performance in a quantitative base, where methodological gaps have been identified to understand the learning quotient, which could be addressed through future studies.

1. INTRODUCTION

Learning analytics has been identified as one of the emerging fields in different educational settings, which basically focuses on the improvements of education in general. Further, learning analytics enables understanding the learner and the learning context, based on collected data of learners' different behaviors (Khalil & Ebner, n.d.). The concept of learning analytics emerged with the boom of information technology, where techniques were developed to gather and store data about learning. The change in education has mainly been shaped by the rapidly changing science and technology aspects, which surprisingly mitigates the barriers in the field of education by giving more opportunities to the learner and the teacher in the process (Gumport & Chun, 1970) thus resulting new learning platforms such as distance learning, online resource sharing, etc. This virtual and digital involvement has given the rise to sharing educational resources and provided more opportunities to create data in education (Ko & Rossen, 2010). The rise of big data handling is strongly supported in decision-making in different sectors including education, specifically through the concept of learning analytics (Zhang et al. n.d.). Currently, learning analytics has become the supporting source of all kinds of education-related proceedings such as assessments, learning patterns analysis, teaching pattern analysis, and professional development. Learning analytics can be viewed as a combination of numerous disciplines of

computer science, education, educational psychology, and statistics. Using the support of these combinations, learning analytics focuses more on aiding decision-making, based on the data stored related to the learning process. By using these learning patterns, the learning analytics frameworks were developed and used to predict the behaviors of the learners (Bainbridge et al. 2015; Lu et al. n.d.). Such predicting models highlighted the student's engagements in online activities and it is proved that the handling of those technological devices such as smartphones, iPads and software applications such as learning management systems, blogs, and podcasts are very effective in confirming students' individual efficiency in learning (Chen, Shih, & Liu, 2015). As most of the studies are now on digital platforms, the learning analytics framework can be easily activated through the student's interactions with the aforesaid digital devices.

As per Pinantoan cited in Zhang et al. (Zhang et al., 2018), the implementation of technology-based learning tools such as Learning Management Systems (LMS) is designed with the final intention of enhancing the efficiency of the learning and development of the learner. Therefore, an important function of the learning analytics framework is, to verify the students' engagement in learning and their behavioral patterns towards the usage of LMS. If students do not actively interact with LMS, there is an issue in generating data in the learning analytics process, which directs the discussion towards, learning beyond technology. However, the LMS has been identified as one of the prominent tools in capturing and analyzing students' performances (Ihantola et al. 2015), which emphasizes the need to verify the students' online engagement in learning. Due to these changes taking place in the learning spectrum, there is an obvious change taking place in the teaching method as well, which is the 3D teaching arena that has emerged compared to the 2D class teaching (Hlapanis & Dimitrakopoulou, 2007). An important notification in this regard is the alignment of the pedagogy and the students' positive behavioral patterns in the learning phase for the learning efficiency and the learners' development, which ultimately quantify their

performance measurements in the learning environment. According to Duffy and Ney (Duffy and Ney 2015) technology has been utilized in enhancing the student's engagement in the learning process. This engagement is specifically supported by the active pedagogical changes in the learning space, which makes the learning more live, active, and interactive (Celsi & Wolfinbarger, 2002).

The paradigm shift took place in education in highlighting the learner and the learning. Rather than considering teaching as an instructional guide, it widely emphasizes the need and the importance of the learner's active engagement in the learning process (Lumpkin, Achen, & Dodd, 2015). Learning design has a big responsibility in creating the learners' desire to learn (Conole, 2012) and substantially align both learners and teachers into one platform through advanced technology in education. Generally, by aligning the student behavior and the pedagogical change through learning analytics, the students learning styles, projecting their performances (Jena, 2018), and providing proper academic advice on better performances are expected to be understood (Angeli et al., 2017). But an arguable doubt is constructed to verify the ability of the online data through learning analytics in predicting student performances, due to different aspects such as changes in the context, subject nature, students' behavior nurture through the uncontrollable environment, etc. (K. D. Strang, 2016).

Therefore, it is important to maintain a very clear understanding of three aspects of how learners learn (behavior), how teachers design the appropriate learning atmosphere, and the context (Pedagogy) in which the learning (Performance) is taken place for the effective use of learning analytics. The utilization of learning analytics through mere clicking behavior of the students in the digital learning space will not facilitate in understanding the learning. Thereby, the performance projections based on the outcomes of learning analytics of the students (Ferguson & Clow, 2017; Rienties et al., 2018), will lead towards failures, in the learning component taking place beyond the LMS and the classroom. Based on the understanding of the need for

proper placement of the three different aspects in the higher education setting, pedagogy, student behavior, and their better performance in the learning analytics platform, this review will motivate to understand how aforesaid concepts have reviewed under different research methodologies in different learning contexts and under different focuses. This paper extends the methodologies used in the aspect of learning and further discussion on the reliability and validity of different methods utilized in conducting the research. Most importantly, the paper aims at an extensive discussion on the positive and negative implications of different research methods, to understand the proper use of appropriate methodologies in learning research.

2. METHOD

2.1. Objective

This paper basically focuses on conducting a systematic literature review and systematic literature reviews can be conducted with different intentions (Okoli & Schabram, 2010). Specifically, the systematic literature review enables understanding meaningful categorization and fruitful comparison in the field (Ihantola et al. 2015). This paper is mainly focusing on a critical review of related literature in the main field of learning analytics, to understand different methodological aspects used to better reveal of the core of learning analytics by aligning pedagogy, student behavior, and their better performance.

2.2. Identifying the relevant Literature

The initial search of the literature is done by using the key terms in the research area. The key terms of learning analytics, higher education, business management, pedagogy, student behavior, and student performance were searched by covering popular databases of Science Citation Index, Education Resources Information Center (ERIC), Scopus, Library, Information Science & Technology Abstracts, Complementary Index, JSTOR Journals, Academic Search Premier, MEDLINE, Business Source Premier, Emerald Insight, Supplemental

Index. However, the initial search based on keywords was conducted in two different dimensions due to the absence of articles representing the required claims of the interest of the study. In the first case, the search is done by highlighting "Learning Analytics in Higher Education" AND "Business Management". Case two in the basic search is done by using "Learning Analytics", "Pedagogy" AND "Student Behavior". Results generated through these two-basic searches were directed to further screening to narrow down the search.

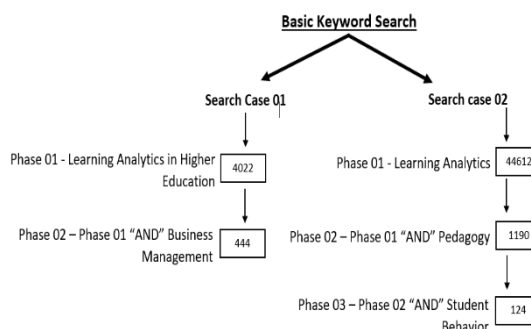


Figure 1. Initial keyword search outline

According to the basic search illustrated in figure 1, 568 articles in total were directed to screening and further filtering.

2.3. Screening and selection procedure and the results of the search

When conducting a systematic review, it is important to ensure the transparency of the literature reviews and its ability in representing the discipline in an appropriate manner (Page and Moher 2017), where the decision of the inclusion and the exclusion has been established based on the PRISMA guidelines. 568 articles in total derived in the basic search, further narrow down at the first iteration, by only considering the articles published in journals, by excluding the magazines, conference papers, reports, and books, due to the ability of journal articles to facilitate researchers in an informative manner through credible and reliable sources (Thelwall & Sud, 2018). Based on this inclusion criteria 122 articles were derived from 1st search set and

48 articles were derived from 2nd search set. The published period is used as the second inclusion criterion, the duration of years 2010 to 2018. This resulted in 88 articles under the 1st search set and 35 articles under the 2nd search set. However, after treating the duplications, the final set of articles was derived and forwarded to the next level of screening. The 3rd inclusion criterion was the title search. The titles have been scanned to capture the most related titles that fit the focus research area. Based on the title search 32 articles were removed from the 1st set and none of the articles were removed from the second search set. In total 58 articles were forwarded to the abstract screening from both the search sets and finally ended up with 23 articles for extensive reference. As the study mainly focuses on the review of the methodologies, full papers were screened in identifying journal articles with rich methodology. However, 16 articles were finalized with required information for the review and the summary of the screening process is presented in table 1.

Table 1. Literature screening summary

<u><i>Inclusion / Exclusion Criteria</i></u>	<u><i>Search Set 01</i></u>	<u><i>Search Set 02</i></u>	<u><i>Total</i></u>
Articles with the basic keyword search	444	147	591
Published ONLY in Academic Journals	122	48	170
Published in the period of 2010 - 2018	88	35	123
After removing Duplicated papers	58	32	90
Title screening result	26	32	58
Abstract Screening result	11	12	23
Full paper screening for methodology	7	9	16

2.4. Data extraction and analysis

The extraction of relevant literature and information of the study basically focused on the methodology of the prior research. To address this focus at the initial stage, the information stated in the selected article was summarized by highlighting the title, author, published year, objective, sampling, participants, data collection methods, Research design/ strategy/ approach, reliability and validity measures used, and the analytical tools used for the analysis. Through this review document, the understandability and convenience of the usage of the literature have been increased in terms of the following methodological aspects.

2.5. Research Approach

Under the research approach, the main concern is to understand the overall research plan that is used as the base of the entire research methodology. A research approach is used to exclusively design the research (Bryman 2012). Basically, the discussion focuses on and coded the use of quantitative, qualitative, and mixed methodological approaches in the selected research papers at glance. This is basically to understand whether the research is focusing on numeric or meanings in the basic research focus.

2.6. Research Strategy / Design

Research design is to ensure the use of efficient and effective data (evidence) in the research process. Therefore, the research strategy/design has a greater influence on the data collection procedures (Bryman, 2012), where the overall research proceedings depend on the strategy selected. The specific design of the selected articles was analyzed, coded and discussed, such as action research, experimental research, observational research and case studies.

2.7. Population, participants, and sampling

In the event of generalization of the final research output, the sample is identified as an important aspect (Dhivyadeepa, n.d.). Broadly understanding the probabilistic and the non-probabilistic sampling techniques, the specific methods used in the selection of the sample are discussed to understand this aspect, such as simple random sampling, cluster sampling,

stratified sampling, convenience sampling, etc. Further, this section facilitates the understanding of the unit of analysis of the study, whether the research conducted focuses on individuals or groups.

2.8. Data Collection Instruments

The use of effective data is an important aspect in deriving quality research outcomes. Therefore, it is important to ensure the adequate quantity and quality of data gathered, which can be confirmed through transparent and efficient collection methods. Further, assessing the use of primary and secondary data, various tools used in data collection of the selected papers were reviewed to understand the appropriate use of collection tools.

2.9. Data Analysis tools

The use of appropriate analytical techniques for the analysis of data is another important dimension to confirm the research outcomes by addressing the set research objectives. Basically, the use of descriptive statistics, correlational and regression analysis, application of dimension reduction techniques and the use of data triangulation and content analysis used in the selected articles were reviewed.

2.10 Credibility, reliability, and validity

Measurement of the credibility, reliability and validity in a research are considered important criteria in assessing the quality of the research (Bryman, 2012). The basic review of this aspect is to understand the use of different validity and reliability measurements in the selected papers and thereby the specific techniques were discussed to identify the appropriate application. Specifically, the suitability of the reliability and validity measurements in confirming the trustworthiness of the used methods in research

3. RESULTS

3.1. Research focus at a glance

The path and the final result of a research is basically supported by the main research focus (Denscombe, 2010). Therefore, in the first section, before elaborating on the research methodologies, the focus of the research is

verified based on the titles and the abstracts of the selected articles. Three main focuses were identified in common, under the main concept of learning analytics in line with the pedagogy, student behavior, and academic performance. Only 4 of the extracted articles out of 16, focus on the prediction of the students' performances using the facts of the learning analytics (Bainbridge et al. 2015; Choi et al. n.d.; Jena 2018; Lu et al. n.d.). Identifying different types of relationships that exist among the learning analytics, pedagogy-related facts, behavioral patterns of the students and their performances are focused by 8 articles extracted from the search (Andergassen, Mödritscher, & Neumann, 2014; Chaurasia et al., 2018; Dennen, 2011; Lin & Hwang, n.d.; Malkin, Rehfeldt, & Shayter, 2018; Rienties et al., 2018; K. D. Strang, 2016; K. Strang, 2016). Different types of learning designs, pedagogical aids, and academics' involvement in creating a better learning environment for the students' focus have been discussed in another 4 articles. (Chaurasia & Frieda Rosin, 2017; Duffy & Ney, 2015; Varouchas, Sicilia, & Sánchez-Alonso, 2018; Zheng, Bender, & Nadershahi, 2017).

3.2. Publication period at a glance

The following table, table 2 is providing a summary of the year of the publication of the extracted articles, which shows more recent publications than early in the year 2010.

Table 2. Publication year summary

Published year	Frequency	Cumulative %
2011	1	6%
2014	1	13%
2015	3	31%
2016	3	50%
2017	1	56%
2018	7	100%
	16	

According to table 2, no articles were found in the year 2010 and most of the selected publications have placed in the year 2018, which

is 7 papers out of the selected 16. of the papers published within the period of 2011 to 2017, where the balance 44% published in the year 2018, most recently.

3.3. Overview of research objectives/research questions

Based on the title verification of the extracted articles in section 3.1, the common objective of most of the articles was focusing on the verification and understanding the influence of student behavior and learning design towards better academic performances in the students' academic path. The verification of data related to these relationships were basically supported through the tool of learning analytics (Andergassen et al., 2014; Chaurasia et al., 2018; Dennen, 2011; Lin & Hwang, n.d.; Malkin et al., 2018; Rienties et al., 2018; K. D. Strang, 2016; K. Strang, 2016). Secondly another set of articles targeted at developing prediction models for the early prediction of Students' performances or their behavioral patterns or certain learning designs utilization based on the learning analytics data generated through several digital platforms (Bainbridge et al. 2015; Choi et al. n.d.; Jena 2018; Lu et al. n.d.). Thirdly, another set of articles was reviewed, which emphasize the objective of creating a better learning space for students and to develop the academics for a quality education along with a digitally appropriate interactive pedagogy (Chaurasia & Frieda Rosin, 2017; Duffy & Ney, 2015; Varouchas et al., 2018; Zheng et al., 2017). Further, supporting the need of proper research focus on the entire research work plan (Denscombe, 2010), the objectives of the studies reviewed briefly, to clarify the research foundation in developing the methodology.

3.4. Methodology related review

3.4.1. Research Approach

Three main approaches can be used in general to conduct a research, namely quantitative approach, qualitative approach, and mixed approach. Most of the selected articles of the study were conducted under the quantitative approach, which is 10 articles out of a total of 16

(Andergassen et al., 2014; Bainbridge et al., 2015; Choi et al., n.d.; Jena, 2018; Lin & Hwang, n.d.; Lu et al., n.d.; Malkin et al., 2018; Rienties et al., 2018; K. D. Strang, 2016; Varouchas et al., 2018). 4 articles have followed qualitative methodologies and 2 followed mix methodology in the papers which shows a combination of both quantitative and qualitative approach. (Chaurasia et al., 2018; Chaurasia & Frieda Rosin, 2017; Dennen, 2011; Duffy & Ney, 2015; K. Strang, 2016; Zheng et al., 2017).

3.4.2. Research Strategy / Design

Research strategy basically discusses about the action plan or the structure of the research, which basically derives through the aims and the objectives of the research (Denscombe 2010). The mostly utilized approach in the extracted articles is the quantitative approach and out of the 10 articles aligned under the quantitative approach, there were three strategies identified. Majority of the articles were under the case study strategy (4 studies) (Bainbridge et al., 2015; Choi et al., n.d.; Jena, 2018; Rienties et al., 2018) and 2 experimental designs (Lu et al., n.d.; Malkin et al., 2018) and one quasi-experimental design (Lin & Hwang, n.d.). However, it is notified that 3 of the articles do not specify the strategy in clear terms (Andergassen et al., 2014; K. D. Strang, 2016; Varouchas et al., 2018). Out of the 4 qualitative approach researches, 2 were clearly stated that design as the exploratory (Chaurasia et al., 2018; Duffy & Ney 2015), while the others have not specifically mentioned the design or the strategy of the research, but merely mentioned the qualitative nature (Chaurasia & Frieda Rosin, 2017; Dennen, 2011)

3.4.3. Population, participants, and sampling

All the related units of a certain domain are termed as the population (Berenson & Levine, 2018), and the selected group from that population is termed as the sample base for the study. All the selected 16 studies were conducted within the education context, where only one study has been conducted with the contribution of industry practitioners. Most of the selected studies, 13 papers out of 16, have initiated their research proceedings with the clear definition

and understanding of the population related to the study scope (Andergassen et al., 2014; Bainbridge et al., 2015; Chaurasia et al., 2018; Chaurasia & Frieda Rosin, 2017; Choi et al., n.d.; Dennen, 2011; Duffy & Ney, 2015; Lin & Hwang, n.d.; Malkin et al., 2018; Rienties et al., 2018; K. D. Strang, 2016; K. Strang, 2016; Varouchas et al., 2018), but the balance studies have initiated their work without a clearly defined boundary for population of the study (Jena, 2018; Lu et al., n.d.). 10 extracted articles have purely conducted the study using students as participants (Andergassen et al., 2014; Bainbridge et al., 2015; Choi et al., n.d.; Jena, 2018; Lin & Hwang, n.d.; Lu et al., n.d.; Malkin et al., 2018; Rienties et al., 2018; K. D. Strang, 2016; K. Strang, 2016) and 6 of the other studies in the extraction have conducted using mix of participants such as students, academics, academic administrators, higher education experts and industry practitioners (Chaurasia et al., 2018; Chaurasia & Frieda Rosin, 2017; Dennen, 2011; Duffy & Ney, 2015; Varouchas et al., 2018; Zheng et al., 2017). Out of the selected papers, only 4 of the papers technically stated the sample technique used in the event of the sample selection (Chaurasia et al., 2018; Chaurasia & Frieda Rosin, 2017; Duffy & Ney, 2015; Zheng et al., 2017). However, except for the two papers without a clearly defined population boundary (Jena, 2018; Lu et al., n.d.), all the other 10 papers have mentioned how they have narrowed down the defined population into a representative subset of the population, but no technical sampling method discussed. It is noted that except for one paper all the other papers have presented a definite sample of study, where one paper [15] has mentioned the sample as an approximation figure.

3.4.4. Data Collection Instruments

Within the selected research scope, mainly five types of data collection tools have been used for the collection of data. In most of the articles, it was visible that the use of more than one data collection tool (6 of the research papers) (Choi et al. n.d.; Lin and Hwang n.d.; Lu et al. n.d.; Malkin et al. 2018; Varouchas et al. 2018; Zheng et al. 2017). Those studies show a collection of questionnaires, observation and secondary data

gathering from the systems. There is only one article with data gathered from a questionnaire (Jena 2018) and one article based on the data collected through a discussion (Dennen 2011). It is noted that only 3 of the studies have used the interview method (Chaurasia et al. 2018; Chaurasia and Frieda Rosin 2017; Duffy and Ney 2015) in data collection. Except for the papers with multi-tools usage in data collection, the balance papers equally carry primary and secondary data in the research context.

3.4.5. Analytical tools

In quantitative approach

The most common research approach of the extracted research articles is the quantitative approach, where exactly these papers show the utilization of statistical measurements as the analytical tool. In common, the quantitative data analysis starts with descriptive statistics, which describe the data set, but 12 of the extracted articles in the quantitative approach have not highlighted the use of descriptive statistics. Most of the papers have used a mix of different statistical techniques in the data analysis, which have been used to validate the findings such as Independent sample t-test (Lin & Hwang, n.d.; Malkin et al., 2018), Pearson coefficient of correlation (Andergassen et al., 2014; Choi et al., n.d.; Rienties et al., 2018; Varouchas et al., 2018), panel data analysis (Rienties et al., 2018), regression (Andergassen et al., 2014; Bainbridge et al., 2015; Choi et al., n.d.; Jena, 2018; Lu et al., n.d.; K. D. Strang, 2016), One-way ANOVA (K. D. Strang, 2016), Analysis of covariance (ANCOVA) (Lin & Hwang, n.d.), factor analysis (Varouchas et al., 2018). Mostly the studies with correlation analysis in identifying the causal effect in different variables have further been validated by regression in confirming the impact of the independent variables on the dependent. A dimension reduction technique, factor analysis has been used along with the correlation. It is highlighted that 2 of the experimental design researches have utilized the independent sample t-test as the analytical tool (Lin and Hwang n.d.; Malkin et al. 2018). Rather than using mere regression, the use of different dimensions has been identified such as step-wise regression, principle component regression, and quantile

regression [5, 17, 26]. Further, the use of Kruskal-Wallis chi-square test was notified in identifying associations among the independent and dependent variables in categorical nature (Choi et al., n.d.).

In qualitative and mixed approach

The identified most common analytical tool in qualitative types papers is the thematic analysis, which is specifically used for the objective of matching the patterns of the data derived (Chaurasia et al., 2018; Chaurasia & Frieda Rosin, 2017; Dennen, 2011; Duffy & Ney 2015). It is highlighted that all four papers under this approach have used a grounded theory or a validated rubric in conducting thematic analysis, by using software tools such as NVivo. Basically, the function of coding has also become common in this analysis, by using the above-mentioned rubric or theory. Specifically, the mixed method papers in the extraction show the utilization of both quantitative and qualitative aspects, which maintain a balance between statistical tools and qualitative tools. One of the main points noted in the mixed method research is the concept and the action of data triangulation. Both the papers used in this systematic review under the mixed approach have used data triangulation (K. Strang, 2016; Zheng et al., 2017).

3.4.6. Credibility, reliability, and validity

Generally, the research is focusing on deriving knowledge claims. Therefore, to confirm the quality of a such research construct is done through validity and reliability measurements (Kimberlin CL and Winterstein AG 2008). Reliability discusses about the stability of the final measurement which derives through a strong measurement process. The extent of the significance and the relevance of the instruments measures is discussed by the validity (Kimberlin CL and Winterstein AG 2008). However, in order derive quality and trustworthy outcomes from the research it is important to test the reliability and the validity of the instrument's measurements used in the study. Though it is important to confirm the reliability and validity in a research, it noted that only two papers have mentioned an discussed about the reliability measurements in the study, which is the

application of Cronbach Alpha (Varouchas et al., 2018) and the application of Cohens' Kappa (Jena, 2018). All the other quantitative papers in the systematics review do not elaborate the utilization of the concepts of reliability and validity [5, 6, 17, 18, 23–26].

Specifically, in the qualitative studies, three studies have highlighted the confirmation of the credibility of the study through the confirmation of the credibility of the data collection. In one paper, it is highlighted the special attention given to the selection of the participants of the study (Chaurasia & Frieda Rosin, 2017). Two studies that collected data through interviews have paid greater attention on the participant selection for the interviews in the data collection process (Chaurasia et al. 2018; Duffy and Ney 2015). The both papers under the mixed method have not specifically mentioned about the utilization of reliability, validity and the credibility. Another qualitative study without any indication about the credibility and reliability have been utilized previously developed and common coding systems or rubric in streamlining their findings (Dennen 2011), which is arguable, whether this will contribute towards the confirmation of the credibility of the research outcome.

4. DISCUSSION

At a glance, the extracted research papers mainly focus on emphasizing the successful use of learning analytics in the learning environment, focusing mainly in shaping pedagogy and student behavior, with an ultimate objective for better academic performances. The main objective of this paper is to systematically review the proceedings of these research papers highlighting the methodological background, which were extracted from a systematical search using the keywords from different databases. The focus of the 16 articles extracted have been categorized into three main sections, based on the objectives stated, it is highlighted the relationships among the aforesaid aspects, secondly the behavioral patterns of students, and thirdly the pedagogy. The selection of the articles done within the time span of 9 years from 2010 to 2018 and majority of the articles were published in the recent years. Learning analytics is considered as a recently emerged discipline (Larsson and White 2014)

and it can be argued that this as the reason for existence of most recent publications in the field. Learning analytics is a vast area that collect, measure, analyses and reporting data and information related to the learners, learning function and its environment (Anon n.d.-a). Based on this main context most of the research aims stated to identify the successful use of learning analytics in the learning context and this common objective has been identified as verifying relationships, confirming quality of learning and predicting students learning and achievement.

The mostly utilized research approach is the quantitative approach, where the research objective is achieved through numerical based measurement. Learning analytics is mainly engaged with online learning behaviors in digital platforms connected to a technological phase (Larsson & White, 2014). Further, in simple terms learning analytics is data, where the technology has provided a platform to gather, store and functionalize those data (Hwang, Chu, & Yin, 2017). Therefore, the quantitative type approach would be more useful to handle online recorded numerical data. One of the main objectives of the field of learning analytics is to meaningful use of learning analytics in creating better learning (Larsson and White 2014). This better learning can be reflected through the ultimate achievement of the students. However, in the general practice the students are finally assessed through a numerical grading, which again proves the suitability of the use of quantitative approach in the studies of learning analytics. This use of quantitative approach in learning analytics related studies has been proved by the previous systematic literature reviews (Mangaroska & Giannakos, 2018; Schwendimann et al., 2017). Specifically, according to section 3.4 under the subheading analytical tools in this paper, most of the papers with the intention of assessing various relationships in the learning context among different variables are analyzed based on the statistical aspects of correlation and regression. These statistical measurements enable in understanding how different the numerically measured variables such as student online learning time, number of times used the online

materials, number of logs to the online learning platforms are connected to good grades. One of the positive implications of the quantitative research is the use of statistical validations than the qualitative approach (Carr, 1994), where the outcomes are derived through a statistical process. Outcomes of the quantitative research are measurement based rather than focusing on researchers' personal experiences or values (Denscombe, 2010) and the generalizability of the research outcomes is mostly promoted through quantitative data and measurements. Therefore, it shows the interconnectivity and the suitability of conducting quantitative research in this field, where the significant tests done in statistics aid in enhancing the researcher's credibility. Therefore, the research interpretations can be positioned in the context firmly (Denscombe, 2010). Further, when the data is recorded in a numerical format in large quantities, the quantitative application would be easy to interpret them quickly with numerous types of presenting techniques such as graphs and charts, etc. (Carr, 1994; Lakshman et al., 2000). Though the quantitative application has more positive aspects in practice, there are negative implications in using quantitative as well. Specially, quantitative can specifically define the numerical boundaries only for the characteristics that can be measured with numbers, where the aspects that cannot be quantified cannot be statistically interpreted such as learning, students thinking patterns, mental capabilities, learning design, etc. Use of the appropriate statistical techniques will be a challenging task, because of the differences of the quantitative data gathered, the result can be different, which will have a great impact on the result. Learning is a complicated concept, where learning can happen at different points such as within the class during the delivery, group discussions, while interacting with LMS, self-studying, presentation, etc. Therefore, the most debatable point is how exactly the learning can be quantified. (Ferguson & Clow, 2017)

Qualitative and the mix approach is the least common analytical approach used in the selected articles in the field of learning analytics, but there is a special feature noticed in the application of this approach in the extracted research papers,

where all those papers mostly discuss about the quality assurance of the learning process, understanding the learning style and developing the learning design and the pedagogy appropriately. The concepts of student behavior and the teaching strategies, basically the pedagogy is mostly discussed as person based terms, which is difficult in quantifying in an accurate manner (Nesselroade & Molenaar, 2016). Therefore, due lack of numerical identification, the qualitative approach would be ideal in capturing and pooling similar learning behaviors and learning designs. Further, in aligning the behavior with the academic performance, a triangulation of the data can be facilitated under the mixed method, with several numerical type data through learning analytics. In the review, none of the papers discuss about the research philosophy used in building up the research study, but an indirect implication can be derived about the philosophy underlying, by reviewing the overall research methodology. However, the required data, thereby the research process, is basically derived by the research objectives and the problems, because it is highlighted the poor connection between education research and scientific inquiry, which every education problem does not require a scientific inquiry (Suter, 2012). However, qualitative data will be more useful in explaining the research context based on the researchers' and the participants' values, specially, when the researchers use data that are more related to human behaviors. In general, positivistic research is based on scientific inquiry, where the knowledge creation is embedded in object or observation or experience (Anon, n.d.-b). On the other hand, the research ideas are mostly supported with concepts such as behavior, designs, perceptions, which cannot be numerically captured and do not have a universally accepted standard in defining can be explained based on the observations or mostly by elaborating ideas. This is mostly discussed in the post-positivistic or interpretivism philosophy (Anon, n.d.-b), which can in line with the qualitative research papers of this study that study about the students learning behaviors, their learning thinking, learning designs etc.

At a glance out of 16, 4 papers were done on case study strategy, where a student group is selected, and their learning aspects are analyzed closely under the set objectives. The 4 papers consider on specific group in the education phase. The use of case studies further emphasize the differences of learning (Ferguson & Clow, 2017). As the case study focuses on a specific case the replication can be seen (Bryman, 2012), which reproduces the same domain in another context. In providing in-depth explanations on social behavior, the case study approach is considered to be most important (Zainal, 2007). The case study strategy can be occupied in the both qualitative as well as quantitative approaches that enable both numerical and categorical types of variables (Zainal, 2007). All the 4 articles with the case study strategy are quantitative case studies, which mostly discuss about the engagement in technology in the learning and teaching phrase. The main drawback of this type of case analysis is the issues pertaining in the generalization of the results derived (Bryman, 2012). The student behavior and learning expectations are subjected to change based on the learning context they exist (K. D. Strang, 2016), which limits the applications of the outcomes in a broader context.

Another highlighted research strategy is experimental designs, which is a study that enables to witness the usefulness of the application of learning analytics in a selected learning setting, where those selected papers under the experimental designs are able in comparing online based learning over traditional learning aspects. Data directly taken from the logs of learning management system or another digital platform or device throughout a course and they experiment how marks can be used in developing a predicting model, where the actual success and the failure of the student is compared with the prediction derived through the model as well. Another type of an experiment was conducted by grouping the sample in to sections, which finally experiments the success of the two groups under different conditions and these types of experiments promote the comparison of the results. These experiments are field experiments that have taken place in real-life incidents, not taken place in a laboratory setting. However,

there is an argument in applying experimental design more in sociological research (Bryman, 2012), where experiments related to Sociology enable to understand different behaviors. There is an argument that the experiments are facilitating causal investigations, which can be considered as a positive point in using experiments (Scoles, Huxham, & McArthur 2014). Further, the experiments be a benchmark to stimulate a considerable confidence in sturdiness and reliability of causal findings and the true experiments tend to confirm high internal validity, as the results are observed and notified in a real setting (Bryman, 2012). The ability to control is one of the key features in experiments and a prerequisite as well. It enables the researcher to conduct research on how different situations, and factors influence a certain domain. This is mostly to understand the cause and effect relationships among variables (Labaree, n.d.). The artificially set experiments can limit the generalizability of the results under the experimental designs. On the other hand, when ethical reasoning is highlighted, the activation of the experimental design might be restricted. Specially in education-based research the experiments would be biased to a group, which will affect their performance in a different manner. This point highlights the inappropriateness of using experiments with control groups, under an ethical platform, which restricts the privilege of education to a certain set of target students. Therefore, rather than controlling the group, investigating certain behaviors through observation will be suitable in a sound ethical base. Another perspective presented against experiments, is the inability of verifying the genuine performance and the behavior of the participants of the research, due to the knowing fact of monitoring. Then the issue rises in validating the collected data, process and the results.

When highlighting the idea of generalizability of the research, it indicates the application of the outcomes throughout the population than restricting within the boundaries of the sample. Most of the research papers in the review have shown a clearly defined population and a sampling scope. Students are the most used unit of analysis of the papers as the learning has been

taken place, making the learner and the learning, the central point (Mangaroska & Giannakos, 2018), but specifically the studies discussed about the learning design, pedagogy and the quality assurance aspects academics or experts in the field have taken into consideration. However, the students, educators, and researchers have become common phase of population in most of educational research related to learning analytics (Mangaroska & Giannakos, 2018). As learning analytics basically highlight the learning phase, it is important to highlight the student, teacher and the educational administrator's involvement, which aid in deriving valid outcomes to align the behavior and pedagogy.

In most of the papers, sampling techniques have not been explained in a detailed manner. Sampling can be basically done on two methods in a broad manner, either probabilistic or non-probabilistic. Probabilistic techniques highlight the chance given to the population to get selected for the sample and the non-probabilistic methods mostly highlight the preference or the convenience of the investigator and there is no way to calculate the probability, with respect to the sample (Dhivyadeepa, n.d.). Specifically, when it comes to generalization of results probabilistic sampling is more useful than using non-probabilistic sampling. Further, the use of probabilistic sampling is helpful in minimizing the sampling biases and enhancing the representativeness of the sample compared to the population than the qualitative methods. Randomization is one of the common features in probabilistic sampling. To promote the probabilistic sampling method under randomization concept, it is essential to maintain a list of the population (Dhivyadeepa, n.d.). When it comes to the common unit of analysis in an education research, student, is kind of a difficult unit to list out as a population, due to use of different aspects in identifying the term student, but in a case study, the student population list can be easily defined, with respect to the certain cohort of students. Therefore, it is arguable that use of probabilistic sampling in all the researches in Education, where in most the cases specific cases are studies, specifically in the experiments designs in the educational research (Cobb et al., 2003). As the behavior and

the learning patterns are different from one to the other (Shushok et al., 2009), mostly the cases are studied. In the selection of this review also commonly used strategy is the case base study, but in order to improve the effectiveness of the of the sample representativeness an in-detail study can be done on the selected sample under a certain case (Akker et al., n.d.). This will help to confirm the reliability as well.

Data has been collected for quantitative type research papers by using primary data such as questionnaire or by using system data, which is secondary. In contrast, the use of interviews can be seen in the qualitative type of research studies. Use of the interviews in the qualitative studies confirms the utilization of categorical types data, such as behavior, ideas, imaginations, etc. An interview enables to gather more descriptive explanations on the response, but the time taken in this process is a great disadvantage, which limits the data collection scope. Coding is one of the negative implications of using interviews (Denscombe, 2010). Qualitative data may not be effectively gathered through questionnaire since it will not deliver the required in-depth information. However, data of such kind can be successfully gathered through interviews, discussions or observations. When analyzing the data statistical measurements such as correlation and regression are applied in studies with data with numerical format and the categorical type descriptive data gathered in studies have been analyzed using thematic, code or pattern matching techniques and mostly the author interpretations are also given in the data analysis of qualitative approach studies in this review. In the context of qualitative data analytics, most of the papers have used well-defined and standard coding systems or rubrics, which confirms the reliability and the validity of the research work done and is further considered as a strong tool in mitigating the biases of the research outcome towards the preferences of the researcher.

Except two papers, most of the papers reviewed the missing aspect is the test on reliability and the validity measurement. This has been mostly noted in the quantitative researchers. Specifically, the validity in the quantitative research, is used to confirm the unbiased and the replicability of the results, where the standard

protocols should be used to streamline the quantitative used in the research (Scoles et al., 2014). However, the basic idea of reliability measurement is to confirm the meaningfulness and consistent nature of the measurement tools, specially used in the quantitative research studies (Suter, 2012). Therefore, absence of the reliability and the validity statistics generate a doubtful situation about the instruments and the measurements those instruments flows. Therefore, applying the reliability and the validity measurement gives an extra acceptance to your research data thereby the outcomes that proves the data and the outcomes are free from biases and well developed. Out of the 10 quantitative studies in this review only one article has used the Cronbach Alpha measurement in confirming the internal consistency and the highlighted point is that article basically utilized the questionnaire data for the study, while other quantitative studies mostly depending on tracking data through LMS or observations. However, Cronbach Alpha is not the one and best measure in confirming the data (Suter, 2012), which with certain critics toward the use of Alpha value. Specifically, when it comes to observational or secondary data-based quantitative research, several reliability measures such as Cronbach Alpha, Kappa, etc. are not considered as a strong mediators in confirming the reliability (Mashburn et al., 2014), where, the use of randomized prevention trials have taken in to the research context (Snyder et al., 2006).

Moreover, the acceptability of a research is taken place upon a sound methodology and the extent to which these methodologies are valid and reliable (Long & Johnson, 2000). As discussed earlier, quantitative studies utilized numerous statistical and numerical base techniques in confirming the reliability and validity, but in the case of qualitative study it is difficult to confirm the reliability and the validity in a standardized manner, due to the absence of numerical support (Long & Johnson, 2000). In most cases in the qualitative research papers, the discussion on reliability and validity were poor. It is difficult in confirming the trustworthiness of a qualitative research compared to quantitative research (Shento, 2004). Instead of the numerical verification of the reliability and the validity

under quantitative research, qualitative research highlight the use of 4 dimensions in confirming reliability and validity of the research work, namely credibility, transferability, dependability and conformability (Shento, 2004). It is observed that the low use of validity measurement in qualitative nature research, as it does not aim at confirming much on the internal validity, due to the absence of experimental nature in qualitative research (Brink, 1991). But on the other hand, it is highlighted the use of credible judge panels or evaluators in confirming the validity in qualitative research (Brink, 1991).

Review of the collected literature mostly placed their research in a context, in which the students are highly utilizing the learning management systems and most of the courses underlying in these studies are online courses. A gap has been identified in incorporating LMS to a context, where students are given more priority on the traditional classroom-based teaching and the systems are used only to store the materials. Further, none of the articles indicate the continuation of the process within the learning function in an attractive manner to get a consistent student support. In this case the whole model should be redesigned by triangulating the concepts of pedagogy, student learning behavior and the performance, thorough learning analytics, to understand how the learning process to be continued with the support of the aforesaid concepts. Data triangulation is one of the techniques used in confirming the pragmatic validity in qualitative research (Brink, 1991) and use of various data collection techniques is the highlighted action in confirming the pragmatic validity such as validating the observed data through interviews, use of experts, etc. However, the confirmation of the validity within a qualitative research has become a challenging task, because the use of different data collection methods with different measurement levels (Brink, 1991). Further, the review highlighted the areas to be mostly concerned in designing the research work, which will be able to generate more accurate and reliable data and information that confirms the ultimate objective of efficient and effective utilization of learning analytics for better learning.

Use of descriptive and inferential statistics were noticed under analytical tools of quantitative research. The mostly used statistical tools are correlation and different types of regressions. Basically the correlation and the regression concepts are used to understand the casual and the cause and effect relationship among the variables, by investigation how variables get influenced (Bryman, 2012). As the learning was supported through numerous measurements, multi-level regression was used and it is promoted due to its ability in balancing unequal group sizes, adjustment to biases and errors occurred due to non-independent observations (Bray & Thomas, 1995). Use of learning analytics in predicting the students' risks in academic performance is one of the tasks highlighted in the selected papers. In this regard the final expected outcome of the research is to develop a model to predict at risk students, which specifically decide on the group membership. Statistically it is supported by methods such as logistics regression, which is highly used in the education research and other social research (Peng, Lee, & Ingersoll, 2002). In the classification, logistics regression can be more utilized due to the absence of the assumption regarding the multivariate normal distribution with equal covariance in predictor variables. However, there are arguments in using the sample size in logistic regression, which is not exactly confirmed (Peng et al., 2002). In qualitative studies the most highlighted analytical tool is the exploratory research, where the research work is based on unstructured observations. The most arguable point is the way the reliability and the validity are confirmed. Use of experts and their credentials have been used in this regard. In qualitative data analysis the process basically focusses on three continues tasks namely describing, classifying and connecting. These types of vague analytical procedures are occupying in the qualitative research due to its use of meanings than numbers as quantitative (Dey, n.d.). Once the proper connection of the facts completed, the network or matrices can be developed to make the qualitative facts more meaningful. However, these qualitative researches focus on a socially constructed reality, that reality is supported

through the subjective involvement of the participants of the research. Therefore, the most arguable point of the qualitative analysis is the dependency of the reality upon the participant. Specifically, learning is a concept which is differently practiced among different people, therefore mere use of qualitative data might create a huge gap in addressing the learning needs that indicate the support of quantitative approach in confirming the students' performance (Cassell & Symon, 2004).

5. CONCLUSION

According to the collected literature and its review, specifically in the methodological content, the use of quantitative data rather than the qualitative is highlighted. Specifically, the use of mix method approach is low. But the aspect of aligning student behavior, pedagogy and performance upon the platform of learning analytics, is an area of learning which cannot be answered merely through a numerical fact or a rich experience explained under the qualitative approach. Although, in order to align student behavioral patterns, the quantitative approach can be utilized in understanding important trends of learning along the causes. This is basically due to the need of assessment of the behavioral and design type personal-based data and the performance type quantitative data into one platform, which should be done successfully through a mix of both quantitative and qualitative approaches, by providing an understanding to the user about the learning environment at a glance. Learning is a critical aspect that can be taken place at different places, at different modes, and most importantly the deviations of the learning are also comparatively high (Shushok et al., 2009), therefore the achievement of the learning in terms of students' perspectives and educators' perspectives should effectively collaborate, in understanding the proper learning. This concern facilitated with a combination of both quantitative and qualitative approaches, where each approach gains more value through compensation over the other (Scoles et al., 2014). Therefore, promoting a mixed research approach on learning research would be more appropriate rather solely depending on quantitative or qualitative, which just discuss certain aspects in

learning. These ideas were supported using a very limited number of articles related to the research focus under a strict framework of inclusion and exclusion criteria. Therefore, the ultimate facts supported through this review might be limited to a certain domain, but this will be a strong foundation in developing future research in learning and learning analytics research phenomenon.

REFERENCES

- Akker, Jan van den, Koeno Gravemeijer, Susan McKenney, and Nienke Nieveen. n.d. "Introducing Educational Design Research." 279.
- Andergassen, Monika, Felix Mödritscher, and Gustaf Neumann. 2014. "Practice and Repetition during Exam Preparation in Blended Learning Courses: Correlations with Learning Results." *Journal of Learning Analytics* 1(1):48–74. doi: 10.18608/jla.2014.11.4.
- Angeli, Charoula, Sarah K. Howard, Jun Ma, Jie Yang, and Paul A. Kirschner. 2017. "Data Mining in Educational Technology Classroom Research: Can It Make a Contribution?" *Computers & Education* 113:226–42. doi: 10.1016/j.compedu.2017.05.021.
- Anon. n.d.-a. "1st International Conference on Learning Analytics and Knowledge 2011 | Connecting the Technical, Pedagogical, and Social Dimensions of Learning Analytics." Retrieved November 27, 2018 (<https://tekri.athabasca.ca/analytics/>).
- Anon. n.d.-b. "Research in the College Context : Approaches and Methods." Retrieved November 27, 2018 (<http://eds.b.ebscohost.com.ezp.sub.su.se/eds/ebookviewer/ebook/bmxlYmtfXzEwNTUzMjFfX0FOO?sid=c833a7af-f844-4029-86b9-b12544c32351@sessionmgr4007&vid=1&format=EB>).
- Bainbridge, Jay, James Melitski, Anne Zahradnik, Eitel J. M. Lauría, Sandeep Jayaprakash, and Josh Baron. 2015. "Using Learning Analytics to Predict At-Risk Students in Online Graduate Public Affairs and Administration Education." *Journal of*

- Public Affairs Education* 21(2):247–62. doi: 10.1080/15236803.2015.12001831.
- Berenson, Mark, and David Levine. 2018. *Basic Business Statistics*. Melbourne, AUSTRALIA: P.Ed Australia.
- Bray, Mark, and R. Murray Thomas. 1995. “Levels of Comparison in Educational Studies: Different Insights from Different Literatures and the Value of Multilevel Analyses.” *Harvard Educational Review* 65(3):472–91. doi: 10.17763/haer.65.3.g3228437224v4877.
- Brink, Pamela J. 1991. “Issues of Reliability and Validity.” Pp. 164–86 in *Qualitative Nursing Research: A Contemporary Dialogue*. 2455 Teller Road, Thousand Oaks California 91320 United States: SAGE Publications, Inc.
- Bryman, Alan. 2012. *Social Research Methods*. 4th ed. Oxford; New York: Oxford University Press.
- Carr, Linda T. 1994. “The Strengths and Weaknesses of Quantitative and Qualitative Research: What Method for Nursing?” *Journal of Advanced Nursing* 20(4):716–21. doi: 10.1046/j.1365-2648.1994.20040716.x.
- Cassell, Catherine, and Gillian Symon. 2004. *Essential Guide to Qualitative Methods in Organizational Research*. SAGE.
- Celsi, Richard L., and Mary Wolfenbarger. 2002. “Discontinuous Classroom Innovation: Waves of Change for Marketing Education.” *Journal of Marketing Education; Boulder* 24(1):64–72.
- Chaurasia, Sushil S., and Anna Frieda Rosin. 2017. “From Big Data to Big Impact: Analytics for Teaching and Learning in Higher Education.” *Industrial and Commercial Training* 49(7/8):321–28. doi: 10.1108/ICT-10-2016-0069.
- Chaurasia, Sushil S., Devendra Kodwani, Hitendra Lachhwani, and Manisha Avadhut Ketkar. 2018. “Big Data Academic and Learning Analytics: Connecting the Dots for Academic Excellence in Higher Education.” *International Journal of Educational Management* 32(6):1099–1117. doi: 10.1108/IJEM-08-2017-0199.
- Chen, Wen-Chun, Yu-Chih Doris Shih, and Gi-Zen Liu. 2015. “Task Design and Its Induced Learning Effects in a Cross-Institutional Blog-Mediated Telecollaboration.” *Computer Assisted Language Learning* 28(4):285–305. doi: 10.1080/09588221.2013.818557.
- Choi, Samuel P. M., S. S. Lam, Kam Cheong Li, and Billy T. M. Wong. n.d. “Learning Analytics at Low Cost: At-Risk Student Prediction with Clicker Data and Systematic Proactive Interventions.” 19.
- Cobb, Paul, Jere Confrey, Andrea diSessa, Richard Lehrer, and Leona Schauble. 2003. “Design Experiments in Educational Research.” *Educational Researcher* 32(1):9–13. doi: 10.3102/0013189X032001009.
- Conole, Gráinne. 2012. *Designing for Learning in an Open World*. Springer Science & Business Media.
- Dennen, Vanessa P. 2011. “Facilitator Presence and Identity in Online Discourse: Use of Positioning Theory as an Analytic Framework.” *Instructional Science* 39(4):527–41. doi: 10.1007/s11251-010-9139-0.
- Denscombe, Martyn. 2010. *The Good Research Guide: For Small-Scale Social Research Projects*. Maidenhead, England: McGraw-Hill/Open University Press.
- Dey, Ian. n.d. “Qualitative Data Analysis: A User-Friendly Guide for Social Scientists.” 309.
- Dhivyadeepa, Dr E. n.d. *Sampling Techniques in Educational Research*. Lulu.com.
- Duffy, Katherine, and Jillian Ney. 2015. “Exploring the Divides Among Students, Educators, and Practitioners in the Use of Digital Media as a Pedagogical Tool.” *Journal of Marketing Education* 37(2):104–13. doi: 10.1177/0273475315585826.
- Ferguson, Rebecca, and Doug Clow. 2017. “Where Is the Evidence?: A Call to Action for Learning Analytics.” Pp. 56–65 in *Proceedings of the Seventh International Learning Analytics & Knowledge Conference on - LAK '17*. Vancouver, British Columbia, Canada: ACM Press.
- Gumport, Patricia J., and Marc Chun. 1970. “Technology and Higher Education: Opportunities and Challenges for the New

- Era.” *INSANIA : Jurnal Pemikiran Alternatif Kependidikan* 12(2):263–83. doi: 10.24090/insania.v12i2.255.
- Hlapanis, G., and A. Dimitrakopoulou. 2007. “A Course Model Implemented in a Teacher’s Learning Community Context: Issues of Course Assessment.” *BEHAVIOUR AND INFORMATION TECHNOLOGY*, 561.
- Hwang, Gwo-Jen, Hui-Chun Chu, and Chengjiu Yin. 2017. “Objectives, Methodologies and Research Issues of Learning Analytics.” *Interactive Learning Environments* 25(2):143–46. doi: 10.1080/10494820.2017.1287338.
- Ihantola, Petri, Kelly Rivers, Miguel Ángel Rubio, Judy Sheard, Bronius Skupas, Jaime Spacco, Claudia Szabo, Daniel Toll, Arto Vihavainen, Alireza Ahadi, Matthew Butler, Jürgen Börstler, Stephen H. Edwards, Essi Isohanni, Ari Korhonen, and Andrew Petersen. 2015. “Educational Data Mining and Learning Analytics in Programming: Literature Review and Case Studies.” Pp. 41–63 in *Proceedings of the 2015 ITiCSE on Working Group Reports - ITiCSE-WGR '15*. Vilnius, Lithuania: ACM Press.
- Jena, R. K. 2018. “Predicting Students’ Learning Style Using Learning Analytics: A Case Study of Business Management Students from India.” *Behaviour & Information Technology* 37(10–11):978–92. doi: 10.1080/0144929X.2018.1482369.
- Khalil, Mohammad, and Martin Ebner. n.d. “What Is Learning Analytics about? A Survey of Different Methods Used in 2013–2015.” 11.
- Kimberlin CL and Winterstein AG. 2008. “Validity and Reliability of Measurement Instruments Used in Research.” *American Journal of Health-System Pharmacy* 65(23):2276–84. doi: 10.2146/ajhp070364.
- Ko, Susan Schor, and Steve Rossen. 2010. *Teaching Online: A Practical Guide*. 3rd ed. New York: Routledge.
- Labaree, Robert V. n.d. “Research Guides: Organizing Your Social Sciences Research Paper: Types of Research Designs.” Retrieved February 19, 2019 (<http://libguides.usc.edu/writingguide/researchdesigns>).
- Lakshman, M., Leena Sinha, Moumita Biswas, Maryann Charles, and N. K. Arora. 2000. “Quantitative Vs Qualitative Research Methods.” *The Indian Journal of Pediatrics* 67(5):369–77. doi: 10.1007/BF02820690.
- Larsson, Johann Ari, and Brandon White. 2014. *Learning Analytics: From Research to Practice*. New York: Springer.
- Lin, Chi-Jen, and Gwo-Jen Hwang. n.d. “A Learning Analytics Approach to Investigating Factors Affecting EFL Students’ Oral Performance in a Flipped Classroom.” 16.
- Long, T., and M. Johnson. 2000. “Rigour, Reliability and Validity in Qualitative Research.” *Clinical Effectiveness in Nursing* 4(1):30–37. doi: 10.1054/cein.2000.0106.
- Lu, Owen H. T., Anna Y. Q. Huang, Jeff C. H. Huang, Albert J. Q. Lin, and Stephen J. H. Yang. n.d. “Applying Learning Analytics for the Early Prediction of Students’ Academic Performance in Blended Learning.” 14.
- Lumpkin, Angela L., Rebecca M. Achen, and Regan K. Dodd. 2015. “Student Perceptions of Active Learning.” *College Student Journal* 49(1):121–33.
- Malkin, Albert, Ruth Anne Rehfeldt, and Ashley M. Shayter. 2018. “An Investigation of the Efficacy of Asynchronous Discussion on Students’ Performance in an Online Research Method Course.” *Behavior Analysis in Practice* 11(3):274–78. doi: 10.1007/s40617-016-0157-5.
- Mangaroska, Katerina, and Michail N. Giannakos. 2018. “Learning Analytics for Learning Design: A Systematic Literature Review of Analytics-Driven Design to Enhance Learning.” *IEEE Transactions on Learning Technologies* 1–1. doi: 10.1109/TLT.2018.2868673.
- Mashburn, Andrew J., Jason T. Downer, Susan E. Rivers, Marc A. Brackett, and Andres Martinez. 2014. “Improving the Power of an Efficacy Study of a Social and Emotional Learning Program: Application of Generalizability Theory to the Measurement of Classroom-Level Outcomes.” *Prevention Science; New York* 15(2):146–55. doi: <http://dx.doi.org.ezp.sub.su.se/10.1007/s1121-012-0357-3>.

- Nesselroade, John R., and Peter C. M. Molenaar. 2016. "Some Behavioral Science Measurement Concerns and Proposals." *Multivariate Behavioral Research* 51(2–3):396–412. doi: 10.1080/00273171.2015.1050481.
- Okoli, Chitu, and Kira Schabram. 2010. "A Guide to Conducting a Systematic Literature Review of Information Systems Research." *SSRN Electronic Journal*. doi: 10.2139/ssrn.1954824.
- Page, Matthew J., and David Moher. 2017. "Evaluations of the Uptake and Impact of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement and Extensions: A Scoping Review." *Systematic Reviews* 6. doi: 10.1186/s13643-017-0663-8.
- Peng, Chao-Ying Joanne, Kuk Lida Lee, and Gary M. Ingersoll. 2002. "An Introduction to Logistic Regression Analysis and Reporting." *The Journal of Educational Research* 96(1):3–14. doi: 10.1080/00220670209598786.
- Rienties, Bart, Tim Lewis, Ruth McFarlane, Quan Nguyen, and Lisette Toetenel. 2018. "Analytics in Online and Offline Language Learning Environments: The Role of Learning Design to Understand Student Online Engagement." *Computer Assisted Language Learning* 31(3):273–93. doi: 10.1080/09588221.2017.1401548.
- Schwendimann, Beat A., Maria Jesus Rodriguez-Triana, Andrii Vozniuk, Luis P. Prieto, Mina Shirvani Boroujeni, Adrian Holzer, Denis Gillet, and Pierre Dillenbourg. 2017. "Perceiving Learning at a Glance: A Systematic Literature Review of Learning Dashboard Research." *IEEE Transactions on Learning Technologies* 10(1):30–41. doi: 10.1109/TLT.2016.2599522.
- Scoles, Jennifer, Mark Huxham, and Jan McArthur. 2014. *Mixed-Methods Research in Education: Exploring Students' Response to a Focused Feedback Initiative*. 1 Oliver's Yard, 55 City Road, London EC1Y 1SP United Kingdom: SAGE Publications, Ltd.
- Shento, Andrew K. 2004. "Strategies for Ensuring Trustworthiness in Qualitative Research Projects." *Education for Information* 22(2):63–75. doi: 10.3233/EFI-2004-22201.
- Shushok, Frank, Douglas V. Henry, Glenn Blalock, and Rishi R. Sriram. 2009. "Learning at Any Time: Supporting Student Learning Wherever It Happens." *About Campus* 14(1):10–15. doi: 10.1002/abc.278.
- Snyder, James, John Reid, Mike Stoolmiller, George Howe, Hendricks Brown, Getachew Dagne, and Wendi Cross. 2006. "The Role of Behavior Observation in Measurement Systems for Randomized Prevention Trials." *Prevention Science; New York* 7(1):43–56. doi: <http://dx.doi.org.ezp.sub.su.se/10.1007/s11121-005-0020-3>.
- Strang, Kenneth. 2016. "How Student Behavior and Reflective Learning Impact Grades in Online Business Courses." *Journal of Applied Research in Higher Education* 8(3):390–410. doi: 10.1108/JARHE-06-2015-0048.
- Strang, Kenneth David. 2016. "Do the Critical Success Factors From Learning Analytics Predict Student Outcomes?" *Journal of Educational Technology Systems* 44(3):273–99. doi: 10.1177/0047239515615850.
- Suter, W. 2012. *Introduction to Educational Research: A Critical Thinking Approach*. 2455 Teller Road, Thousand Oaks California 91320 United States: SAGE Publications, Inc.
- Thelwall, Mike, and Pardeep Sud. 2018. "A Comparison of Title Words for Journal Articles and Wikipedia Pages: Coverage and Stylistic Differences?" *PROFESIONAL DE LA INFORMACION* 27(1):49–64. doi: 10.3145/epi.2018.ene.05.
- Varouchas, Emmanouil, Miguel-Angel Sicilia, and Salvador Sánchez-Alonso. 2018. "Towards an Integrated Learning Analytics Framework for Quality Perceptions in Higher Education: A 3-Tier Content, Process, Engagement Model for Key Performance Indicators." *Behaviour & Information Technology* 37(10–11):1129–41. doi: 10.1080/0144929X.2018.1495765.

- Zainal, Zaidah. 2007. "Case Study as a Research Method." 6.
- Zhang, Jia-Hua, Ye-Xing Zhang, Qin Zou, and Sen Huang. n.d. "What Learning Analytics Tells Us: Group Behavior Analysis and Individual Learning Diagnosis Based on Long-Term and Large-Scale Data." 15.
- Zhang, Jinzhuo, Xi Zhang, Shan Jiang, Patricia Ordóñez de Pablos, and Yongqiang Sun. 2018. "Mapping the Study of Learning Analytics in Higher Education." *Behaviour & Information Technology* 37(10–11):1142–55. doi: 10.1080/0144929X.2018.1529198.
- Zheng, M., D. Bender, and N. Nadershahi. 2017. "Faculty Professional Development in Emergent Pedagogies for Instructional Innovation in Dental Education." *European Journal of Dental Education* 21(2):67–78. doi: 10.1111/eje.12180.
- Chen, W., (1991). *Nonlinear Analysis of Electronic Prognostics*. Doctoral dissertation. The Technical University of Napoli, Napoli, Italy.
- Ferrell, B. L. (1999), JSF Prognostics and Health Management. *Proceedings of IEEE Aerospace Conference*. March 6-13, Big Sky, MO. doi: 10.1109/AERO.1999.793190
- Hyndman, R. J., & Koehler, A. B. (2006). Another look at measures of forecast accuracy. *International Journal of Forecasting*, vol. 22, pp. 679-688. doi:10.1016/j.ijforecast.2006.03.001
- International Standards Organization (ISO) (2004). Condition Monitoring and Diagnostics of Machines - Prognostics part 1: General Guidelines. In ISO, *ISO13381-1:2004(e)*. vol. *ISO/IEC Directives Part 2, I. O. f. S.* (ISO), (p. 14). Genève, Switzerland: International Standards Organization.
- Schwabacher, M., & Goebel, K. F. (2007). A survey of artificial intelligence for prognostics. *Proceedings of AAAI Fall Symposium*, November 9–11, Arlington, VA.
www.aaai.org/Library/Symposia/Fall/2007/fs07-02-016.php
- Vachtsevanos, G., Lewis, F. L., Roemer, M., Hess, A., & Wu, B. (2006). *Intelligent fault diagnosis and prognosis for engineering system*. Hoboken, NJ: John Wiley & Sons, Inc

Need for Guidance and Counseling Training for Teachers in Sri Lanka: A Study Based on the B.Ed. Undergraduates at the University of Vocational Technology

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ABSTRACT

Teachers nowadays play many different roles in society and they must be capable of handling their obligations to their students both within and outside the classroom if they are to carry out their tasks professionally. Providing advice and counseling to students is a crucial aspect of a teacher's job both within and outside the classroom. Some professionals define counseling as a process that involves two counselors working with a client who needs help. The academic, professional, social, and personal development of students is frequently impacted by these problems. The study aims to investigate the teachers' perception of training needs in carrying out their guidance and counseling responsibilities at school. The total population of the study was all the Bachelor of Education undergraduates in the 2018/2019 batch at the Faculty of Education at the University of Vocational Technology. The sample was selected using a simple random sampling method. So, from the B.Ed. undergraduates in the 2018/2019 batch, 1/3rd of the students were selected. The data was collected using a self-made questionnaire. They were asked to respond to questions based on their training requirements, obstacles to executing their guidance and counseling duties at school, and facilitation of personal strengths or resources counseling. The researcher created 10 categories for training requirements, 7 categories for obstacles, and 6 categories for individual assets or abilities that can help them in their guiding and counseling profession as a questionnaire. There were some

limitations of this study as well. The sample consisted of only the UoVT (University of Vocational Technology) undergraduates who were willing to become teachers after the completion of the degree. The current study discovered that teachers have a variety of training needs, perceived strengths, and obstacles/ issues in relation to performing the guidance and counseling role at school. The results have significantly increased the understanding of the necessity for teacher guidance and counseling training. It summarizes the topics and considerations that should be made while creating programs for teacher preparation or education. Immersive, reflexive, and interactive training methods were suggested to meet teachers' training needs in the school context.

1. INTRODUCTION

Teachers today are expected to perform a wide range of duties in addition to teaching. Some of their responsibilities include counseling and guidance as well. Both of these terms often have different connotations in the literature on guidance and counseling. While the latter typically focuses on assisting students with their difficulties, the former refers to supporting children's overall growth. In other words, counseling is more supporting and corrective work, whereas guiding work is preventative and development. The broad field of counseling encompasses three basic personal, academic, and professional areas. Caipang (2014) asserts that a school counselor does not know the subject matter in the interview while a teacher is aware

of the results in order to clearly distinguish between teachers, school counselors, and psychotherapists. According to her, counseling has a wider scope than psychotherapy, which has a deeper one. Counseling is a procedure that involves counselors working with a client who is in need of assistance. These issues that students often have an impact on student's academic, professional, social, and personal growth. There are three important factors that significantly influence students. Students who have moved on to the next level of their education are anxious, enthusiastic, and enthused about the new institution. Students who experience these feelings become anxious and stressed. Teacher counselor insight and the integration of all sources of data and information supports the client in self-exploration and the decision-making process. Okumu (2017) defines counseling as the help some students receive from credentialed professionals to help them overcome personal and social problems which interfere with learning. Garret (1996) says that the counseling program is an integral part of the total educational program. Parents expect the school to provide solutions to the indiscipline in schools caused by their children and assist them to make career choices. Since all teachers are involved in student guidance and counseling at school to varying degrees, there is a definite and important need for guidance and counseling training for all teachers. Some guidance teachers have indeed demanded such training for all teachers. They even thought this was "the basic requirement of a teacher" (Yuen, 2002). However, a search in the literature about teachers' training needs in guidance and counseling showed a scarcity of research on this topic. Most studies focused on peripheral topics such as qualifications and mode of training for guidance personnel (McCarthy, 2001), or the training needs of career guidance personnel (Patton & Burton, 1997; Patton, 2000). The study aims to investigate the teachers' perception of training needs in carrying out their guidance and counseling responsibilities at school, by specifically searching on;

What are their training needs?

What are the personal strengths or resources that might facilitate their guidance and counseling role?

2. LITERATURE REVIEW

According to the American School Counselor Association (ASCA), school counselors are certified /licensed educators who improve student success for all students by implementing a comprehensive school counseling program. They are trained professionals who meet with students individually and in groups to address concerns that may interfere with their learning and personal development. As stated there, school counselors may be facilitating whole-school workshops, leading small-group discussions, or providing one-on-one instruction. School counselors are consultants when they spend time working individually or with groups of teachers and parents, or other mental health and school personnel. Also, they sometimes encounters difficulties while trying to do their job. Reporting the student's success and the problems the student to the parents sometimes can be challenging and difficult. Many parents are not prepared and do not want to collaborate with counselors rejecting their children's needs. The responsibilities of the school counselor were unclear for a considerable period of time. It is frequently thought to be under the purview of the classroom teacher, pedagogue, or school counselor. The school counselor has a significant and vital role in the organization, structure, programs, and policies of the school. School counselors may influence school policies by making sure they mirror the values the school actively promotes. School counselors may also have an impact on educational initiatives by ensuring that they are actually useful for students and provide them with opportunities to engage with the greater school community.

School counselors play a crucial role in helping students deal with academic challenges as well as other concerns pertaining to their academic performance. They support students by demonstrating individual academic planning and goal setting for students, classroom counseling lessons based on student success standards, short-term counseling to students, referrals for

long-term support, and collaboration with families, teachers, administrators, administrators, and the community for student success. According to Okumu (2017), although school counselors' responsibilities differ depending on the setting, they typically perform these tasks. Such as individual counseling, small-group counseling, large-group or classroom presentations, participation in school-wide behavior plans for promoting positive and flattening negative behaviors, and consultation with other professionals, including teachers, parents, stakeholders, and the community. They are assessed to determine whether the Guidance Counseling program has been executed and whether students' needs and expectations have been met, despite the fact that they have significant responsibility for the implementation and success of the school program. Gysbergs (2011) says that school counselors are expected to show how their work supports students' performance, particularly academic accomplishment, within the context of comprehensive guidance and counseling programs. As a result, school counselors are expected to not only describe what they do but also to give examples of how it has a positive impact on children's lives. They are also expected to be responsible for their work and to answer for it. Today, school counseling is a requirement for all educational levels. Throughout the academic year, students face a variety of personal, educational, and academic challenges, and frequently they are unsure of where to turn for professional assistance or whom to turn to in the first place. In addition to offering a wide range of skills and services, school counseling also attends to all of the requests made by students. To prepare students for life, the needs for guidance and counseling are determined. To do all these things, the teachers need good training. Meeting students' needs in the areas of the school, employment, personal/social advice, and counseling is part of preparing them for life. A child who gets these needs met may build harmonious relationships with parents and friends, know who they are, and develop their communication and problem-solving abilities. Such a person could ultimately have the capacity to choose a job. A student may form harmonious

relationships with peers and parents, know who they are, and develop their communication and problem-solving abilities if their personal guidance and counseling needs are met. Additionally, he or she can gain problem-solving abilities, social skills, and the ability to manage exam anxiety.

3. METHODOLOGY

The study aims to investigate the teachers' perception of training needs in carrying out their guidance and counseling responsibilities at school considering the pre-service undergraduate B.Ed. teachers at the University of Vocational Technology. The total population of the study was all the Bachelor of Education undergraduates at the Faculty of Education at the University of Vocational Technology. The sample was selected using a simple random sampling method. So, from the B.Ed. undergraduates in the 2018/2019 batch, 1/3rd of the students were selected. That means the sample was 30 students. In this sample, 64% of the students were females and the rest of the participants were males. To collect the data, a self-made questionnaire was used and it was distributed among the participants as a google form. The collected data was then gradually discussed under these three topics using a thematic analysis method. The need for the training of the teachers, the impediment issues they face at the schools, and the facilitation of personal strengths or resources in counseling. All the participants completed a personal reflection activity at the beginning of the course module and also, and these participants did their teaching practice internship at the government schools for ten weeks. Due to that, they had school experience as well.

4. RESULTS AND DISCUSSION

The research twisted only 10 categories for training requirements, 7 categories for obstacles, and 6 categories for individual assets or abilities that can help them in their guiding and counseling roles.

4.1 NEED FOR THE TRAINING OF THE TEACHERS

When considering the need for guidance and counseling training for the teachers, the

following were the responses from the B.Ed. undergraduate students who were willing to be teachers in the future.

Table 1. Need for Training of the teachers

Area of training needs	No. of responses (n)	Percentage (%)
Collaboration skills (e.g. with stakeholders, parents and etc.)	2	6.66%
Communication skills	3	10%
Counseling skills	5	16.66%
Interpersonal/interactive skills	3	10%
Knowledge about practical issues in schools(e.g. school policy)	3	10%
Knowledge related to guidance and counseling (e.g. theoretical knowledge)	5	16.66%
Methods used to deal with own issues (e.g. time management, emotional intelligence, to be more objective)	4	13.33%
Role of the teacher	1	3.33%
Skills in handling cases	3	10%
Others	1	3.33%
Total	30	100%

From the first table, we can portray that, knowledge and theories related to guidance and counseling and development of the counseling skills take an equal percentage. This is the highest percentage among other areas of training they need. The respondents further stated that they need training in dealing with their own issues such as time management, emotional intelligence, and how to become more objective in some cases. 40% of the participants responded that they need training related to communication skills, knowledge about the practical issues in the schools such as school policies and others, etc., skills in handling the issues and the problems (cases) in the schools, and to develop their interpersonal skills when handling those cases.

These major areas were identified by the participants of the study. A lower percentage of the participants have reported that they need collaboration skills to deal with the stakeholders as well. Further 3.33% of the participants responded that they need training related to the teacher's role as well.

4.2 IMPEDIMENT ISSUES

The following issues were perceived to impede their guidance and counseling work at school. These concerns were mostly focused on the individuals' personal traits, bias or prejudging of students, lack of expertise, workload, and deadline demands (see Table 2). Here are a few illustrations of how students the participants in various categories.

Table 2. Barriers/ issues of the teachers

Areas of impending issues	No. of responses(n)	Percentage (%)
Personal qualities	5	16.66%
Prejudgment or bias against students	3	10%
Lack of experience	5	13.33%
Workload or time pressures	6	20%
Lack of knowledge	5	16.66%
School Policies	5	16.66%
Others	1	6.66%
Total	30	100%

Table two discusses barriers and some obstacles teachers face and how those issues relate to the teacher counselor's role. 20% of the teachers responded that they had workload pressure and time pressure when dealing with the work inside the schools. They expressed that it affects directly the process of counseling in the school as well. More than 50% of the respondents highlighted the personal qualities of the teachers, lack of knowledge related to the counseling process, lack of experience and the issues related to the school policies affect directly for them. So, they wanted training in handling the cases of the students with all the barriers in the schools. Further, from the table, we can see that they

highlight the prejudgment and the bias towards the students as very important issues to be addressed.

4.3 FACILITATION OF PERSONAL STRENGTHS OR RESOURCES COUNSELING

Considering their personal strengths and the school counseling resources, the respondents presented the following responses.

Table 3. Facilitation of Personal Strengths

Area of strengths or resources	No. of responses(n)	Percentage (%)
Personal qualities	5	16.66%
Social networks	4	13.33%
Skills or abilities	7	23.33%
Working experience	7	23.33%
knowledge	6	20%
Others	1	3.33%
Total	30	100%

Table three discusses the areas or the resources that should be developed and among those areas, skills and abilities and the working experience of the teachers should be addressed. Further, 16.66% of the respondents answered that they need to improve their personal qualities as well.

4.4 DISCUSSION

All of the respondents agreed that training was clearly needed for the teachers in the schools. Further, they have identified the issues related to the areas of counseling and the improvements of the teachers and their knowledge will be a very positive factor in developing a good guidance and counseling service in the school context. It seems that there are so many issues and barriers in these schools when offering counseling services to students. Lack of theoretical knowledge and lack of experience should be addressed as major issues. So, their perceived training requirements included life skills as well as knowledge and abilities linked to guiding and counseling. They required instruction in human relations, communication, and problem-solving techniques. This knowledge is crucial since

training programs must meet trainee demands for the training materials to be effective. Ineffective teacher development initiatives are unlikely to inspire instructors to work more.

5. LIMITATIONS

There were some limitations of this study. First of all, it is a small sample of undergraduate students enrolled in a teacher preparation program and those who did their internship training for 10 weeks in government schools only. These findings may be varied in other demographics, other universities such as working teachers or educators in postgraduate teacher preparation programs. According to Fok, Chan, Sin, Ng, and Yeung (2005), teachers at various phases of professional growth or with various skills may require various types of training. Second, the study's design was quantitative. The researcher acknowledges the interpretative character of all qualitative analyses, even if every precaution was taken to assure the reliability and correctness of the data coding.

6. CONCLUSION & RECOMMENDATIONS

Counseling in the educational system should help students alike, to develop their capacities to the full. Effective school counseling should help improve young people's self-image and facilitate achievement in life tasks. The study has produced valuable data that will help to spruce up the literature on teachers' need for guidance and counseling training. It clarifies subjects and problems to consider while creating teacher preparation or education programs. To meet the requirements of instructors seeking training and to increase trainees' motivation and interest in their studies, immersive, reflective, and interactive training methods are advised. It is also advised to conduct further research on the need for teacher training in guidance and counseling by utilizing bigger samples of instructors with diverse backgrounds. Future studies can look into the diverse roles they play, their amount of expertise providing advice and counseling, and their training needs. Further, the government and the Ministry of Education with the support of expert scholars in this field should take necessary

arrangements to solve these issues since these are burning issues in the schools in Sri Lanka. They can have some kind of training programs with the participation of the teachers and the respective authorities as well. Conducting workshops, seminar series, and some practical training is also needed. Examining how well different training programs work and how they relate to participants' training demands is another area of research.

REFERENCES

- Boyatzis, R. E. (1998). Transforming qualitative information: Thematic analysis and code development. Thousand Oaks, California: Sage.
- Chen, W., (1991). *Nonlinear Analysis of Electronic Prognostics*. Doctoral dissertation. The Technical University of Napoli, Napoli, Italy.
- Day, C. (2002). The challenge to be the best: Reckless curiosity and mischievous motivation. *Teachers and Teaching: Theory and Practice*, 8, 421 – 434.
- Fok, S.C., Chan, K.W., Sin, K.F., Ng, A.H.S. & Yeung, A.S. (2005). In-service teacher training needs in Hong Kong. Paper presented at the Annual Conference of the Australian Association for Research in Education, Sydney, Australia.
- Gysbers, N.C., & Henderson, P. (1994). *Developing and managing your school guidance program*. Alexandria, V. A.: American Counselling Association.
- Heppner, M. J., & O'Brien, K.M. (1994). Multicultural counselor training: Students' perceptions of helpful and hindering events. *Counselor Education and Supervision*, 34 (1), 4 – 18.
- Hong Kong Education Department (1986). Guidance work in secondary schools: A suggested guide for principals and teachers. Hong Kong: Hong Kong Government Printer.
- Law, L.M.T.(2000). *Guidance training needs and support*. Unpublished master's thesis. Hong Kong: the University of Hong Kong.
- McCarthy, J. (2001). The skills, training and qualification of guidance workers.
- Patton, W. (2000). Perceptions of training needs of career guidance personnel before and after a university program, *Journal of Career Development*, 26, 175 -190.
- Patton,W., & Burton, T. (1997). Training needs of career guidance personnel in Australia and Hong Kong: A comparative study.
- Yuen, M. (2002). Exploring Hong Kong Chinese guidance teachers' positive beliefs: A focus group study. *International Journal for the Advancement of Counselling*, 24, 169 – 182.

The importance of Fashion for the Career Growth of White-collar Female Employees in the Apparel Industry, Sri Lanka

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ABSTRACT

All people must dress themselves every day. It is a distinctive mark that influences people and interpersonal connections. Fashion expresses emotive meanings and has the ability to reveal information about the person. As a result, one of the primary languages of human lifestyle is fashion, which is communicated through body type, size, money, practicality, culture, religion, gender identity, career, and a variety of viewpoints. In that regard, fashion is an expressive medium and has a long history of being associated with the place of women's lifestyles in society. By taking a comprehensive approach to women's roles in society, fashion may also have an effect on their professional lives. Since fashion speaks to how women are viewed in society, it may have an effect on how women build their careers. In that point of view, this study will look at how women's career growth in Sri Lanka's garment industry is impacted by fashion. One of Sri Lanka's most significant industries, the garment sector attracts female workers and has a high potential for job growth. Eighty percent of the clothing workers in Sri Lanka are women. As a result, the research has a tendency to only focus on white collar female employees working in the Sri Lankan garment industry. The researcher evaluates the influence of fashion on white collar female employees' career growth related to the apparel industry in Sri Lanka. As per the study, present finding provides a positive approach to identify

interrelationship in between career development and practices of fashion concepts in Sri Lankan apparel industry and this will provide creative marketing strategies for successful fashion movements in the Sri Lankan society. As same as it guides future researchers to build up an argument about fashion in Sri Lanka related to the career life of people.

1. INTRODUCTION

Fashion is about the modern impression of life. Clothing is frequently linked to fashion. A wide range of scientific disciplines, including social science, psychology, anthropology, art, history, and cultural and communication studies, have long been fascinated by clothing. However, it safeguards all areas of life. Fashion never stays consistent; it constantly changes as time goes.

The term "Fashion" is discussed in different viewpoints. Given below are two highlighting perspectives focused on the study area.

"The purpose of fashion can be as simple as you need clothing to maneuver in the world.

- Forget fashion as a trend, think of fashion and clothing as a necessity. You need a pair of pants, a shirt, and shoes to go on that interview, to the grocery store, to your cousin's wedding. Its' how we present ourselves to live." (Jacques, 2018)

- “Our clothing is the physical representation of our perceptions, our dissatisfactions, and our desires. When we look beyond the physical to our internal workings, we can create a change at the core. Unlike change that occurs in therapy, these difficult internal examinations are softened by the light of the wardrobe makeover . . . Taking care of your self begins with self-discovery. The clothing you put on your back is an incredibly accurate indicator of what you think of yourself and your life. Cracking open the closet doors can lead to great insight. When you strive toward self-discovery, improvement often follows wearing clothing that makes you feel comfortable, happy, and good about yourself does make life better” (Baumgartner, 2012).
- “Fashion is not a trivial and ephemeral phenomenon is the way in which fashionable clothing and have been used to express and shape personal and social identities” (González & Bovone, 2012)

It is clear from the previous definitions that one's appearance in situations serves as a reflection of who one is. When meeting someone for the first time, someone's appearance leaves a lasting impact. Particularly for female employees, how they dress might have an impact on their careers.

Women are claimed to have the same opportunities as men to climb the corporate ladder, particularly if they pursue the same professions and share men's objectives and skills. This is according to previous research in the field of career growth. However past researches are not addressed to the research problem which is the impact of fashion for the career growth of white-collar female employees.

According to the past findings white collar classifying as supervisor/manager roles, professional or semi-professional roles. Due to the nature of their profession, white-collar employees are likely to have greater ethical autonomy (Melissa K. Gibson, 2000). Therefore, research is limited to white collar female employees because they are having intension and

career ladder to reach the growth of their profession.

Career development has a significant impact from the employee's point of view because it serves as a valuable tool or even a launching pad for them to fulfill their goals, which could range from achieving greater salary or receiving incentives and bonuses to achieving job flexibility and contentment (Belyh, 2020). Few main definitions for “career development” are;

“Career development is the process of implementing and developing the self-concept” (Huang, 2006)

“Career development refers to a change or a series of changes that occur in an individual's career” (Brown, 2002)

The garment sector holds a prominent position in Sri Lanka's industrial structure among the distribution of jobs (Kelegama 2009). The study's focus is on the garment sector because women are considered to be the second most important foreign source of income for Sri Lankans who work in the ready-to-wear sector. For the research, to represent the apparel industry in Sri Lanka MAS Holdings and Brandix Group is selected. Among that apparel sector group of companies, the MAS group and Brandix apparel Ltd are the major players in the Sri Lankan garment market, according to the Industry Capability Report (Export Development Board (EDB), 2020) .Around 76,000 people in Sri Lanka and over 99,000 persons worldwide (70 percent women) are employed in MAS Holdings (66 percent women). MAS values diversity and is working toward the aspirational goal of having a gender ratio of 1:1 in managing positions by the year 2025 (coporation, 2019). More than 29,000 employees (69% of them are women) work for the \$700 million Brandix Group at 24 locations around Sri Lanka (Tackling childcare:The Business Case for Employer - supported childern care in Sri Lanka, 2019).Therefore, the research drive with literature review and face to face interview secondary data from pioneers in MAS holdings and Brandix Group which are most

prominent apparel giants representing the apparel industry in Sri Lanka.

The findings of the research provide a high impact to upliftment of career growth of white-collar female workers in the Apparel industry Sri Lanka.

Based on the findings of the past studies some evidence for the interconnection between fashion and career life can be found. Therefore, the literature review can guide as the methodology of the research to achieve the objective of the study. The objective of the study is, to analyse the interconnection between fashion practices with career growth related to the white-collar female employees through literature. Moreover face-to-face discussions with selected female white-collar employees in the apparel sector were conducted to get to know the present prevailing situations in the Apparel industry related to the MAS Holdings and Brandix Group which are the pioneers of apparel industry in Sri Lanka.

Research findings may give a positive impact to uplift the strategies for the organizations related to the apparel industry. Hence past research findings described fashion as a nonverbal communication method of human's lifestyle, the research objective can be hypothesized to have a significant positive influence on fashion as having a positive importance for the career growth of white-collar female employees.

2. BACKGROUND

Fashion is the primary form of non-verbal communication, from various angles which is directly affect with human eye and the perception. According to Sampson, 2016 fashion is a nonverbal communication method which includes the facts of an individual's values, attitudes, interests, lifestyle, social, personal relationships, wearer's identity authority, status, and occupation (Sampson, 2016)

It is a powerful means to read the internal mindset of the wearer as well as to provide strategies to tackle observers to provide the external appearance as the wearer needs. Recent research has found that fashion sense of a person, has an impact on how people act and behave. The importance of fashion on the career growth of

white-collar female employees of apparel industry in Sri Lanka will be revealed by this research.

It is clear from the definitions of fashion derived from earlier research that fashion is a reflection of one's way of life. When meeting a person for the first time, someone's appearance leaves a lasting impact. Particularly for female employees, how they dress might have an impact on their career growth.

It has been said that one's self-worth and self-confidence are essential for career growth. For example, how external barriers like social expectations and stereotypical ideologies affect an individual's workplace success; more significantly, the role is played by internal barriers like self-esteem, confidence, and resilience (Collins, 2009). The concept of "self" is developed through and individuals' experience in terms of work, relationships, and social interactions (Powell, 2011).

When considering the factors for the career growth of female employees the research is guiding to convince the importance of fashion for the career growth.

The garment sector holds a prominent position in Sri Lanka's industrial structure among the distribution of careers. The study's focus is on the garment sector because women are considered to be the second most important foreign source of income for Sri Lankans who work in the ready-to-wear sector. The ready-made clothing industry employs 85% women, making it a female-dominated sector, per the annual survey of industries (2017). (Empowering Female Workers, 2017). The study is restricted to female white-collar workers in the Sri Lankan apparel industry.

2.1. Concept of Workwear fashion in Sri Lanka

Over the years, workwear has developed into a range of designs and patterns. The standard office clothing was formal for both men and women. Nevertheless, corporate attire has changed to more casual or informal styles since the internet explosion in the 1990s (Wardhana, 2020). A formal dress code deviates from

business casual in terms of appearance. Business formal attire is sometimes referred to as conventional dress attire, formal wear, or formal attire.

As a result of globalization and free-market economic principles, Sri Lanka has made it easier for people to adopt international design trends. In addition to contributing to the garment manufacturing industry, Sri Lanka not only adopts Western fashion trends but also started doing so in the twenty-first century (Wardhana, 2020).

In Sri Lanka's apparel business, the majority of management staff members who interact with consumers often prefer to wear "smart casual attire," or semi-formal clothing. For several employees, the lack of specific types of business dress in Sri Lanka proved to be a significant difficulty. Other difficulties included clothing that was too expensive, uncomfortable, and lacked the correct fabrics and styles (Niromi Seram, 2022). These past findings depict that it is important to pay attention to the dressing behavior of the employees because they are interconnecting with consumers and also that fashion is affecting the personal productivity too. Specially the employees' attire depends on the decisions they make based on their fashion sense.

Researchers discovered that employers who describe themselves as "well dressed" believe themselves to be more responsible, trustworthy, and competent, as well as having the essential skills and knowledge. This is in contrast to employers who do not present themselves in a "properly dressed" manner. (Kwon, 1994).

Solomon and Schopler mentioned that the employees who are interested in fashion are more productive (Schopler, Self-Consciousness and Clothing, 1982). Workwear has changed in recent generations, adopting new patterns and styles. Both men and women wore the traditional, business-casual style of clothing for the office. However, since the 1990s, when the internet boom began, the workplace has adopted a more casual or informal dress code (Schopler, Self-Consciousness and Clothing, 1982).

By considering the past findings regarding workwear fashion in Sri Lanka there is a research

gap which is lack of awareness regarding the importance of fashion for the organization. Furthermore, in Sri Lanka it was derived that achieving the research objective is effective for the selected organization for the benefit for them and employees too.

2.2. Fashion and Career growth

According to Gibson et al., Organizational culture is what employees believe and how that believes drive to their values, and expectations (Lunenburg, 2012).

Depending on what they are wearing, people have varied perspectives of themselves (Katherine Karl, 2013). People frequently create their own mental representations of appropriate attire and the expected behavior that goes with it. It also means that how appropriately dressed employees are at work may affect how they behave at work. Another study by Kwon (1994) was published in Karl et al. (2013), and it focused on how employees feel when they are dressed appropriately for work, which can make them appear more responsible, competent, knowledgeable, professional, honest, reliable, intelligent, trustworthy, hardworking, and efficient than when they are not with proper dress codes (Katherine Karl, 2013)

Open cultural conflict with others and with self is encouraged by wearing whatever one wants. In their interactions with others, people have also used clothing to achieve specific aims (Joy V. Peluchette, 2007). In accordance with earlier studies, people have chosen particular types of attire to accomplish professional goals, with formal business attire being used to raise status and command respect (Margaret Rucker, 1999)

From the past finding fashion has been described as a key component for the lifestyle of humans. Specially fashion and women have an unconditional interconnection.

As a first impression, appearance is crucial to the pleasant experience in the service industry. The customer's top priority, though, is the actual quality of the service. According to Nelson & Bowen (2000), look is a potent design element that contributes to making an impression. According to Lennon and Miller (1984 in Nelson

& Bowen, 2000), attractive people are more outgoing and task-achievers (Bowen, 2000).

Karl et al. (2013) asserts that people's perceptions of themselves varied depending on the attire they were wearing. According to Schneider (1973) and Karl et al. (2013) mentioned that how people often create their own mental models of appropriate clothes and the conduct that goes along with. Katherine Karl suggests that the appropriateness of employees' work dress may have an effect on the employees' work behavior (Katherine Karl, 2013).

According to Nelson & Bowen (2000), employee uniforms typically have a positive impact on customer satisfaction because certain uniforms worn by the personnel may foster a favorable environment while the customers are being served. Mishra & Mishra (2015) added that personal appearance decisions reflect dependency on the gaze of others for that existence to have meaning in addition to relying on an idea of individual existence. Then, freedom of attire encourages direct cultural conflict with others and with oneself.

By considering the previous arguments, uniforms have a positive impact for the external factors such as customer satisfaction but when considering the female employees in the organization uniforms have a less impact for their freedom for personal attire with self-satisfaction. On the other hand, this argument proceeds to a positive hypothesize that fashion is giving positive importance for the career growth of female employees in the selected organization for the research because when fashion gives the freedom for personal attire it affects for the self-satisfaction, efficiency and factors can guide for the career growth.

3. CONCLUSION

The results of previous studies and based on the arguments from past findings. It shows that there is an interconnection between fashion and career lives of females. Especially it can be argued that since fashion is the most important nonverbal communication method of human lives fashion is important for career growth too. As a result, to solve one of the most interesting questions

regarding fashion and female career growth this research provides a path for the future researchers. It encourages innovative strategies for the industry pioneers because the research is solving an interesting factor about fashion and career. It is also offering a forum for discussing how it affects the professional advancement of white-collar female employees working in Sri Lankan apparel industry such as MAS Holdings and Brandix Group.

REFERENCES

- Baumgartner, J. (2012). *You Are What you wear*.
- Bowen, K. N. (2000). The Effect of Employee Uniforms on Employee Satisfaction. *SAGE Journal*.
- Brown, D. (2002). *Career choice and development*. USA: Jossey Bass.
- Case Study Of MAS Holdings (Pvt) Ltd. (2019). Retrieved from <https://www.ipl.org/>.
- Collins, G. (2009). *When Everything Changed: The Amazing Journey of American Women from 1960 to the Present*. Newyork: Little, Brown and Company.
- coporation, I. f. (2019). *Making progress, Sri Lankan business advance Gender equality at workplace*. Colombo: IFC women in work progress.
- (2017). *Empowering Female Workers*.
- Export Development Board (EDB), S. L. (2020). *Industry capability report Sri lankan apparel sector*.
- González, A. M., & Bovone, L. (2012). *Identities Through Fashion: A Multidisciplinary Approach*. New york: Berg.
- Huang, Q. (2006). *The Nature of Women's Career Development: Determinants and Consequences of Career Patterns*. STOCKHOLM UNIVERSITY.
- Jacques, R. (2018). What's the Point of Fashion? *Repeller*.
- Joy V. Peluchette, K. K. (2007). *The impact of workplace attire on employee self-perceptions*.
- Katherine Karl, J. V. (2013). Employee self perceptions regarding Workplace attire in Turkey. *Journal of organizational psychology*, 125.

- Kwon. (1994). The influence of appropriateness of dress and gender on the self-perception of occupational attributes. *Clothing and Textiles Research Journal*, 33 - 39.
- Lunenburg, F. C. (2012). Power and Leadership: An Influence Process. *INTERNATIONAL JOURNAL OF MANAGEMENT, BUSINESS, AND ADMINISTRATION*.
- Margaret Rucker, E. A. (1999). *Clothing power, and the workplace*. bloomsburyfashioncentral.
- Melissa K. Gibson, M. J. (2000). The mud, the blood, and the beer guys: Organizational osmosis in blue-collar work groups. *Journal of Applied Communication research*, 68-88.
- Niromi Seram, G. D. (2022). usiness attire: challenges for employees regularly in contact with customers in the Sri Lankan apparel industry. *Research Journal of Textile and Apparel*.
- Powell, G. N. (2011). *Women and Men in Management*. Los Angeles: Sage publications.
- Sampson, E. C. (2016). *Teachers' Perceptions of the Effect of Their Attire on Middle-School Students' Behavior and Learning*. Walden University.
- Schopler, M. R. (1982). Self-Consciousness and Clothing. *Personality and Social Psychology Bulletin*, 508 - 514.
- Schopler, M. R. (1982). Self-Consciousness and Clothing. *SAGE Journals*.
- (2019). *Tackling childcare: The Business Case for Employer - supported children care in Sri Lanka*. Colombo: The finance corporation.
- Wardhana, D. Y. (2020). *Employees' Attitudes towards Jobs: Does Work Attires Matter?*

The Impact of Mindfulness-Based Interventions on University Scholars' Well-Being And Academic Performance: A Systematic Review

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ABSTRACT

Objectives:

The excessive burnout rates among university scholars worldwide serve as a sign that the well-being of university students is at threat. Alarminglly, stressed-out university students are more likely to exhibit poor moral character and provide inadequate academic involvement. According to research, holistic interventions focused on mindfulness can help university students' well-being and reduce being burnout. Mindfulness-based interventions (MBIs) may also improve the overall academic performance of college students (e.g., studies work). To inform future studies and character development programs, there are not any published systematic evaluations that clearly show how MBIs affect university students' academic performance or well-being. The researcher thoroughly analyzed and narratively synthesized information on the effects of MBIs on university students' overall performance in their studies.

Methods: The researcher independently analyzed studies examining the effects of MBIs on University scholars' (postgraduates and undergraduates) well-being or academic performance by searching Google student publications and PsycINFO from the beginning to 2016. Data were carefully extracted, study quality was evaluated using the Medical Education Research Study Quality Instrument (MERSQI), and findings were narratively reported.

Results: Eighteen studies that fulfilled the criteria out of a total of 934 papers we retrieved

were of excellent quality and included randomized, (un)controlled, or qualitative research. Effects differ between MBIs with varied educational material or formats: MBIs that incorporate important components of mindfulness education or use group-based learning have frequently demonstrated significant effects in improving university students' well-being or academic performance in a variety of academic and collegiate environments. The advantages of MBIs (stronger sense of self and different understanding) and their drawbacks (time constraints and practicality) were all perceived by university students. Findings have challenged the research's methodological limitations (e.g., the usage of self-decided participants, loss of placebo interventions, and use of self-suggested outcomes).

Conclusions: This evaluation demonstrates that the university students can comprehend how MBIs affect their overall performance and sense of well-being. The evidence, however, evolved into challenging methodological constraints and is no longer helpful for the standardization of MBIs in training programs. Instead, a better academic institute should keep in mind to include a group based on MBIs as optional modules for university students with well-being goals or objectives for academic growth.

Key terms: *MBI, university scholars, well-being, academic performance, higher education, mindfulness.*

1. INTRODUCTION

The use of mindfulness-based interventions (MBIs) in adolescence is gaining popularity, and it has most recently been extended to include the study of students in academic settings. This exploration composition reviewed the literature of applied studies using MBIs with scholars in university settings to identify constraints in the scientific literature and form future exploration directions.

The university community has become less aware that competent scholars care for their personal well-being as well as the well-being of other university scholars (Oró et al., 2021). In university education, the faculty framework has included a commitment to well-being as a crucial capacity of professionalism (Parson et al., 2019). However, it can be difficult to translate this faculty into the daily academic routine of university scholars (Lalor, et al., 2019).

The academic practice involves working in a competitive and demanding learning environment, where university students have little time and money to care for their personal well-being (Atroszko et al., 2018). Physical, mental, and social health are all interrelated aspects of student well-being that, taken together, are important for students to thrive and succeed in a variety of exciting spheres of personal and social life (Selvaraj & Bhat, 2018). So, according to Liu, Ping, and Gao (2019), well-being entails more than only the absence of anxiety and negative (such as demotivation throughout the study) indicators (Esposito et al., 2020).

Alarmingly, university students are reporting lower levels of well-being, which is supported by instances where students around the world are under a lot of stress (Sverdlik et al., 2018). The diverse requirements of present practice, such as workload and managing stress, have been linked to university scholars' suffering (Jääskeläinen et al., 2022). These requirements reduce autonomy and interfere with relationships, undermining university students' energy levels and feelings of purpose in their academic work (Cannizzo et al., 2019). According to research, mindfulness can

result from intentionally focusing on the present moment in a challenging practice environment without passing judgment. This could help with meaning enhancement and reconnecting (Epstein et al., 2022). University students usually respond to stress by working harder.

By enhancing self-regulation, fostering self-regulation, and facilitating self-reflection on one's behaviors and academic workshops, mindfulness offers an essential addition to university students' mindfulness of stress and of their own feelings and expectations (Huerta et al., 2021). Scholars perceive mindfulness as assisting them to become more conscious of stress, proactively set boundaries and rules, and develop stronger relationships to function in a demanding academic environment, according to a qualitative study (Sinclair et al, 2021). Finally, undergraduates and graduates who practice awareness report fewer instances of collapsing, according to reviews (university scholars who practice awareness report fewer instances of collapsing, according to reviews) and as a result, mindfulness-based interventions (MBIs) are less frequently used in higher education and academic work (Naji et al, 2021).

The widely utilized Mindfulness-Based Stress Reduction (MBSR) method (Svtlak et al., 2021) uses awareness contemplation and other strategies to encourage mindfulness and alertness. Similar programs use similar strategies. According to certain research, MBIs may help people feel better (such as by promoting good internal health) (Joseph et al, 2021). However, this justification has not yet been thoroughly examined; earlier assessments of MBIs focused only on detrimental well-being issues (Tement, S et al, 2021).

In addition to its apparent advantages for well-being, research has shown that MBIs may improve university students' performance in terms of their involvement in providing social good (Fontana et al., 2020). MBIs may improve academic performance in subtle ways (e.g., regarding slip-ups and attention errors) as they improve attention and mindfulness (Wimmer et al., 2020). However, former reviews have not

clarified whether or how the interpersonal or rigorousness of university scholars' performance is affected by MBIs.

The most effective mindfulness-based interventions are those that address system-related demands (such as workloads) while simultaneously promoting a culture of wellness among university students in a variety of educational phases (from post-graduate to continuing higher education) (Panagopoulos & Montgomery, 2019). Understanding the benefits of MBIs will help university educators and faculty creators successfully adjust MBIs to satisfy the different needs of university students' well-being and professional growth, which facilitates the acceptable design of this method. The way that mindfulness is taught in post-graduate and continuing higher education, as well as how university students and academic scholars interpret the effects of MBIs on their health and academic performance, have not, however, been fully examined in previous research. So, we studied the effects of MBIs on university students' academic performance and general well-being.

2. METHOD

Electronic database searches were done to find English-language reviews from Western and Asian nations that had been published between 2016 and 2022. Included were any review-position empirical research involving college students or university students that looked at interventions to improve overall mental health and wellbeing.

The researcher focused on the eligibility requirements, search method, study selection, data extraction, and quality assessment when starting the review. PRISMA (preferred reporting details for systematic reviews and meta-analyses) guidelines were followed while documenting the review procedure (Runner, M.J., et al, 2021).

2.1. Eligibility Criteria

Studies that looked at the impact of MBIs on performance metrics for university education or indicators of wellbeing were considered

admissible. The MBIs included interventions that adopted a mindfulness approach to teaching deliberate and nonjudgmental attention to present experiences, thoughts, and sensibilities (Sebastian et al., 2022). We included studies in which university students' general health or academic performance were the primary concerns and were communicated to university students individually or in groups. Empirical papers, including letters, commentary, and editorials, as well as articles written in languages other than English, were closed out.

2.2. Data Sources and Searches

The researcher did not use predefined search terms because the well-being and academic performance can be measured by a variety of indexes, and this review was the first to combine these. Instead, the researcher used the full-textbook review to systematically assess the question of whether studies included indexes of well-being or academic performance. In addition, the researcher conducted a man-made search in the references of relevant studies and reviews on this theme.

2.3. Study Selection

The researcher conducted an exhaustive title and abstract screening for the first stage of the investigation, removing non-empirical studies and studies that did not address the topics of "mindfulness" and "University scholars." When it was unable to get the abstracts, the researcher independently examined the titles to weed out papers that were blatantly irrelevant. The researcher evaluated the entire textbook papers individually throughout the alternative stage. Arguments were discussed and settled by consensus between the researcher and the supervisor.

2.4. Data Extraction and Analysis

In this research composition, data is singly uprooted on the study design, participants and setting, intervention type, measures, and study findings. To reach an invariant extraction procedure, the first ten papers were checked and talked over by the supervisor. The researcher

assessed the absoluteness and fineness of uprooted data for all papers.

The participants and setting of the study, the type of intervention, the measurements used, and the study's findings are all separately uprooted in this research composition. The supervisor checked and discussed the first ten publications in order to arrive at an invariant extraction technique. The researcher evaluated the precision and absoluteness of uprooted data for each study.

The researcher used ten criteria to assess the study's quality: study design, number of institutions, response rate, type of data, internal structure, content validity, criterion validity, correctness of data analyses, the complexity of data analyses, and resultant status. Additionally, the researcher made use of the Medical Education Research Study Quality Instrument (MERSQI) as well as the Higher Education Research Study Quality Instrument (HERSQI). We skipped the meta-analysis since there was such wide variation in the problems with academic performance and well-being of university scholars.

University scholars observed a variety of benefits and obstacles in the context of MBIs, and studies were also inconsistent in intervention characteristics (training content or format) and the educational contexts under examination. This variability rendered reporting MBI concerns at an accumulated position meaningless. Therefore, we examined the results considering the many research characteristics, including the intervention (training content or format), study setting (postgraduate or continuing high education), and the advantages and disadvantages of MBIs. While also considering study quality and methodological constraints, methodical comparisons between studies allowed the researcher to convey the various findings of diverse investigations in a narrative fashion (Cerigo & Quesnel- Vallée, 2020).

3. RESULTS

3.1. Search Results

The search turned up 940 distinct successes, and the title screening and objectification produced

sixty-one papers that would be qualified. Eighteen papers were kept after full-text webbing; 15 additional studies were added as a result.

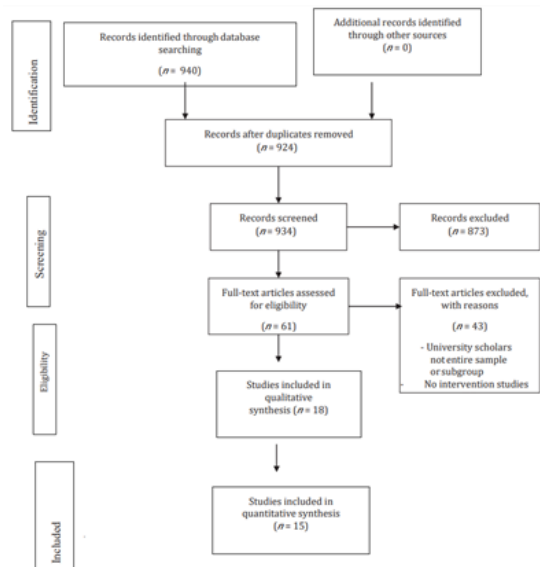


Figure 2 - PRISMA (preferred reporting items for systematic reviews and meta-analyses) flow chart of the review process

3.2. Study Characteristics

The university students who participated in the eligible studies (undergraduates, postgraduates, and other students who follow the diploma courses) were in Asia, Europe, the USA, and Australia. All the research assessed the effects of an MBI immediately following the intervention.

Results addressing the well-being of university students focused on physical, psychological, and social activities. Blood pressure and heart rate were assessed in studies on physical health (Sommerfeld et al, 2019), along with self-reported physical health (Marais et al., 2020). Psychological well-being was investigated using questionnaires on anxiety (Forbes & Fikretoglu, 2018), depression (Rong et al., 2021), mental health (Verweij et al., 2018), mood (Simionato et al., 2019), negative affect (McGuire et al., 2019), perceived (Pulido- Criollo et al., 2018), adaptability and quality of life(Verweij et al., 2018). Work engagement, job satisfaction,

specialty satisfaction, and tiredness questionnaires were used to assess occupational well-being (Sarrionandia et al., 2018). Self-perceived physical and internal health (Banerjee et al., 2019), as well as weariness (Felver et al., 2018), were indicators of both physical and mental health. University students' performance was evaluated based on their adherence to safety and interpersonal guidelines. Interpersonal indicators of performance included psychosocial exposure and empathy (Ma & Siu, 2020, Chmielewski, 2021). By observing hand hygiene compliance, safety indicators of performance were explored (Dyrbye et al., 2019) as self-reported cognitive shortcomings or poor academic performance (Fernie et al., 2018) (Horvat & Tement, 2020).

3.3. Study Findings

According to the study's findings, the impact of MBIs on wellbeing and academic performance varies depending on the training's format, topic, and educational contexts (i.e., postgraduate or continuing higher education). Additionally, the products of MBIs were different based on some advantages and difficulties of MBIs, which were based on university scholars' understanding of why certain MBIs were (not) effective.

3.4. Training Content of MBIs

Five main principles can be used to create the training material for MBIs based on the abstract framework of awareness interventions proposed by Crane et al. (i) Integration of awareness proposition (ii) the dissemination of moral information regarding awareness; (iii) the cultivation of self-mindfulness regarding studies, passions, and bodily sensations; (iv) the development of behavioral self-regulation and positive emotions (curiosity, joy, compassion); and (v) instruction in the practice of meditation (figure:2) (Loucks et al, 2022). The research examined in this study varied in the specific elements they used, ranging from those that consistently embraced all MBIs principles to those that did not adopt any principles at all. Different mindfulness-based therapies' benefits

on participants' well-being or academic achievement were seen.

Mindfulness theory	Informed by theories that follow from a combination of contemplative traditions and science (medicine psychology, education)
Didactic information on mindfulness	Addresses how distress is created and maintained, and how mindfulness deals with alleviating distress
Self-awareness	Develops self-awareness of experience characterized by present moment focus, decentering, and approach orientation
Self-regulation	Supports attentional, emotional, and behavioral self-regulation, as well as positive qualities (e.g., Compassion, wisdom, equanimity)
Meditation practice	Involves participants in training in mindfulness meditation practice

3.4.1. Effects of MBIs with All Mindfulness Intervention Fundamentals

Nine research included every aspect of mindfulness according to Crane et al's definition (Crane et al., 2017). These studies used MBIs that were based on mindfulness practices that had been proven effective, such as MBSR or Mindfulness-Based Cognitive Therapeutics (MBCT). The Jon Kabat-Zinn-designed MBSR program (Husgafvel, 2018) entails group-based discussions and exercises that are focused on using mindfulness in daily life; MBCT is an altered reading of MBSR that focuses primarily on cognitive self-regulation (Macdonald & Muran, 2021).

Studies on MBSR and MBCT found benefits for performance and well-being (De la Fuente et al. 2018). Positive performance effects were specifically designed for interpersonal disciplines (i.e., cooperation with colleagues) (Erol & Celik, 2022). No impact on academic performance safety disciplines, such as self-

reporting of academic wrongdoings, was reported due to inconsistency (Valenzuela et al., 2020). psychological (stress, agitation, relaxation) or occupational (burn-out, commitment) disciplines that specifically improve well-being (Hj Ramli & Alavi et al., 2018).

However, not all aspects of well-being (such as good internal health or work engagement) were impacted (Rudaz et al., 2021). Similarly, not all studies on MBI indicated the same benefits for performance or well-being, which was partly due to various outgrowth metrics among studies. For instance, two studies on MBI that examined several indicators of physical well-being and performed in various ways showed that physical well-being can improve, although heart rate and blood pressure did not (Noyes et al., 2019). Additionally, inconsistent results were a result of inconsistent study quality, which included RCTs (Martnez-Rubio et al., 2020), qualitative assessments (Briesch et al., 2020), and tiny (undepowered), unbridled post studies (Li & Qin, 2021). Indeed, the high-quality trials did not use interventions with a placebo effect and used tone-named actors, which all reduced the validity of the evidence supporting the benefits of MBSR and MBCT.

3.4.2. Personal effects of MBIs with variable mindfulness intervention

A total of fifteen studies included more than one but less than five of the Crane et al. characteristics (Scheepers et al., 2020). Most of this research focused on fundamental concepts like mindfulness meditation (10 studies) or moralistic mindfulness information (11 studies). However, fewer studies (6 studies) addressed self-mindfulness or self-regulation or included the mindfulness offer (seven studies for each). Studies using a multifaceted MBI with multiple (four of five) mindfulness fundamentals primarily showed improvements in well-being. But not all well-being indicators—such as negative emotion and exhaustion—improved when awareness training elements were properly applied (Wimmer et al., 2020). These outcomes were reported for various mental or occupational well-being indicators, including anxiety, stress,

quality of life, mood, and positive affect, as well as weariness and work satisfaction. These results were reported for a variety of measures of psychological (anxiety, stress, quality of life, mood, and positive affect) or occupational (tiredness, work satisfaction) well-being (Wimmer et al., 2020). However, not all measures of well-being (negative affect, exhaustion) improved when awareness training rudiments were particularly incorporated in web-based programs rather than group-based ones (Fendel et al., 2020).

Specific, rather than varied, well-being or academic performance objectives were targeted and improved by mindfulness-based therapies that only contained one or two training fundamentals (Santovea, 2019). An MBI that encouraged community and collegiality at work specifically addressed occupational well-being (exhaustion, empowerment at work), which was evident in the training curriculum (Spilg et al., 2022). Other MBIs emphasized mindful observation to focus on safety performance (hand hygiene adherence) or used meditation or psychological silence to particularly alleviate stress (Van Winkle et al., 2018 & Humran et al., 2018). The research did not mention if participants were given a heads-up about the intended outcomes, therefore it is unknown whether this overestimation bias affected the results in self-reported studies (McGonagle et al., 2020).

3.5. Training format of MBIs

The duration of the MBI, the length of the MBI, the length of the MBI trainers, and the methods used to give the training (web-based or in-person) all had different effects on wellbeing or performance. First, MBI instructors ranged from certified instructors to professionals (from the same or different units). Validated MBSR and MBCT programs believe the use of certified, independent trainers to be the best practice (Crane, et al., 2017); in fact, these trainers were more frequently chosen by the studies including Burns (Lee, et al., 2011). In contrast, medical professionals with independent training were particularly hired for MBIs that also placed an emphasis on exchanging insights into the

integration of mindfulness into routine clinical practice. In these circumstances, the trainer's personal medical knowledge may be useful in directing the conversation (Rimes & Wingrove, 2011). Thirteen research on group-based MBIs involved the appointment of trainers; studies concentrating on web-based MBIs did not (two studies). MBIs used in groups and on the web had varied effects on performance and overall happiness.

3.5.1. Effects of the web- and group-based MBIs

Web-based MBIs developed a personalized method of teaching mindfulness using Internet- or smartphone-based tasks. These MBIs had conflicting effects on health (Lahtinen et al., 2021). Negative well-being indicators (such as fatigue and negative affect) were unaffected, whereas positive well-being indicators (such as positive affect) showed improvements, though these were merely based on non-randomized, uncontrolled studies that did not qualitatively assess participants' experiences with MBIs.

Group-based MBIs featured mindfulness activities done at home in addition to awareness training sessions. Investigations with high-quality diversity, ranging from major RCTs with qualitative evaluations to tiny non-randomized and uncontrolled studies, used these MBIs. Despite this variation in study quality, studies were consistent in demonstrating beneficial benefits on performance or well-being. Although these outcomes were based on tone-reported difficulties, academic performance improved in interpreting- zonal fields (empathy or psychosocial exposure) (Rong et al., 2021). Behavioral (exhaustion, empowerment at study, specialty satisfaction, dedication) and psychological (anxiety, psychological health, mood, relaxation, adaptability, stress, uneasiness, and quality of life) disciplines improve wellbeing (Rong et al., 2021). The triangulation of the research was made possible by the mixed (quantitative and qualitative) styles, even though the various study designs and the many topics under investigation prevented the interpretation of data at an accrued point.

However, the effects of group based MBIs varied depending on the length of the training technique. The duration of the MBI programs ranged from short-term (one to two sessions) to medium-term (two to three months) to long-term (nine months) training techniques (Magnano et al., 2021).

3.5.2. Short-, medium-, and long-term MBI effects

There were both single-session and two-session short-term MBIs (Magnano et al., 2021 & Cullen et al., 2019) or a 2-day mindfulness retreat (Kaplan-Rakowski et al., 2021). When participants were followed up after the intervention or explicit discussions about how to go on practicing mindfulness were held, short-term MBIs had an impact on well-being (stress, anxiety, and burnout) (Kaplan-Rakowski et al., 2021 & Verweij et al., 2018). Programs with weekly classes and a duration of two to three months were used in medium-term MBIs, despite the long-term effects. As was also evident in 2- or 3-month follow-ups, medium-term MBIs had a good impact on well-being (stress, burnout, or job satisfaction) or academic achievement (empathy or psychosocial orientation).

These MBIs displayed greater consistency in their training methodology and outcomes (Sarrionandia et al., 2018). Two medium-term MBIs included a maintenance phase after the initial intervention program that includes once-monthly training sessions for 10 months; these studies showed that the well-being improvement was sustained during the maintenance phase (Ahmad et al., 2022). These MBIs were not identified, but these training materials might be particularly useful for short-term MBIs.

Collegiality, community, and shared experience were used in the program to foster workplace well-being (burnout, empowerment), but psychological well-being (depression, stress), or interpersonal effectiveness were not improved (Onan et al., 2019), which was the only study to look into long-term MBIs (empathy).

3.6. Settings of MBIs

Studies on academic personnel or non-academic staff with university degrees were undertaken in the contexts of undergraduates, postgraduates, or continuing higher education.

3.6.1. Effects of MBIs on Postgraduate University Education

As opportunities for people to voluntarily invest in their professional and personal improvement throughout postgraduate university studies, departments or faculties offered MBIs. Occasionally, MBIs may be included in training portfolios (Levin et al., 2020). There were participants from various populations (mixed academics, graduates, post-graduates, students, or non-academics). No effects on happiness were detected in the psychiatry department, even though uncontrolled trials with low power reported these findings (Kang, et al., 2019). Particularly, randomized, and controlled research in diverse disciplines showed positive effects on psychological (stress, concern) or occupational (burnout, specialized satisfaction) areas of well-being following medium-term, group based MBIs (Manca et al., 2020). However, not every resident may receive these advantages in the same way (Baeza-Velasco et al., 2020). Particularly, individuals with low baseline well-being (high levels of exhaustion) were more likely to benefit from MBIs than those with high baseline well-being (low levels of exhaustion) (Borjalilu, 2019). This outcome was in line with the suggestions made by the locals that MBI involvement is particularly encouraged for locals in need of better wellbeing ((Baeza-Velasco et al., 2020).

3.6.2. Effects of MBIs on Higher Education Persistence

For university students who desired to invest in their professional and personal growth in the framework of continuing their higher education, departments or faculties offered MBIs (on a voluntary basis). Some research suggests that college students who successfully completed the MBI could earn credits or add them to their portfolios (Dawson et al., 2020). Academic engagements involved conducting studies with mixed-specialty samples from internal university students. The well-being of university-based researchers was positively impacted by group-based MBIs in the areas of psychological (anxiety, stress, relaxation) or occupational (burnout, empowerment at work) fields (Nielsen, 2020). General practitioners also indicated favorable effects on psychological (stress, sadness) or occupational (burnout, work engagement) well-being (Dawson et al. 2020).

3.7. Advantages and Challenges of MBIs

Both mixed-method research and qualitative interview studies provide insight into certain advantages and difficulties that made it clear why MBIs affected academic performance and well-being or not.

3.7.1. MBI Advantages

Studies noted that MBIs had drawbacks as well as advantages; these were time constraints and practicality in daily practice (Rith-Najarian et al., 2019). One of the biggest problems was time because practicing mindfulness required time investment, but people felt guilty about taking time off from work or family duties to focus on their own professional and personal development (Hudson et al., 2020). The amount of time required for mindfulness-based treatments varied since some MBIs were conducted during the time that was not considered work time (Padrino, 2020). While certain events were planned for the evening (Chmielewski, 2021).

Numerous MBIs instructed participants to practice mindfulness at home (for instance, for 45 minutes each day) (Chmielewski,2021). Findings also demonstrated that mindfulness allowed participants to safeguard their work-home balance. Participants were better able to set priorities and limitations to work demands thanks to their increased awareness of stress and self-reflection on values because of practicing mindfulness (Le & Alefaio ,2019).

Participants said that it was challenging to sustain mindfulness in daily life, making the viability of practicing mindfulness difficult to believe (Moore et al., 2020). High workloads or additional assignment volumes hindered participants from being and remaining mindful in daily practice (Ungar et al., 2022). To increase the viability of daily practice, participants suggested taking brief moments for mindfulness with the entire team, for example before doing rounds (Gilmartin et al., 2018). Some participants claimed, for instance, that quick drills like mindful breathing could be utilized intentionally before a stressful circumstance and were useful in regular practice (e.g., before performing academic responsibilities). Overall, academics acknowledged that practicing mindfulness satisfied unmet demands for self-reflection and self-care and were driven to investigate its viability over the long term (Hudson et al.,2020).

3.7.2. Challenges of MBI

In addition to benefits, studies also reported challenges associated with MBIs; these specifically included limitations to time and feasibility in daily practice (Rith-Najarian et al.,2019). Time was one of the major challenges as practicing mindfulness required an investment of time, but participants felt guilty about taking time for their own professional and personal development and, consequently, spending less

time on work or home responsibilities (Hudson et al.,2020). Mindfulness-based interventions differed in the degree of time investment required as some MBIs were organized during protected work time (Padrino,2020). whereas others were organized in the evenings (Chmielewski,2021). Many MBIs prescribed that participants should practice mindfulness at home (e.g., for 45 minutes per day) (Chmielewski,2021). Although these time investments in the evenings or at home could put further pressure on the work-home balance, findings also showed that mindfulness helped participants to protect their work-home balance: awareness of stress and self-reflection on values facilitated participants in setting priorities and limits to work demands (Le & Alefaio,2019).

The feasibility of practicing mindfulness was considered challenging as participants reported that exercising mindfulness was difficult to sustain in daily life (Moore et al., 2020). In daily practice, high workloads or extra assignments volumes were a barrier to being and staying mindful (Ungar et al.,2022) enhancing the feasibility of daily practice, participants recommended engaging in brief moments of mindfulness with the whole team, for example before doing rounds (Gilmartin et al., 2018). In addition, different MBIs provided room for discussion and the sharing of experiences on how to apply mindfulness in daily life (Jnaneswar & Sulphay,2021). For example, participants reported that brief exercises, such as mindful breathing, were applicable in daily practice as they could be purposefully used in advance of a stressful situation (e.g., before performing academic responsibilities). Overall, university scholars recognized that practicing mindfulness met unfulfilled needs to reflect and care for themselves and were motivated to explore its feasibility in the long term (Hudson et al. ,2020).

4. DISCUSSION

4.1. Main findings

When participating university scholars assessed both the advantages and disadvantages of MBIs, this systematic study found that the effects of MBIs varied among programs with diverse training topics or forms, as well as between higher education and university contexts. Most mindfulness-based therapies that used a group-based training format or that covered several key aspects of mindfulness in their training material had positive outcomes. (Hudson et al., 2020; Chmielewski, 2021). In the context of postgraduate or continuing higher education, these beneficial impacts were especially relevant to university students and faculty members' interpersonal performance and academic and psychological well-being (Rith-Najarian et al., 2019; Chmielewski, 2021). However, this evidence was susceptible to methodological restrictions of randomized, controlled, or uncontrolled research (i.e., participants were self-selected, placebo interventions were absent, and results were self-reported). However, mixed-method or qualitative research revealed that university personnel and students saw MBI benefits as improved understanding of oneself or others (Novak et al., 2020). The use of mindfulness in regular academic work, however, may be hampered by time and feasibility issues, especially in the long run.

4.2. Description of results

Most of the research in this study (10 of 15) was released between 2017 and 2022, demonstrating the MBIs' growing acceptance in academic discourse and higher education (Worsley et al., 2022).

The research that was included used MBIs with variable training content, therefore this

popularity did not lead to agreement on the best training design for an MBI. Despite this variation, numerous research incorporated crucial aspects of mindfulness, which were most frequently incorporated by MBSR or MBCT, two highly validated MBIs that have been demonstrated to be successful in a variety of professional settings outside of academia (Henshall et al., 2022). Nevertheless, in contemporary scientific literature, mindfulness is also seen as a socio-cognitive concept, involving openness to novelty in which people give new meaning to their social context (Ngnoumen, 2019). This strategy was also used by some MBIs, for example by encouraging participants to give new meaning to daily routines in academic engagements (Axelrod et al., 2022). More specifically, hand hygiene routines were reframed as mindful moments in which to briefly pause and reflect on in. Such a maintenance phase was included in two of the research in our review, and both showed post-training improvements in wellbeing that lasted (O'Shea, 2022). Only four research examined outcomes at follow-up, revealing increased wellbeing (reduced stress or burnout) at 2 months or 3 months. Outside of these instances, there was limited understanding of the sustained effects of an MBI (O'Shea, 2022). According to a recent RCT conducted on medical students, persistent benefits of MBIs have been proven to extend up to 6 years in different settings (Liu et al., 2022). In response to better self-awareness and attention, emotional, and behavioral self-regulation following an MBI, an approach-focused (as opposed to avoidance-focused) coping strategy was thought to be responsible for these long-lasting effects.

4.3. Limitations

Such a maintenance phase was included in one of the types of research in our review, and both showed post-training improvements in wellbeing

that lasted (O'Shea,2022). Only three research examined outcomes at follow-up, revealing increased well-being (reduced stress or burnout) at 2 months (Kroflin et al., 2021) or 3 months. Outside of these instances, there was limited understanding of the sustained effects of an MBI ((O'Shea ,2022). According to a recent RCT conducted on medical students, persistent benefits of MBIs have been proven to extend up to six years in different settings (Liu et al., 2022). In response to better self-awareness and attention, emotional, and behavioral self-regulation following an MBI, an approach-focused (as opposed to avoidance-focused) coping strategy was thought to be responsible for these long-lasting effects.

As opposed to placebo therapies, the RCTs in this evaluation used waitlist or passive control conditions, and respondents' participation was voluntary, which could have led to selection bias. In contrast, forced or required participation would be impractical or even wrong. To evaluate selection bias, future RCTs might report on the characteristics of non-participants (including their scores on outcome measures). Additionally, a mix of RCTs, in-depth pre-post, and qualitative research is needed to assess the efficacy of MBIs and to shed light on how university scholars integrate self-care practices like mindfulness into their regular academic activities.

4.4. Implications

University students feel that MBIs have positive benefits since they felt greater positive well-being (empowerment, devotion, and happiness) and less burnout, stress, and anxiety after being exposed to MBIs (O'Shea,2022 & Kajitani et al.,2020).

The good news is that because different MBIs had different training themes and formats, not all MBIs had the same favorable effects.

Universities interested in offering MBIs may want to use programs like MBSR or MBCT, which have been shown to be successful, or they may routinely practice simple mindfulness techniques (Zhang et al.,2021). Furthermore, group-based training methods that promote experience sharing and peer support are more likely to result in positive participant outcomes. Individual, web-based approaches may be considered in specific situations when personal preferences or pragmatic concerns are addressed. The best approaches to modifying an MBI to meet the requirements of university students with varying levels of support, coping mechanisms, and well-being should be clarified in further research (Deitte et al.,2018). Future research on MBIs with intentional modifications in training content, format, intensity, and length of the program, as well as a systematic evaluation of chosen (rather than heterogeneous) outcomes, would be advantageous when combining quantitative and qualitative study approaches (Van Dam et al.,2018). The success and cost benefits of various MBIs for wider deployment, as well as the ideal training design, may be determined by researchers with the help of these initiatives (Van Dam et al.,2018).

5. CONCLUSIONS

According to the findings of this review, MBIs that used a group-based training format or incorporated a lot of crucial mindfulness components in their training content (Hudson et al., 2020 & Chmielewski, 2021 & O'Shea,2022 & Kajitani et al., 2020) had mostly positive impacts. Although findings were subject to methodological limitations involving participant self-selection and a lack of active control, they were allegedly applicable to the well-being of undergraduates and post-graduates in diverse academic or university environments. The level of evidence currently available does not support standardizing MBI implementation; rather, MBIs

could be made available as elective programs to university students who desire to enhance their well-being. These modules ought to address the problems with time and viability that MBIs present.

The most recent data also imply that university staff may indirectly gain from MBIs because researchers from those academic institutions were said to have given. University students who had had an MBI were said to be more study-focused and empathetic. Future research should, however, clarify the extent to which MBIs have beneficial effects on empathetic care from the perspective of the campus community as these results were based on student-related research.

REFERENCES

- Abbasi, F., Shariati, K., & Tajikzadeh, F. (2018). Comparison of the Cognitive Behavioral Therapy (CBT) and Mindfulness-Based Stress Reduction (MBSR): Reducing Anxiety Symptoms. *Women's Health Bulletin*, 5(4), 1-5.
- Atroszko, P. A., Balcerowska, J. M., Bereznowski, P., Biernatowska, A., Pallesen, S., & Andreassen, C. S. (2018). Facebook addiction among Polish undergraduate students: Validity of measurement and relationship with personality and well-being. *Computers in Human Behavior*, 85, 329-338.
- Axelrod, M. I., & Santagata, M. L. (2022). Evaluating a mindfulness-based intervention to improve academic engagement. *Journal of Applied School Psychology*, 38(3), 262-282.
- Banerjee, Y., Akhras, A., Khamis, A. H., Alsheikh-Ali, A., & Davis, D. (2019). Investigating the relationship between resilience, stress-coping strategies, and learning approaches to predict academic performance in undergraduate medical students: protocol for a proof-of-concept study. *JMIR research protocols*, 8(9), e14677.
- Borjalilu, S., Mazaheri, M. A., & Talebpour, A. (2019). Effectiveness of mindfulness-based stress management in the mental health of Iranian university students: a comparison of blended therapy, face-to-face sessions, and mHealth app (Aramgar). *Iranian Journal of Psychiatry and Behavioral Sciences*, 13(2).
- Cannizzo, F., Mauri, C., & Osbaldiston, N. (2019). Moral barriers between work/life balance policy and practice in academia. *Journal of Cultural Economy*, 12(4), 251-264.
- Cerigo, H., & Quesnel-Vallée, A. (2020). Systematic mixed studies reviews: Leveraging the literature to answer complex questions through the integration of quantitative and qualitative evidence. *International Journal of Public Health*, 65(5), 699-703.
- Chmielewski, J. (2021). Mindfulness in healthcare professionals and medical education. *International journal of occupational medicine and environmental health*, 34(1), 1-14.
- De la Fuente, J., Mañas, I., Franco, C., Cangas, A. J., & Soriano, E. (2018). Differential effect of level of self-regulation and mindfulness training on coping strategies used by university students. *International journal of environmental research and public health*, 15(10), 2230.
- De la Fuente, J., Mañas, I., Franco, C., Cangas, A. J., & Soriano, E. (2018). Differential effect of level of self-regulation and mindfulness training on coping strategies used by university students. *International journal of environmental research and public health*, 15(10), 2230.
- Deitte, L. A., Fleming, A. E., Lewis, M. C., Robbins, J. B., Chew, F. S., & Slanetz, P. J. (2018). From medical student to practicing physician: promoting well-being in the learning continuum. *Journal of the American College of Radiology*, 15(8), 1150-1152.
- Dyrbye, L. N., Sciolla, A. F., Dekhtyar, M., Rajasekaran, S., Allgood, J. A., Rea, M., ... & Stephens, M. B. (2019). Medical school strategies to address student well-being: a national survey. *Academic Medicine*, 94(6), 861-868.

- Edwards, D. J., Rainey, E., Boukouvala, V., Wells, Y., Bennett, P., Tree, J., & Kemp, A. H. (2019). Novel ACT-based eHealth psychoeducational intervention for students with mental distress: a study protocol for a mixed-methodology pilot trial. *BMJ open*, 9(7), e029411.
- Epstein, R. M., Marshall, F., Sanders, M., & Krasner, M. S. (2022). Effect of an Intensive Mindful Practice Workshop on Patient-Centered Compassionate Care, Clinician Well-Being, Work Engagement, and Teamwork. *Journal of Continuing Education in the Health Professions*, 42(1), 19-27
- Esposito, G., Passeggia, R., Pepicelli, G., Cannata, A., Parlato, F., & Freda, M. F. (2020)
- Esposito, G., Passeggia, R., Pepicelli, G., Cannata, A., Parlato, F., & Freda, M. F. (2020). Mentalizing the University experience: an exploratory study on the relationship between university students' reflective functioning, psychological well-being, and academic performance. *Mediterranean Journal of Clinical Psychology*, 8(2)
- Felver, J. C., Morton, M. L., & Clawson, A. J. (2018). Mindfulness-based stress reduction reduces psychological distress in college students. *College Student Journal*, 52(3), 291-298.
- Fernie, B. A., Kopar, U. Y., Fisher, P. L., & Spada, M. M. (2018). Further development and testing of the metacognitive model of procrastination: Self-reported academic performance. *Journal of affective disorders*, 240, 1-5.
- Fontana, M. C. P., Generoso, I. P., Sizilio, A., & Bivanco-Lima, D. (2020). Burnout syndrome, extracurricular activities, and social support among Brazilian internship medical students: a cross-sectional analysis. *BMC medical education*, 20(1), 1-9).
- Forbes, S., & Fikretoglu, D. (2018). Building resilience: The conceptual basis and research evidence for resilience training programs. *Review of General Psychology*, 22(4), 452-468.
- Gilmartin, H., Saint, S., Rogers, M., Winter, S., Snyder, A., Quinn, M., & Chopra, V. (2018). A pilot randomized controlled trial to improve hand hygiene through mindful moments. *BMJ quality & safety*, 27(10), 799-806.
- Gilmartin, H., Saint, S., Rogers, M., Winter, S., Snyder, A., Quinn, M., & Chopra, V. (2018). A pilot randomized controlled trial to improve hand hygiene through mindful moments. *BMJ quality & safety*, 27(10), 799-806.
- Gilmartin, H., Saint, S., Rogers, M., Winter, S., Snyder, A., Quinn, M., & Chopra, V. (2018). Pilot randomised controlled trial to improve hand hygiene through mindful moments. *BMJ quality & safety*, 27(10), 799-806.
- Henshall, C., Ostinelli, E., Harvey, J., Davey, Z., Aghanenu, B., Cipriani, A., & Attenburrow, M. J. (2022). Examining the Effectiveness of Web-Based Interventions to Enhance Resilience in Health Care Professionals: Systematic Review. *JMIR Medical Education*, 8(3), e34230.0266725.
- Horvat, M., & Tement, S. (2020). Self-reported cognitive difficulties and cognitive functioning in relation to emotional exhaustion: Evidence from two studies. *Stress and Health*, 36(3), 350-364.
- Hudson, K. G., Lawton, R., & Hugh-Jones, S. (2020). Factors affecting the implementation of a whole school mindfulness program: a qualitative study using the consolidated framework for implementation research. *BMC Health Services Research*, 20(1), 1-13.
- Huerta, M. V., Carberry, A. R., Pipe, T., & McKenna, A. F. (2021). Inner Engineering: Evaluating the utility of mindfulness training to cultivate intrapersonal and interpersonal competencies among first-year engineering students. *Journal of Engineering Education*, 110(3), 636-670).
- Islam, M. A. (2020). Service Quality of Higher Education in the Selected Govt. Colleges of Northern Bangladesh: An Evaluation on Servqual Dimensions. *LC International Journal of STEM (ISSN: 2708-7123)*, 1(4), 75-89

- Jääskeläinen, T., López-Íñiguez, G., & Phillips, M. (2022). Music students' experienced workload in higher education: A systematic review and recommendations for good practice. *Musicae Scientiae*, 10298649221093976
- Jensen, L., & Konradsen, F. (2018). A review of the use of virtual reality head-mounted displays in education and training. *Education and Information Technologies*, 23(4), 1515-1529.
- Jnaneswar, K., & Sulphey, M. (2021). A study on the relationship between workplace spirituality, mental wellbeing, and mindfulness. *Management Science Letters*, 11(3), 1045-1054.
- Johnson, S. J., Willis, S. M., & Evans, J. (2019). An examination of stressors, strain, and resilience in academic and non-academic UK university job roles. *International Journal of Stress Management*, 26(2), 162.
- Joseph, N., Nallapati, A., Machado, M. X., Nair, V., Matele, S., Muthusamy, N., & Sinha, A. (2021). Assessment of academic stress and its coping mechanisms among medical undergraduate students in a large Midwestern university. *Current Psychology*, 40(6), 2599-2609.
- Kajitani, K., Higashijima, I., Kaneko, K., Matsushita, T., Fukumori, H., & Kim, D. (2020). Short-term effect of a smartphone application on the mental health of university students: a pilot study using a user-centered design self-monitoring application for mental health. *PloS one*, 15(9), e0239592.
- Kroflin, K., Krstanović, K., & Kušević, Z. (2021). How can we improve clinical outcome by understanding the inseparability of mind and body? *Medica Jadertina*, 51(3), 243-252.
- Lalor, A., Yu, M. L., Brown, T., & Thyer, L. (2019). Occupational therapy international undergraduate students' perspectives on the purpose of practice education and what contributes to successful practice learning experiences. *British Journal of Occupational Therapy*, 82(6), 367-375.)
- Le, T. N., & Alefaio, D. (2019). Hawaii educators' experiences in a professional development course on mindfulness. *Professional Development in Education*, 45(4), 627-641.
- Liu, X., Ping, S., & Gao, W. (2019). Changes in undergraduate students' psychological well-being as they experience university life. *International journal of environmental research and public health*, 16(16), 2864
- Liu, X., Wang, Q., & Zhou, Z. (2022). The Association between Mindfulness and Resilience among University Students: A Meta-Analysis. *Sustainability*, 14(16), 10405.
- Loucks, E. B., Crane, R. S., Sanghvi, M. A., Montero-Marin, J., Proulx, J., Brewer, J. A., & Kuyken, W. (2022). Mindfulness-Based Programs: Why, When, and How to Adapt? *Global Advances in Health and Medicine*, 11, 21649561211068805.
- Ma, Y., & Siu, A. F. Y. (2020). Dispositional mindfulness and mental health in Hong Kong college students: The mediating roles of decentering and self-acceptance. *Australian Journal of Psychology*, 72(2), 156-164.
- Marais, G. A., Lantheaume, S., Fiault, R., & Shankland, R. (2020). Mindfulness-based programs improve psychological flexibility, mental health, well-being, and time Management in Academics. *European Journal of Investigation in Health, Psychology and Education*, 10(4), 1035-1050.
- Moore, S., Barbour, R., Ngo, H., Sinclair, C., Chambers, R., Auret, K., ... & Playford, D. (2020). Determining the feasibility and effectiveness of brief online mindfulness training for rural medical students: a pilot study. *BMC medical education*, 20(1), 1-12.
- Naji, L., Singh, B., Shah, A., Naji, F., Dennis, B., Kavanagh, O., ... & Sohani, Z. N. (2021). The global prevalence of burnout among postgraduate medical trainees: a systematic review and meta-regression. *Canadian Medical Association Open Access Journal*, 9(1), E189-E200).
- Ngnounen, C. T. (2019). *The use of socio-cognitive mindfulness in mitigating implicit bias and stereotype-activated*

- behaviors* (Doctoral dissertation, Harvard University).
- Nielsen, E. G. (2020). Moving Beyond the Mat: Exploring the Application of Mindfulness Training in Professional and Educational Settings.
- Novak, B. K., Gebhardt, A., Pallerla, H., McDonald, S. B., Haramati, A., & Cotton, S. (2020). Impact of a university-wide interdisciplinary mind-body skills program on student mental and emotional well-being. *Global Advances in Health and Medicine*, 9, 2164956120973983.
- Onan, N., Karaca, S., & Unsal Barlas, G. (2019). Evaluation of a stress coping course for psychological resilience among a group of university nursing students. *Perspectives in psychiatric care*, 55(2), 233-238.
- Oró, P., Esquerda, M., Mas, B., Viñas, J., Yuguero, O., & Pifarré, J. (2021). Effectiveness of a mindfulness-based program on perceived stress, psychopathological symptomatology, and burnout in medical students. *Mindfulness*, 12(5), 1138-1147.
- O'Shea, J., Dannenfelser, M., White, M., Osborne, A., Moran, T. P., & Lall, M. D. (2022). A Resident Retreat with Emergency Medicine Specific Mindfulness Training Significantly Reduces Burnout and Perceived Stress. *Journal of Wellness*, 4(1), 3.
- Padrino, S. L. (2020). Capsule Commentary on Neto et al.: Effects of a Required Large-Group Mindfulness Meditation Course on First-Year Medical Students' Mental Health and Quality of Life: A Randomized Controlled Trial. *Journal of General Internal Medicine*, 35(3), 978-978.
- Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & McKenzie, J. E. (2021). PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. *bmj*, 372.
- Panagopoulou, E., & Montgomery, A. (2019). From burnout to resilient practice: is it a matter of the individual or the context? *Medical Education*, 53(2), 112-114).
- Parson, R., Danilovich, N., Lochnan, H., Kitto, S., Delva, D., Viner, G., ... & Hendry, P. (2019)
- Pulido-Criollo, F., Cueto-Escobedo, J., & Guillén-Ruiz, G. (2018). Stress in nursing university students and mental health. In *Health and academic achievement*. IntechOpen.
- Rith-Najarian, L. R., Boustani, M. M., & Chorpita, B. F. (2019). A systematic review of prevention programs targeting depression, anxiety, and stress in university students. *Journal of Affective Disorders*, 257, 568-584.
- Rong, R., Chen, W., Dai, Z., Gu, J., Chen, W., Zhou, Y., ... & Xiao, H. (2021). Improvement of the management of mental well-being and empathy in Chinese medical students: a randomized controlled study. *BMC medical education*, 21(1), 1-10.
- Sarrionandia, A., Ramos-Díaz, E., & Fernández-Lasarte, O. (2018). Resilience as a mediator of emotional intelligence and perceived stress: A cross-country study. *Frontiers in psychology*, 9, 2653.
- Sebastian, B. B., & Slaten, C. D. (2022). "I'm prepared for this moment": The role of mindfulness in the psychosocial health of women of color. *Journal of Multicultural Counseling and Development*.
- Selvaraj, P. R., & Bhat, C. S. (2018). Predicting the mental health of college students with psychological capital. *Journal of Mental Health*, 27(3), 279-287).
- Simionato, G., Simpson, S., & Reid, C. (2019). Burnout as an ethical issue in psychotherapy. *Psychotherapy*, 56(4), 470.
- Sinclair, S., Kondejewski, J., Jaggi, P., Dennett, L., des Ordon, A. L. R., & Hack, T. F. (2021). What is the state of compassion education? A systematic review of compassion training in health care. *Academic Medicine*, 96(7), 1057).
- Sommerfeldt, S. L., Schaefer, S. M., Brauer, M., Ryff, C. D., & Davidson, R. J. (2019). Individual differences in the association between subjective stress and heart rate are related to psychological and physical well-being. *Psychological science*, 30(7), 1016-1029

- Sverdlík, A., Hall, N. C., McAlpine, L., & Hubbard, K. (2018). The PhD experience: A review of the factors influencing doctoral students' completion, achievement, and well-being. *International Journal of Doctoral Studies*, 13, 361-388).
- Světlák, M., Linhartová, P., Knejzlíková, T., Knejzlík, J., Kóša, B., Horníčková, V., ... & Šumec, R. (2021). Being mindful at university: a pilot evaluation of the feasibility of an online mindfulness-based mental health support program for students. *Frontiers in psychology*, 3673
- Tement, S., Ketiš, Z. K., Mirošević, Š., & Selič-Zupančič, P. (2021). The impact of Psychological Interventions with Elements of Mindfulness (PIM) on empathy, well-being, and reduction of burnout in physicians: a systematic review. *International journal of environmental research and public health*, 18(21), 11181).
- Ungar, P., Schindler, A. K., Polujanski, S., & Rotthoff, T. (2022). Online programs to strengthen the mental health of medical students: A systematic review of the literature. *Medical Education Online*, 27(1), 2082909.
- Van Dam, N. T., Van Vugt, M. K., Vago, D. R., Schmalzl, L., Saron, C. D., Olendzki, A., ... & Meyer, D. E. (2018). Mind the hype: A critical evaluation and prescriptive agenda for research on mindfulness and meditation. *Perspectives on psychological science*, 13(1), 36-61.
- Verweij H, van Ravesteijn H, van Hooff MLM, Lagro-Janssen ALM, Speckens AEM. Mindfulness-based stress reduction for residents: a randomized controlled trial. *J Gen Intern Med*. 2018; 33:429-436.
- Verweij, H., van Ravesteijn, H., van Hooff, M. L., Lagro-Janssen, A. L., & Speckens, A. E. (2018). Mindfulness-based stress reduction for residents: a randomized controlled trial. *Journal of general internal medicine*, 33(4), 429-436.
- Villarreal, M., Hanson, P., Clarke, A., Khan, M., & Dale, J. (2021). Feasibility, acceptability, and effect of the Mindful Practice curriculum in postgraduate training of general practitioners. *BMC Medical Education*, 21(1), 1-8.
- Wimmer, L., Bellingrath, S., & Von Stockhausen, L. (2020). Mindfulness training for improving attention regulation in university students: Is it effective? and do yoga and homework matter? *Frontiers in psychology*, 11, 719).
- Worsley, J. D., Pennington, A., & Corcoran, R. (2022). Supporting mental health and wellbeing of university and college students: A systematic review of review-level evidence of interventions. *PloS one*, 17(7), e
- Zhang, D., Lee, E. K., Mak, E. C., Ho, C. Y., & Wong, S. Y. (2021). Mindfulness-based interventions: an overall review. *British medical bulletin*, 138(1), 41-57.

A Review of Methodological choices relating to Employee Turnover in Female Dominant Service Industries

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ABSTRACT

Studies on female employee turnover in service sector businesses published between 2012 and 2022 were subjected to a methodological evaluation. This review methodically chose 31 journal papers detailing employee turnover in female dominated industries. Articles were evaluated based on methodological decisions such as type of data and data sources, data collection method, sample techniques, overall research design, data analysis method, validity, and reliability.

Researchers employed various methodological viewpoints to perform their studies, as evidenced by the review's findings. The majority of studies in the subject took a quantitative approach, and all studies describing employee turnover in female-dominated industries were field studies with a cross-sectional design. Primarily, grounded theory served as the foundation for qualitative studies in this field. There were significant methodological inadequacies that could be addressed in future research.

Moreover, significant recommendations were made about the selected studies reliability and validity measures

1. INTRODUCTION

Many organizations have struggled to overcome a problem of high employee turnover. Numerous academics have conducted conceptual and empirical research in an effort to comprehend the

phenomenon of employee turnover and identify its primary causes.

Since 2019 (pre-pandemic), more than one million American women have missing from the labor force (U.S. Chamber of Commerce, 2022). Lim & Mohd Rasdi (2019) identifies that the majority of married women professionals leaving the workforce are affected by factors, such as workplace inflexibility, long working hours, and high volume of work, as opposed to "opt-out" factors, which focus on the biological and psychological "pulls" that lure women back into their traditional motherhood roles, and many lack the confidence to reenter the workforce.

U.S. Chamber of Commerce (2022) identifies the ever-increasing cost of childcare for infants as another key factor discouraging women from reentering the workforce, which is also impacted by factors such as mothers mistrusting the childcare system due to the massive increase in daycare negligence lawsuits.

This issue of high female employee turnover has affected a number of organizations. In both the manufacturing and service sectors, organizations with a preponderance of female employees have felt a significant impact. The service sector/ industry has been the most impacted as some businesses are unable to replace female employees in the service sector due to cultural and social norms, and in some instances, legislation. Even though numerous systematic literature reviews have been conducted on employee turnover as a whole, only a small number of SLRs have been conducted to provide methodological insight on female employee turnover. There has been no

direct systematic literature review evaluating the methodological choices used to study the factors influencing employee turnover in service industries dominated by women.

This paper intends to evaluate the methodology used to investigate the factors influencing employee turnover in female-dominated service industries. This review will evaluate the validity, reliability, and credibility of previous empirical studies on the factors influencing employee turnover in service industries dominated by women. This review will also profile the methodological choices in work factors influencing employee turnover in service industries dominated by women, assisting researchers in identifying methodological gaps in the field.

The remaining sections are organized as follows: The following section will discuss methods used. The subsequent section will detail the findings of the systematic review. In the final two sections, implications and recommendations will be discussed.

2. METHOD

2.1. Selection of Literature and Inclusion and Exclusion Criteria

Due to the restricted scope of the selected research topics, identifying what to exclude and what to include in the Systematic literature review is essential (Gaur & Kumar, 2017).

In order to establish the credibility of the chosen material, a systematic search of the literature was conducted to identify only journal articles that had been peer-reviewed. Moreover, it was decided to include only articles published between 2012 and 2023, as workforce trends have shifted significantly since 2012, with many workfrom-home jobs and a whole new flexi work time availability due to the gig economy (Maureen & Gerstle, 2020). In addition, it was determined that only empiric journal articles would be used, as the objective is to review the methodologies of previous studies. Furthermore, the selection criteria were limited

to studies conducted in female dominated service industries, as the focus of the paper is to systematize a reflection on methodologies on previous research pertaining to employee turnover in female-dominated service industries.

After determining the inclusion and exclusion criteria, a systematic literature search was conducted using the Primo search engine available at the Plymouth University Library. This search engine enables access to multiple databases via a single portal. For this study, all Primo-accessible databases were utilized to determine the total number of relevant studies. A major advantage of using the Primo search engine is that it excludes predatory journal articles, thereby enhancing the study's credibility.

Primo's advanced search function was used to locate relevant articles for this review. Therefore, the following algorithmic statement was used to retrieve articles about employee turnover in service industries dominated by women. (employee turnover OR staff turnover OR employee retention OR staff retention) (Female employee OR female workforce) (service industry OR service business)

The initial search result returned 583 articles. The number was then reduced to 518 by selecting full-text peer reviewed articles. The addition of a time frame between 2012 and 2022 further restricted the search to 350 peer-reviewed articles. The aforementioned inclusion and exclusion criteria were then applied, and 31 articles were selected for analysis. (Achinstein et al., 2010; Andrews & Mohammed, 2020; Auerbach et al., 2010; Basnyat & Clarence Lao, 2020; Blomme et al., 2010; Brannan, 2015; Burns & Christie, 2013; Campbell et al., 2020; Chaacha & Botha, 2021; Chiao et al., 2021; CHOI et al., 2020; Choi, 2020; Donoghue, 2010;; Halter et al., 2017; Johnco et al., 2014; Jolly et al., 2022; Kashyap & Rangnekar, 2014; Kothari et al., 2021; Lee et al., 2018; Lim & Mohd Rasdi, 2019; McCartney et al., 2022; Modau et al., 2018; Noranee et al., 2021; Renaud et al., 2017; Roy et al., 2017; Sainju et al., 2021; Schaap & Olckers, 2020; Shah et al., 2020; Swanepoel &

Saurombe, 2022; Wilkens, 2020; Yang et al., 2019)

3. ANALYSIS OF CONTENT AND CODING

Since this is a methodology focused review. The analysis will center on methodological considerations. Due to the lack of expertise in developing a coding mechanism (Potter & Levine Donnerstein, 1999) and the inability to locate a previous systematic literature review pertaining directly to the topic (Krippendorff, 2004), we utilize a coding mechanism identified by Gaur & Kumar (2017), where clear directions are given regarding the categories used in coding for a methodological reviews, which we will be using as the standard.

The categories used are as follows ;

1. Type of data & data sources
2. Data collection method
3. Sampling technique
4. Research design (Qualitative, quantitative, multimethod) & Type of analysis (cross-sectional or longitudinal)
5. Type of interpretation
6. Check for validity and reliability of results

3.1. Type of Data & Data Sources

When conducting an empirical investigation, it is crucial to identify the data type and source from which the data was collected. Whether the data is primary or secondary, internal or external. The type of data source as well as the credibility of the chosen source will have an effect on the validity based on the research objective, as the timeliness and relevance of data play a significant role in any successfully conducted research (Potter & Levine Donnerstein, 1999). This review focuses on determining the type of data used in the selected papers as well as the veracity of the sources from which the data were obtained.

3.2. Data Collection Method

In this review, data collection techniques were classified as follows: survey, structured

interviews, semi structured interviews, in-depth interviews, diary, focus group, archive data, and others. In addition, research were categorized according to the number of data sources employed. Therefore, if a study used many sources, it was recorded as 'multisource,' and if it just used one, it was coded as 'single source.'

3.3. Sampling Technique

In an empirical investigation, the ability to generalize depends mostly on the kind of representativeness. Eight sample approaches, including probability and non-probability methods, were employed in the coding process. Random, stratified, clustered, convenience, snowball, purposeful, quota, and respondent-driven sampling procedures were used.

3.4. Research design (Qualitative, quantitative, multimethod) & Type of analysis (cross-sectional or longitudinal)

Research design provides crucial structure for the researcher to conduct research and greatly guides the data collection and data analysis processes (Bryman 2012). For this review, research design methodological options were classified as follows. The study was first categorized based on whether it employed a quantitative or qualitative methodology (categorized in regards to inductive and deductive). Secondly was encoded according to whether it was multi-wave (longitudinal) or cross-sectional. Finally, papers were categorized based on study settings, such as whether they were field studies or laboratory studies. In this context, laboratory research is one in which examples, scenarios, or vignettes were utilized to assess the views of respondents.

3.5. Type of Interpretation (Data analytical Method)

Casper et al(2007) .'s categorization for coding was utilized to assess the methodological choices surrounding the data analysis; the same was used by De Alwis & Hernwall's (2021) methodological study relevant to work life balance. It is as follows ;

1. Simple inferential statistics (e.g. correlation, t-tests)

2. Techniques to examine one dependent variable (e.g. Multiple regression, anova)
3. Techniques to examine multiple dependent variables (e.g. manova, mancova)
4. Techniques to examine multiple relations (e.g. structural equation models)
5. Techniques to examine the structure of data (e.g. exploratory factor analysis)
6. Repeated measures (e.g. time series, repeated anova)
7. Qualitative analysis (e.g. content analysis)

3.6. Validity and Reliability of Results

According to Bryman (2012), the ability to generalize research findings is contingent on the validity and dependability of the collected data. Therefore, it is essential to comprehend whether the appropriate instruments were used to measure the concepts relevant to the study.

First, the type of scale used in the study (existing scale adapted or new scale) was coded separately, followed by coding based on the availability of validity and reliability testing evidence in studies.

4. RESULTS

4.1. Type of Data & Data Sources

All 31 (100%) of selected articles use primary data as the data used in the study. No secondary data has been used in any of the studies and all data collected is through primary data sources

4.2. Data Collection Method

Ninety percent of papers (29) employ surveys as the major method for collecting primary data. While 2 papers use semi structured interviews to collect data. One article collects data from its participants through a survey and a semi structured interview. 23 out of 31 studies collected data from single sources while the remaining collected data from multiple sources.

4.3. Sampling Technique

8 (25 percent) of the 31 articles utilized the convenience sampling method, while 13 (41 percent) utilized the clustered sampling method. Two articles used probability-based sampling, while eight utilized non-probability-based sampling. Sixty percent of the reviewed quantitative studies employed cluster sampling.

Research design (Qualitative, Quantitative, Multimethod) & Type of Analysis (cross-sectional or longitudinal)

The majority of studies on employee turnover in the service sector (i.e., 80 percent or 28 out of 31) used a quantitative approach in their research design, while two (6 percent) used a qualitative approach and one employed a mixed methodology. 67% (21 articles) utilized the cross-sectional method, while 33% (10 articles) collected data from respondents more than once. All studies reviewed here are field studies.

4.4. Type of Interpretation (Data Analytic Method)

58 percent (18 papers) of examined studies employed simple inferential statistics to analyze and report data, with correlations, standard deviation, and the mean being the most common tools. Two researchers employed

MANOVA and MANCOVA to investigate numerous dependent variables. While seven researchers (22 percent) employed data modeling to interpret various relationships. One article employed multiple regression to understand data.

4.5. Validity and Reliability of results

Twenty-five of the thirty-one studies examined (80 percent) utilized explicit variable measuring methods.

Sixty percent (15 articles) of the studies that employed variable measurement utilized existing scales, while thirty-two percent (eight articles) altered the existing scales to their study aims and two studies created new scales for their research.

Regarding the evidence of validity, 64% (20 papers) addressed the validity measures performed in the research, while 38% (11 articles) did not. Eighty-three percent (26 articles) of the publications reported the study's reliability measures, whereas

seventeen percent (5 articles) did not provide any evidence of reliability.

5. DISCUSSION

Based on the sort of study employed, the discussion portion is divided into two sections. Evidently, the bulk of the evaluated research is quantitative (28/31); hence, the emphasis of the first section will be on quantitative research reviews. Only two of the reviewed publications were qualitative and employed the mix method; therefore, part 2 of the discussion is devoted to the use of qualitative and mix methods in research projects.

5.1. Quantitative Research

5.1.1. Data collection

As seen in the results section, it is evident that all considered papers utilized primary data to conduct research. It was evident that the most preferred method for collecting quantitative data in studies of factors influencing female employee turnover was the survey method (28 articles). This skew towards the use of questionnaires demonstrates a preference for the collection of quantitative information through the use of questionnaires (mainly online questionnaires). This may be due to factors such as the fact that collecting data from larger samples using primarily online questionnaires may be both cost and time efficient. Understanding the phenomenon of employee turnover in female-dominated industries in multiple regions, as opposed to a single region, would be facilitated by access to geographically diverse samples, which would enhance the efficacy of future research (Adkins and Premeaux 2014;) However, there are disadvantages associated with the use of online surveys, such as identifying the respondent's authenticity and the reluctance of respondents to click on shared links due to security breaches (Toepoel 2017).

When attempting to comprehend why female employees leave their jobs, it is crucial to consider not only the female employee, but also her complex networks of relationships within and outside the organization. Consequently, obtaining information from family members, coworkers, and supervisors is crucial. However,

the review revealed that the majority of data was obtained from a single source as opposed to multiple sources, creating bias in certain circumstances.

5.1.2. Sampling method

Numerous researchers contend that the generalizability of a study is a crucial factor. According to Bryman (2012), generalizability is the capacity to extend beyond the specific context in which the research was conducted. The generalizability of the study is contingent upon the representativeness of the sample chosen.

When examining the sampling methods used in the reviewed articles, it was determined that the majority (41 percent) employed clustered sampling, 25 percent employed convenient sampling, and only two of the 31 papers used random probability sampling. No evidence was presented in the selected papers for the ability to represent every aspect of the population, removing the ability to generalize research findings.

Due to numerous instances of practical constraints, such as the inability to recruit respondents, the availability and willingness of respondents, and primarily the cost incurred, the majority of quantitative studies employ the convenience sampling method. If additional research is conducted in this area and if such limitations are encountered, it would be prudent to increase the variety of sample characteristics (Etikan, Musa, and Alkassim 2016)

5.1.3. Research design

Although there has been no area-focused systematic literature review on female employee turnover in service industries, there have been numerous methodological reviews on the research methods utilized in Employee turnover studies. Similar to these findings on employee turnover, it has been determined that the majority of studies on female employee turnover employ quantitative methods. According to Berman (2012), this shift in scale toward a preference for quantitative studies is attributable to preoccupied perceptions because quantitative studies permit the precise measurement of variables, as well as

the ability to generalize research and repeat findings.

These concerns were evident in this methodological review, as the majority of quantitative studies (60 percent) employed the modification of existing scales.

In the above review none of the articles selected utilizes an experiment type research. But more insight to the phenomena could be understood if a coupled with an experimental type of research.

The majority of studies evaluated casual interferences using cross-sectional data. Due to its common method bias in comparison to multivariate designs such as this has been questioned and criticized by the academic community (Bryman, 2012). Variations in study responses are not attributed to the true dispositions of the participants, but rather to nature outside the instrument (McGonigle 2017). This would be a significant obstacle in determining why a former employee left the workforce. However, when skewed the reviewed articles, we found that approximately 80 percent of articles published after use a longitudinal approach.

5.1.4. Data analytical Strategies

The majority of the reviewed quantitative articles relied primarily on inferential statistics, such as mean correlation and standard deviation. Nonetheless, the multiple hierarchical regression method was used to synthesize causal relationships between variables. The application of structural equation modeling to comprehend multiple relationships between variables was observed.

Further use of multilevel modeling in the study area could further reduce bias, as it could be adjusted to reduce bias in comparison relative to conventional measures. Moreover, the ability to handle unequal group sizes effectively through the use of multi-level modeling would further improve the reliability of data analysis (Kenny, Kocharis, and Bolger 2003).

Validity and reliability measures According to the current review, 24/28 (85%) quantitative studies reported reliability measures, whereas 18/28 (64%) quantitative studies presented

reliability measures. All studies discussing reliability utilized Cronbach's Alpha as their guiding instrument. Vasken, Beaman, and Saponaria (2017), along with several other scholars such as (Schmitt 1996), criticize the measurement's validity on the grounds that a large number of items on a scale invariably report a higher alpha value, despite the fact that data are not consistent. In addition, alpha calculations assume that all constructs are unidimensional, which is not always the case. According to Schmitt (1996), this can conceal data inconsistencies. Therefore, the lack of use of other tools to establish reliability in the area of study must be addressed.

5.2. Qualitative Research & Mixed

5.2.1. Methods

Two of the thirty-one chosen articles were qualitative studies, and one was a mixed-method study. Contrary to quantitative studies, qualitative studies argue that it is a socially constructed phenomenon (Bryman, 2012), and employee turnover is a social phenomenon. The qualitative approach is more emergent and adaptable, and therefore better suited to uncovering complex phenomena employee turnover (Beigi and Shirmohammadi 2017).

As stated in the results section, both qualitative studies were conducted on the field. None of the two studies included in the review employed a multiple-wave model. Using a longitudinal design increases the researcher's ability to understand the factors influencing females to leave service sector industries in a more in-depth manner, as the researcher is able to develop a stronger rapport with the participant in order to obtain subsurface data (Thomson and Holland 2003).

Both Studies have employed valid sampling techniques. As it is customary to use small sample sizes, the use may be justifiable; however, questions remain regarding the generalizability of the results.

Both qualitative studies collect data through semi-structured interviews. When an in-depth examination of a phenomenon is required, semi-structured interviews are optimal. According to the study of female employee turnover using

semi-structured interviews, researchers would once again be able to delve deeply (Given 2008).

The grounded theory is utilized in both qualitative studies to analyze research findings. The grounded theory is the most commonly used qualitative data analytic framework (Bryman, 2012), and it enables the researcher to develop concepts about the discrete phenomena revealed by data analysis. Some critics contend that it violates the social construct by attempting to objectify people's experiences (Bryman, 2012) and in some cases employing a different method to analyze quantitative data would be suited over the grounded theory.

Positive critics of the qualitative method argue that the studies are too subjective and difficult to replicate (Bryman, 2012). In addition, the subjectivity of qualitative research and the ability to make decisions based on the flow of nature make it more difficult to validate data. The two articles under consideration lack measures to validate the research procedure. Some postpositivist and interpretivist scholars have proposed alternative frameworks to enhance the rigor and reliability of qualitative research (Malterud 2001; Morrow 2005; Whittemore, Chase, and Mandle 2001; Polit and Beck 2010; Shento 2004). Consequently, qualitative researchers must be conscious of the methodological decisions they make in various aspects of their research, including: • Credibility (similar to Internal Validity) • Transferability (similar to External Validity) Dependability (similar to Reliability) Verifiability (similar to Objectivity) And could use this to increase rigor and credibility.

5.3. Mix Method

One of the thirty-one articles selected for the review uses a combination of questionnaires and structured interviews to collect research data. Following pragmatic research philosophy, mix methods (Bryman, 2012). Even though the mix method combines qualitative and quantitative research, it is essential to note that it is not superior to either quantitative or qualitative research. In the case of studying the factors influencing female employee turnover in the service industry, however, the use of mixed

method research would help overcome the limitations of selecting a single type of research and permit a more thorough examination of complex phenomena.

6. CONCLUSION

This methodological overview of research on female employee turnover in service sector companies offers a comprehensive picture of the methodological choices made by scholars who have investigated the problem. This evaluation found that researchers investigated factors influencing female employee turnover from a variety of methodological perspectives. However, there are a number of methodological gaps that might be filled by future studies.

Quantitative researchers should prioritize selection problems, such as the representativeness of the sample they select, in light of the parametric data analysis techniques they employ in their studies. Random sampling strategies are optimal if their implementation is practicable. In addition, it is suggested that additional multi-wave research be conducted in the field in order to address problems with causal conclusions in quantitative studies. Clearly, researchers in this field rely excessively on Cronbach's alpha as the only metric of trustworthiness. Nonetheless, in light of recent criticism, researchers must utilize alpha values with caution when discussing dependability.

Based on this evaluation, qualitative investigations have exclusively employed grounded theory as their data analysis methodology. Researchers have abundant access to qualitative methodologies suitable to qualitative data analysis. In addition, researchers might investigate data using numerous data sources, such as focus groups, rather than depending excessively on semi-structured interviews.

In their articles, qualitative researchers must explicitly explain and defend their methodological choices. This explanation would contribute to the study's validity and reliability. In addition, researchers might potentially use mixed methodological

approaches to examine the turnover of female employees in service sectors.

There are some limitations to this evaluation. The shortlisted papers are selected solely from the PRIMO database at the University of Plymouth Library. A wider variety of publications might have increased the validity of this analysis. Despite these limitations, this analysis provides an excellent starting point for future researchers who wish to investigate the variables influencing female employee turnover in service sector businesses.

REFERENCES

- Achinstein, B., Ogawa, R. T., Sexton, D., & Freitas, C. (2010). Retaining Teachers of Color: A Pressing Problem and a Potential Strategy for "Hard-to-Staff" Schools. *Review of Educational Research*, 80(1), 71–107. <https://doi.org/10.3102/0034654309355994>
- Adkins, C. L., and S. A. Premeaux. 2014. 'The Use of Communication Technology to Manage Work Home Boundaries.' *Journal of Behavioral and Applied Management* 15 (2): 82–100.
- Andrews, K. S., & Mohammed, T. (2020). Strategies for Reducing Employee Turnover in Small- and Medium-Sized Enterprises. *Westcliff International Journal of Applied Research*, 4(1), 57–71. <https://doi.org/10.47670/wuwijar202041KATM>
- Auerbach, C., McGowan, B. G., Ausberger, A., Strolin-Goltzman, J., & Schudrich, W. (2010). Differential factors influencing public and voluntary child welfare workers' intention to leave. *Children and Youth Services Review*, 32(10), 1396–1402. <https://doi.org/10.1016/j.childyouth.2010.06.008>
- Basnyat, S., & Clarence Lao, C. S. (2020). Employees' perceptions on the relationship between human resource management practices and employee turnover: A qualitative study. *Employee Relations*, 42(2), 453–470. <https://doi.org/10.1108/ER-04-2019-0182>
- Beigi, M., and M. Shirmohammadi. 2017. 'Qualitative Research on Work- Family in the Management Field: A Review.' *Applied Psychology* 66 (3):382–433.
- Blomme, R. J., van Rheede, A., & Tromp, D. M. (2010). Work-family conflict as a cause for turnover intentions in the hospitality industry. *Tourism and Hospitality Research*, 10(4), 269–285. <https://doi.org/10.1057/thr.2010.15>
- Brannan, M. J. (2015). "You're not going anywhere": employee retention, symbolic violence and the structuring of subordination in a UK-based call centre. *The Sociological Review* (Keele), 63(4), 801–819. <https://doi.org/10.1111/1467-954X.12312>
- Bryman, A. 2012. *Social Research Methods*. Oxford: Oxford University Press
- Burns, K., & Christie, A. (2013). Employment mobility or turnover? An analysis of child welfare and protection employee retention. *Children and Youth Services Review*, 35(2), 340–346. <https://doi.org/10.1016/j.childyouth.2012.11.014>
- Campbell, K. A., van Borek, N., Marcellus, L., Landy, C. K., & Jack, S. M. (2020). "The hardest job you will ever love": Nurse recruitment, retention, and turnover in the Nurse-Family Partnership program in British Columbia, Canada. *PloS One*, 15(9), e0237028–e0237028. <https://doi.org/10.1371/journal.pone.0237028>
- Casper, W. J., L. T. Eby, C. Bordeaux, A. Lockwood, and D. Lambert. 2007. 'A Review of Research Methods in io/ob Work-Family Research.' *Journal of Applied Psychology* 92 (1): 28–43.
- Chaacha, T. D., & Botha, E. (2021). Factors influencing intention to leave of younger employees in an academic institution. *SA Journal of Human Resource Management*, 19(10), e1–e12. <https://doi.org/10.4102/sajhrm.v19i0.1519>
- Chiao, L.-H., Wu, C.-F., Tzeng, I.-S., Teng, A.N., Liao, R.-W., Yu, L. Y., Huang, C. M.,

- Pan, W.-H., Chen, C.-Y., & Su, T.-T. (2021). Exploring factors influencing the retention of nurses in a religious hospital in Taiwan: a cross-sectional quantitative study. *BMC Nursing*, 20(1), 42. <https://doi.org/10.1186/s12912-021-00558-7>
- CHOI, J., KIM, D. E., & YOON, J. Y. (2020). Person-Centered Care Environment Associated With Care Staff Outcomes in Long-Term Care Facilities. *The Journal of Nursing Research*, 29(1), e133–e133. <https://doi.org/10.1097/JNR.0000000000000412>
- Choi, S. (2020). Flexible Work Arrangements and Employee Retention: A Longitudinal Analysis of the Federal Workforces. *Public Personnel Management*, 49(3), 470–495. <https://doi.org/10.1177/0091026019886340>
- De Alwis, S., & Hernwall, P. (2021). A Review of Methodological Choices Relating to Work-Life Boundary Research. *Managing Global Transitions*, 19(1).
- Donoghue, C. (2010). Nursing Home Staff Turnover and Retention: An Analysis of National Level Data. *Journal of Applied Gerontology*, 29(1), 89–106. <https://doi.org/10.1177/0733464809334899>
- Etikan, I., S. A. Musa, and R. S. Alkassim. 2016. 'Comparison of Convenience Sampling and Purposive Sampling.' *American Journal of Theoretical and Applied Statistics* 5 (1): 1–4.
- Gaur, A., & Kumar, M. (2017). A systematic approach to conducting review studies: An assessment of content analysis in 25 years of IB research. *Journal of World Business*, 53. <https://doi.org/10.1016/j.jwb.2017.11.003>
- Gialuisi, O. (2011). Employee retention practices in small businesses: A proposed study. *Small Enterprise Research*, 18(2), 152–154. <https://doi.org/10.5172/ser.2011.18.2.152>
- Given, L. M., ed. 2008. *The Sage Encyclopedia of Qualitative Research Methods*. Thousand Oaks, ca: Sage.
- Halter, M., Boiko, O., Pelone, F., Beighton, C., Harris, R., Gale, J., Gourlay, S., & Drennan, V. (2017). The determinants and consequences of adult nursing staff turnover: a systematic review of systematic reviews. *BMC Health Services Research*, 17(1), 824. <https://doi.org/10.1186/s12913-017-2707-0>
- International Journal of Contemporary Hospitality Management, 31(10), 4086–4104. <https://doi.org/10.1108/IJCHM-07-2017-0398>
- Johnco, C., Salloum, A., Olson, K. R., & Edwards, L. M. (2014). Child Welfare Workers' Perspectives on Contributing Factors to Retention and Turnover: Recommendations for Improvement. *Children and Youth Services Review*, 47, 397–407. <https://doi.org/10.1016/j.childyouth.2014.10.016>
- Jolly, P. M., Gordon, S. E., & Self, T. T. (2022). Family-supportive supervisor behaviors and employee turnover intention in the foodservice industry: does gender matter? *International Journal of Contemporary Hospitality Management*, 34(3), 1084–1105. <https://doi.org/10.1108/IJCHM-02-2021-0280>
- Kashyap, V., & Rangnekar, S. (2014). A Structural Equation Model for Measuring the Impact of Employee Retention Practices on Employee's Turnover Intentions: An Indian Perspective. *South Asian Journal of Human Resource Management*, 1(2), 221–247. <https://doi.org/10.1177/2322093714549109>
- Kenny, D. A., J. D. Korchmaros, and N. Bolger. 2003. 'Lower Level Mediation in Multilevel Models.' *Psychological Methods* 8 (2): 115–28.
- Kothari, B. H., Chandler, K. D., Waugh, A., McElvaine, K. K., Jaramillo, J., & Lipscomb, S. (2021). Retention of child welfare caseworkers: The role of case severity and workplace resources. *Children and Youth Services Review*, 126, 106039. <https://doi.org/10.1016/j.childyouth.2021.106039>
- Lee, T. W., Hom, P., Eberly, M., & Li, J. (Jason). (2018). Managing employee retention and

- turnover with 21st century ideas. *Organizational Dynamics*, 47(2), 88–98.
<https://doi.org/10.1016/j.orgdyn.2017.08.004>
- Lim, W. L., & Mohd Rasdi, R. (2019). “Optout” or pushed out? *European Journal of Training and Development*, 43(9), 785–800.
<https://doi.org/10.1108/EJTD-04-2019-0063>
- Malterud, K. 2001. ‘Qualitative Research: Standards, Challenges, and Guidelines.’ *The Lancet* 358 (9280): 483–8.
- McCartney, G., Chi In, C. L., & Pinto, J. S. de A. F. (2022). COVID-19 impact on hospitality retail employees’ turnover intentions. *International Journal of Contemporary Hospitality Management*, 34(6), 2092–2112.
<https://doi.org/10.1108/IJCHM-08-2021-1053>
- McGonagle, A. 2017. ‘Common Method Variance.’ In *The Sage Encyclopedia of Industrial and Organizational Psychology*, 2nd ed., edited by S. Rogelberg, 192–4. Thousand Oaks, ca: Sage.
- Modau, F. D., Dhanpat, N., Lugisani, P., Maboane, R., & Phiri, M. (2018). Exploring employee retention and intention to leave within a call centre. *SA Journal of Human Resource Management*, 16(1), 1–13.
<https://doi.org/10.4102/sajhrm.v16i0.905>
- Morrow, S. L. 2005. ‘Quality and Trustworthiness in Qualitative Research in Counseling Psychology.’ *Journal of Counseling Psychology* 52 (2): 250–60.
- Norane, S., Som, R. M., Adam, N. A., Aziz, R. A., & Shahrudin, S. (2021). The Relationship between Human Resource Practices and Employee Retention at a Private University: Work Environment as a Moderator. *Global Business and Management Research*, 13(4), 299.
- Potter, W. J., & Levine-Donnerstein, D. (1999). Rethinking validity and reliability in content analysis. *Journal of Applied Communication Research*, 27(3), 258–284.
<https://doi.org/10.1080/00909889909365539>
- Polit, D. F., and C. T. Beck. 2010. ‘Generalization in Quantitative and Qualitative Research: Myths and Strategies.’ *International Journal of Nursing Studies* 47 (11): 1451–8.
- Renaud, S., Morin, L., & Béchard, A. (2017). Traditional Benefits Versus Perquisites: A Longitudinal Test of Their Differential Impact on Employee Turnover. *Journal of Personnel Psychology*, 16(2), 91–103.
<https://doi.org/10.1027/1866-5888/a000180>
- Roy, A., van der Weijden, T., & de Vries, N. (2017). Relationships of work characteristics to job satisfaction, turnover intention, and burnout among doctors in the district public-private mixed health system of Bangladesh. *BMC Health Services Research*, 17(1), 421.
<https://doi.org/10.1186/s12913-017-2369-y>
- Sainju, B., Hartwell, C., & Edwards, J. (2021). Job satisfaction and employee turnover determinants in Fortune 50 companies: Insights from employee reviews from Indeed.com. *Decision Support Systems*, 148, 113582.
<https://doi.org/10.1016/j.dss.2021.113582>
- Schaap, P., & Olckers, C. (2020). Relationships between employee retention factors and attitudinal antecedents of voluntary turnover: An extended structural equation modelling approach. *SA Journal of Human Resource Management*, 18, e1–e15.
<https://doi.org/10.4102/sajhrm.v18i0.1358>
- Schmitt, N. 1996. ‘Uses and Abuses of Coefficient Alpha.’ *Psychological Assessment* 8 (4): 350–3.
- Shah, I. A., Yadav, A., Afzal, F., Shah, S. M. Z. A., Junaid, D., Azam, S., Jonkman, M., de Boer, F., Ahammad, R., & Shanmugam, B. (2020). Factors Affecting Staff Turnover of Young Academics: Job Embeddedness and Creative Work Performance in Higher Academic Institutions. *Frontiers in Psychology*, 11, 570345.
<https://doi.org/10.3389/fpsyg.2020.570345>
- Shento, A. K. 2004. ‘Strategies for Ensuring

- Trustworthiness in Qualitative Research Projects.' *Education for Information* 22 (2): 63–75.
- Shimp, K. M. (2017). Systematic Review Of Turnover/Retention and Staff Perception of Staffing and Resource Adequacy Related to Staffing. *Nursing Economic*, 35(5), 239-266A.
- Swanepoel, K., & Saurombe, M. D. (2022). The significance of an employee value proposition in the retention of teachers at selected South African private schools. *South African Journal of Economic and Management Sciences*, 25(1), 1–11. <https://doi.org/10.4102/sajems.v25i1.4358>
- Thomson, R., and J. Holland. 2003. 'Hindsight, Foresight and Insight: The Challenges of Longitudinal Qualitative Research.' *International Journal of Social Research Methodology* 6 (3): 233–44.
- Toepoel, V. 2017. 'Online Survey Design.' In *The Sage Handbook of Online Research Methods*, edited by N. Fielding, R. Lee, and G. Blank, 184–202. London: Sage.
- Wilkins, M. (2020). Employee Churn in AfterSchool Care: Manager Influences on Retention and Turnover. *Journal of Youth Development (Online)*, 15(1), 94–121. <https://doi.org/10.5195/jyd.2020.812>
- Whittemore, R., S. K. Chase, and C. L. Mandle. 2001. 'Validity in Qualitative Research.' *Qualitative Health Research* 11 (4): 522–37.
- Yang, C., Guo, N., Wang, Y., & Li, C. (2019). The effects of mentoring on hotel staff turnover: Organizational and occupational embeddedness as mediators. *International Journal of Contemporary Hospitality Management*, 31(10), 4086–4104. <https://doi.org/10.1108/IJCHM-07-2017-0398> 2022, 09 27). Retrieved from U.S. Chamber of Commerce: <https://www.uschamber.com/workforce/data-deep-dive-a-decline-of-women-in-the-workforce>

Selection Criteria for an Enterprise Resource Planning (ERP) System for a Business Organization

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ABSTRACT

Enterprise Resource Planning (ERP) system performance highly affects the organization's performance. Whether it is the right product or not should be decided before purchasing the software. Selection of the right and most suitable ERP system is a challenge in today's business environment. Some ERP having more functionalities not required for your business organization, some having limited functionalities not satisfied with the minimum requirements. The organization needs to be adjusted or customized and match with the available product. Selection a right product to your organization saves lot of money, time, resources ultimately making better performance. In this article describe how do we select right ERP's, what are the factors should be considered when selecting a good ERP system.

1. INTRODUCTION

There are thousands of ERP systems available in the market, without having good understanding selecting an ERP system is a waste of money and resources. What we expect from an ERP system implementation, productivity and efficiency improvement, increase accuracy and minimize human mistakes, secure organization data and information, create organization process, best practices and workflow management, reduce cost, time and human intervention for smooth running business process.

2. METHOD

Methodology is used to do a systematic literature review what existing research papers has been written for ERP system selection, it is used Plymouth University primo database and google scholar databases for finding existing research

papers. Search key words are likes "ERP System Selection", "Requirement of ERP system", "ERP selection criteria", then it was listed hundreds of research articles, out of them selected ten articles listed below.

Research Inclusion criteria is, the word with ERP and system selection considered as relevant articles

Exclusion criteria is published before year 2000 research papers not considered as relevant papers.

According to search criteria found following articles,

Enterprise Resource planning (ERP) system selection (Lall & Teyarachakul, 2006)

Selection of the ERP system with regard to the Global 4th industrial revolution(Polivka & Dvorakova, 2021)

Selection process of ERP systems (Molnár et al., 2013)

ERP System Selection based on SVM (Zhang & Zhang, 2009)

Influencing factors on ERP system selection (Lv & Chen, 2010)

System selection and performance evaluation for manufacturing company's ERP adoption (Niu et al., 2017)

Consider each one by and discuss methodologies used to evaluate

First method

Data Envelopment Analysis (DEA) MODEL for software selection and discussion of result (Lall & Teyarachakul, 2006).

DEA model is identified critical attributes of ERP system, then it converts these attributes to the single relatively efficiency measurement. This measurement will help decision makers to identify how usefulness of the ERP system, following same procedure for each ERP system and find out which ERP system is useful and effectiveness

DEA identify each ERP systems critical relative attributes, then convert multiple and gives values to the each, how usefulness of these attributes of ERP system.

Second method

Factors should be considered industry 4.0 and fourth industry revolution (Polivka & Dvorakova, 2021).

What are the factors have influence with industry 4.0 evolution to the ERP market. Following factors has been identified, Bigdata, Autonomous collaborative robots, Simulation technologies, System integration, internet of things, Cyber physical systems, cloud technologies, additive production, augmented reality. Fourth industrial revolution massively considering above technological factors. Also, it is important integration with existing information systems in an organization, that can be categorized as horizontal system integration, vertical system integration, digital continuity every digital product should read through the system, service-oriented architecture it should be possible to use individual component separately. Information aggregation and processing it should be integrated with input from various other information systems, cyber security. ERP system should collaborative with various platforms such as mobile phones, different web browsers. Software and hardware compatibility with industry standards, it should be considered modularity and customization levels of the ERP system. Usually, ERP selection process getting highly experience technical employees' involvement is important, up to what extend they can understand technical issues, impotency of modules and functionalities.

Third method

Analytic Hierarchy Processing (AHP) (Molnár et al., 2013)

In this method arranging goals and objectives on hierarchical order. Support decision making process easier, objective is to select an ERP system in a systematic method, basic problem with this, top management and stakeholders lack of understanding mathematical and theory background

There are three method companies can follow an ERP system

Develop in-house solution, IT department or dedicated development team develop a ERP system according to business requirement.

Open-source ERP system, without paying monthly or yearly used freely available solution and implement.

Open ERP solutions renting or leasing, can be tailor made according to requirements,

Fourth method

This method design selection flow, step by step procedure, there are five steps (Zhang & Zhang, 2009).

Follows by easy steps, collect all possible information about ERP Vendors and Buyers

Design questionnaire to give evaluation information of each attribute for each ERP system from relational ERP buyers.

Input all external professional evaluation information to the model

Every member in project team interviews vendors, examines the vendor's demonstration

Combine the evaluation of both information sources to make final selection.

Fifth method

Phase by Phase selection approach, this gives a phase selection model (Munkelt & Völker, 2013)



Figure 1 Phases of ERP system selection

Five different phases show in above figure, project setup phase, this is the first step, most important step. It is important to select right project team, one representative from each department, most industry experience persons have ability to think strategically, budget plan, how much spend for the ERP system,

Second phase is analysis is required, long term business execution plan, the functional requirements of new system, vague at the beginning, quantitative and qualitative factors, it involve business process reengineering work,

Business process design third step of above proposed model. Major business process should include to the ERP implementation project

Third step remaining system assessed based on requirement

Fourth step system evaluation, divided into four steps, first identify the ERP variables as much as possible, second detail study publicly available documents, self-report from ERP vender, three aspects suitability, sustainability and cost.

Fifth step system selection, a company chosen will implement the system, until the end there won't be change in selection.

Sixth method

ERP system selection in multinational enterprises (Haddara, 2018)

In this article discussed factors should be consider when selecting an ERP system. Those factors are, functionality of ERP system, technical criteria, the cost & budget, service and support, vision criterion, system reliability, compatibility, market position, modularity and integration, implementation methodology and ERP package fitness. Considering each these factors, functionality of the ERP system is most important factor, having height weight,

Technical criteria, selection of hardware and software, should consider current trends, security updates, fundamental organization staff knowledge, internal staff and external staff.

The cost and budget, organization how much is going to spend, should include maintenance and

upgrade, license cost, consultancy, training, human resources, organization change management, etc.

Service and support, most of the organizations face difficulties during the implementation, execution or when go to the live environment.

Integration with current existing systems, customization and security measures some of the problems.

Vision criterion, vender organization future business direction, how long their going serve business, market position, improvement support and constant support.

System reliability, vendor how long do the business, how much reliable product in the market. If strong vendor and market leader can be beneficial for the organization.

Compatibility ERP system with existing systems used, such as attendance, payroll systems, etc. there is a requirement of integration with these systems. If not support must replace existing other systems as well.

Market position vender market share, large organizations highly concern about vendor market share because there are followed global best practices.

Modularity and integration, best ERP systems developed as separate modules and have integration facility. Company can select modules what they want and integrate accordingly.

Implementation methodology, how system going to implement, whether parallel run, section by section, module by module or an overnight change.

ERP package fitness, whether ERP system match with organization, if larger complex ERP system select for a small organization, cannot survive with ERP system, cost, maintenance, hardware resources required and staff salaries, complexity of the system is required for the operational need. If small organization select large complex ERP system, they cannot maintain the system according to requirement, opposite side as well, if large organization select small simple ERP system, they cannot meet their business and operational requirement. ERP package fitness

says, up to what extend match business requirement and system functionality.

Seventh method

ERP selection process may differ in multinational companies (Haddara, 2018).

ERP systems are implemented with involvement of business and key IT personals in an organization as a multi-phase project. Multinational organizations ERP selection process may differ. Business process complexity, supply chain connectivity and external factors are strongly affected. ERP to organization fitness, organization business process requirement and system functionalities, capabilities is an important factor.

According to multiple case studies conducted in Egypt, simple multi-attribute rating technique (SMART) analysis commonly used in Egypt organizations. Vendors references also used as top deciding factor.

According to the research functionality, hardware & software, cost & budget, service & support, vendor vision, system reliability, compatibility, market position, modularity & integration, implementation methodology and ERP package fitness are considered as selection factors.

Eighth method

System selection and performance evaluation for manufacturing companies, to develop framework and evaluate, use analytical hierarchy processing (AHP) and fuzzy integrated evaluation (FIE) methods (Niu et al., 2017).

according to research most important factor of implementing ERP system, improve the business, build integration between cross-department, better service to the customers etc.

When ERP selecting vender reputation has put considerable attention.

Nineth method

A robust MCDM approach for ERP system selection under uncertain environment (Temur & Bolat, 2018).

In early 1980s system requirement was manage material requirements, information systems were material requirement planning (MRP) were very popular, it was give many advantages to the organization, improve business performance, later finance planning decisions also added to the organization, then it call as MRP II, it was very successful, today's highly dynamic, many other divisions activities, external activities involved with organization information system, manufacturing, finance, human resources, supply chain, now it called as enterprise resource planning (ERP) systems.

Recognizing the lack of uncertainty consideration in micro and macro-economical environment, could-based design optimization (CBDO), multi-criteria decision making (MCDM) tools give some contribution to ERP selection process.

Tenth Method

Customer-Centered ERP implementation (C-CEI) method, provide vendors to get an understanding of the company process and context of use. It more suitable for Small and medium-size enterprises (SMEs) because give flexibility to organization adjust according to their requirements. identify company-specific requirements and get an understanding process caried out with ERP system. C-CEI results an ERP requirements document which include deep understanding of the current operations of the process, understanding of the information flows and management planning practices. C-CEI document preparation process involve organization key players, ERP project manager, steering committee members, company top managements and executives. They focus and discuss on business most important business critical needs and prepare document(Vilpola et al., 2007).

Once finalized the C-CEI document shared with vendors and call for quotations. C-CEI method decrease the risk of selecting inappropriate system because it provides in-depth understanding of the company's process and context of use for vendor. C-CEI method is involved human decision factors, focuses on the company's exceptional practices and information

management need. It gives multi-disciplinary point of view for before make implementation decision. It is combination of operational, contextual and risk analyses. Company identified specific requirement and design how the business process is carried out in new ERP system.

3. RESULT

First method data Envelopment Analysis (DEA) model considered by critical attributes of ERP system; it basically measures efficiency but not considered about qualitative factors.

Second method highly considered about industry revolution what new technologies affect to the ERP systems, how new technologies and existing systems are integrated.

Third method discussed how open-source solutions usefulness in ERP systems, how systems can save money and go better solution. How analytical hierarchy processing was done.

Fourth method focused on vendor selection, how vendor important in ERP software selection.

Fifth method proposed five steps selection process model, how to select best ERP by following step by step.

Sixth method considered about multinational large companies, long term perspective view, how to select better ERP system. How system fit with the business process, reliability, compatibility etc.

Seventh method discussed how internal and external factors affect to the ERP selection, based on case studies done past.

Eighth method introduced framework, Analytical Hierarchy Processing (AHP) and Fuzzy Integrated Evaluation method.

Ninth method how ERP evaluation process happened and uncertainty

Tenth method based on customer centered ERP implementation method, it gives more flexibility to small and medium scale businesses to adjust according to their requirement.

4. DISCUSSION

Enterprise Resource Planning (ERP) selection is not an easy task, it is software base solution, intangible, no proper visibility entire functionality, just looking the product cannot make judgment, successful ERP implementation depend on correct ERP selection, it is prejudgment, we cannot use and select an ERP because implementation is not an easy task, time, cost, resources utilizing, must follow a process. According to research case studies lot of companies succeed due to correct decision and fail due to wrong decision.

According to the literature various factors have been identified during their research works. Some of are common for many research works. Such as vendor market share, supplier reliability, software complexity, etc.

there are factors are varied from business to business, such as product cost, if large multinational company they can invest money for long term profit gain but if it is a small business they cannot go for large investment, business revenue not sufficient for invest and return a profit.

ERP selection should be done with a team, organization top management, steering committee, highly technical experience staff and cross functional team should involve for the process.

Bibliography

- Haddara, M. (2018). ERP systems selection in multinational enterprises: A practical guide. *International Journal of Information Systems and Project Management*, 6(1), 43–57. <https://doi.org/10.12821/ijispm060103>
- Lall, V., & Teyarachakul, S. (2006). Enterprise Resource Planning (ERP) System Selection: A Data Envelopment Anaysis (DEA) Approach. *Journal of Computer Information Systems*, 47(1), 123–127. <https://doi.org/10.1080/08874417.2006.11645946>
- Lv, F., & Chen, J. (2010). Influencing factors on ERP system selection. *Proceedings 2010 IEEE International Conference on Software Engineering and Service Sciences, ICSESS 2010*,

- 671–673.
<https://doi.org/10.1109/ICSESS.2010.5552253>
- Molnár, B., Szabó, G., & Benczúr, A. (2013). Selection Process of ERP Systems. *Bsrj*, 4(1), 36–48.
<https://doi.org/10.2478/bsrj-2013-0004>
- Munkelt, T., & Völker, S. (2013). ERP systems: Aspects of selection, implementation and sustainable operations. *International Journal of Information Systems and Project Management*, 1(2), 25–39.
<https://doi.org/10.12821/ijispm010202>
- Niu, B. Z., Chen, K. L., Huang, H. Z., Li, Y., Chen, L., Niu, B., Chen, K., Chen, L., Huang, H., & Li, Y. (2017). System Selection and Performance Evaluation for Manufacturing Company's ERP Adoption. *INTERNATIONAL JOURNAL OF COMPUTERS COMMUNICATIONS & CONTROL ISSN*, 12(3), 347–364.
<http://www.technologyevaluation.com>
- Polivka, M., & Dvorakova, L. (2021). Selection of the ERP System with Regard to the Global 4th Industrial Revolution. *SHS Web of Conferences*, 92, 04019.
<https://doi.org/10.1051/shsconf/20219204019>
- Temur, G. T., & Bolat, B. (2018). A robust MCDM approach for ERP system selection under uncertain environment based on worst case scenario. *Journal of Enterprise Information Management*, 31(3), 405–425.
<https://doi.org/10.1108/JEIM-12-2017-0175>
- Vilpolo, I., Kouri, I., & Väänänen-Vainio-Mattila, K. (2007). Rescuing small and medium-sized enterprises from inefficient information systems - A multi-disciplinary method for ERP system requirements engineering. *Proceedings of the Annual Hawaii International Conference on System Sciences*.
<https://doi.org/10.1109/HICSS.2007.464>
- Zhang, M., & Zhang, Z. (2009). ERP system selection based on SVM. *Proceedings - 2009 International Conference on Networking and Digital Society, ICNDS 2009*, 1, 13–16.
<https://doi.org/10.1109/ICNDS.2009.10>

Constructivist Approach to Curriculum Development: A Methodological Literature Review

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ABSTRACT

A methodological review was performed on constructivist approach to curriculum development. This review systematically selected articles through a profound analysis of literature from 2009 to 2022 and selected 15 articles which had been published in well-known journals. All these articles had hypothesis tested empirically and focused on the main key words ‘constructivism’ and ‘curriculum development’. Articles were reviewed based on methodological devices such as research design, sampling methods, data collection, data analysis and reliability and validity measures. Majority of the studies were quantitative studies or mixed method studies which followed a deductive approach. The important finding in the review is that most of the studies had a control and an experimental group involved in a learning intervention, which clearly showed pre-experiment and post-experiment experiment data collected and analyzed. Significant methodological gaps were identified and further notable suggestions were proposed.

Key words: *Constructivism, curriculum development, social constructivism, zone of proximal development.*

1. INTRODUCTION

Empirical studies in the field of curriculum development in the education sector in Sri Lanka are so far the minimal or even unattainable. Incorporating educational theories into curriculum development and reforms and

implementing them into learning environments is significant in making every student, a life-long learner.

The Democratic Socialist Republic of Sri Lanka is an island in the Indian Ocean in which the total population is 20.3 million in 2012 (Department of Census and Statistics, 2012). In Sri Lanka there is a total of 10,155 Government Schools providing education to 4.1 million students (Department of Census and Statistics, 2012; Ministry of Education, 2020). With an academic staff of 250,000 there are 1.6 million students in the Primary Cycle, 1.3 million in Junior-Secondary Cycle Six hundred thousand of senior-secondary students (Department of Census and Statistics, 2012; Ministry of Education, 2020).

Sri Lankan education system has been through many curriculum reforms throughout the past years. In 2007, some salient changes were made such as the 5E model (Engagement, Exploration, Explanation, Elaboration and Evaluation) and competency based curriculum which expected the entire education system to change and reform to the needs of a more learned population (Tharmaseelan N., 2007; Widanapathirana et al., 2014). The reforms even looked at encouraging activity based learning, facilitating students in constructive knowledge (Fareed Nawastheen, 2019). However, in a study conducted by the National Institute of Education (NIE) on curriculum development in Sri Lanka, it highlights that none of these reforms have influenced a student’s learning journey. As a result, many have concerns over the quality of the

outputs generated by the system (Widanapathirana et al., 2014).

In an extensive study conducted by the Sri Lanka Association for Advancement of Education (SLAAED) in 2010, it highlights in detail the areas which have been overlooked or not implemented accurately in relation to the current school curriculum. The report highlighted that basic competencies were not incorporated in the curriculums and even potential competencies such as personality development, communication, environment and learning to learn which contributes to learner achievement has been overlooked (Widanapathirana et al., 2014). Hence most of the school curriculums are overloaded and tend to be too centralized with minimal focus on actual and life-long learning (Liyanage, 2014). Although the recent reforms were expected to reduce the recent content overload and introduce meaningful, creative and activity-based approaches it seems that expected levels have not been met and need to be re-examined (Liyanage, 2014; Widanapathirana et al., 2014).

Due to the reason those new curriculums have not been formed and founded on a clear theoretical base and had not been able to fulfill the students' social expectations, it is learned that these curriculum reforms have not been delivered effectively (Fareed Nawastheen, 2019; Widanapathirana et al., 2014). Out of the very minimal studies conducted in this area, some researches have clearly highlighted the importance of teaching methodologies that must focus on the modern and innovative learning, assessment systems that are flexible, curriculums which are meaningful, creative and activity-based learning (Fareed Nawastheen, 2019; Tharmaseelan N., 2007; Widanapathirana et al., 2014). This emphasis leads to the need for producing new curriculum reforms based on strong educational theories and empirical findings so that such reforms can be incorporated to an education system which will make learning more life-long and make learners critical thinkers.

The literature on curriculum development and

theories in education has been in the spectrum for centuries. Many articles can be found in this context both conceptual and empirical. In the most recent literature, it is found that *Constructivism* is a very important branch of cognitive learning theory. This paper intends to evaluate the methodological choices of constructivism theory in learning. This review will systematically evaluate the methodologies applied in the empirical research that has been conducted across spans of related areas in education and will assist to decide which methodological approach will attribute towards most accurate results.

2. THEORETICAL BACKGROUND

Constructivism is where people acquire knowledge and learn. Hence, it has a direct application to learning. A constructivist will construct their knowledge based upon the past experiences of what they know and build knowledge or modify knowledge into a new learning experience. When using this approach to learn, learners are more active rather than passive and confront their own understanding over a situation and change to accommodate new knowledge (Bada & Olusegun, 2015; Li Chengyun, 2022; Schrader, 2015; Sjøberg, 2010). Some of the major works of constructivism has been found in the works of John Dewey (1929), James Bruner (1961), Lev Vygotsky (1962), and Jean Piaget (1980).

The theorists above focused on how the curriculum must be designed to accommodate the constructivist approach and what other attributes are required for a constructivist to gather knowledge. Piaget and Dewey both highlighted the term of individual and cognitive constructivism (Bada & Olusegun, 2015; Sjøberg, 2010). Lev Vygotsky referred to social constructivism in which he says that learners must socially connected to build, compare and gather new knowledge.

It is through social constructivism that learners construct knowledge through their interaction with the physical world. Bruner also highlighted that learning is a social process (Amineh & Asl, 2015; Andrews, 2012; Bada & Olusegun, 2015;

Powell & Kalina, 2009).

A constructivist classroom ideally moves the focus from the teacher to a student. In a constructive model, the students are urged to actively take part in their own process of learning (Bada & Olusegun, 2015). As such the typical role of a learner in a constructivist environment would be building and transforming knowledge (Amineh & Asl, 2015). Piaget's focus was how and in what stages will an individual construct knowledge. In his theory, he emphasized that "humans cannot be given information, instead humans must construct their own knowledge"(Powell & Kalina, 2009) . As a result, students learn more and enjoy learning, develops their thinking and analytical skills, transfers knowledge from one setting to another, students learn to question things and are more curious about their surroundings(Bada & Olusegun, 2015; Powell & Kalina, 2009). Theorists also highlighted the view that learners constructs knowledge best when they are socially connected. Hence it is critical to consider the background and culture of the learner during the learning process which helps to shape the knowledge and truth that the learner creates (Amineh & Asl, 2015; Powell & Kalina, 2009; Sjøberg, 2010).

A main branch of Social Constructivism is the zone of proximal development (ZPD). This was a strong focus of Vygotsky in which he focuses a period of time in between assistance and guidance given for a learner up to the zone where they are able to conduct tasks independently(Powell & Kalina, 2009). In this context, Vygotsky highlights that "learning is developmental in nature and constitutes two zones: actual (current) and potential (proximal)" (Kantar et al., 2020). Vygotsky further highlights to say that when students immerse in matters they become more independent and with time students will not only be motivated but will take charge of their learning(Kantar et al., 2020; Powell & Kalina, 2009).

Educator's view and their knowledge in creating the best classroom to foster constructivism approach are significant in order to gain effective

outcomes. In a constructive learning environment and educator is often referred to a '*facilitator*' in which the facilitator must create situations which the learners make use of to question themselves as well as their peers(Amineh & Asl, 2015). The facilitator must coach, mediate, prompt and help students develop and assess their understanding (Bada & Olusegun, 2015). Facilitator's belief about learning also can be a critical factor. It is important that the facilitators must first believe in transforming a learner through constructivism and apply scaffolding approach when creating and taking part in the learning environments. In such a case, the learner will play an active role when the facilitator facilitates the learning process and helps the learner to learn.(Amineh & Asl, 2015).

Although many researchers have discussed and reviewed the concepts of constructivism it is important to look at empirically how well these theories can be applied to the actual context a student learning environment. It was remarkable to find that although these theories do sound very deep and true, carefully strategized methodological formations had to be chosen in order to prove them empirically. Hence, the next part of the paper heavily focuses on systematically analyzing the methodologies used and the results gained in studies focusing on constructivist approach to learning.

3. METHOD

3.1 Literature Selection and Criteria for Study Inclusion

A systematic literature search was conducted to identify peer-reviewed journal articles published from 2009 to 2022. Manual searches were performed in Google Scholar and PRIMO (Peer Reviewed Instructional Materials Online) databases.

3.1.1 Google Scholar

At the most initial stage Google Scholar was used to find articles in the context of constructivism and 614,000 articles were generated by this

search. In order to narrow down the search, further articles were looked for “constructivism AND curriculum development”. This criterion was helpful to reduce the articles to 285,000. In order to further refine the search, articles that were considered the most recent between the years 2009-2022 were selected which counted up to 19,200. A strong emphasis was given to the search keywords and keywords mentioned in the titles of the articles.

The most contiguous articles which had the following keywords and terms embedded into the articles’ abstract and or titles were selected. The terms are:

‘Constructivism’, ‘Constructivism Learning Theory’, ‘Learning and construction’, ‘Social constructivism’, ‘Zone of Proximal Development’, ‘Constructivists learning environment’, ‘curriculum development’, ‘Critical Thinking’, ‘Constructivism pedagogy practice’.

Out of all articles that was yielded only empirical studies which had followed a methodological process was selected for further review. It must be highlighted that the significance of selecting empirically tested findings is that it is done through the use of appropriate methods and through it reality can be understood (Bryman, 2012).

3.1.2 PRIMO Database

As the second approach PRIMO database available in the University of Plymouth online portal was utilized to search for relevant articles. This search opened access to vast amounts of resource material through a variety of gateways to other online libraries. The initial search focused on the two main key words and narrowed it only to search for articles which included the two main keywords: “constructivism AND curriculum development”. This search generated 1210 articles. The search was then refined to articles that were published between 2010 to 2022 and the articles that were returned was 672.

The following keywords and terms embedded into the articles’ abstract and or titles were selected. The terms are:

Constructivism’, ‘Constructivism Learning Theory’, ‘Learning and construction’, ‘Social constructivism’, ‘Zone of Proximal Development’, ‘Constructivists learning environment’, ‘curriculum development’, ‘Critical Thinking’, ‘Constructivism pedagogy practice’, ‘Sustainable growth’, ‘Education’, ‘Transactional Learning’.

All subject terms relevant to the above key terms were skimmed through. Further subject terms related that were also looked into was computer-assisted learning, transactional learning, pedagogy practice, instructional approach, e-learning environments, digital literacy, technology-driven and social constructivism, design thinking, Motivation. Articles that were directly titled as empirical or mixed-method approach or case study or an experimental study were also taken as an inclusion criterion.

Conceptual paper and or articles which did not demonstrate any empirical findings through proper methodological devices were excluded. Literature reviews and meta-analysis were also excluded from the yielded articles.

The articles that were selected for the review consists of a mixture of qualitative, quantitative and mixed-method approach to research. Among the articles are non-experimental, experimental design methodologies. Some studies were conducted in classroom environments among school and a few were among undergraduate student. A detailed list of articles and authors of the selected articles are presented in the table 1.

The most relevant articles were found from ELSEVIER (4 articles) followed by Routledge Taylor & Francis (4 articles.) Article were also found from Springer Open, Springer, SAGE, IOP publishing and Emerald were included in the review.

Table1: The Title and Authors of the articles selected

No.	Article Name	Author
1	Transforming Constructivist Learning into Action: Design Thinking in Educations	Scheer et.al(2012)
2	Constructivist approach in teaching sustainability and business ethics	Dziubaniuk & Nyholm(2021)
3	Recontextualising Education for Sustainable Development in pedagogic practice in Vietnam: linking Bernsteinian and constructivist perspectives.	Nguyen et.al(2021)
4	Rethinking clinical instruction through the zone of proximal development.	Kantar et.al(2020)
5	Sri Lankan Teacher's concerns towards implementation of curriculum reforms in the competence based curriculum reforms.	Nawastheen(2021)
6	Defining, designing for, and measure "social constructivist digital literacy" development in learners: a proposed framework.	Reynolds(2016)
7	Effects of constructivist learning environment on students' critical thinking ability: cognitive and motivational variables as mediators	Kwan & Wong(2015)
8	Constructivist or Christian: A Mixed-Methods Examination of Teacher Purposes and Practices at Mennonite Schools	Yoder et.al (2021)
9	Enhancing E-learning effectiveness using an intelligent agent-supported personalized virtual learning environment: empirical investigation	Xu et.al(2014)
10	Differential relations of constructivist and didactic instruction to students' cognition, motivation and achievement.	Nie & Lau (2009)
11	Enhancing summary writing of ESL learners via Theory-based Online Tool: Systems development and evaluation	Chew et.al (2020)
12	Using design thinking to cultivate the next generation of females STEM Thinkers	Kijima et.al(2021)
13	Constructivism as pedagogical framework and poetry learning outcomes among Nigerian students: An experimental study	Ugwuozor(2020)
14	Exploring constructivism learning theory using mobile game	Padirayon et.al(2019)
15	How does an interactive approach to literary texts work in English as a foreign language context? Learner's perspectives in close-up.	Nguyen(2016)

Table 2: The Journals of the articles selected.

Journal Name
Design and technology: An International Journal
Emerald Insight Journal
Environmental Education Research
Nurse Education Today
Muallim Journal of Social Sciences and Humanities
Educational Technology research And Development
International Journal of Educational Research
Journal of Research on Christian Education
Information & Management
Learning and Instruction
Journal of Educational Computing Research
International Journal of STEM Education
Cogent Education

In this methodological review the content analysis was conducted focusing on the methodological aspects the researcher has used in the selected studies. As the initial process, the selected studies were individually read through to identify the characteristics, details of participants and the contexts (Olaf Zawacki-Richter · et al., 2020). As described in Olaf Zawacki-Richter et. al (2020) in the E-book *Systematic Reviews in Educational Research* the content analysis of this review looked mainly at the details and design of the study and ways of it can be mapped to the context, the relevance of the studies in addressing the reviewed area of research and the results which can be synthesized to answer the review question.

3.2 Research Design

A research design will provide the framework to collect and analyze data in order to be able to find connections between variables and most importantly to be able to generalize findings to larger group (Bryman, 2012). For this review the two main approaches to research design was given focus to: qualitative and quantitative. A notable amount of studies were also found having used a mixed-method approach. Secondly, in order to be more critical the setting in which the quality of the

execution of the study were looked into (Olaf Zawacki-Richter · et al., 2020). Most of the studies were conducted in an experimental setting supported by empirical data. The experiments were conducted with control and experimental groups testing variables according to a stated hypothesis. Some studies were conducted in a few schools causing a case study approach. All studies presented how a chosen subject area had been used in an intervention program to measure the strength of the constructivist approach in a real learning environment.

A mixed-method research design was seen to be the approach taken by five articles that were reviewed. Most of the five articles took a quantitative approach and then a qualitative approach in its design. A very few were found to have been taken a qualitative approach first and then followed by a quantitative one.

An exclusively quantitative design was found to be the approach in many articles whereas a few were seen qualitative only. Three studies were to be case studies where one was conducted in a single school environment. Two other studies were found to have been conducted in many schools.

Table 3: Summary of the articles in this review and the methodologies used.

No .	Author	Research Design	Sampling Method	Data Collection Methods	Validity & Reliability	Data Analysis
1	Scheer et.al(2012)	Three day case study, empirical study , Quantitative		Questionnaires		
2	Dziubaniuk & Nyholm(2021)	Case study, longitudinal study		Open-ended questionnaire	Nvivo textual data	
3	Nguyen et.al(2021)	Case study , qualitative ,deductive approach		Video recorded observations and documented observations.		MAXQDA Software
4	Kantar et.al(2020)	Multiple case study, qualitative	Purposive Sampling	Three-hour observations and interviews		
5	Nawastheen(2021)	Mixed method(Quantitative and Qualitative), experimental study	Stratified Random Sampling	Questionnaires , interviews and classroom observations		Inferential Statistical Tools
6	Reynolds (2016)	Quantitative , non-experimental longitudinal study	Random Sampling	Pre and Post Questionnaires	Not stated	T-test, ANOVA test, Multiple Regression Analysis
7	Kwan & Wong(2015)	Cross sectional survey design, Quantitative study	Convenience Sampling	Questionnaire		
8	Yoder et.al (2021)	Mixed Method(Quantitative & Qualitative)	Purposive Sampling			Inferential Statistical Tools
9	Xu et.al(2014)	Quantitative study, field experiment	Convenience sampling	Pre and Post Questionnaires		Correlation , Structural equation modeling.

No	Author	Research Design	Sampling Method	Data Collection Method	Validity & Reliability	Data Analysis
10	Nie & Lau (2009)	Quantitative study	Stratified Random Sampling	Questionnaires	Cronbach's Alpha and Confirmatory Factor Analysis (CFA)	
11	Chew et.al (2020)	Mixed Method, control and experimental groups	Convenience Sampling	Semi-structured and focus group interviews	Kappa Value	
12	Kijima et.al (2021)	Mixed Method (Quantitative & Qualitative), longitudinal study	Purposive sampling	Structured interviews and surveys		
13	Ugwuozor (2020)	Quantitative, experimental study with control and experimental groups	Purposive Sampling	Essay Type Questionnaire		ANOVA, Univariate ANOVA, Inferential Statistical Tools
14	Padirayon et.al (2019)	Quantitative intervention study	Purposive sampling	Pre-test and Post-test values		Inferential Statistical Tools
15	Nguyen (2016)	Mixed method (Qualitative and Quantitative), experimental design	Purposive Sampling	Class recordings, journal entries, after-class evaluations, questionnaires and student writings	Nvivo Software	

In this review seven of the articles were found to have used an experimental design. The articles presented clear findings of pre and post experimental design data of both control and experimental groups. Fourteen of the studies selected in this review used questionnaires and using statistical methods such as ANOVA test, PEARSON's product-moment correlation coefficient, t-tests etc. presented data gathered for analysis. Inferential statistical tools such as mean, standard deviation were used in most articles. Interviews both structured and semi-structured, observations, recorded observations were also seen being done in most of the articles that were reviewed.

Among the articles that were reviewed most of the populations chosen were school environments. Although some studies had selected samples from undergraduate environments. Five of the studies in the review had used purposive sampling where convenience and stratified sampling techniques had been used in four and two articles respectively.

In terms of validity and reliability evidence some articles did show evidence whereas some failed to do so. Coding using Nvivo software was seen by one article for reliability and validity whereas Cohen's Kappa value, Cronbach's alpha value and Confirmatory Factor Analysis (CFA) were used in articles to measure reliability and validity. There were at least about thirteen articles which did not mention any evidence of reliability and validity.

In this review, two articles were longitudinal studies. However these two studies were non-experimental. In most of the articles reviewed a substantial amount of articles were found either followed a mixed-method approach or a quantitative analysis with an experimental setting with control and experimental groups involved in an intervention in an actual learning environment.

3.3 Discussion

In this review a notable finding is that most researches have followed a quantitative analysis in an experimental setting (Kwan & Wong, 2015; Nie & Lau, 2010, 2010; Padirayon et al., 2019; Reynolds, 2016; Scheer & Noweski, 2012, 2012; Xu et al., 2014).

A quantitative research is a one that emphasizes "quantification in collecting data that entails a deductive approach" (Bryman, 2012). In mostly all the studies it was clearly found that the existing theory of constructivism was incorporated as the base and data findings were gathered to prove its applicability to different settings. Constructivism is learning a theory in which embedding it into curriculum development will need the research design to measure certain variables pre and post values. Hence it is important that the research is constructed and implemented in an experimental setting in order to follow a deductive approach.

A significant finding in this review was that the studies used a control and an experimental group who have been a part of a learning intervention for a period of time in designing the experiment. (Chew et al., 2020; Fareed Nawastheen, 2019; Ugwuozor, 2020 ;Kijima et al., 2021). Some studies clearly stated that intervention programs being incorporated had a positive impact on learning (Kijima et al., 2021). Researches had tested learning environments which were designed with learning interventions which promoted constructivism. These experiments had an experimental and a control group involved. By forming such groups researches' are able to find out the differences between the groups that are responsible for variations among variables (Bryman, 2012).

A mixed method approach was also identified to be followed by a reasonable amount of researchers' and mostly a quantitative approach was followed by a qualitative one (Fareed Nawastheen, 2019; Kijima et al., 2021; Yoder et al., 2021).

In one article it was found that the researcher

preferred qualitative to be followed by a quantitative approach. Triangulation process in a mixed method research can have a critical impact to the findings. Hence it is important that researchers' clearly identify which method must be initially followed to make sure that findings are consistent (Bryman, 2012). According to Bryman (2012) by including both quantitative and qualitative methods researchers' can fill out gaps left by one method. As both quantitative and qualitative approaches are used in a mixed method research the relationship among variables are related and well formed. A mixed method research design also will have a high credibility in the results that it would generate and can produce a diversity of views on the research area (Bryman, 2012). As both approaches of qualitative and quantitative research design focuses on two different perspectives on what is being researched it does create a balanced for the research which will enable a more generalized solution to be emerged (Wenger, 1999).

A common method of data collection in this review was questionnaires. However, it must be stated that methods such as observations, semi-structured interview, recorded observations, teacher-student logs, journal recordings, open-ended and essay type questionnaires were also seen as commonly used (Chew et al., 2020; Dziubaniuk & Nyholm, 2021; Fareed Nawastheen, 2019; Kantar et al., 2020; Nguyen, 2016; Ugwuozor, 2020). A combination of many data collection methods would be the most appropriate in order to gather data in a consistent manner (Nie & Lau, 2010).

Many studies were seen highlighting the importance in making learning interventions last for a substantial period of time in order to gain more consistent findings which can then be generalized. Most studies hence recommended that further research methodologies in this context be conducted as longitudinal studies. (Chew et al., 2020; Kwan & Wong, 2015; Nie & Lau, 2010; Xu et al., 2014). The interaction of both types of data in

a longitudinal methodology will predict better responses and more effective results as quantitative data will provide more insight into developing accurate hypothesis, validate and generalize findings (Wenger, 1999).

Most of the reviewed articles had selected either convenience sampling or purposive sampling. It was noted in some literature that a main limitation in convenience sampling is its generalizability and the most critical factor being the data not producing definitive findings to the research question. (Kwan & Wong, 2015). Convenience sampling is one that simply and easily available. However although many researches have used convenience sampling in this review it has a limitation which is the inability to generalize beyond sample which is critical (Acharya et al., 2013).

Among most of the reviewed articles purposive sampling was found to be used by many researches. In purposive sampling technique the "researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of knowledge or experience". Purposive sampling also emphasizes on obtaining a "comprehensive understanding by continuing to sample until no new substantive information is acquired" (Etikan, 2016). The reviewed articles also highlighted the use of stratified random sampling technique to gather data. This is where researches focused a particular learning environment where learners followed a single subject or across different learner groups. When obtaining a sample the researcher is supposed to consider various strata and a random sample is taken where there by all groups are represented in the population reduces.

In the current review it was found that much literature did not show any significant evidence of validity and reliability measurements. In one of the quantitative studies the Cronbach's Alpha and the Confirmatory Factor Analysis measurements had been used for validity and reliability.

In an experimentally designed methodology the presence of a control group and an experimental group will enable to enhance the internal validity and eliminate rival explanations as the control group will control causal findings in a given context (Bryman, 2012). Therefore it is significant that an experimental design must have validity and reliability measurements constructed (Bryman, 2012).

Deductive approach was the widely used approach in most all the studies that were reviewed. The theory of constructivism was deeply researched in all the studies with different variables either being connected to each other or contributing towards the relationships as a moderating variable (Fareed Nawastheen, 2019; Nguyen, 2016; Nie & Lau, 2010; Reynolds, 2016; Ugwuozor, 2020; Xu et al., 2014). In a deductive approach the theoretical consideration in relation to a particular domain deduces a hypothesis which is subjective to empirical analysis by the researcher (Bryman, 2012). It is therefore significant to design and propose a methodological foundation of a mixed method analysis which will use actual evidence in order to confirm or reject the hypothesis formed. In most of the quantitative and mixed method studies that were reviewed it was noted that inferential statistical tools, t-test, ANOVA test were commonly found to be used to provide an analysis of data.

3.4 Conclusion

This methodological literature review of studies in constructivist approach to curriculum development discusses in detail the methodological choices applied by researchers in this context. This review presented the methodological stands of several articles which has the foundation of theory of constructivism tested on different context and among different samples. It was made clear in this review that in order to implement this deductive approach an actual intervention must take place in an actual learning environment. This will take the form of an experimental study design with control and

experiment groups. A mixed methodological study can also be considered in this context as this review pointed both approaches as it does create a balance for the research which will enable a more generalized solution to be emerged. The researcher must give importance and critically evaluate the process of triangulation which will enable the researcher to gather the accurate data at the correct instance. As suggested in this review a longitudinal study should also be considered as a more consistent result can be gathered and hence can be applied to learning environments.

References

- Acharya, A. S., Prakash, A., Saxena, P., & Nigam, A. (2013). Sampling: Why and how of it? *Indian Journal of Medical Specialities*, 4(2).
<https://doi.org/10.7713/ijms.2013.0032>
- Amineh, R. J., & Asl, H. D. (2015). Review of Constructivism and Social Constructivism. 9.
- Andrews, T. (2012). What is Social Constructionism? 11(1), 10.
- Bada, D., & Olusegun, S. (2015). Constructivism Learning Theory: A Paradigm for Teaching and Learning. 6.
- Bryman, A. (2012). Social research methods (Third). Oxford University Press.
- Chew, C. S., Wu, W.-C. V., Idris, N., Loh, E. F., & Chua, Y. P. (2020). Enhancing Summary Writing of ESL Learners via a Theory-Based Online Tool: System Development and Evaluation. *Journal of Educational Computing Research*, 58(2), 398–432.
<https://doi.org/10.1177/0735633119837765>
- Department of Census and Statistics. (2012). *Jana hā nivāsa saṅgaṇanaya, 2011: Gaṇan gānīmē adiyara Pebaravāri, Mārtu, 2012.*

Department of Census and Statistics,
Ministry of Finance and Planning.

- Dziubaniuk, O., & Nyholm, M. (2021). Constructivist approach in teaching sustainability and business ethics: A case study. *International Journal of Sustainability in Higher Education*, 22(1), 177–197. <https://doi.org/10.1108/IJSHE-02-2020-0081>
- Etikan, I. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1. <https://doi.org/10.11648/j.ajtas.20160501.11>
- Fareed Nawastheen. (2019). EDUCATIONAL AND CURRICULUM CHANGES IN SRI LANKA: IN LIGHT OF LITERATURE. *Muallim Journal of Social Science and Humanities*, 342–361. <https://doi.org/10.33306/mjssh/43>
- Kantar, L. D., Ezzeddine, S., & Rizk, U. (2020). Rethinking clinical instruction through the zone of proximal development. *Nurse Education Today*, 95, 104595. <https://doi.org/10.1016/j.nedt.2020.104595>
- Kijima, R., Yang-Yoshihara, M., & Maekawa, M. S. (2021). Using design thinking to cultivate the next generation of female STEAM thinkers. *International Journal of STEM Education*, 8(1), 14. <https://doi.org/10.1186/s40594-021-00271-6>
- Kwan, Y. W., & Wong, A. F. L. (2015). Effects of the constructivist learning environment on students' critical thinking ability: Cognitive and motivational variables as mediators. *International Journal of Educational Research*, 70, 68–79. <https://doi.org/10.1016/j.ijer.2015.02.006>
- Li Chengyun. (2022). English Research Learning and Functional Research based on Constructivism theory and Few-Shot Learning. *Computational Intelligence and Neuroscience*.
- Liyanage, I. M. K. (2014). Education System of Sri Lanka: Strengths and Weaknesses. 25.
- Ministry of Education. (2020). Annual School Census of Sri Lanka (Final Report, p. 154).
- Nguyen, H. T. T. (2016). How does an interactive approach to literary texts work in an English as a foreign language context? Learners' perspectives in close-up. *Innovation in Language Learning and Teaching*, 10(3), 171–189. <https://doi.org/10.1080/17501229.2014.932361>
- Nie, Y., & Lau, S. (2010). Differential relations of constructivist and didactic instruction to students' cognition, motivation, and achievement. *Learning and Instruction*, 20(5), 411–423. <https://doi.org/10.1016/j.learninstruc.2009.04.002>
- Olaf Zawacki-Richter ·, Michael Kerres ·, Svenja Bedenlier ·, & Melissa Bond · Katja Buntins Eds. (2020). *Systematic Reviews in Educational Research*. Springer VS. <https://doi.org/10.1007/978-3-658-27602-7>
- Padirayon, L. M., Pagudpud, M. V., & Cruz, J. S. D. (2019). Exploring constructivism learning theory using mobile game. *IOP Conference Series: Materials Science and Engineering*, 482, 012004. <https://doi.org/10.1088/1757-899X/482/1/012004>
- Powell, K. C., & Kalina, C. J. (2009). COGNITIVE AND SOCIAL

CONSTRUCTIVISM: DEVELOPING
TOOLS FOR AN EFFECTIVE
CLASSROOM. 10.

[https://doi.org/10.1016/S0890-4065\(99\)00015-8](https://doi.org/10.1016/S0890-4065(99)00015-8)

- Reynolds, R. (2016). Defining, designing for, and measuring “social constructivist digital literacy” development in learners: A proposed framework. *Educational Technology Research and Development*, 64(4), 735–762. <https://doi.org/10.1007/s11423-015-9423-4>
- Scheer, A., & Noweski, C. (2012). Transforming Constructivist Learning into Action: Design Thinking in education. 12.
- Schrader, D. E. (2015). Constructivism and Learning in the Age of Social Media: Changing Minds and Learning Communities: Constructivism and Learning in the Age of Social Media. *New Directions for Teaching and Learning*, 2015(144), 23–35. <https://doi.org/10.1002/tl.20160>
- Sjøberg, S. (2010). Constructivism and Learning. In *International Encyclopedia of Education* (pp. 485–490). Elsevier. <https://doi.org/10.1016/B978-0-08-044894-7.00467-X>
- Tharmaseelan N. (2007). Tertiary Education in Sri Lanka: Issues and Challenges. *Bulgarian Journal of Science and Education*, 1.
- Ugwuozor, F. O. (2020). Constructivism as pedagogical framework and poetry learning outcomes among Nigerian students: An experimental study. *Cogent Education*, 7(1), 1818410. <https://doi.org/10.1080/2331186X.2020.1818410>
- Wenger, G. C. (1999). Advantages Gained By Combining Qualitative and Quantitative Data in a Longitudinal Study. *Journal of Aging Studies*, 13(4), 369–376.
- Widanapathirana, S., Mampitiya, D. U., Jayawardena, M. R. C., & Chandratilleke, D. K. L. (2014). STUDY ON CURRICULUM DEVELOPMENT IN GENERAL EDUCATION IN SRI LANKA. 33.
- Xu, D., Huang, W. W., Wang, H., & Heales, J. (2014). Enhancing e-learning effectiveness using an intelligent agent-supported personalized virtual learning environment: An empirical investigation. *Information & Management*, 51(4), 430–440. <https://doi.org/10.1016/j.im.2014.02.009>
- Yoder, P. J., Wiens, P. D., & Chou, A. (2021). Constructivist or Christian: A Mixed-Methods Examination of Teacher Purposes and Practices at Mennonite Schools. *Journal of Research on Christian Education*, 30(1), 59–78. <https://doi.org/10.1080/10656219.2021.1906369>

Media and its Intersections with Workplace Femininities: A Systematic Literature Review

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ABSTRACT

An overarching literature review was performed on studies focused on media and its intersections with workplace femininities published from the year 2010 to 2022. This review systematically selected 16 journal articles on media and its influence on femininities within the workplace. Articles were reviewed based on its methodological choices, context, use of theories, main findings and conclusions, in order to gain a thorough overview of the literature and knowledge in this area of study. Findings of the review revealed that researchers had utilized a variety of methodological stances to conduct their studies. The majority of the studies in the field followed a qualitative approach, and most studies relating to media, organizations/workplace and femininities or gender utilized content or discourse analysis as the research analysis lens to extract and evaluate the data. The qualitative studies in the area were primarily based on gender, feminist and postfeminist theories. Moreover, the review uncovered core rubrics within the main findings of the studies, such as institutional influence, the romanticization of the 'career woman' and its aesthetic nuances, the postfeminist ideology which negates the issues of hegemonic structures, and the existence of sexual objectification via the commodification of women's bodies. Further, significant gaps were identified, pertaining to context and other variable factors of gendered identities, that could be bridged by future studies.

Keywords: Media, Femininities, Organization and Gendered Identities, Workplace Femininities, Gender Representations

1. INTRODUCTION

Media has been accepted as a powerful tool to influence society's views on various issues, angles and subjects. Research has shown that even within contemporary societies, media does indeed influence society's perceptions of gender and gendered identities (Tabassum & Nayak, 2021; De Silva & Narampanava, 2014; Sriwimon & Zili, 2017; Bligh et al., 2012; Ward & Grower, 2020; Grau & Zotos, 2016). Moreover, gender stereotyping, concerning both femininities and masculinities transmitted via various sources of media, such as television commercials, print media and even the cinema can have negative implications and lead to prejudice and discrimination (Shamilishvili, 2019; Fernandez & Menon, 2022). Furthermore, many studies have found that an increased exposure to various forms of media stemming from television, the news to music and social media that disseminate gender stereotyping may lead to increased acceptance of traditional gender roles (Ferris et al., 2007; Seabrook et al., 2017; Zurbriggen & Morgan, 2006). Moreover, many studies indicate that various sources of media, including music videos, and other popular culture genres are compellingly potent spaces that disseminate, and sometimes repudiate sexual objectification and gender stereotyping, with women being more vulnerable to such acts (Aubrey et al., 2011; Conrad et al., 2009; Cummins, 2007; Frisby & Aubrey, 2012).

While the media might broadcast messages that may or may not be accurate, the media does however normalize these said behaviors, thereby establishing norms that influence individuals and their attitudes, behaviors, and motivations (Riddle & DeSimone, 2013). Therefore, it can be assumed that such effects could transfer onto numerous subsets of society and even across varying communities, for the purpose of this study, the workplace or professional spheres. Thus, this stereotyping of gender-based competencies, identities and attributes, re-affirmed by pre-existing attitudes, can have an impact on organizational socialization and culture, and may directly or indirectly lead to biases at the point of recruitment, career progression, the assignment of job roles and responsibilities, and ultimately the distribution of men and women among different opportunity structures (Tabassum & Nayak, 2021).

Understanding this crucial impact that media may have on societal perspectives and implications based on media transmitted gender stereotyping, especially on women, this paper aims to systematically review the existing literature pertaining to research on media and its intersections with femininities within the workplace. Reviews pertaining to gender and media, as discussed above, are common place, however, there is a lack of literature on the influence of the gendering in media on the notions of femininities within the workplace. Thus, via this systematic review I hope to understand the various nuances and aspects that previous researchers have delved into regarding gender and its intersections with workplace femininities, in order to understand the gaps within this research niche.

2. METHODOLOGY

A systematic literature search on media and its influence on workplace femininities was performed using PRIMO, the University of Plymouth electronic library. Specific high impact databases such as Emerald, Wiley and Blackwell, Taylor and Francis, Sage, Jstor, and Elsevier were utilized in order to gather the most relevant and high-quality articles, pertaining to the research area. The following

search terms were used in appropriate combinations: media or popular culture, femininities or gender, workplace or organization or company. The terms were appropriately combined within a search string, in order to extract the most relevant literature available (Refer Figure 1 – flowchart of inclusion/exclusion criteria).

Limits were placed during the search on the PRIMO site with regard to the Year of Publication (data posterior to 2010), the language of publication (English only), the type of articles (peer-reviewed only). These limitations were due to practical and feasible reasons, the inclusion of literature only after 2010, was to ensure that the most recent information was extracted, as media has greatly evolved over the years, and so have the notions of gender and femininities. Moreover, I selected articles published in English only, for practical linguistic reasons of comprehension. Furthermore, peer reviewed articles were selected to maintain quality. Thus, the initial manual search yielded 87 articles.

This was further limited based on more inclusion criteria, such as the availability of full texts only, and removal of duplicates. This resulted in a total of 79 articles. Following this, I eliminated articles that had titles that were irrelevant to the study, for instance studies that discussed femininities among university or school students, only articles that discussed professional women were taken into consideration. Thus, this further limited the number of articles to 27. The final count of articles that met the criteria, was therefore, 16, following close readings of titles, abstracts and subsequently the full text, in order to select only the most relevant and closely linked articles to the question at hand.

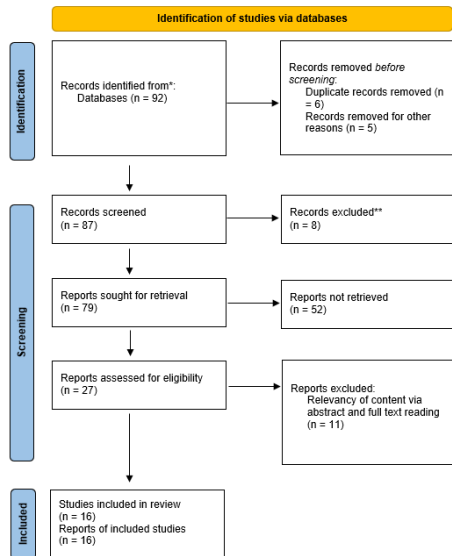


Figure 1:flow chart of inclusion/exclusion criteria(Adapted from: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71)

3. RESULTS

3.1 Methods and Methodologies

Most of the research articles selected for the review of this study (14 out of 16), had adapted a qualitative approach (Askanius, 2021; E. Smith et al., 2021; Gill et al., 2017; Jay, 2013; Lewis et al., 2017; Mavin et al., 2019; Nadin et al., 2020; Nodzak, 2021; Oktaviani et al., 2021; Orser et al., 2013; Pritchard et al., 2019; Rasmussen et al., 2021; Swan, 2017; Tsaousi, 2017) with one article using a quantitative approach (Stoker et al., 2012), and one using a mixed method (qualitative and quantitative) (Vandenberghe, 2019).

Moreover, among the chosen literature, 6 out of the 16 articles had utilized content analysis (Askanius, 2021; Jay, 2013; Nodzak, 2021; Rasmussen et al., 2021; Tsaousi, 2017; Vandenberghe, 2019). Further, 2 articles had used textual analysis as a tool to extract data (Oktaviani et al., 2021; Swan, 2017), furthermore, some (4 out of 16) had used

discourse analysis (Gill et al., 2017; Jay, 2013; Nadin et al., 2020; Oktaviani et al., 2021). One particular study had utilized a novel methodology, netnography (E. Smith et al., 2021), a derivation of ethnographic studies. Another study had utilized electronic questionnaires to gather information (Stoker et al., 2012), whilst another study had used semi-structured interviews and observations (Orser et al., 2013), and yet another had used participant responses to images/visuals (Pritchard et al., 2019).

3.2 Theoretical frameworks

The studies use various theoretical lenses to understand the multiple representations of femininities and gender dynamics within diverse contexts, however, the most predominant is feminist and gender theories adopted from Judith Butler's (1990) and Foucault's (1978) concept of gender performativity and identity. Since most of the studies take on a qualitative stance, the literature helps develop on these theories, and contributes towards the expansion of said theories. Moreover, a popular theory utilized in the most recent studies, published from the year 2017 onwards, is the Postfeminism/Postfeminist Sensibility.

3.3 Context – Locating the selected studies

Majority of the studies (14 out of 16) stem from the European or American contexts, such as UK, USA, Canada, Netherlands, Portugal and Sweden (Askanius, 2021; E. Smith et al., 2021; Gill et al., 2017; Lewis et al., 2017; Mavin et al., 2019; Nadin et al., 2020; Nodzak, 2021; Orser et al., 2013; Pritchard et al., 2019; Rasmussen et al., 2021; Stoker et al., 2012; Swan, 2017; Tsaousi, 2017; Vandenberghe, 2019). One study is from an Asian context, placed within Indonesia (Oktaviani et al., 2021), and one from the African state, Morocco (Jay, 2013).

3.4 Types of Data and Media Analyzed

The studies selected analyzed and delve into various types of media, some studies looked at gender representations and portrayals within print media, specifically newspapers, a few

studies examined television dramas, and reality shows, some evaluated the content in commercials, both images and videos, whilst another study reviewed websites, and online publications. Moreover, a couple of studies chose social media as their main data gathering environments. Most of the studies, however, used a mix of various types of media in order to extract the data required for their analysis.

3.5 Main Findings of the Selected Studies

3.5.1 Institutional Influence on Gendered Identities

Numerous studies found that there were various underlying institutions and existing notions of bias, and prejudice disseminated via authoritative bodies, government propaganda or fixed industrial norms (E. Smith et al., 2021; Jay, 2013; Oktaviani et al., 2021). These agendas, whether positive or negative were implicitly or explicitly transferred onto media via disparate actors, such as producers and directors of theatre productions, tv dramas or commercials, including professionals who believe in the propagating narratives on gender circulated by such official or unofficial authorities (Jay, 2013; Nodzak, 2021; Rasmussen et al., 2021). Moreover, it was found that even though the storytellers or media agencies may seem like independent bodies, they might still subscribe to the traditional and/or conventional ideas of gender, and in turn, femininity, and thus, converge their narratives within the larger more accepted discourse of gender and femininity within the given context (Askanius, 2021; Tsaousi, 2017; Vandenberghe, 2019). Thus, these policing perceptions act as spaces of self-disciplining and internal control (Rasmussen et al., 2021). Therefore, the overarching sense of gender equality and equity displayed within various forms of media, can be assumed to be superficial in some cases, and, hence, not a genuine reflection of the ground realities of the context in discussion (Swan, 2017).

3.5.2 The Romanticized 'Career Woman'

Further to the institutionalized, constructed notions of gender that are portrayed or

represented via media, the selected studies have further discovered that therein lies a romanticized idea of a 'career woman'. Professional femininities are expected to 'have it all', be successful in the workplace, whilst balancing family, domestic and social spheres as successfully (Askanius, 2021; E. Smith et al., 2021; Nadin et al., 2020; Stoker et al., 2012). This version of entrepreneurial femininity is the female equivalent of the mythologized male hero – accomplished, hard-working and successful at work and home. The main concerns stemming from this ideology is that the other realities of the professional woman are ignored, the emotional, economic and political. Moreover, it was found that inequalities were addressed, however, the social, political and economic explanations for the constraints and barriers women face were erased, even within a site developed to support women (Swan, 2017). Social and cultural constraints and difficulties such as the unequal division of labour at home, privatization of childcare, lack of societal support at work for working mothers, physical exhaustion and lack of leisure time, and the injuries of neoliberalism and heteronormativity, are largely 'repudiated' and 'silenced' (Askanius, 2021; Jay, 2013; Nadin et al., 2020; Stoker et al., 2012; Tsaousi, 2017).

3.5.3 The Postfeminist Mindset

Studies argue that in the cotemporary context most workplaces repudiate feminist notions, and prefer to believe that issues pertaining to gendered inequalities do not exist within the current context. This denial of issues, support a false sense of gender balance, whilst men and women are still predominantly allocated different roles and responsibilities, have differing expectations in terms of contribution, and even are expected to look and act differently within and outside the work space (Gill et al., 2017; Swan, 2017). Women are especially judged harshly for either opting out of the commercial sphere, or overtly dedicating oneself to professional advancement (Askanius, 2021; Vandenberghe, 2019). Such beliefs that negate the existence of feminist issues, may lead to a narrow definition of

appropriate gendered behavior, in this case, athletic behavior (Rasmussen et al., 2021). Thus, it can be surmised that hegemonic masculine ideals continue to be strictly reinforced in both media, and may transfer to various organizational values and operations.

3.5.4 Commodification and Positive Discrimination

Moreover, the selected literature uncovered existence of sexual objectification and commodification of women's bodies across various industries, including sports, and politics (Lewis et al., 2017; Mavin et al., 2019; Orser et al., 2013; Pritchard et al., 2019; Rasmussen et al., 2021). Further, even though beauty standards and norms have become more inclusive over the years, media reinstates the significance of the 'right appearance', for women leaders, and women entrepreneurs, i.e. thin, light skinned, beautiful smiles and air brushed hair (Orser et al., 2013). Media would emphasize more on professional's women's femininity, being a role model for other women, being part of a family and having certain looks. Furthermore, the predominance of make-over shows, such as the one discussed in Tsousi (2017), have sustained the idea that women must re-organize their bodies in order to look more presentable and successful in various aspects of life, whether it be professional or personal. Thus, in the contemporary context, women may not be explicitly requested to transform their appearance to suit the expectations of feminine beauty, however, are now advised to re-organize their body in order to regain their social worth and social capital. Further, most forms of media, including social media business pages, construct and distribute playful imagery that objectifies female staff and hyper-feminizes work spaces (E. Smith et al., 2021). Success is thus equated with a form of contrived beauty and privilege, with the promotion of glamour shots and images, over working or action images of professional women (Orser et al., 2013; Rasmussen et al., 2021).

3.6 Conclusions

Collating the conclusions from the literature discussed above, it is apparent that gendered identities and representations are problematized. Moreover, the portrayals of femininities within various media, even media formats that are deemed to be inclusive and feminist, do indeed harbor notions that discriminate and objectify women, both in positive and negative ways. Furthermore, whilst workplaces are interesting spaces of 'doing gender', media portrayals of gender, pertaining to entrepreneurial femininities, and professional women seem to negate the ground realities and issue faced by such women, and instead romanticize the career woman, and situate her within a postfeminist world where inequalities do not exist, and the ability to have a successful profession is considered a privilege and marker of 'having it all'.

4. DISCUSSION

4.1 Qualitative Design

As discussed previously, majority of the studies selected for this review had utilized qualitative research designs and methodologies to extract and analyze the data extracted from diverse sources of media. As most of the research articles seek to analyze and interpret representations of gender and gendered readings of various types of media, such as images, print media like newspaper articles, online publications, social media posts, tv shows and television commercials, utilizing a qualitative design is essential. Qualitative design is more focused on discourses, content and language, all of which are heavily embedded within all forms of media platforms (Bryman, 2012). Moreover, qualitative design is best used to uncover perspectives, participant observations and human interaction and socialization processes (Descombe, 2014), all of which are essential aspects discussed within the selected literature for this study. Thus, it is apparent that most of the researchers subscribed to this notion, and therefore chose the most suitable methodologies to effectively read, and analyze the content extracted from the chosen sources

of media, resulting in majority of the studies utilizing content and discourse analysis as the primary form of analysis.

4.2 Research Context

A constant point of contention with feminist research is its white supremacist quality, with many researchers arguing that it discusses only issues faced by white, middle class women, whilst neglecting issues that may occur due to other factors, such as race, class and context (Gill et al., 2017). This rings true to a large extent within this study as well, as majority of the studies (14 out of 16) hail from European or American contexts, and the sampling does not indicate if the researchers have taken into consideration other external factors. Therefore, these research studies cannot, under any circumstances be considered valid or reliable out of its euro-centric context.

4.3 Media and Workplace Femininities

According to Yoong (2020), the worlds of media and work place femininities converge within various discourses, the most productive among them being;

“‘female heroes’, which suggests that women can achieve success through confidence, control, resilience and passion; ‘female lack’, which blames gender work disparities on women’s personal behaviour and psyches; ‘balanced femininity’, which invites women to embrace yet carefully manage their femininity in the workplace; and ‘aesthetic labour’, which calls on career women to participate in intensive beauty practices.” (p.93)

Within the above discussed studies too, such themes were discussed, and scrutinized, and found that such realities still exist for women across industries, even in organisations that claim to be more inclusive and open to unconventional trends and norms. The ‘ideal feminine’ figure, who is both aesthetically pleasing and an entrepreneurial genius or skilled leader, is still commodified and marketed, thereby promoting traditional gender norms, whilst positively discriminating women in the workplace.

Such representation of women roles in media, can certainly have negative implications within the workplace, especially coupled with pre-conceived notions on the part of the authoritative figures that wield the power to make decisions on job roles, responsibilities and hierarchies. Moreover, it can place undue pressure on working women to look and behave in a specific way, ensuring that they skillfully balance their professional and domestic spheres, whilst looking aesthetically flawless, in order to be considered a successful career woman. This ideology posits a neoliberal sense of feminism ‘a happy work-family balance as a feminist ideal and as the signifier for emancipation for “progressive womanhood”’ (Banet- Weiser et al., 2020, p.14).

5. CONCLUSION

In the light of gendered progression and defying traditional roles within feminine workspaces, there has been a positive outlook in terms of female empowerment within the workplace, and media has been instrumental in building this narrative. However, within this postfeminist era, there is a tendency to overlook the ground realities and other challenges women of less privilege may face due to economic, social and political reasons. Moreover, institutional and government agencies may influence the portrayal of femininities in media, and utilize media as a tool to disseminate and execute their political agendas. Thus, encouraging a farcical or superficial sense of empowerment, and contrived sense of beauty. Thus, it becomes important for future studies to analyze other factors that influence the ideas of workplace femininities, in addition to the various issues that women from other social backgrounds (non-white, below middle-class levels), and within less elite workspaces, in order to provide a broader understanding. Moreover, this must be discussed within other contexts, as most studies are primarily euro-centric, especially contexts where gendered discrimination is ‘silenced’ or considered ‘non-existent’ by authorities, and organizations. Therefore, Asian work

femininities and its intersections with media, is indeed an interesting and area to delve further.

REFERENCES

- Askanius, T. (2021). Women in the Nordic Resistance Movement and their online media practices: between internalised misogyny and “embedded feminism.” *Feminist Media Studies*. <https://doi.org/10.1080/14680777.2021.1916772>
- Bligh, M. C., Schlehofer, M. M., Casad, B. J., & Gaffney, A. M. (2012). Competent enough, but would you vote for her? Gender stereotypes and media influences on perceptions of women politicians. *Journal of Applied Social Psychology*, 42(3), 560–597.
- Bryman, A. (2012). *Social Research Methods* (4th Edition). Oxford University Press.
- Butler, J., (1990). *Gender Trouble: Feminism and the Subversion of Identity*, NY: Routledge.
- de Silva, G., & Narampanawa, W. (2014). Sociological Study on the Female Stereotypes in Sri Lankan Commercials. *International Research Conference Proceedings: Management, Social Sciences & Humanities*, 104–110.
- Denscombe, M. (2014). *The Good Research Guide For small-scale social research projects* (5th Edition). Open University Press.
- Fernandez, M., & Menon, M. (2022). Media Influences on Gender Stereotypes. *IAHRW International Journal of Social Sciences*, 10(2), 121–125.
- Foucault, M., (1978). *The History of Sexuality*, translated by R. Hurley, Penguin Books.
- Grau, S. L., & Zotos, Y. C. (2016). Gender stereotypes in advertising: a review of current research. *International Journal of Advertising*, 35(5), 761–770.
- E. Smith, W., Kimbu, A. N., de Jong, A., & Cohen, S. (2021). Gendered Instagram representations in the aviation industry. *Journal of Sustainable Tourism*. <https://doi.org/10.1080/09669582.2021.1932933>
- Gill, R., K. Kelan, E., & M. Scharff, C. (2017). A Postfeminist Sensibility at Work. *Gender, Work and Organization*, 24(3), 226–244. <https://doi.org/10.1111/gwao.12132>
- Jay, C. (2013). Acting up: Performance and the politics of womanhood in contemporary Morocco. In *Journal of African Cultural Studies* (Vol. 25, Issue 3, pp. 305–318). <https://doi.org/10.1080/13696815.2013.819777>
- Lewis, P., Benschop, Y., & Simpson, R. (2017). Postfeminism, Gender and Organization. In *Gender, Work and Organization* (Vol. 24, Issue 3, pp. 213–225). Blackwell Publishing Ltd. <https://doi.org/10.1111/gwao.12175>
- Mavin, S., Elliott, C., Stead, V., & Williams, J. (2019). Economies of visibility as a moderator of feminism: ‘Never mind Brexit. Who won Legs-it!’ *Gender, Work and Organization*, 26(8), 1156–1175. <https://doi.org/10.1111/gwao.12291>
- Nadin, S., Smith, R., & Jones, S. (2020). Heroines of enterprise: Post-recession media representations of women and entrepreneurship in a UK newspaper 2008–2016. *International Small Business Journal: Researching Entrepreneurship*, 38(6), 557–577. <https://doi.org/10.1177/0266242620913209>
- Nodzak, E. (2021). Dressed for Work: The Sartorial Representations of Working Women in Early 21st-Century American Primetime Dramas. *New Horizons in English Studies*, 6, 130–145. <https://doi.org/10.17951/nh.2021.6.130-145>
- Oktaviani, F. H., McKenna, B., & Fitzsimmons, T. (2021). Trapped within ideological wars: Femininities in a Muslim society and the contest of women as leaders. *Gender, Work and Organization*, 28(3), 1152–1176. <https://doi.org/10.1111/gwao.12662>
- Orser, B., Elliott, C., & Leck, J. (2013). Entrepreneurial Feminists: Perspectives About Opportunity Recognition and Governance. *Journal of Business Ethics*,

- 115(2), 241–257.
<https://doi.org/10.1007/s10551-012-1391-6>
- Pritchard, K., Mackenzie Davey, K., & Cooper, H. (2019). Aesthetic labouring and the female entrepreneur: 'Entrepreneurship that wouldn't chip your nails.' *International Small Business Journal: Researching Entrepreneurship*, 37(4), 343–364.
<https://doi.org/10.1177/0266242618823408>
- Rasmussen, K., Dufur, M. J., Cope, M. R., & Pierce, H. (2021). Gender marginalization in sports participation through advertising: The case of Nike. *International Journal of Environmental Research and Public Health*, 18(15).
<https://doi.org/10.3390/ijerph18157759>
- Shamilishvili, G. (2019). Psychological influence of modern mass media on formation of gender stereotypes. *Economics. Ecology. Socium*, 3(2), 71–76.
- Sriwimon, L., & Zilli, P. J. (2017). Applying Critical Discourse Analysis as a conceptual framework for investigating gender stereotypes in political media discourse. *Kasetsart Journal of Social Sciences*, 38(2), 136–142.
- Stoker, J. I., van der Velde, M., & Lammers, J. (2012). Factors Relating to Managerial Stereotypes: The Role of Gender of the Employee and the Manager and Management Gender Ratio. In *Journal of Business and Psychology* (Vol. 27, Issue 1).
<https://www.jstor.org/stable/41474904>
- Swan, E. (2017). Postfeminist Stylistics, Work Femininities and Coaching: a Multimodal Study of a Website. *Gender, Work and Organization*, 24(3), 274–296.
<https://doi.org/10.1111/gwao.12162>
- Tabassum, N., & Nayak, B. S. (2021). Gender Stereotypes and Their Impact on Women's Career Progressions from a Managerial Perspective. *IIM Kozhikode Society & Management Review*, 10(2), 192–208.
<https://doi.org/10.1177/2277975220975513>
- Tsaousi, C. (2017). How to organise your body 101: postfeminism and the (re)construction of the female body through How to Look Good Naked. *Media, Culture and Society*, 39(2), 145–158.
<https://doi.org/10.1177/0163443715608258>
- Vandenberghe, H. (2019). Representation of women in the news: Balancing between career and family life. *Media and Communication*, 7(1), 4–12.
<https://doi.org/10.17645/mac.v7i1.1627>
- Ward, L. M., & Grower, P. (2020). Media and the development of gender role stereotypes. *Annual Review of Developmental Psychology*, 2, 177–199.
- Yoong, M. (2020). Professional Discourses, Gender and Identity in Women's Media.

Online Education for Sustainable Development: An Analysis of Test Scores of Tertiary Sri Lankan ESL Learners in Onsite Summative and Online Summative Examinations

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ABSTRACT

The present study is a quantitative study which aims to analyse online summative written examinations and its effectiveness against the onsite summative written examinations. When the entire planet faced COVID-19 pandemic, the education system in Sri Lanka was on hold for a considerable period. As a result, online examinations or computer-based language tests became a popular testing method to continue education amidst all the challenges. Multiple higher education institutes (both state and private) have implemented online exams to assess the students' language skills. Thus, 42 second year students were selected from the Department of Human Resource Management, University of Kelaniya who follows a compulsory English module; Advance English for Commerce and Management studies. Their scores at two different examinations (online and onsite) were analysed using the SPSS. The present study is based on concurrent validation, which focuses on the degree of equivalence between two test scores. The result of the analysis proves that online tests are more valid and relevant than the onsite tests as there is a significant gap between the scores of the online examination and onsite examination. The analysis further proves that the students have outperformed in online examination whereas scores of onsite test fall onto regular distribution around a single mean. The findings of this study will be of significant value to ESL (English as a Second Language) academics and students who learn English as a

Second Language. The findings problematize the effectiveness of onsite examinations as a successful language evaluation method even though it is the conventional and the most used method of language testing in Sri Lanka.

Key words: *language testing, online examinations, onsite examinations validity, relevance, test scores*

1. INTRODUCTION

The global pandemic COVID-19 has adversely affected the day to day lives of people worldwide creating a new way of life which everyone calls the 'new normal'. All domains in Sri Lanka including education shows considerable drawbacks after being exposed to the outbreak of the coronavirus. For instance, the educational system, from primary to tertiary levels, was put on hold for a considerable amount of time and this would have eventually affected the academia of the country if an immediate alternative were not found. Within this framework, both teachers and students were compelled to adapt to online teaching and learning which was never/rarely used in state education before. As a result, both the form of instruction and evaluation was replaced by a virtual education system. Online education in its various modes has been growing steadily worldwide due to the confluence of modern technologies and global adoption of the internet but it is a novel concept to third world developing countries like Sri

Lanka which has its own challenges to grapple with due to the vast socioeconomic and political disparities within communities. However, multiple higher education systems implemented conducting examinations via online platforms, also known as e-examination which enables examiners to conduct exams using the internet within a pre-decided timeframe for remote candidates. In this form of adjustment online examinations or computer-based language tests became a popular mode of evaluation to ensure that the education system remains intact. Therefore, the current study aims to analyze the effectiveness of online summative examinations against onsite summative examinations which were conducted to assess the language skills of tertiary level ESL students from the Department of Human Resource Management, University of Kelaniya who follow a compulsory English module; Advance English for Commerce and Management. While problematizing onsite examinations as a successful method of language evaluation this study will also add significant value to ESL academics and students who learn English as a second language.

2. LITERATURE REVIEW

During the COVID-19 pandemic developing and using computer-based tests was an alternative solution for educational assessment in tertiary level. Many researchers argue that what worked in the past in face-to-face settings does not necessarily work in online environments (Goldstein & Behuniak 2012). Nevertheless, with the increasing availability of online assessment platform options, online examinations are being increasingly implemented in higher education institutions as a means of supplementing or even replacing paper-based tests (Nicol, 2007). Despite that, research to examine the online examinations conducted for tertiary level remains unexplored.

As Vonderwell, Liang, and Alderman (2007) point out, assessment (whether formative or

summative) in online learning frameworks incorporates diverse features as related to face-to-face environments mostly due to the asynchronous environment of interactivity among the online contributors (the lecturer and students). Formative assessment is usually used in the classroom as a basis of continuing feedback aiming to advance teaching and learning.

According to Shraim (2019), e-exams are particularly suitable for formative assessment, for measuring learning rather than the summative assessment of learning. Each attempt is automatically marked, and the teacher can choose whether to give feedback and/or show the correct answers. Hence, one purpose of the online exam should be to promote learning by the provision of constructive and real-time feedback. An online exam is, therefore, not just an automated tool used for evaluating and grading tool; it is also an integral part for the learning process of the students (Jordan, 2013).

As a solution for students' cheating, Farzin (2016) identifies that the same questions can be presented to each student in a different order from or different set of questions randomly chosen from a question bank. Furthermore, online assessments whether formative or summative are beneficial due to reliability, validity, and practicality. It is very useful for marking to be reliable, particularly for large classes (Heinrich et al., 2009). According to Dermo (2009) that technological tools can be used to mark online exams more accurately than paper-based ones.

Baleni (2015) states that first-year undergraduates at Eastern Cape University were positive about the accuracy of scoring exams and the technology used in online assessments is more reliable since computers are free of human error. According to Baleni's study, participants perceived online exams as having significant advantages over traditional, paper-based ones, including reliability of scoring and long-term efficiency in terms of time, effort and costs. The findings also

indicate that fairness, validity and security aspects are the main challenges facing the successful implementation of online exams.

Online examination systems, therefore, enable the simplification of the traditional paper-based examinations process especially when class sizes are large, from the designing and delivering the exam to marking, reporting, storing the results and conducting statistical analysis (Osuji, 2012; Farzin, 2016).

As discussed above, there has been a significant body of literature highlighting the advantages of conducting online evaluations aftermath of Corona virus pandemic by focusing on the perceptions of the learners, the examiners, and the challenges they face. Most of the existing literature highlights the advantages of online formative assessments over online summative assessments. Therefore, this study examines the effectiveness of online summative examinations against onsite summative examinations which were conducted to assess the language skills of tertiary level students.

3. METHODOLOGY

The study focuses on the degree of equivalence between two test scores, the concurrent validation method which was introduced by O'Loughlin (2001) was used to correlate the test scores obtained from the same group of test-takers who have faced two distinct examinations.

In addition, the quantitative approach was adopted for the purpose of this research as it deals with numerical values. The basic purpose of adopting the quantitative research approach, according to Babbie (2010), is to discover the link between an independent variable and other dependent or outcome variables. Thus, the purpose of this study is to examine how test scores, which is the dependent variable, vary when employing online and onsite testing methods, which are the independent variables.

The participants of the study were second year students from the Department of Human Resource Management, Faculty of Commerce

and Management Studies, University of Kelaniya. A sample of 42 second year students were selected from a population of 78 students based on the results of the English placement test, which was conducted by the Department of English Language Teaching for all the undergraduates of the Faculty of Commerce and Management Studies. All 42 students belonged to the category of UTEL benchmark 6. The sample includes 28 female students and 14 male students who are between 22 - 24 years.

As ethical considerations should be given importance, first the Dean of the faculty of Commerce and Management Studies was informed through the Head of the Department of Human Resource Management. After the approval was granted, the consent from the students to be research participants was taken. As Govil (2013) states that, participants must have prior knowledge of the work expected from them, the students were first informed about the study and the procedure. Then a consent form was distributed among the students and the consent form was designed using both mediums, Sinhala and English.

With the prior permission of authorities and the consent from the participants the module 'Advanced English for Management Studies' was taught and completed for four months. Then an online test was conducted using the EKel platform. This test included two grammar questions (a fill in the blanks and a multiple-choice question), two vocabulary questions (a fill in the blanks and a multiple-choice question), two comprehension questions (a poem and a prose passage) and a writing question. After the online test was conducted, the onsite test was also carried out. The format of the onsite examination paper was identical to the online examination paper. To ensure that the formats of the two tests are alike, all the instructions and questions in the two tests were checked through a readability test. Then the papers were marked physically, and the scores were collected. Finally, the scores of both the tests were analyzed by using the Statistical Package for the Social Sciences (SPSS).

4. DATA ANALYSIS AND FINDINGS

The collected test scores of the online and onsite examinations were analyzed through the SPSS 25.0 software. Initially, an individual analysis was done for both online and onsite scores as follows.

Table 1: Individual Statistics

		Online	Onsite
N	Valid	42	42
	Missing	0	0
Mean		70.60	62.69
Std. Error of Mean		1.831	1.810
Median		73.00	62.00
Mode		82 ^a	60
Std. Deviation		11.869	11.732
Variance		140.881	137.634
Range		45	60
Minimum		43	22
Maximum		88	82
Sum		2965	2633
Percentiles	25	62.00	57.25
	50	73.00	62.00
	75	81.00	71.00

According to the statistics provided in table 01, the minimum score of the online test is 43 while the minimum score of the onsite test is 22. In this case, the minimum score of the online test is higher compared to that of the onsite test. In contrast, the maximum score of the onsite test which is 88 is higher than the maximum score of the online test which is 82.

Further, the mean of the online test is 70.60 and the mean of the onsite test is 62.69. On the other hand, the standard deviation of the online test is 11.869 and the onsite test is 11.732 which is almost the same. Yet, as there is a significant gap between the means of the online and the onsite tests and as the mean of the online test is higher than the onsite test, it

is safe to assume that the students have performed well in online tests.

To further analyze the collected data, graphical representations were also used as given below.

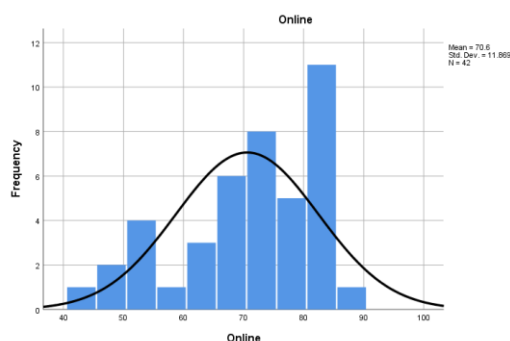


Figure 1: Graph-Histogram for Online Test

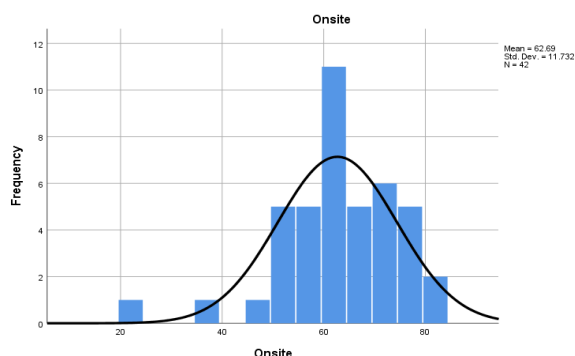


Figure 1: Graph-Histogram for Onsite Test

The two histograms (Figure 1 & 2) given above show the distribution of the online and onsite marks of the students from the Department of Human Resource Management, University of Kelaniya. The mean and the median of the online test scores are 70.6 and 73 respectively. This suggests that the distribution of the online test is rightly skewed. In the onsite test, the mean value is 62.7 and median value is 62, which suggests that the distribution is normal as the mean value is almost equal to the median value. The mean of the online test scores is higher than the onsite tests. Hence, by mean comparison, it can be concluded that the performance of the students

is better in online examination when compared with the onsite examination.

Table 02: Paired Samples Statistics of Online and Onsite

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Online	70.60	42	11.869	1.831
	Onsite	62.69	42	11.732	1.810

As shown in the above table, the mean of the online and the onsite test are 70.60 and 62.69 respectively. Here we can see that the mean of the online test is higher than the onsite test. Additionally, in terms of standard deviation, it is 11.869 in the online test and 11.732 in the onsite test. Similarly, the standard error mean value is also higher in the online test when compared to the onsite test. Therefore, it is proven that the students have outperformed in the online test.

Table 03: Paired Samples Test of Online and Onsite test marks

		Mean	Std. Deviation	Std. Error Mean	Sig. (2-tailed)
Pair 1	Online - Onsite	7.905	9.832	1.517	.000

A paired sample test was conducted between the test scores of the onsite and online test. According to the test, the p-value is less than 0.01. Hence the assumption of equal means is rejected. Therefore, it can be concluded that there is a statistically significant difference between the means of the online and onsite test scores. Therefore, by looking at the statistics it can be concluded that online examinations are more effective than the onsite tests for tertiary level students.

The findings clearly reveal that online summative tests are important to sustain online

education in crisis situations like the covid-19 pandemic. This is not to conclude that onsite examinations should be disregarded. The suggestion is that online tests are the next best alternative when the traditional assessment method cannot be practiced. However, there are certain limitations to this study. For instance, the role of the exam invigilator during online examinations is restricted and there is comparatively more space for the student to cheat during exams. Therefore, good results do not directly indicate that online examinations are successful but as reiterated before, it could be regarded as a reliable method to assess the students when necessary.

5. CONCLUSION

With the COVID-19 outbreak and loss of human connection, the entire world was bound together via online mediums of communication. As sustaining the education system amidst all challenges is of utmost importance, the digital space became popular in no time even in developing countries like Sri Lanka where online education was a novel concept. With the adoption of the online education system in the tertiary level, the unquestioned traditional methods of teaching and learning were put into the spotlight and certain alternatives like online summative tests proved to be more effective. The research findings reveal that online summative tests could be considered as the next best alternative to assess students in crisis situations and therefore to sustain an effective education system. In addition, the current study will be of significant value to ESL academics and students who learn English as a second language. The findings problematize the effectiveness of onsite examinations as a successful language evaluation method even though it is the conventional and the most used method of language testing in Sri Lanka.

6. REFERENCES

Farzin, S.(2016). Attitude of Students Towards E-Examination System: An Application of E-Learning. Management

Science and Information Technology, 1(2), 20-25.

Journal of Research on Technology in Education, 39(3): 309–328.

Govil, P. (2013). Ethical Considerations in Educational Research. *International Journal of Advancement in Education and Social Sciences*.1(2). p. 17-22.

Goldstein, J., & Behuniak, P. (2012). Can Assessment Drive Instruction? Understanding the Impact of One State's Alternate Assessment. *Research & Practice for Persons with Severe Disabilities*. 37(3): 199-209.

Jamieson, J. (2005). Trends in computer-based second language assessment. *Annual Review of Applied Linguistics*. 25. p. 228–42.

Jordan, S. E. (2013). E-assessment: Past, present and future. *New Directions for Adult and Continuing Education*, 9(1), 87-106.

Nicol, D. (2007). E-assessment by design: using multiple-choice tests to good effect. *Journal of Further and Higher Education*, 31(1), 53–64.

O'Loughlin, K. (2001). *Studies in Language Testing 13: The Equivalence and Semi-Direct Speaking Tests*. Cambridge: Cambridge University Press.

Osuji, U. (2012). The use of e-assessments in the Nigerian higher education system. *Turkish Online Journal of Distance Education*, 13(4), 140–152.

Shraim, K. (2019). Online Examination Practices in Higher Education Institutions: Learners' Perspectives. *Turkish Online Journal of Distance Education*, 20 (4) , 185-196 . DOI: 10.17718/tojde.640588.

Vonderwell, S., Liang, X., & Alderman, K. (2007). Asynchronous discussions and assessment in online learning.

BIOGRAPHIES

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Evaluation of Day Pattern Choice of Individuals in the Western Province of Sri Lanka

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ABSTRACT

Traditional considerations of traffic safety focus on the physical environment, and road user's behaviour to ensure sustainable transportation. Road user's driving behaviour and travel patterns play an important role among these. New forms of transportation demand models use an activity-based approach that requires an activity pattern to be assigned to each road user. This research presents the analysis of travel patterns based on a classification procedure in which the set of measurements that define human behaviour is represented by a coding pattern using the outcomes of the dataset of 35,850 households among a total of 124,673 individual daily diaries collected from the CoMTrans study. A total of 1431 activity patterns were observed in the western province. The most common daily pattern is Staying at Home (H), which is around 35.51% of the total population. The 2nd and 3rd most common tour patterns are "H2S3H" (school tour starts at home, leaving home on AM Peak to school and returning to home on Mid-Day) and "H2W4H" (work tour starts at home, leaving home on AM Peak to work and back to home on PM Peak). Each pattern of activity was related to the socioeconomic characteristics of that person. Tour modes were also identified according to each activity. Tour modes were also identified according to each activity. This analysis will form the basis for the development of an activity-based transport model for Sri Lanka in

the future, which will help town planners better understand the city's travel behaviour and thus formulate well-organized travel demand management policies to move towards sustainable transportation.

Keywords: *Day pattern; Travel behaviour; Activity-based; Socio-economic characteristics; Western province.*

1. INTRODUCTION

Transportation models have played an important role in predicting transport demands. Transportation models have been evaluated since their origin in the late 1960s. The new systems of transportation demand models use an activity-based tactic, which needs an activity pattern assigned to each individual. The traditional four-step tactic does not provide reliable evaluations of the travel patterns, but the activity-based method, which accounts for the travel behaviour of individual households or persons, seems to be more suitable for estimating trips.

In the context of transportation modelling and social research in general, understanding human behaviour is pivotal to the accuracy of forecasting. Because driver behaviour has a strong relationship with the decisions of the driver, this leads to many accidents on the road (Shaja M.M.M., & Bandara Y.M., 2021). However, considering the complexity of

human behaviour, many have resorted to making simplified assumptions with a reduced temporal resolution, but over the years, there has been a trend to relax these assumptions and consider them at a more disaggregated level.

This research focuses on analysing the activity pattern of each individual in the collected sample data set using coding techniques and finding the relationship between activity patterns and socio-economic characteristics.

2. LITERATURE REVIEW

2.1. Introduction of Transport Modes

The purpose of the transportation models is to forecast the response to transportation demand of changes both in the attributes of the transportation system and the people using it. More specifically, travel demand models are used to predict travel characteristics and usage of transport services under alternative socioeconomic scenarios and land-use configurations (Bhat et al., 2003), such that road capacity programs and traffic management could be based on predicted demand.

2.2. Trip-Based Travel Demand Models

Traditional models are commonly referred to as "four-step models." In this model, individuals are aggregated by traffic zone. There are four sequential decisions that cause traffic:

- Trip generation
- Trip distribution
- Mode split
- Traffic assignment.

These results are modelled separately for succeeding phases. (Stopher et al., 2006) Even though the four-step models have been widely used, a major deficiency of these extensive, aggregate, and supply-oriented models is their absence of behavioural content.

The aggregate approach was gradually replaced by a disaggregated modelling

approach. This approach mainly focuses on decision-making and choice processes at the level of individuals. Individual decision-making facilitates the impact of transportation plans on travel patterns. If the impact on an individual's travel behaviour can be predicted, the effects of transport plans can be easily derived by aggregating across individuals.

Because of their intrinsic weaknesses, the trip-based aggregate and disaggregate approaches may be less suitable for predicting the effects of these potential behaviour changes. Later activity-based approaches established some early attention and became a leading modelling technique in recent years. This approach considers travel decisions as derived from activity choices. Travel demand is thus accounted for by explaining and analysing individuals' and households' activity decisions. (Axhausen and Garling, 2002). These choices include where, when, how, for how long, and with whom activities are conducted.

2.3. Literature on day pattern modelling and its role in transport demand modelling

A key element in the activity-based approach is determining the activity schedule for an individual, and Bowman (1998) was the first to use this approach to simultaneously model the key elements of a day-long pattern. He initially considered the purpose and 10 locations of a primary activity for in-home or out-of-home activities of an individual and then considered the number of intermediate stops made when performing the primary activity; additionally, he considered the number and purpose of additional home-based tours to complete a day's schedule of an individual. (De Silva D. 2011)

Many applications have been used with the activity-based approach. Bhat et al. (2004) used activity stop generation to model inter-shopping duration by looking at multi-day activities. Garling et al. (2003) looked into habitual travel behaviour. Kitamura et al.

(2000) went one step further to micro-simulate the daily activity travel patterns using Monte Carlo simulation. Similarly, Kulkarni et al. (2000) used a micro-simulation approach but incorporated geographic information systems to make a more advanced prediction.

2.4. Example of day pattern

An example of an activity pattern of an individual, Mr. X is shown below in figure 1. It contains all of the activities that this individual undertakes in a single day.

- 1st Trip-in the morning, Mr. X went to work from home.
- 2nd Trip-in the afternoon, he went for shopping from the workplace.
- 3rd trip-After the Shopping, he returned home.

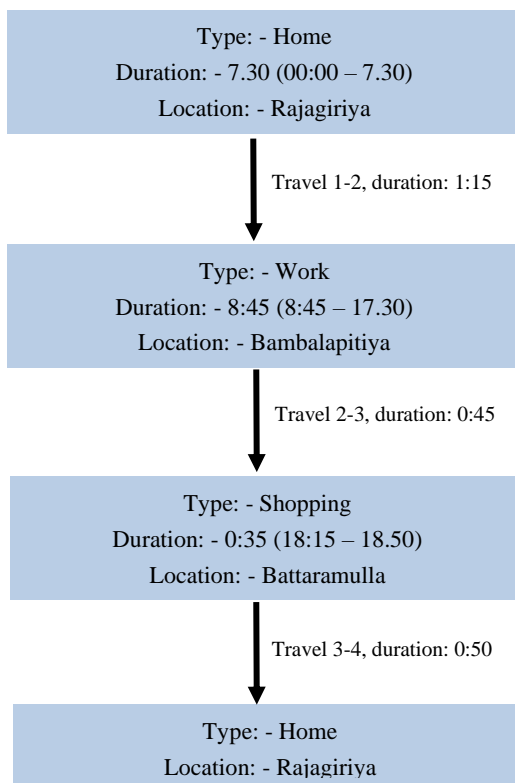


Figure 1: Example of day pattern for one individual

2.5. Previous works on day pattern interpretation

Time slices are a method of interpreting individuals' daytime behaviour with a single character representing the activity for that 15-minute interval. For each 15-minute time slice, activities were coded with a location code character over the whole day, which simplifies the day into a single line of characters (De Silva D. 2011)

Coding system is another method of expressing a person's daily behaviour in a well-defined set of characters. An example day pattern is H2W3H, which represents a home activity (H), followed by peak AM travel to a work activity (W), followed by midday travel back to home (H). (Kevin J. Stefan, Alan T. Brownlee, and J. D. Hunt (2016)

3. DATA

The data was not collected as a part of this research but was derived from the data collected for the CoMTrans Study by the Japan International Cooperation Agency (JICA).

3.1. JICA Household Activity Survey

The JICA Household Activity Survey (HAS) collected information on both in-home and out-home activities, the number of trips that an individual makes, along with attributes of the trips, for a 24-hour duration on a weekday during November 2012-August 2013. (JICA Technical Report, 2014)

A sample of households selected from the Western Province Region provided 24-hour activity diaries for all household members for 35,850 households, out of a total of 124,673 individual daily diaries available with activity and location for each activity. A range of individual socioeconomic characteristics were also obtained. These included ages, gender, and household characteristics such as income, car ownership, and household size, which are described in detail in the latter part of this chapter.

Each person's record was enlarged to represent the entire population of Western Province by a weight based on income and social status distribution and a measure based on a combination of family size and composition.

3.2. Validity of the Sample

To check whether the sample is valid to represent the whole population, the 2020 Census of Population and Housing (Department of Census and Statistics, 2020) is used to compare socioeconomic distribution between the census, sample set, and weighted sample set. Only age and gender distribution were compared, as in Figure 2 and Figure 3.

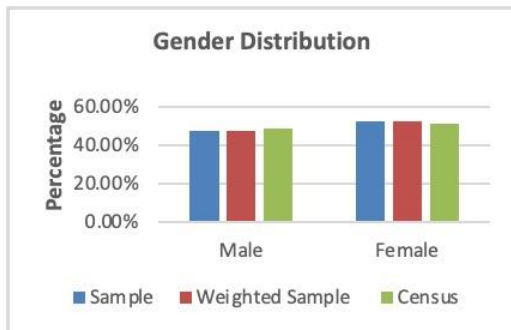


Figure 2: Gender Distribution

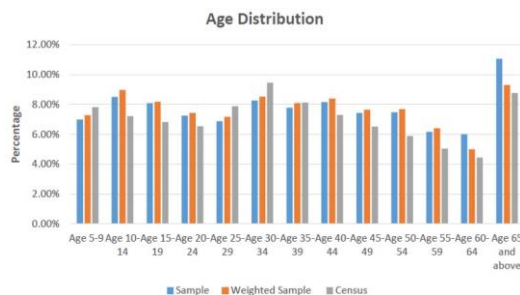


Figure 3: Age Distribution

The weighted sample matches the census data more closely, and the variation between the two is very minimal, suggesting the validity of the weighted sample. In addition, this dataset has been extensively used for modelling work for the Urban Transport System Development Project for the Colombo Metropolitan Region and Suburbs. (JICA Report, 2014)

3.3. Vehicle Ownership

Figure 4 shows the household vehicle distribution. 55% of the community does not have a vehicle, with 38% of the community owning one vehicle per household.

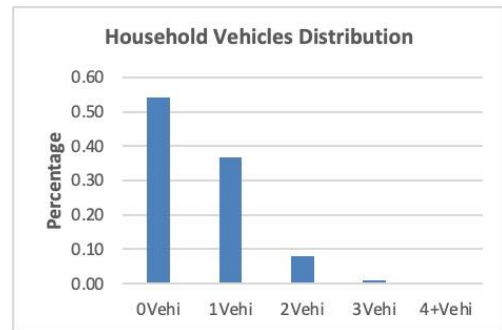


Figure 4: Household Vehicle Distribution

Figure 5 shows the number of vehicles per household by district. Gampaha District shows a relatively high percentage of 0.62 vehicles per household. Kalutara district shows the lowest percentage of 0.45 vehicles per household.

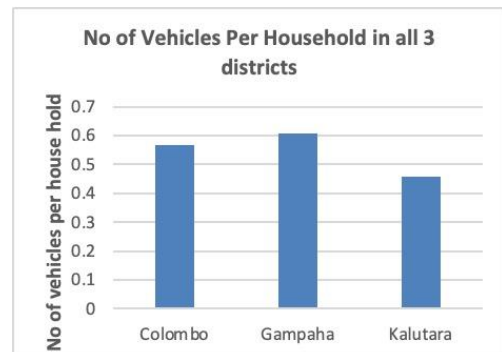


Figure 5: Vehicles per household

3.4. Income Classification

Around 70% of the population earns less than Rs. 40,000 per month. On the other hand, very few are in Group A (greater than Rs. 80,000); it is less than 8%.

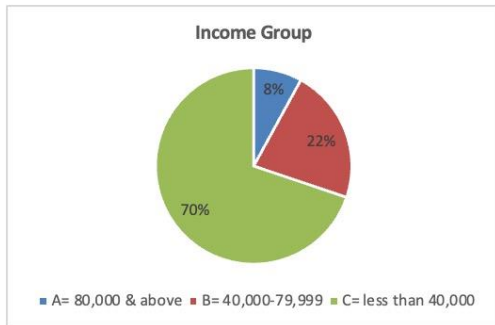


Figure 6: Income Group

4. METHODOLOGY

After considering the methodologies in previous literature, the coding system was adapted for this research. The coding system expresses a person's daily behaviour in a well-defined set of characters. The advantage of this method is that a person's day pattern can be reduced to a set of characters that explain activity plus the time period of travel, which we are more concerned of when we try to understand the trip behaviour. Therefore, it is more convenient compared to time slices.

A tour can be defined as "the movement of a person from an origin to a destination with a purpose." A tour is composed of travel activities and a time period within a day. Both of them have a coding scheme for simple descriptions. (JICA Technical Report, 2014)

It is considered five time periods for modelling and analysis purposes.

Table 1: Time Definition

Code	Time
1	Early Off peak (3AM – 6 AM)
2	AM Peak (6 AM – 10 AM)
3	Midday (10 AM – 3 PM)
4	PM Peak (3 PM – 7 PM)
5	Late Off peak (7 PM – 3 AM)

Table 2: Travel Activity Definition

Code	Activity
H	Home
W	Work
S	School
K	Shop
P	Personal Business
O	Other

To develop the tour and day pattern, the first step is to identify the destination activity and the time of day for each trip. Next, the primary destination for each tour is determined, along with secondary destinations or sub-tours if present. In the tour development process, the following rules are applied:

1. For work tours, the primary destination is the work location, even if the person stops for another activity on the way to work. The purpose of the tour is home-based work.
2. For school tours without work activity, the primary destination is the school location. The purpose of the tour is to visit a home-based school.
3. The primary destination for non-work, non-school tours is the first stop on the tour.
4. The tour without home at both ends is considered a "non-home-based tour."

Python language, which is used to code the travel diaries of individuals using the definitions above and the JICA data. The tour overview describes the overall nature of the tour. The trip overview "H2W4H" can be described as a work tour that begins from home during the AM. peak from 6 AM to 10 AM and returns home during the PM Peak 3PM-7PM (See Table 1 and Table 2 for code definitions.)

5. DATA ANALYSIS AND RESULTS

5.1. Coding HAS Data

Python language, which is used to code the travel diaries of individuals using the definitions above and the JICA data. Figure 7 shows the code.

```
[1] Import pandas as pd
Import numpy as np
df = pd.read_csv("H2S3H_new.csv")

def origin_converter(row):
    if (row["origin"] == "H"):
        return "H"
    elif (row["origin"] == "S"):
        return "S"
    elif (row["origin"] == "W"):
        return "W"
    elif (row["origin"] == "None"):
        return "None"
    else:
        return "None"

def destination_converter(row):
    if (row["destination"] == "H"):
        return "H"
    elif (row["destination"] == "S"):
        return "S"
    elif (row["destination"] == "W"):
        return "W"
    elif (row["destination"] == "None"):
        return "None"
    else:
        return "None"

def purpose_converter(row):
    if (row["purpose"] == "H"):
        return "H"
    elif (row["purpose"] == "S"):
        return "S"
    elif (row["purpose"] == "W"):
        return "W"
    elif (row["purpose"] == "None"):
        return "None"
    else:
        return "None"

df["origin"] = df["origin"].apply(origin_converter)
df["destination"] = df["destination"].apply(destination_converter)
df["purpose"] = df["purpose"].apply(purpose_converter)

df["origin"] = df["origin"].apply(lambda x: "H" if x == "H" else "S" if x == "S" else "W" if x == "W" else "None")
df["destination"] = df["destination"].apply(lambda x: "H" if x == "H" else "S" if x == "S" else "W" if x == "W" else "None")
df["purpose"] = df["purpose"].apply(lambda x: "H" if x == "H" else "S" if x == "S" else "W" if x == "W" else "None")

df["origin"] = df["origin"].apply(lambda x: "H" if x == "H" else "S" if x == "S" else "W" if x == "W" else "None")
df["destination"] = df["destination"].apply(lambda x: "H" if x == "H" else "S" if x == "S" else "W" if x == "W" else "None")
df["purpose"] = df["purpose"].apply(lambda x: "H" if x == "H" else "S" if x == "S" else "W" if x == "W" else "None")
```

Figure 7: Python Coding

5.2. Data Analysis

5.2.1. Tour Purpose

Table 3 below presents absolute number of tours by purpose.

Table 3: Tour Proportions by Purpose

Purpose	Count	Percentage
HBW	1,359,552	39.02%
HBS	1,183,864	33.98%
HBO	932,646	26.7%
None Home Ends	7,856	0.23%
Total	3,483,918	100.0%

5.2.2. Tour Overview

The tour overview describes the overall nature of the tour. The trip overview "H2W4H" can be described as **a work tour that begins from home during the AM peak (6AM–10AM) and returns home during the PM peak (3PM–7PM).** (See Table 1 and Table 2 for code definitions.) Other common tour overviews and their proportions are outlined in Tables 4–5 below.

From the analysis, it was observed that there are a total of 1431 activity patterns happening in the western province. Table 4 illustrates the

top 10 predominant tour occurrences. The first common tour pattern is "H." Out of the 5,401,716 weighted samples, 1,918,159 samples are staying at home without any trips. The second most common tour pattern is "H2S3H." It starts at home, leaving home on AM Peak (6 AM–10 AM) to go to school and back to home on Middy (10 AM–3 PM).

Table 4: Tour Occurrence Frequency

No	Tour	Weighted Count	Percentages
1	H	1,918,159	35.51%
2	H2S3H	1,006,634	18.63%
3	H2W4H	742,206	13.74%
4	H2W5H	191,441	3.54%
5	H2P3H	158,680	2.94%
6	H2P4H	133,347	2.47%
7	H3P3H	107,714	1.99%
8	H2W3H	95,556	1.77%
9	H1W4H	72,400	1.34%
10	H2P2H3P3H	65,481	1.21%

The time and space behaviour of an individual's activity pattern on a given day (for the Second Most Common Tour Pattern, H2S3H) is shown below.

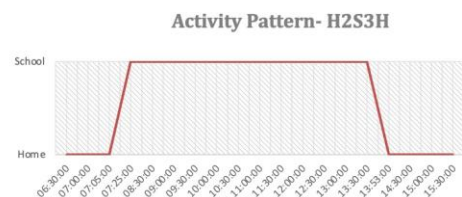


Figure 8: Spatio-temporal behaviour of H2S3H pattern

Below table 5 shows the travel percentages according to the purpose of the trip

Table 5: Proportion of Travel Activities

Purpose	Weighted Count	Percentage
W (Work)	1,365,419	39.19%
S (School)	1,185,473	34.03%

P (Private matters, business)	741,953	21.30%
K (Shopping)	124,960	3.59%
O (Other)	66,112	1.90%
Total	3,483,918	100.00%

5.3. Distribution of Tour Modes

Table 6 shows the distribution of tour modes. The most common tour mode is non-A/C bus (private), followed by walking and motorcycles, respectively.

Table 6: Distribution of Tour Modes

Tour Mode Name	Count of Tours	Percentage
Non-A/C bus (private)	1,016,246	29.17%
Walking only	647,741	18.59%
Motorcycle	361,047	10.36%
School bus/van	331,173	9.51%
Three-wheeler (hired)	202,631	5.82%
Non-A/C bus (SLTB)	188,996	5.42%
Car/Jeep/Van	169,845	4.88%
Three-wheeler (private use)	160,137	4.60%
Bicycle	156,872	4.50%
Railway	124,835	3.58%
Staff service	43,686	1.25%
Employee transport	40,332	1.16%
Others	20,210	0.57%
A/C bus	7,016	0.20%
Taxi (car/van)	6,795	0.20%
Pickup	5,251	0.15%
Taxi (nano)	1,324	0.04%

Table 7 illustrates the top 9 tour modes by tour purpose. This table will help to construct the tour mode choice model for each purpose.

Table 7: Percentage Share of Tour Mode by Tour Purpose

Tour purpose	Tour Mode	Count of Tours	Percentage
Work	Non-A/C bus (private)	453,948	33.25%
	Motorcycle	219,285	16.06%
	Walking only	174,007	12.74%
	Car/Jeep/Van	90,690	6.64%
	Railway	88,745	6.50%
	Three-wheeler (private use)	72,145	5.28%
	Non-A/C bus (SLTB)	71,647	5.25%
	Bicycle	70,381	5.15%
	Staff service	44,191	3.24%
School	School bus/van	330,731	27.90%
	Walking only	281,561	23.75%
	Non-A/C bus (private)	269,234	22.71%
	Three-wheeler (hired)	96,844	8.17%
	Non-A/C bus (SLTB)	56,738	4.79%
	Motorcycle	42,825	3.61%
	Three-wheeler (private use)	34,668	2.92%
	Bicycle	27,961	2.36%
	Car/Jeep/Van	21,299	1.80%
Other	Non-A/C bus (private)	291,060	31.20%
	Walking	190,559	20.42%
	Motorcycle	98,561	10.56%
	Three-wheeler (hired)	83,991	9.00%
	Non-A/C bus (SLTB)	59,723	6.40%
	Bicycle	57,040	6.11%
	Car/Jeep/Van	56,710	6.08%
	Three-wheeler (private use)	52,376	5.61%

5.4. Summary of results

Socio-economic characteristics for each day pattern (for predominant 10-day patterns) were analysed and the majority of items are shown with their percentages in Table 8 below.

Day Pattern	Socio-economic Characteristic	Majority	Percentage
H	Gender	Female	70.00%
	Age	More than 65 years	19.51%
	Social Status	Housewife	46.79%
H2S3H	Gender	Male	50.5%
	Age	05-14 yrs	74.82%
	Social Status	Student (grade 1-5)	38.87%
H2W4H	Gender	Male	62.8%
	Social Status	Working (Full Time)	89.82%
	Occupation	Office clerks customer service clerks	15.43%
H2W5H	Gender	Male	82.9%
	Social Status	Working (Full Time)	86.58%
	Occupation	Sales persons at shop, stall, and market	18.34%
H2P3H	Gender	Female	53.2%
	Social Status	Housewife	35.32%
H2P4H	Gender	Male	84.20%
	Social Status	Working (Part Time)	47.51%
H3P3H	Gender	Female	63.83%
	Social Status	Housewife	49.68%
H2W3H	Gender	Female	68.98%
	Social Status	Working (Full Time)	85.06%
	Occupation	Professors, Lectures, Teachers	60.36%
H1W4H	Gender	Male	78.92%
	Social Status	Working (Full Time)	88.83%
	Occupation	Labours	17.22%
	Gender	Female	71.03%

H2P2H3P3H	Social Status	Housewife	65.47%
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6. CONCLUSION

There are different ways of interpreting the behaviour of a person. The present study found that the coding system is more suitable since a person's daily pattern can be compressed into a set of characters that explain activity and time period of travel, with which we are more concerned when we try to understand the trip behaviour.

There are a total of 1431 day patterns observed in the western province from this analysis. "H," "H2S3H," "H2W4H," "H2W5H," "H2P3H," "H2P4H," "H3P3H," "H2W3H," "H1W4H," and "H2P2H3P3H" are the top 10 activity patterns happening in the western province. The results of this study show that 35% of the total population is not making any trips. Among them, 70% of the population is female. In terms of social status, around 47% of the population are housewives, 14% are unemployed, and 13% are retired people. Under an age-wise categorization, around 20% of people who stay at home are over 65 years old, either because they are retired from work, ill, or too old to travel.

The remaining 65% are making trips on a particular day, of which 39.19% are work trips, 34.03% are school trips, 21.30% are personal business trips, 3.6% are shopping trips, and 1.9% are other types of trips. Moreover, the most common mode of transportation is non-A/C buses (private), which account for 29.17% of all trips, followed by walking and motorcycles as the 2nd and 3rd most common modes, respectively.

In conclusion, the key findings from the present studies are that when we consider the activity patterns of traveling people, the most common activity is "H2S3H", which is 18.63% of the total population. All the people are students. Around 75% of the trip makers are between 5 and 14 years old. The next common activity pattern is "H2W4H," which is 13.74%

of the total population. It was observed that government employees, clerks, and senior officers are returning home in the PM peak. Meanwhile, the next common activity pattern is "H2W5H," which is 3.54% of the total population. This group consists of salespeople, workers in construction, and drivers and operators of vehicles who return home in the late off-peak. The next common activity is "H2P3H," which includes housewives and retired people as the majority. Since they are not working, they do activities such as visiting relatives' houses, meeting friends, and other personal activities in the morning and return home by lunchtime.

These findings of the research will help to develop an activity-based model in the future.

REFERENCES

- Axhausen, K., Garling, T. (2002). "Activity-based approaches to travel analysis: conceptual frameworks, models and research problems", *Transport Reviews*, 12, 324-341.
- Bhat, R., Koppelman, S. (2003). "Activity-Based modelling of travel demand" *Handbook of transportation Science. International Series in Operations Research & Management Science*, Volume 56, Part 2, 39-65.
- Bhat C.R. et. al. (2004). *Inter-shopping Duration: An Analysis Using Multi-Week Data. Transportation Research Part B*, 38 (1): 39-60.
- Bowman J.L., (1998). *The Day Activity Schedule Approach to Travel Demand Analysis*. Ph.D. Dissertation, Department of Civil and Environmental Engineering, Massachusetts Institute of Technology.
- CSTDM09 - California Statewide Travel Demand Model. (May 2011). *Travel Behavior Datasets*, 50-62.
- CSTDM09 - California Statewide Travel Demand Model. (May 2011). *Short Distance Personal Travel Model*, 1-58.
- De Silva D. (2011), "An Analysis of Daily Activity Patterns in Time and Space", 2011.
- De Silva D., Hunt J.D. (2007). *Fuzzy Clustering Examination of Activity Patterns in Time and Space*. TRB Seminar on Doctoral Student Research in Transportation Modelling, Washington DC.
- Garling T., Axhausen K.W. (2003). *Introduction: Habitual Travel Choice. Transportation* 30 (1): 1-11.
- Hagerstrand, T. (1970). "What about people in Regional Science?" *Papers and Proceedings of the Regional Science Association*, 24, 7-24.
- (JICA), J. I. (AUGUST 2014). *Urban Transport System Development Project for Colombo Metropolitan Region And Suburbs, Technical reports & Final Reports*.
- Kevin J. Stefan, Alan T. Brownlee, J. D. Hunt (2016). *Unifying Long- and Short-Distance Personal Travel in a State-wide Planning Model*
- Kitamura R. et. al. (2000). *Micro-Simulation of Daily Activity-Travel Patterns for Travel Demand Forecasting. Transportation* 27 (1): 25-51
- Kulkarni A., McNally M.G. (2000). *A Micro-simulation of Daily Activity Patterns*. ITS Working Paper UCI-ITS-AS-WP-00-7, Irvine CA.
- Pas, E. I., 1985, *State of the art and research opportunities in travel demand: another perspective. Transportation Research*, 19A, pp. 460-464.

- Shaja, M.M.M., Bandara, Y.M., 2021, Relationship between utility of driving, socio-economic characteristics and risk behaviour of drivers, SLERC, 149 - 155
- Stopher, P. R., Hartgen, D. T., and Li, Y., 2006, SMART: simulation model for activities, resources and travel. Transportation, 23, 293–312
- Wilson C. (1998). Activity Pattern Analysis by means of Sequence-Alignment Methods. Environment and Planning A, 30: 1017-1038

Formalised Emotional Labour in The Higher Education Sector: A Systematic Literature Review

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ABSTRACT

Emotional labour has always been controversial and defining of the education sector, but with the recent global pandemic and technological advancements, it has taken on greater significance. As a result, academics feel extremely challenged in terms of preserving a service-oriented job. This study conducts a critical qualitative literature analysis on emotional labour in the educational sector in order to shed light on the literature and methodological approaches through a systematic literature review. This study evaluates a distinct set of data on academics' emotional labour and work performance from over twenty-two articles published between 2018 and 2022 to gain a deeper understanding of how this important facet of emotional labour emerges in the higher education sector. While academia is often viewed as a job that necessitates both mental and emotional agility, research has found that many academics struggle with all three of the emotional labour components—emotional labour, personal efficacy, and surface-level acting. In contrast, academics who engage in emotional labour and focus on personal effectiveness indicate better job performance and professional reputation. Research into the theoretical underpinnings of emotional labour and the ways in which these underpinnings are important to the educational quest of academics active in higher education is justified in light of these findings. Overall, this study finds that there is a positive correlation between surface acting and burnout on the job, but deep acting has a more complicated effect on burnout, which may ultimately prove to be a mitigating influence.

Key Words: *Emotional labour; burnout; higher education; emotional exhaustion; systematic review*

1. INTRODUCTION

1.1. Emotional labour in education sector

1.1.1. Deriving the Meaning of Emotional Labour

Emotional labour has been formally acknowledged as a result of Glaser and Strauss's studies on emotion work or 'sentimental work' in the care-giving sector; however, much theoretical and empirical interest was generated by Hochschild's study of the Managed Heart in year 2003 (Williams, 2013). According to Lee and Madera (2019), the term "emotional labour" refers to the effort put into controlling one's emotions and behaviours to conform to the norms of behaviour and outputs favoured by one's workplace environment. With the introduction of the concept of "transmutation" to describe the impact of one's own emotions on their behaviour in the workplace, the theory of emotion work has been taken into the public sphere (Williams, 2013). According to the studies of Hochschild (2003), it was revealed that the workers' smiles were "on them but not of them". As a result, it was apparent that feelings have to be induced or suppressed in order to present an appropriate outward appearance. Therefore, Surface and deeper acting strategies were key, personal, internal facets in the maintenance of the external appearance. According to research conducted by Hochschild (2003), it was determined that the workers' smiles were on them despite the fact that

it is not one of them. Consequently, it was clear that emotions must be induced or suppressed in order to present an acceptable exterior. Therefore, surface and deeper acting strategies were essential, institutional, personal components for the maintenance of the exterior appearance as part of the emotion work.

1.1.2. The Contemporary Practice of Emotional Labour in Education Sector

To begin with, using the definition obtained from the concept of emotional labour, it can be viewed as an effort and even a source of stress that an individual must do in terms of planning and controlling to exhibit organisationally desired emotions during interpersonal interactions. In other words, it is an employee's endeavour to control his or her emotions, feelings, and expressions in accordance with organisational objectives. Emotional labour, as described by Yang and Chen (2021), is a relatively recent development in the service industry and consists merely of the employee regulating his or her own emotional responses in order to further the organisational objectives.

Even while emotional labour is widely used in service-related occupations, the educational sector has received comparatively little research (Grandey et al., 2013, Yang & Chen, 2021). Academics are regarded to be a subset of the service industry. Therefore, this study also identified what was supported above: that the focus on emotional labour has been centred on elementary and primary school teachers but has largely overlooked those in higher education in its searching process. Emotional labour in the educational sector is undoubtedly significant since educators need to engage daily with their students, which is a distinguishing aspect of work. Despite the fact that emotional labour is a defining characteristic of work, it is also specific to the teaching styles of individuals and the recurrent, intensive, and long-term daily interaction that is incurred in a teaching tenure (Morris & Feldman, 1996). Furthermore, the role of the teacher is a demanding profession in which educators encounter various challenges in the setting of the classroom environment, including excessive academic workload, research requirements, demanding students, aspirational

leadership in the organisation, and high professional standards to uphold in terms of career advancement (Lyndon et al., 2021).

Besides, it is known that teaching contains both emotional and cognitive aspects, including not only the act of teaching and designing the curriculum, but also the act of expressing or suppressing actual feelings, or expressing the appropriate emotion for the occasion, regardless of whether it is candid (Taxer & Frenzel, 2015). Therefore, a lot of emotional labour is expended during the educational process. Hargreaves (2000) argues that teachers should indeed engage in "emotional labour" in order to maintain a professional demeanour in the classroom. Emotional labour is a defining feature of the classroom because, as Hargreaves (2000) points out, educators often have to fake their feelings in the workplace, whether it's to show enthusiasm for a new programme, pride in a student's achievement, tolerance for a difficult co-worker, or serenity in the face of parental criticism.

According to Lyndon et al. (2021), the teaching profession is a service industry in which emotional labour is relevant due to the contact and communication between teachers and students. In their interactions with students and others, teachers are required to demonstrate certain emotional states, such as joy and excitement. Due to the many ethical principles and professional conventions prevalent in educational institutions, teachers' emotional labour remains mostly concealed. Extending the research of Lyndon et al. (2021), it was noted that academics play a variety of roles in their interactions with students, including those of mentor, counsellor, and facilitator. Mahoney et al. (2011) contend that educators feel pressure to regulate their emotional responses in the classroom setting while students assess and judge the academics through student feedback, which forms a significant part of the performance appraisal of professors. In 1996, Morris and Feldman asserted that emotional performance has become a crucial component of the teaching profession, leading us to infer that emotional labour is highly exploited in the educational sector, taking into account all of the previous literature reviews (Morris & Feldman, 1996).

2. THEORETICAL BACKGROUND

2.1. The Components of Emotional Labour

The three primary aspects of emotional labour, namely surface acting, deep acting, and naturally felt emotions, have been analysed in terms of the three fundamental concepts that comprise it (Kariou, Koutsimani, Montgomery & Lainidi, 2021). The notions of surface and deep acting were developed from the theorised works of Hochschild and Grandey, in Noor et al. (2011) study, in which two distinct forms of research on the regulation of emotions in response to job-related expectations of emotional behaviour were conducted. The term "surface acting" refers to altering one's outer emotional expression without making any effort to experience the feelings being exhibited. Altering one's outward displays of emotion while simultaneously making an effort to internalise them is the definition of "deep acting."

In other words, employees may experience emotional dissonance between how they feel and how they act due to surface acting, which suggests that they are in a situation where they must respond by concealing negative emotions and presenting anticipated good responses. Conversely, workers engage in "deep acting," in which it involves changing one's emotional state in order to elicit a true positive response. Therefore, organizational display rules necessitate that workers engage in emotional labour in the form of "surface acting" and "deep acting" to control their emotions (Lee & Madera, 2019).

Naturally felt emotions, as described by Kariou et al. (2021), is the efforts a person places into articulating the emotions they are genuinely experiencing. The degree of internalisation shown in a person's behaviours is a key differentiator between surface acting, deep acting, and naturally felt emotions.

In the context of the discussion of emotional labour, there are a plethora of concepts and constructs that can be overlapping, including emotion regulation, emotion regulation strategies, emotion management, and impression management. These topics, however, will not be

covered in this article; however, they do carry the potential for further developing these theories within the context of the educational system.

2.2. Burnout and Emotional Labour

The field of education is one that places a high premium not just on having in-depth expertise in the subject matter but also on having infinite emotional stability at one's disposal to deal with the stresses of day-to-day life. This implies that educators can potentially experience burnout because of the effects of emotional labour.

A significant association was observed between emotional labour and burnout in a study of its effects on teacher satisfaction and turnover in Chinese universities (Zhang & Zhu, 2008). Further, burnout has been related with emotional cognitive loss of control. This is because employees who suffer from burnout frequently struggle to regulate their behaviour, which may be the result of impairments in executive control.

Zhang and Zhu (2008) found that whereas surface acting negatively influenced teacher burnout and satisfaction, deep acting positively impacted both. Emotional exhaustion, depersonalization, and a loss of personal accomplishment are essential components of burnout that have been studied and utilised to quantify the value of employees' emotional labour. COR theory, a concept developed in Hobfoll's studies in 1989, was primarily used to explain emotional labour and burnout, with the outcome stated as employees' emotional reserves being depleted when they are called upon to meet the demands of emotional labour, leading to emotional exhaustion. Furthermore, the research concludes, in a manner that is in line with the COR theory, that engaging in emotionally exhausting types of labour, such as surface acting and emotional dissonance, is negatively related to employee outcomes in which individuals experience burnout and stress, which then generates organizational-related outcomes like job satisfaction and extends to customer-related outcomes, such as service recovery performance, customer disrupt, and customer orientation. In other words, engaging in emotionally exhausting types of labour has a negative impact on employee outcomes (Lee & Madera, 2019).

Deceptive emotions use up and deplete cognitive resources, as theorised by Li et al. (2017), leading to emotional exhaustion in those who engage in constant surface acting. Finally, Lee and Ok (2012) discovered that emotional labour (measured as emotional dissonance) increased emotional exhaustion. They speculated that this was because cognitive energy is drained when employees' felt and expressed emotions during interactions with customers did not correspond.

The majority of university professors in India (74%) have a moderate-to-high degree of stress, and 86% of teachers experience professional burnout, as reported by Lyndon et al. (2021).

Extending this theory further, Yu et al. (2015) found that those working in helping professions like nursing and teaching are more likely to experience burnout. As a consequence of this, a great number of academics go through the experience of having their capabilities questioned or judged more severely in regard to whether or not they are able to carry out an action, which ultimately contributes to the development of the self-efficacy theory. An individual's capability to carry out an action is subject to conjecture and evaluation in this idea. Researchers have been studying occupational burnout and the role of self-efficacy in the development of burnout in greater depth, drawing heavily from self-efficacy theory, in recent years.

In conclusion, a positive association between occupational stress and professional burnout among university lecturers was found to exist in the research conducted by Lyndon et al. (2021) and summarised by the authors. Nevertheless, the stress experienced by academics has a ripple effect, causing problems not just in their profession but also for the students and the institution as a whole. The findings of the study conducted by Lyndon et al. (2021) were summarised as follows: it was found that the pressure of academics had alarmingly adverse effects on the mental, bodily, and behavioural reactions of lecturers; and it was found that the use of "deep acting" was influenced by the emotional intelligence factor. In addition, it was found that a person's attitude might influence the acting style that they utilise, with deep acting

being utilised for portraying feelings that are good and surface acting being utilised for portraying emotions that are negative.

A comprehensive literature and methodology evaluation, including a summary and analysis of emotional labour studies, was undertaken on academics in higher education. Since fewer studies have been done on various sectors of academic emotional labour, this study aims to fill the gaps and review what subjects are most reaping the rewards of research.

3. METHODOLOGY

3.1. The Components of Emotional Labour

This study conducts a critical qualitative literature analysis on emotional labour in the educational sector in order to shed light on methodological methods through a systematic literature review. In addition, this is a review that will focus exclusively on academics working in the field of higher education. The fundamental objectives of this study are to improve the contributors' comprehension of the existing literature and to point the way toward new avenues of research that should be pursued.

3.2. Search Methods

Starting with Google Scholar and the University of Plymouth's PRIMO database, both search engines were used to create the search string. In the course of gaining access to the relevant journal articles, it was discovered that several well-leading electronic databases existed, the majority of which were utilised as follows in order to gain access to publications of a high quality: Elsevier, Wiley and Blackwell, Sage, JSTOR, and ResearchGate in addition to Emerald, Taylor & Francis, and Ebsco.

Measures were taken to identify all relevant studies, and these were guided by the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement. Using the PICOS technique as a framework, I aimed to make the research questions and the approach to finding answers more practical. PICOS, which stands for population, intervention, comparators, outcomes, and study design, was used to refine the research questions. This was done so that the

terms may be developed and used in the search of the appropriate literature.

A comprehensive database search was conducted in PRIMO and it was very limited of publications available specifically pertaining to the search string of conjunction of emotional labour and higher education. However, with a basic search of emotional labour and higher education, the initial results of the search yielded 18,900 articles from various journals and sources. Secondly, search results were limited to articles published in between 2018 and 2022, which reduced the number of articles to 17,000. These results were generated initially in the google scholar and majority of the publications were made pertained to the hospitality and airline service industry and if any study related to the education, those were published in relation to the early childhood or primary or elementary educational level.

After searching PRIMO extensively, I found only a small handful of articles that addressed the topic of emotional labour in the context of higher education. Initially a simple search of "emotional labour" and "higher education" conducted however, turned almost 18,900 articles from a wide variety of journals and other sources. Second, researchers narrowed the scope of the search to only include articles from 2018 through 2022, which brought the total number of results down to 17,000. These findings originated in Google Scholar, where the vast majority of articles focused on the travel and hospitality industries. Those that did deal with education tended to focus on which was before through early childhood education to elementary education but not the professionals employed in the higher education.

The search results were refined by removing duplicates and publications written in languages other than English. The search was also confined to articles that had already been peer reviewed because of concerns about the study's likelihood of success and the search's prospective practical relevance. Because the inclusion criteria of this study have been broadened in order to facilitate conducting a methodological review, the descriptive study of the identified literature will be restricted to discussions of methodology. The evaluation procedure has been broken down into

numerous categories in order to increase expediency, which may help the researcher get a more precise analysis by conducting more in-depth observations. The design of the research, sampling method, data collection method, variable measurement, validity and reliability of the obtained literature on methodology in relation to emotional labour in the higher education sector have all been incorporated into the coding system that has been devised. I have designed a search string in order to collect the information that is most pertinent, appropriate, and valid to the time period and relevancy to the key terms of the study. The following advanced search string was carried out on PRIMO in order to collect this data. Because of this, it enabled me to refine the search results to an unprecedented degree of specificity. ('emotional labour' or 'emotional labor' or 'surface acting' or 'deep acting') ('educational services' or 'higher education' or 'university' or 'education field' or 'educational institutions' or 'schools' or 'tutoring' or 'teachers')

PRIMO's original search yielded 1,410 articles, but the results were narrowed down to just those containing the key terms in the headline, reducing the number to 96; further refinement yielded a further reduction to a timespan of 2018–2022, resulting in a total of articles down to 47. Among the conclusions that can be drawn from this search's findings is the understanding that many research were undertaken after 2020, indicating the possibility of a future distinct discipline of this research.

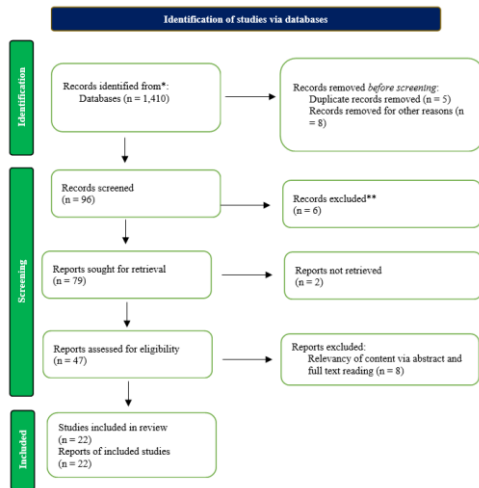


Figure 3: Inclusion and Exclusion Criteria of the Study

4. FINDINGS

4.1. Methods and Methodology

A total of 1,410 documents were returned by the database search, of which 22 met the criteria. Quantitative research methods were employed by 41% of the retrieved publications in order to establish a statistically significant correlation or differences between emotional labour and a few prevalent factors in higher education. The majority of the identified studies, or exactly 50% of the total, were conducted using a qualitative research design or a mixed methodologies approach (9%). There have been numerous theoretical and critical analyses of emotional burnout. To date, there has been a dearth of empirical research examining the interplay between emotional labour, workplace expectations, and organisational viewpoints.

4.2. Research Design

It was extremely noteworthy in the study because Crawford et al. (2018) had employed the qualitative design with a 'Story Pot' technique. This was very significant because it was the only study that was comprised of this strategy. One study (Gonzales & Ayers, 2018) was established in empirical research, one article (Louw, 2019) was published from a narrative interview

perspective, while another article (Kelly et al., 2021) utilised an intersectional approach.

Research Design	Publications
Quantitative Method	(Castejon et al., 2018; de Ruiter et al., 2021; Küçükberber & Balkar, 2021; Liao et al., 2020; Lindqvist et al., 2019; Toprak & Savaş, 2020; Wu et al., 2020; Zaretsky & Katz, 2019; Zhou et al., 2019)
Qualitative Method	(Crawford et al., 2018; de Ruiter et al., 2021; Gonzales & Ayers, 2018; Heffernan & Bosetti, 2020; Kelly et al., 2021; Kocabaş-Gedik & Ortaçtepe Hart, 2021; Louw, 2019; Molyneux, 2021; Richardson, 2021; Rinfret, McCandless, & Grewell, 2022; Rinfret, McCandless, & Muehlbauer, 2022)
Mixed Methods	(Baker et al., 2021; Sobel & Evans, 2020)

Table 3: Summary of Research Designs of this Study

According to the variable analysis of many studies in which utilised the Likert Scale, with many coding systems and SEM Analysis. Most of the articles used these methods, with the exception of one that used a hierarchical multiple linear regression analysis. Since several qualitative systematic literature studies are possible at this time, major approaches or methods connected to emotional labour can be explored further through the analysis of variables in this study. In the research conducted by Louw (2019), interviewees were first asked to share two narratives: the first was about how they personally became involved in PRME (Principles for Responsible Management Education) activity, and the second was about how their respective institutions became signatories. With all of the readings of the gathered studies, it is conclusive that the field of emotional labour is still in the process of theorising several concepts and other progressions remain to be brought. This is certainly relevant in light of the fact that there was an article about combining multiple theories in order to apply them to a more expansive and all-encompassing context.

4.3. Context

From the publications selected for this study, it can be inferred that the great majority of research has been undertaken in a European context, specifically in Sweden, the Netherlands, Poland, and the United Kingdom (Castejon et al., 2018;

de Ruiter et al., 2021; Heffernan & Bosetti, 2020; Lindqvist et al., 2019; Louw, 2019; Richardson, 2021). Following on from that, Australia, China, and Turkey are the other major geographical contexts that have been highly involved in the realm of emotional labour (Baker et al., 2021; Crawford et al., 2018; Kocabaş-Gedik & Ortaçtepe Hart, 2021; Küçükbere & Balkar, 2021; Toprak & Savaş, 2020; Wu et al., 2020; Zhou et al., 2019).

5. DISCUSSION

This study was designed with the goal of examining the relationship between emotional labour and academics who are working in the higher education sector. More specifically, this review is a methodical review of selected studies on emotional labour in higher education.

To gather and evaluate data related to emotional labour in the educational sector, emotional exhaustion, and burnout related to both surface and deep acting, the majority of the studies included in this analysis relied on qualitative research designs and techniques. The aims of the majority of research endeavour to review and analyse gender roles, organisational boundaries, personal commitments, lecture delivery and style, student participation, academic credentials, and professional experience. Behaviour, content, attitudes and the sixth sense are integral to all types of emotional labour, and this is what qualitative design focuses on Bryman (2012). The literature reviewed for this study employs a qualitative approach since it is better suited to discovering opinions, participant observations, and human interaction and socialisation processes. Most researchers agreed with this viewpoint, thus they mostly analysed data through content and discourse analysis to properly interpret and assess produced ideas and integrate theories to build the best model to eradicate all issues in emotional labour in the higher education sector.

The aforementioned studies only skim the surface of the possible research on emotional labour that can be conducted using a wide broad range of approaches and applying a diverse

number of theoretical frames. Quantitative, qualitative, and mixed-methods studies are all necessary components of any successful research design.

Considering that the studies that were chosen to focus on only the European context also included some other countries, including Australia, the United Kingdom, and the United States of America, it is possible to consider that conducting research on the Asian context more closely resembles the South Asian region, which is comprised of good education systems. Kelly et al. (2021) adds that in addition to the importance of one's skin colour, one's gender also plays a significant influence in emotional labour. The data collection for that Chicago-based study took place mostly at institutions of higher education that had historically served White students. Therefore, an extension must be considered for future studies and not only that, but the scope must also be more focused on each geographical area to dig in deeper where to find all aspects of the education sector pertained to the emotional labour.

Based on the collected studies, it was evident that the emotional labour is psychological factor where the responses can be varied depends on various cultural dimensions where the engagement with the students will be differentiated in terms of academic delivery. Evidence from Baker et al. (2021) suggests that educating pupils from culturally and linguistically diverse backgrounds may need a higher investment of emotional labour on the part of academics.

The everyday interactions with students have an effect on academics' emotional state. As a result, educators' decisions on how to employ emotional labour are heavily influenced by the quality of their relationships with the students involved. This is because a lecturer's emotional labour is influenced by how much he or she values teaching. Friendship and reduced animosity among the pupils may lead to greater emotional transparency. Reducing reliance may protect teachers' wellbeing by relieving the stress they feel to mask their true feelings in the classroom,

which can lead to emotional exhaustion and, eventually, burnout, as they try to protect the most vulnerable students (de Ruiter et al., 2021).

6. LIMITATIONS

Results from this study painted a clear image of what works and what might be expanded upon in future research. The vast majority of research illustrates that qualitative analysis is preferable to quantitative when testing theoretical methods and constructing models. Nevertheless, conducting additional study on quantitative analysis in areas where it is advantageous to have a larger knowledge and appreciation of the social sphere is always pertinent and should be done at the appropriate time. When studying occurrences or events that have an impact on individuals, researchers often employ quantitative research methodologies. Quantitative studies yield unbiased information that is commonly defined through numerical examples. In addition, it might be beneficial to recognise patterns, to form hypotheses, to evaluate interrelations, and to generalise the results to larger populations. When taking into consideration the fact that academics learn through experience how to emotionally regulate themselves and that the intensity of emotional labour may rise with time, methods of data collecting that combine longitudinal and repeated measurements take on a particularly important purpose.

7. SIGNIFICANCE

Lindqvist et al. (2019) found that setting explicit boundaries with students around the subject of care, particularly with regard to disclosing personal information, was extremely important. Teaching is one of many service professions where strong emotional responses must be suppressed in order to engage effectively with students. This is especially true in the academic setting, where expressing strong emotions can have a negative impact on the learning process. Further, Zhou et al. (2019) drew the conclusion of the conducted study from the organisational aspects of lecture delivery, stating that a playfulness climate has a direct and positive influence on teaching creativity and job engagement. Furthermore, a flexible and

engaging workplace, with its work assignments typically being unorthodox, is essential for the study's prolonged teaching environment.

There is a very interesting consideration in the study of Castejon et al. (2018) that how academic performance of students affect the emotional labour in relation to the academics. It was about a study that elaborated university graduates in the field of education who find work earlier have a greater sense of responsibility, pay more attention to their emotions and, despite having less control over them, they put their emotions to better use and their academic performance is higher. Therefore, professional achievement of academics where it relates to the labour integration is partially predicted or explained by technical competencies as evidenced by academic performance, greater explanatory power is attributed to emotional competencies where it does not indicate that any general intelligence may have any significant effect in this scenario.

Arguments supported by the literature review section, and with the study of Zaretsky & Katz (2019) demonstrated that lecturers who had experienced a high level of burnout were significantly more likely to use the surface acting technique than teachers who had experienced a low level of burnout. The use of surface acting was substantially higher among academics with only a diploma program, contrasted to those with a master's degree. Furthermore, there were substantial differences between teachers' levels of education and their employment of the deep acting style of emotional labour.

It is possible to use adaptive humour as a coping strategy to shield oneself from negative feelings. This may have been one of the factors that assisted the sampled academics in maintaining their self-confidence despite the challenges they faced on the job. Because of the favourable attitudes they held regarding their jobs, it is possible that they identified with their work and expressed the emotions that come effortlessly to them while at work which is more related with deep level acting (Liao et al., 2020). Further, controlling one's emotions and expressions to

fulfil the emotional requirements of one's job is connected to maladaptive forms of humour where more in favour of surface acting though the anger is a legitimate feeling (Torres-Marín et al., 2018). The failure to provide the bare minimum of necessary emotional labour almost always results in work challenges and is detrimental to the mental health of academics where it may lead to emotional exhaustion and job burnout (Liao et al., 2020).

8. CONCLUSION

In conclusion, although much attention has been paid to the negative aspects of emotional labour, it has also provided many useful insights towards improving productivity in the workplace by addressing emotional labour issues. The researchers in this study set out to examine previous studies that had taken a methodological stance toward emotional labour in the field of education. One study included in this analysis found that recognising academics' emotional labour in the workplace setting would be beneficial to both parties. This study examined 22 articles that focused on the literature, and it became clear that there were several important themes that needed to be implemented in the workplace in order to reduce job burnout and emotional exhaustion. These themes included things like surface and deep level acting, naturally felt emotions, and different approaches to and perspectives on emotional labour.

REFERENCES

- Baker, S., Due, C., Karan, P., & Rose, M. (2021). Teaching for diversity: university educators' accounts of care work and emotional labour with CALD students. *Teaching in Higher Education*.
<https://doi.org/10.1080/13562517.2021.2015751>
- Bryman, A. (2012). *Social Research Methods* (4th Edition). Oxford University Press.
- Castejon, J. L., Gilar, R., & Minano, P. (2018). 2 Personal and Emotional Factors in the Labour Integration of University Graduates in the Field of Education. *CEPS Journal*, 1(1).
- Crawford, N., Olds, A., Lisciandro, J., Jaceglav, M., Westacott, M., & Osenieks, L. (2018). Emotional labour demands in enabling education: A qualitative exploration of the unique challenges and protective factors. *Student Success*, 9(1), 23–33.
<https://doi.org/10.5204/ssj.v9i1.430>
- de Ruiter, J. A., Poorthuis, A. M. G., & Koomen, H. M. Y. (2021). Teachers' emotional labor in response to daily events with individual students: The role of teacher–student relationship quality. *Teaching and Teacher Education*, 107.
<https://doi.org/10.1016/j.tate.2021.103467>
- Gonzales, L. D., & Ayers, D. F. (2018). The convergence of institutional logics on the community college sector and the normalization of emotional labor: A new theoretical approach for considering the community college faculty labor expectations. *Review of Higher Education*, 41(3), 455–478.
<https://doi.org/10.1353/rhe.2018.0015>
- Grandey, A., Diefendorff, J., & E. Rupp, D. (2013). *Emotional labor in the 21st century: diverse perspectives on the psychology of emotion regulation at work*. New York: Routledge Academic. (Grandey et al., 2013)
- Heffernan, T. A., & Bosetti, L. (2020). The emotional labour and toll of managerial academia on higher education leaders. *Journal of Educational Administration and History*, 52(4), 357–372.
<https://doi.org/10.1080/00220620.2020.1725741>
- Hochschild, A.R., 2003. *The Managed Heart*. Twentieth Anniversary Edition. University of California Press Ltd., London.
- Kariou, A., Koutsimani, P., Montgomery, A., & Lainidi, O. (2021). Emotional labor

- and burnout among teachers: A systematic review. In *International Journal of Environmental Research and Public Health* (Vol. 18, Issue 23). MDPI. <https://doi.org/10.3390/ijerph182312760>
- Kelly, B. T., Gardner, P. J., Stone, J., Hixson, A., & Dissassa, D. T. (2021). Hidden in plain sight: Uncovering the emotional labor of Black women students at historically White colleges and universities. *Journal of Diversity in Higher Education*, 14(2), 203–216. <https://doi.org/10.1037/dhe0000161>
- Kocabaş-Gedik, P., & Ortaçtepe Hart, D. (2021). “It’s Not Like That at All”: A Poststructuralist Case Study on Language Teacher Identity and Emotional Labor. *Journal of Language, Identity and Education*, 20(2), 103–117. <https://doi.org/10.1080/15348458.2020.1726756>
- Küçükbere, R. Ö., & Balkar, B. (2021). Teacher accountability for teacher occupational professionalism: The effect of accountability on occupational awareness with the mediating roles of contribution to organization, emotional labor and personal development. *Journal on Efficiency and Responsibility in Education and Science*, 14(3), 167–179. <https://doi.org/10.7160/eriesj.2021.140304>
- Lee, J. H. J., & Ok, C. (2012). Reducing burnout and enhancing job satisfaction: Critical role of hotel employees’ emotional intelligence and emotional labor. *International Journal of Hospitality Management*, 31(4), 1101–1112. <https://doi.org/10.1016/j.ijhm.2012.01.007>
- Lee, L., & Madera, J. M. (2019). A systematic literature review of emotional labor research from the hospitality and tourism literature. In *International Journal of Contemporary Hospitality Management* (Vol. 31, Issue 7, pp. 2808–2826). Emerald Group Holdings Ltd. <https://doi.org/10.1108/IJCHM-05-2018-0395>
- Li, J. (Justin), Wong, I. K. A., & Kim, W. G. (2017). Does mindfulness reduce emotional exhaustion? A multilevel analysis of emotional labor among casino employees. *International Journal of Hospitality Management*, 64, 21–30. <https://doi.org/10.1016/j.ijhm.2017.03.008>
- Liao, Y. H., Luo, S. Y., Tsai, M. H., & Chen, H. C. (2020). An exploration of the relationships between elementary school teachers’ humor styles and their emotional labor. *Teaching and Teacher Education*, 87. <https://doi.org/10.1016/j.tate.2019.102950>
- Lindqvist, H., Weurlander, M., Wernerson, A., & Thornberg, R. (2019). Boundaries as a coping strategy: emotional labour and relationship maintenance in distressing teacher education situations. *European Journal of Teacher Education*, 42(5), 634–649. <https://doi.org/10.1080/02619768.2019.1652904>
- Louw, J. (2019). Going against the grain: emotional labour in the face of established business school institutional logics. *Studies in Higher Education*, 44(6), 946–959. <https://doi.org/10.1080/03075079.2017.1405251>
- Lyndon, S., Rawat, P. S., & Pawar, D. (2021). Is emotional labour a positive experience for teachers? A qualitative study. *International Journal of Educational Management*, 35(2), 532–548. <https://doi.org/10.1108/IJEM-03-2020-0149> (Lyndon et al., 2021)

- Mahoney, K. T., Buboltz, W. C., Buckner, J. E., & Doverspike, D. (2011). Emotional Labor in American Professors. *Journal of Occupational Health Psychology*, 16(4), 406–423.
<https://doi.org/10.1037/a0025099>
(Mahoney et al., 2011)
- Molyneux, T. M. (2021). Preparing Teachers for Emotional Labour: The Missing Piece in Teacher Education. *Journal of Teaching and Learning*, 15(1), 39–56.
<https://doi.org/10.22329/JTL.V15I1.6333>
- Morris, J. A., & Feldman, D. C. (1996). The dimensions, antecedents, and consequences of emotional labor. In *S) Academy of Management Review* (Vol. 21, Issue 4). (Morris & Feldman, 1996)
- Richardson, A. (2021). ‘We too find it difficult’: A consideration of site-based Holocaust education as emotional labour. *History Education Research Journal*, 18(2).
<https://doi.org/10.14324/herj.18.2.07>
- Sobel, K., & Evans, L. (2020). *Journal of Learning Development in Higher Education* Emotional labour, information literacy instruction, and the COVID-19 pandemic.
- Taxer, J. L., & Frenzel, A. C. (2015). Facets of teachers’ emotional lives: A quantitative investigation of teachers’ genuine, faked, and hidden emotions. *Teaching and Teacher Education*, 49, 78–88.
<https://doi.org/10.1016/j.tate.2015.03.003> (Taxer & Frenzel, 2015)
- Toprak, M., & Savaş, A. C. (2020). School headmasters’ emotional intelligence and teachers’ job satisfaction: Moderation effect of emotional labor. *New Horizons in Adult Education and Human Resource Development*, 32(2), 4–18.
<https://doi.org/10.1002/nha3.20282>
- Torres-Marín, J., Navarro-Carrillo, G., & Carretero-Dios, H. (2018). Is the use of humor associated with anger management? The assessment of individual differences in humor styles in Spain. *Personality and Individual Differences*, 120, 193–201.
<https://doi.org/10.1016/j.paid.2017.08.040>
- Waldbuesser, C., Rubinsky, V., & Titsworth, S. (2021). Teacher emotional labor: examining teacher feeling rules in the college classroom. *Communication Education*, 70(4), 384–401.
<https://doi.org/10.1080/03634523.2021.1936097>
- Williams, A. (2013). Hochschild (2003) - The managed heart: The recognition of emotional labour in public service work. *Nurse Education Today*, 33(1), 5–7.
<https://doi.org/10.1016/j.nedt.2012.07.006>
- Wu, T. J., Wang, L. Y., Gao, J. Y., & Wei, A. P. (2020). Social support and well-being of chinese special education teachers—an emotional labor perspective. *International Journal of Environmental Research and Public Health*, 17(18), 1–16.
<https://doi.org/10.3390/ijerph17186884>
- Yang, C., & Chen, A. (2021). Emotional labor: A comprehensive literature review. In *Human Systems Management* (Vol. 40, Issue 4, pp. 479–501). IOS Press BV.
<https://doi.org/10.3233/HSM-200937>
(Yang & Chen, 2021)
- Yu, X., Wang, P., Zhai, X., Dai, H., & Yang, Q. (2015). The Effect of Work Stress on Job Burnout Among Teachers: The Mediating Role of Self-efficacy. *Social Indicators Research*, 122(3), 701–708. <https://doi.org/10.1007/s11205-014-0716-5>

- Zaretsky, R., & Katz, Y. J. (2019). The Relationship between Teachers' Perceptions of Emotional Labor and Teacher Burnout and Teachers' Educational Level. *ATHENS JOURNAL OF EDUCATION*, 6(2), 127–144. <https://doi.org/10.30958/aje.6-2-3>
- Zhang, Q., & Zhu, W. (2008). Exploring Emotion in Teaching: Emotional Labor, Burnout, and Satisfaction in Chinese Higher Education. *Communication Education*, 57(1), 105–122. <https://doi.org/10.1080/03634520701586310> (Zhang & Zhu, 2008)
- Zhou, F., Wang, N., & Wu, Y. J. (2019). Does university playfulness climate matter? A testing of the mediation model of emotional labour. *Innovations in Education and Teaching International*, 56(2), 239–250. <https://doi.org/10.1080/14703297.2018.1453854>

Impact of Career Indecision on University Student's Academic Engagement: Mediating role of Hope

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ABSTRACT

Using a sample of 185 undergraduates, we studied how career indecisiveness could affect the academic engagement level of the students. Accordingly, results showed that the academic engagement of undergraduate students is influenced by the student's hope for academic success and the contingent effect of academic success on career development and overall life success. In this milieu, career decisiveness plays an important role in increasing academic engagement of university students. Universities must start career guidance programme from the entry point itself and develop clear career goals in students' mind.

Keywords: Academic engagement, Career Indecision, Hope, University Students

1. INTRODUCTION

Career indecisiveness is a significant issue which many scholars have studied in the recent past (Vondracek et al., 1990; Xu & Bhang, 2019).. Much empirical evidence suggests that young individuals who are aged 20 to 30 are less decisive on which career they should pursue in their lives (Xu & Bhang, 2019). This could hinder their opportunity to select the best course of higher education and also to groom themselves for the most suitable career for their personality and skills.

Individuals pursue higher education mainly to establish the qualifications needed for their future employment. However, the student's choice to enrol in an undergraduate programme

is impacted by other factors such as parents, peers, teachers, and labour market trends. Hence, there is a probability that they have less decisiveness on which career they want to pursue in future (Galhena & Kumanayake, 2022). This indecisiveness of the students could lead to less interest in academic matters and less confidence in academic success (Perkmann et al., 2021). This could result in mediocre academic performance and increase the number of dropouts.

In this milieu, the present study attempts to uncover the impact of career indecision on student's academic engagement. Further, we also discuss how Hope could mediate the relationship between career decisiveness and academic engagement. Empirically, this study is valuable as fewer studies discuss the role of career indecisiveness in academic engagement. Such knowledge will be beneficial to universities in deciding strategies to increase the academic engagement levels of the students.

2. THEORETICAL BACKGROUND

2.1 Career Indecisiveness

Vocational indecision or career indecision is a much-researched area in vocational and educational psychology. According to Vondracek et al. (1990), career indecision needs to be carefully conceptualised in career-related research. They suggest that career indecision should be differentiated from the general indecision of people. General indecisiveness is a personality trait which should not be a part of career indecision. Career indecision stands for

the inability to set career goals and stay committed to the initial career choice they make due to a lack of career awareness (Xu & Bhang, 2019). There are ample studies which show that some individuals do not pursue a career that is related to their degree specialisation. This indicates that those individuals were experiencing career indecisiveness when they select their degree major.

2.2 Hope

Hope is an important part of the psychological capital of individuals. Empirical evidence suggests that hope reliably predicts individuals' academic and career attainments. Azila-Gbetteor et al. (2021) describe hope as the expectations about future goals. The theory of hope has two dimensions, the agency element and the pathway element. The motivation to attain goals and sustain the effort towards goal achievement represents the agency element. The pathway element describes the ability to devise plans to achieve the desired goals amidst the challenges faced. Empirical evidence suggests that hope increases resilience and supports individuals to cope with challenges and negative situations (Azila-Gbetteor et al., 2021; Marques & Shane, 2019).

2.3 Academic Engagement

Academic engagement refers to students involvement and effort towards academic activities (Wong & Liem, 2021). These behaviours include behaviours that reflect students' commitment to academic achievements such as active participation in classroom sessions, independent learning, academic relationships with academics and taking the academic support to the fullest extent (Azila-Gbetteor et al., 2021). Students' engagement in academic activities is a key correlate for academic success. Empirical evidence shows that academic engagement is an important antecedent to timely completion of studies. Hence, universities must consider the academic engagement levels of the students as one of the key performance criteria in their organisations (Wong & Liem, 2021). Students' academic engagement levels emphasise that universities provide a conducive and encouraging

environment for student learning (Zilvinskis & Rocconi, 2018).

2.4 Theoretical Model

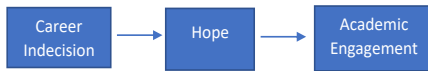
In the current study, we conceptualise that career indecisiveness plays an important role in academic engagement of students via its influence on students' hope towards their academic success and its consequences. Hence, we assume that if students have increased career awareness and clear expectations on their future career ambitions, it will elevate their hopefulness that academic success would help them to achieve their future career goals. Consequently, the hopefulness that education will facilitate them to be successful in the future will motivate students to involve in academic activities enthusiastically. However, if students are higher in career indecisiveness, this will reduce their hope on the success that would come through academic achievements. Hence, a lack of career awareness and goals related to future careers will not facilitate students to connect what they learn in their degree programmes are related with their future success. Accordingly, they will not consider that academic activities will help them to become a successful individual. Such a perception will result in less involvement in academic activities. Hence, the students who report a lower level of career decisiveness will be less engaged in academic activities as they do not hope that academic achievements will secure their future success. Accordingly, the following propositions were tested in this study

H1: Career indecisiveness will reduce the hopefulness of students

H2: Hopeful students will have higher academic engagement levels

H3: Hopefulness mediates the relationship between career indecision and academic engagement.

Figure 1: Theoretical Framework



3. METHODS

3.1 Sample

A group of students who are following the second year of their business management programme at Sri Lanka higher educational institute was selected as the participants of this study. We selected second-year students intentionally as these students have now spent one year in their programme and also planned to engage in their internships in the next academic year. Accordingly, the survey was distributed among 300 students and 185 completed the questionnaire as advised.

3.2 Data Collection and Measurement tool

Data for the study was collected through an online survey which was distributed to students via their student emails. The first part of the questionnaire covered basic demographic data and the second part consisted of questions about career indecisiveness, hope and academic engagement. Career indecisiveness questions of the survey were developed using the work of Ng and Feldman (2009). Items related to hope and academic engagement was taken from the scales developed by Azila-Gbettor et al. (2021).

3.3 Data Analysis, Validity and Reliability

The data collected through the survey were analysed using the Smart PLS software. Accordingly, the relevant statistical tests were performed to check the reliability and validity of the data. Some items were removed as they showed less contribution to the overall validity and reliability of the model.

Average Variance Extracted (AVE) was more than 0.5 for Career Indecision, but Hope and Academic engagement reported AVE values between 0.5 and 0.38. However, composite reliability for all factors was more than 0.7. Hence, according to Fornell and Larcker (1981), the model showed

adequate convergent validity. The three constructs also showed an acceptable level of discriminant validity as heterotrait-monotrait ratio of correlations (HTMT) values were less than 0.85. Reliability levels of all three constructs were more than 0.7; hence, the constructs' reliability was also deemed acceptable.

4. FINDINGS

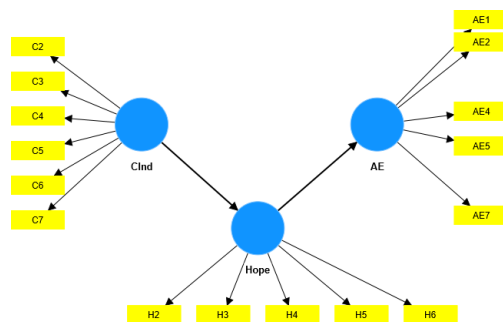
In terms of descriptive statistics, 69% of the respondents were female students, and 31% of the participants were male students. Means and standard deviations for career indecisiveness, hope and academic engagement are given in Table 1.

Table 1: Descriptive Statistics

Statistic	CI	Hope	AE
Mean	3.28	3.84	3.78
Standard Deviation	0.9	0.8	0.9

In order to test the hypothesis developed in this study, we used SMART PLS version 4.0. Figure 2 shows the structural equation model developed in SMART PLS to test the hypothesis statements of this study.

Figure 2: Mediation Model



According to the study's results, career indecision showed a negative effect on hope towards academic success (*direct* $\beta = -0.27, p < 0.05$). This confirmed hypothesis 1 that career indecisiveness leads to a lack of hope towards academic success. Our analysis also confirmed hypothesis 2 and showed that hope contributes positively to academic engagement levels of the

students (*direct* $\beta = 0.51$, $p < 0.01$). Further, the mediation analysis showed that hope mediates the relationship between career indecisiveness and academic engagement (indirect $\beta = -0.14$, $p < 0.05$). This confirmed hypothesis 3, and showed that career indecisiveness has a significant indirect relationship with academic engagement via hope. Hence, higher indecisiveness will predict lower academic engagement as indecisiveness reduce the hope that academic achievements will lead to success.

5. DISCUSSION

This study provides valuable insights on academic engagement and how universities could elevate the academic engagement levels of the students. Career decisiveness is an important predictor of the academic engagement levels of students. In order to make a proper decision about their future career, the students must be provided with relevant information that facilitates them to performn their own analysis and select the best career path that suits their personality and skill set. However, in Sri Lankan context career decisions are not taken based on the personality and skill set of the individuals. In Sri Lanka, students' decision to select their degree specialisation is much influenced by external factors such as parental pressure, peer pressure and labour market trends. Moreover, the school education system does not have properly developed career guidance programmes which also contributes to the career indecisiveness of the students.

In this milieu, universities have an important role in increasing career awareness and facilitating students to develop their career focus in the first year of their study. If universities fail to implement such programmes, it will lead students to perceive that academic activities are not adding value to their future success. This will finally reduce student involvement in academic activities. Less academic engagement would lead to adverse outcomes for both the universities and students. As a result of low academic engagement quality of the graduates will be reduced and lead to a higher number of dropout cases.

6. CONCLUSION

In conclusion, this study provides important insights to understand the students' low academic enagement level. Universities need to inculcate career knowledge and career planning as an integral part of the degree curriculum. Future studies in this area could focus on different aspects of career indecision and the effectiveness of career guidance programmes that exist in organisations.

References

- Azila-Gbetteor, E. M., Mensah, C., Atatsi, E. A., & Abiemo, M. K. (2021). Predicting students' engagement from hope and mindfulness. *Journal of Applied Research in Higher Education*.
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of marketing research*, 18(1), 39-50.
- Galhena, B., & Kumanayake, P. (2022). Determinants of Career Indecision among Management Undergraduates in Sri Lanka. *Kelaniya Journal of Management*, 11(1).
- Marques, S. C., & Shane, J. (2019). Measuring and Promoting Hope in Schoolchildren. In *Handbook of Positive Psychology in Schools* (pp. 43-58). Routledge.
- Ng, T. W., & Feldman, D. C. (2009). Personality, social relationships, and vocational indecision among college students: The mediating effects of identity construction. *Career development international*, 14(4), 309-332.
- Perkmann, M., Salandra, R., Tartari, V., McKelvey, M., & Hughes, A. (2021). Academic engagement: A review of the literature 2011-2019. *Research Policy*, 50(1), 104114. <https://doi.org/https://doi.org/10.1016/j.respol.2020.104114>
- Vondracek, F. W., Hostetler, M., Schulenberg, J. E., & Shimizu, K. (1990). Dimensions of career indecision. *Journal of Counseling Psychology*, 37(1), 98.
- Wong, Z. Y., & Liem, G. A. D. (2021). Student engagement: Current state of the

construct, conceptual refinement, and future research directions. *Educational Psychology Review*, 1-32.

- Xu, H., & Bhang, C. H. (2019). The structure and measurement of career indecision: A critical review. *The Career Development Quarterly*, 67(1), 2-20.
- Zilvinskis, J., & Rocconi, L. (2018). Revisiting the relationship between institutional rank and student engagement. *The Review of Higher Education*, 41(2), 253-280.

Building Inclusive Workplace Culture in Underdeveloped Countries Focusing on Marginalized Communities

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ABSTRACT

An Inclusive workplace is described as a workplace where every person feels appreciated and is recognized for their differences and how they affect the culture and business results of the enterprise. Affirmative action, which eliminates the effects of prejudice, discrimination, and uneven opportunity, is a defining feature of an Inclusive workplace. Building a Inclusive workplace focusing on marginalized communities entails more than just pledging pay fairness and employing people from marginalized communities. Although this is unquestionably a positive beginning step, marginalized community is a deeply ingrained systemic problem that requires some effort at the fundamental level. Laying the foundation for diverse and Marginalized perspectives to be heard and for their work to be valued is the creation of a culture of support and inclusiveness. A welcoming culture of inclusion and equity is required for marginalized communities to succeed in the workplace. Communities that are marginalized include individuals who have traditionally been excluded from participation in our cities as well as those who still experience significant hurdles to civic engagement.

As a result, rather than concentrating on diversity objectives and activities, this study will concentrate on the features of an Inclusive culture and the extent to which organizations in developing nations expressly aim an Inclusive culture. The research will next go through the commercial motivations for constructing an Inclusive culture in underdeveloped nations with an emphasis on marginalized communities. This

paper then focus about driving an Inclusive culture and what seems to work well and what

doesn't. At the conclusion, it will be explored how firms in developing nations might restructure their human resources practices, such as talent management, recruitment, and performance management, to support an Inclusive culture that focuses on the marginalized population. Finally, this study will determine how Inclusive workplace culture in developing nations concentrating on marginalized communities and business success relate to one another.

1. INTRODUCTION

Leaders must have a culture of inclusion in place if they want to effectively manage any organization, whether it is a for-profit company, a nonprofit, or a university (Chang, 2017). It cultivates a feeling of purpose and belonging, promotes effectiveness, and improves the experience for everyone when a place is created where everyone feels welcome. The movement in the culture toward appreciating and valuing diversity has pushed the boundaries for businesses and employers worldwide to develop Inclusive workplaces (Selden & Selden, 2001). The creation of an Inclusive as opposed to a varied workplace or university is significantly different (Chang, 2017). Diversity in an organization refers to the presence of individuals of various racial, religious, gendered, and sexual orientation backgrounds (Singley & Sedlacek, 2009). Being varied alone, however, is insufficient. Organizations that succeed move on to become Inclusive, where the atmosphere also

fosters a sense of belonging, importance, and worth for everyone.

The culture of an organization establishes the appropriate conduct for employees (Chan & Clegg, 2002). This culture is made up of common values and beliefs that have been formed by leaders, disseminated, and reinforced via a variety of channels, eventually influencing employee perceptions, actions, and comprehension. The context of an organization's culture determines what an enterprise performs (Chuda & Wyrwicka, 2016). There isn't a universal culture template that satisfies the demands of all businesses because industries and circumstances differ greatly. The firm may boost staff productivity and, as a result, increase total work production by developing a strong corporate culture that is in line with the organizational objectives (Wisetsri, 2020). Most workers in developing nations think that organizational culture has a significant impact on their ability to do their jobs. Organizational culture that prioritizes open internal communication and cooperation is typical of firms in developing nations that prefer organizational integration; however, as those firms move toward a market orientation, the organization culture becomes more aggressive and opportunistic to take advantage of market opportunities (Otokwala, 2010). Like a performance orientation, which assigns rewards based on individual performance in relation to objective goals, a people orientation is typically of paternalistic and collectivist organizational cultures and is characterized by a high organizational concern for its employees' well-being as well as an emphasis on teamwork and development.

So, the following questions will serve as the foundation for this research project. What traits distinguish an Inclusive culture? How much do organizations in underdeveloped nations specifically aim towards an Inclusive culture as opposed to concentrating on diversity objectives and initiatives? What financial reasons exist for producing an Inclusive culture that targets marginalized communities in underdeveloped nations? What behaviors lead to an Inclusive culture and which ones don't usually work? To

promote an Inclusive culture concentrating on the marginalized population, how should enterprises in developing nations rearrange people processes like talent management, recruiting, and performance management?

2. CHARACTERISTICS OF AN INCLUSIVE CULTURE

An Inclusive workplace is a workplace that respects both individual and group diversity among its employees (Wevelsiep, 2019). It helps an organization to value the variety of employee backgrounds and viewpoints, which in turn boosts talent, innovation, creativity, and contributions (Mohammadi et al., 2017). Instead of feeling excluded from the workforce, different employees feel respected, welcomed, integrated, and part of it thanks to an Inclusive workplace (Coates, 2006). The Inclusive workplace also stands out for the fact that everyone has equal access to possibilities. Along with shared ownership and responsibility, there is also open communication and information exchange.

2.1. It embraces inclusivity and diversity as a way of life. Diversity is seen in every department of an Inclusive company. Both the staff and the consumer communities have a wide variety of cultures, traditions, beliefs, languages, and lifestyles, all of which are honored without prejudice (van Knippenberg & van Ginkel, 2021). People are seen as people who have banded together to organize efforts toward the accomplishment of shared objectives.

2.2. Based on visible and quantifiable behaviors and abilities, it assesses both individual and group performance.

Employees have a clear understanding of their roles and responsibilities. They are evaluated based upon their actions, not the opinions of others. Goals and expectations are achievable.

2.3. Its policies and practices are open and clear

There aren't any unspoken behavioral norms that apply to some groups but not to others.

2.4. It behaves consistently in all of its contacts.

No double standards exist. All around the institution, rules are faithfully and consistently implemented. Nothing favors one group over another.

2.5. It establishes and keeps up a learning culture.

All employees are assisted in their career development by management. The formal and informal processes that make up mentoring programs are extensive and cater to the unique learning requirements of every employee (Szabó-Bálint, 2019). While errors are acknowledged and their effects are handled, they are not seen as moral failings but rather as teaching opportunities.

2.6. It features a thorough and convenient procedure for resolving disputes at all levels.

It understands that conflict will always arise in a large, multiethnic organization and has put processes in place to deal with it in a way that respects the privacy and dignity of all involved.

2.7. It understands that the community it serves is a part of itself.

Employees, managers, and customers all come from the community. An Inclusive organization is an active participant in community activities and plays a vital role in addressing its needs (Lewis, 2017).

2.8. It lives its mission and core values.

People join an organization because they agree with its mission and objectives. A business runs the danger of losing the faith and confidence of both its employees and its clients if it makes one promise and fulfills another.

2.9. It favors advantage that is earned above undeserved privilege.

Employees are praised for their deeds and successes rather than just their titles or degrees. Customers are respected regardless of their socioeconomic standing or social group.

2.10. It accepts and embraces change.

Change will always occur. An Inclusive firm understands that in order to keep up with the

changing requirements and needs of the market, workforce, and consumers, current and previous practices must be continuously examined and changed.

3. WORKPLACE CULTURE IN DEVELOPING COUNTRIES

According to researchers, hierarchical organizational structure, subordinate submission to authority and directives from the top of the hierarchy, benevolent autocracy from the founder/owner of the firm, and a greater emphasis on relationships than tasks are typical and expected characteristics of organizational culture in these countries (Arbaiza & Guillén, 2016). These countries are among those surveyed because they have large power distances and collectivist societies. However, social culture is just one of many potential factors that might affect organizational culture (Marques, 2007).

Less often, individuals working in underdeveloped nations suggest modifying organizational cultures (Figueiredo, 2013). How to most effectively integrate native culture with Western management principles is one topic of research, which is important given the significant role that incoming foreign investment plays in economic growth (Pathak et al., 2015). The rising understanding that organizational culture is a crucial component of the strategy businesses in developing nations must follow in order to grow and succeed is another factor driving this increase in focus.

A shift in a developing nation's political system is generally followed by a new set of economic objectives and goals as well as structural changes like privatization (Khodzaian, 2019). The rules and regulations that apply to workplace operations are influenced by the political climate as well. A developing nation's economic environment encompasses all facets of the marketplaces for the products and services that businesses manufacture and sell, including monetary and fiscal policy, consumer trends, and investment. Going from a centrally planned to a market economy is often the most difficult and toughest shift for emerging nations. Organizations in developing nations must also

consider how the adoption of new technologies will affect their corporate long-range strategic objectives (cultures), especially those technologies that allow for more thorough monitoring of employee performance or quick communication and extensive information sharing within the organization (Nwagu, 2022). The above-mentioned research demonstrating the influence of societal culture on organizational culture makes it clear that changes to the sociocultural environment in emerging nations will undoubtedly affect the workplace.

3.1. Marginalized communities in developing countries Marginalized populations are groups and communities that endure (social, political, and economic) discrimination and exclusion due to uneven power relationships across economic, political, social, and cultural dimensions (Hargittai, 2007). Groups excluded on the basis of ethnicity, gender identity, sexual orientation, age, physical ability, language, and/or immigration status are examples of Marginalized populations (Cahyani & Widaningsih, 2019). Due to uneven power ties between social groups, marginalization arises.

Marginalized individuals have little influence over their life and the resources accessible to them (Morris, 2005). This thus hinders their ability to contribute to society. A vicious cycle is created in which their lack of good and supportive connections prevents them from engaging in community life, which leads to more isolation (Cahyani & Widaningsih, 2019). This has a significant influence on individual development as well as on society as a whole.

As the purpose of development is to enable individuals to experience a productive, healthy, and creative life, it is essential to address the problem of marginalization (Faber, 2010). Constantly, development is understood generally in terms of popular engagement. Globally, marginalization prevents the participation of the vast majority of individuals in the development process (Munyoka, 2022). It is a complicated issue, and several causes contribute to marginalization. This severe and complicated issue must be addressed at the policy level.

To better illustrate the idea and concept, let's examine some Marginalized group features (Bich, 2012):

- It experiences servitude and prejudice.
- They display distinguishing physical or cultural characteristics that a dominant group finds objectionable.
- They bear similar challenges and feel a feeling of unity.
- They adhere to common social norms on who belongs and who does not.
- They often get married among themselves.

As a result, marginalization is intricate and constantly changing, tied to social position.

3.1.1. Various Marginalized groups and their problems

Women –

Under varying economic situations and the effect of certain historical, cultural, legal, and religious variables, one of the forms of gender inequality is marginalization (Slukhai, 2016). In other words, women may be barred from certain vocations and professions, included in others, and subject to Marginalized in others (Slukhai, 2016). In every nation and society, women are often Marginalized compared to males. Women (or men) do not constitute a homogenous group with shared interests, skills, or behaviors. Women of lower classes, poorer castes, illiteracy, and the poorest area experience varying degrees of marginalization compared to their wealthier counterparts.

People with disabilities –

People with disabilities have fought prejudiced preconceptions, negative stereotypes, and unreasonable fears for generations (Gelbman, 2022). The stigmatization of disability led to the social and economic marginalization of generations with impairments, and, as with many other persecuted minorities, this has left individuals with disabilities in a harsh condition of poverty for centuries.

Schedule Castes (Dalits) –

A rigorously hierarchical social structure, the caste system is predicated on underlying ideas of impurity and filth. Shudras or Dalits make up the bottom of the hierarchy, while Brahmins are at the top (Ayalon, 2004). Dalits are marginalized in all aspects of their lives, which violates their fundamental human rights, including their civil, political, social, economic, and cultural rights (Ayalon, 2004).

Scheduled Tribes –

In Indian society, the Scheduled Tribes and Scheduled Castes both experience institutional prejudice (Masket et al., 2014). The Scheduled Tribes, in contrast to the Scheduled Castes, are a result of racial marginalization. Around 84.3 million Scheduled Tribes live in India, and they are seen to be socially and economically disadvantaged (Meenakshi, 2011).

But their numbers and demographic percentages differ from State to State. They have minimal control over resources like land, forests, and water since they are mostly landless.

Elderly or Aged People –

Life's natural and inexorable progression is aging. In India, the senior population is expanding at an alarming rate and has become a major issue for the government and policymakers (Widener, 2022).

Children –

Children's mortality and morbidity are caused and exacerbated by poverty, their gender, and their social caste.

Sexual Minorities –

Sexual minorities are another group that confronts stigma and persecution. Those who identify as homosexual, lesbian, transgender, bisexual, kothi, or hijra face prejudice in society and the health care system (Widener, 2022). Individuals who are recognized as having same-sex sexual desires are mocked and shunned by their own family and are left with extremely few social structures and community networks that give the conditions of care and support (Meenakshi, 2011). Various health policies and initiatives disregard their needs and concerns.

4. INCLUSIVE WORKPLACE CULTURE AND ORGANIZATIONAL OUTCOME

An Inclusive environment is symbiotic with an organizational culture that actively pursues equity within the workplace (Fanggidae, 2018). Some authors argue that every organization has a culture, and success depends on the health and strength of it (Harris, 2004). For this reason, it is essential that leadership consistently works to build and foster an observable Inclusive culture (Dunn, 2021). Employees learn acceptable and unacceptable behavior by adopting the behavior they observe from other employees, further developing the preestablished culture. Fostering the right organizational culture is one of [management's] most important responsibilities," because "establishing shared values, beliefs, and assumptions" (Sanders, 2016) creates norms that show employees how they are expected to act within the workplace. Some authors argued that businesses must adopt integrated processes for promoting diversity at strategic, tactical, and operational levels for diversity programs to be successful. A general diversity statement is insufficient to establishing such norms; instead, leadership must actively take steps to establish an organizational culture with norms that includes inclusiveness (Ferdman et al., 2020).

Organizations that have successfully established a diverse workforce can reap the proven benefits that it provides, including a wide array of perspectives and experiences (Bayram, 2007). However, seemingly innocuous practices that are embedded in a company's culture have the potential to make a segment of its workforce feel unwelcome and alien. But, when the possible problems with these practices are identified, a commitment to creating an Inclusive culture can lead to changes that can vastly improve a work environment.

Consider the example of a tech start-up company that was founded by a group of friends from college, all coming from very similar backgrounds (Short, 2021). Every year, a company picnic was held on a Saturday or Sunday with two key competitions taking place among the work teams: a relay swim race and a barbecue cook-off, followed by an employee

recognition awards ceremony (Fanggidae, 2018). This tradition continued as the company grew rapidly and employed a diverse range of talent.

When leadership became aware of the distress that the picnic was causing some employees, they took the time to reach out to every employee to get their feedback on the timing and the events held at the picnic (Kornelakis et al., 2018). Great care was taken to implement all of the ideas they received that were feasible and each employee was specifically thanked for their input. This effort was an important step in creating an environment in which every employee felt included and valued – in other words, a culture of inclusion.

5. LITERATURE RELATED TO MARGINALIZED COMMUNITIES IN INCLUSIVE WORKPLACE CULTURE AND UNDERDEVELOPED COUNTRIES

5.1. Opportunities for Marginalized population in developing countries

Marginalized populations can encompass many individuals. This study will focus on three groups that, despite their differences, face similar obstacles to accessing social, economic, and environmental resources (Gatta, 2006). (Gatta, 2006). These are survivors of human trafficking, refugees, and formerly incarcerated persons. These three groups represent a sizeable untapped talent pool, but they still encounter significant barriers to finding stable employment in the modern world (Gatta, 2006). (Gatta, 2006).

Research demonstrates that actively establishing chances for persons from Marginalized groups might benefit companies in numerous ways (Packer et al., 2018). (Packer et al., 2018). These may include:

Diversity and inclusion have been associated with improved team performance, and businesses with greater gender and racial diversity frequently outperform their peers financially (Verma, 2013). The concept of assembling teams comprised of individuals with diverse life experiences represents a new frontier aimed at incorporating cognitive diversity into the traditional demographic lens.

Attracting and retaining top talent – Creating sustainable job opportunities for Marginalized populations may result in higher retention rates for employers—from these hires as well as current staff (Williams, 2018). (Williams, 2018). Additionally, a recent poll indicated that “millennials and Generation Zs exhibit higher devotion to companies that courageously attack the problems that connect with them most.”

Increased social license to operate. According to research, stable, gainful employment helps to reduce vulnerability and increase stability (Härrä et al., 2020). This can, in turn, create greater economic outcomes for traditionally Marginalized individuals and their families, and contribute in small ways toward broader economic equality goals (Härrä et al., 2020).

Employers who hire Marginalized populations may be eligible for federal tax credits through the Work Opportunity Tax Credit (WOTC) program, which provides incentives to businesses that hire from one of nine "target groups," including people with criminal records (Srinivas, 2016).

Despite the obvious benefits, many members of Marginalized groups still have trouble landing stable employment.

5.2. Challenges for Marginalized population in developing countries

Even though individuals from each of the three categories confront different obstacles to work based on their unique experiences and traits, there are some obstacles that Marginalized populations share to varying degrees (Liew, 2012):

Societal stigma: One of the most important hurdles to work for the indicated demographics comes through social stigma and bias. In order to access and fully engage in work, considerations such as race, gender, age, sexual orientation, physical ability, veteran status, religion, and other identities continue to be important (Liew, 2012).

Accessibility: Individuals who lack dependable internet access and digital literacy may have a difficult time searching for and securing employment. In an economy in which more than 70 percent of jobs are never listed openly, the

absence of a social or professional network can also be a substantial obstacle to employment (Feli-Mójer, 2020).

Health issues related to behavior and the body, as well as past traumatic experiences: Obstacles related to mental, emotional, and physical health, in addition to geographical limits, make it difficult for Marginalized people to seek and get work. It is essential for individuals to have access to trauma-informed care as well as proper support infrastructures in order for them to be able to succeed in and maintain work prospects (Jayaram, 2020).

Legal obstacles: Typically, survivors of human trafficking and formerly jailed individuals encounter severe legal obstacles to work. Numerous direct occupational hurdles and extra post-release punishments have an influence on formerly imprisoned individuals (World Bank, 2014). In the absence of discrimination, federal law does not prohibit employers from asking about and considering criminal records when making employment decisions. Some social benefits, for instance, may take months to reestablish upon release from jail.

Financial limitations: Marginalized individuals frequently struggle to locate professional dress, transportation to job interviews, or understanding of the procedure to discover a career that effectively fits their skills and aspirations without steady financial means (World Bank, 2014). Resources limitations also make it challenging for former prisoners, refugees, and trafficking survivors to invest in upskilling, occupational certifications, or the educational qualifications necessary to meet employer demands.

Misaligned education and qualifications: For all three Marginalized categories, job prospects are severely restricted by gaps in employment and by insufficient or misaligned qualifications (either educational or work-based) (Chakraborty, 2016). Alternatively, certain certificates are not internationally recognized. Migrants could need to repeat certification tests in their second language, finish up their academic work, or persuade employers that their credentials are legitimate.

Individuals attempting to navigate a system of employers, service providers, and training programs sometimes find themselves in hazardous or vulnerable positions due to one or frequently several of the above-mentioned impediments (Bich, 2012). Similar to employees, employers could be confused about how to find talent and educate staff without using conventional channels.

5.3. Business drivers for creating an Inclusive culture in developing countries focusing on marginal communities

1. Make sure leaders refrain from partiality.

Building a culture of office politics and infighting can erode trust and make employees believe their workplace isn't really fair (Sridhar & JASROTIA, 2020). While healthy competition is possible, ruthless cultures can undermine community and camaraderie.

2. Employees want to be a part of corporate decisions.

Companies must commit to listening in order for Marginalized employees to feel like they have some control over their job.

3. Provide equitable and transparent access to information.

Although the statistics clearly reveals that firms that concentrate on purpose have a higher likelihood of having a positive employee experience, it's all academic without effective communication (Boswijk, 2017).

Communication that is compartmentalized hurts both companionship and teamwork. It conveys to some employees that they are on the periphery of the organization and are not trusted with crucial business knowledge (Boswijk, 2017). They may experience feelings of betrayal and confusion if they are suddenly confronted with unfavorable news or if they are excluded from critical company decisions.

Everyone in the company is more likely to feel like a valued member when there is open communication throughout the team.

4. Unbiased promotion procedures.

The gender gap in many workplaces is a prevalent example of a workplace. Women in the workplace more frequently see managerial favoritism and uneven project and promotion distribution (Birdthistle et al., 2022).

Promotions are a significant area where the organization can fall short of its declared principles and the developing country company's chance to exhibit its beliefs. Trust is damaged if the leaders emphasize the value of hiring women yet continue to pass them over for advancement.

Additionally, such ladies will believe they don't belong in the company.

5. honoring employees for their hard work

Recognizing workers' achievements teaches them that their company appreciates their special potential (Bich, 2012). Workers that feel appreciated are more likely to report that they feel cared for by the organization, and that there is greater camaraderie within their team.

Recognition programs also help with other elements of belonging.

6. Make staff feel welcome

According to the data, businesses that can make new team members (and their ideas) feel welcome outperform the competition.

7. Embrace the total individual

To foster a sense of belonging, employees must feel comfortable bringing their whole selves to work. It is something that many present employees do not feel comfortable doing.

5.4. Challenges of cultural diversity in the workplace and actions taken to mitigate the existing challenges

Some culture colleagues may be less willing to make their opinions known. However, diversity of intelligence alone is insufficient (Amaram, 2007). It is also essential to establish

an Inclusive workplace atmosphere in which all team members feel encouraged to contribute (Dunn, 2021). This can be especially difficult for coworkers from courteous or deferential cultures. For instance, professionals from Asian nations such as Vietnam or Japan may feel less at ease

speaking out or contributing ideas, especially if they are new to the team or occupy a subordinate position (Melendres, 2020). Conversely, aggressive coworkers from the United States, Western Europe, or Scandinavia who value flat organizational structure may be more likely to speak out in meetings or negotiations when others remain silent (Melendres, 2020).

Across languages and cultures, professional communication might be misunderstood or challenging to grasp (Johnson, 2006). While accurate translations are essential for successful marketing, there is a genuine danger that dialogue between ethnic coworkers might be lost in translation (Johnson, 2006). Language difficulties are only one difficulty. Even in a workplace where everyone speaks English, it might be challenging to decipher a variety of accents or a native speaker's usage of idioms. Furthermore, effective cross-cultural communication involves far more than just spoken words (Garcia & Soest, 2000). Between team members from various nations, nonverbal communication can cause misunderstandings or even anger due to its sensitive and subtle nature. Making or keeping eye contact, gestures, and acceptable amounts of physical distance can all vary greatly amongst cultures (Suarez-Balcazar et al., 2009). In a business setting, it is important to consider the cultural connotations of even the simplest welcome or handshake.

It can be challenging to navigate visa regulations, employment rules, and the cost of meeting workplace criteria. Despite the obvious advantages, hiring people from abroad may be a burden for HR (Melendres, 2020). The challenging process of managing employment rules and visa procedures for overseas workers is not the least of these. Every country has various requirements and rules, and they might change often. Beyond visas, more measures for attracting and keeping a diverse workforce should be taken (Green & Cherrington, 2010). For instance, allowing employees of various faiths to pray in private may make a workplace more friendly and Inclusive, as can taking into account various cultural or religious festivals. Of course, these factors and accommodations can provide a logistical as well as a financial issue.

Various interpretations of professional etiquette exist. Colleagues from other cultures may also bring diverse workplace attitudes, values, behaviors, and etiquette to the workplace. In a varied work setting, they can be enlightening and even advantageous, but they can also lead to misunderstandings or ill will among team members. For example, the expectation of formality (or relative informality), organizational structure, and even working hours might be incompatible between cultures. Whereas a Japanese coworker would not consider it ethical to leave work before their manager (or anybody else), a Swedish professional could be accustomed to a 6-hour workday (Mikkelsen, 2001). Different approaches to timeliness, confrontation, and dispute resolution can also be problematic.

Nevertheless, working habits and attitudes regarding work can vary greatly, reflecting cultural norms and exacerbating disparities. In the absence of recognition and consideration, opposing approaches to work might impede productivity. Approaches to teamwork and collaboration, for instance, might differ considerably (Mikkelsen, 2001). Some cultures, notably many in Asia and Central America, place a premium on agreement while pursuing a common objective. Others, such as Germany and the United States, place a greater premium on individual freedom. Similarly, the workplace's focus on order, precision, and structure as opposed to adaptability and spontaneity might reveal underlying cultural beliefs. The Virgin Group is a trailblazer in encouraging workplace diversity and cultivating a positive culture.

6. RELATIONSHIP BETWEEN INCLUSIVE WORKPLACE CULTURE IN UNDERDEVELOPED COUNTRIES FOCUSING ON MARGINALIZED COMMUNITIES AND BUSINESS SUCCESS

The ability of a company to deploy cutting-edge technology is not the only factor that determines success in the modern workplace. Instead, it's about how an organization's people, mission, and

product work together to produce a winning formula. However, depending on the specific requirements of each business, it might be difficult to decide how much attention should be paid to each of the three categories. Organizations must examine their internal structures and make a concerted effort to develop a diverse and inclusive culture when it comes to people and purpose. Opportunities must be created for everyone, empowering minoritized genders, cultures, and ethnicities.

6.1. Steps to follow to create an inclusive workplace culture in underdeveloped countries focusing on Marginalized communities

Start from the top.

As with any aspect of corporate culture, leadership is the first step in fostering a sense of belonging in the workplace (Peacock, 2014). The company's founders and leadership team must be motivated to create a diverse workplace and must seek out candidates who are willing to collaborate with people of all various races, ethnicities, genders, and sexual orientations (Peacock, 2014).

Focus on inclusive recruitment strategies.

It's essential to spread the mindset established by the company's leadership throughout the whole workforce.

Provide safe spaces for employees.

Inclusive workplaces go above and above to take into account the security and comfort of all workers, particularly those in Marginalized groups. For instance, gendered toilets may

cause transgender and gender nonconforming employees discomfort, especially in light of contentious "bathroom legislation" that have been proposed in a number of states and may or may not affect the rights of transgender individuals (Nkansah-Dwamena, 2022).

Simply by spending time with one another, inclusive places may be built on a larger scale. Think about organizing team lunches and other relaxed gatherings so that staff members may interact with one another (Bourgault & Goforth,

2021). If the business is larger, setting up an internal network or support group for diverse employees might help them connect with others who have experienced similar things.

Connect with employees (but be sensitive).

Making a personal connection with staff members is one of the finest methods to let them know it's okay to be themselves. Tell them everything about the personal life honestly.

Instead of presuming someone's sexual orientation and using gendered words, simple actions like inquiring about "spouses" or "partners" might enable staff to speak up about their personal life and feel included in non-work talks (Young, 2011). It's important to avoid being disrespectful about their identities, though.

Give employees multiple ways to provide feedback.

According to Ullmann, cultivating an inclusive culture is an ongoing process, therefore company should continually review the policies and initiatives to foster a more accepting, varied atmosphere (Leshchuk, 2021).

6.2. Inclusive workplace culture and business success Diversity of personnel has a substantial effect on the competitive advantage of both large and small organizations (Yakubova, 2020). Diversity in the workplace is not just the moral thing to do, but it can also be the catalyst for corporate success (Pritam, 2020).

Diversity in the workplace necessitates an unconventional hiring strategy. Consistently considering factors outside the CV, such as charisma, drive, and enthusiasm. Additionally, examine applicants who may not have industry experience, but whose different backgrounds might contribute to the company's innovative advancement (Praveenadevi & Girimurugan, 2019).

Driving innovation

The vital force behind company innovation and creativity is diversity (Moore & Jull, 2012). Diverse teams foster innovation and creativity by bringing a variety of views, viewpoints, and new ideas to the table, all of which improve decision-making and problem-solving (Moore & Jull,

2012). By highlighting unexplored possibilities and areas to explore, this increased value and broader knowledge may also spur corporate growth.

Increasing productivity

Diverse workplaces provide a more productive environment by increasing employee motivation, engagement, and job satisfaction. A varied and inclusive workplace promotes the open flow of ideas (Caas & Sondak, 2011). It also provides a chance for individuals from various backgrounds to learn from one another, making teams more imaginative and productive. Diverse approaches to existing challenges can also lead to novel solutions to industry-wide concerns. Implementing these new technologies increases productivity across the board.

Boosting profitability

As mentioned, encouraging diversity at work fosters more creativity and innovation (Moore & Jull, 2012). The end result of this ingenuity and innovation is better earnings for businesses, giving them a competitive edge.

Elevating talent attraction and retention

Diversity in the workplace is also beneficial for employee retention. In a diverse workplace, the combination of many skill sets, backgrounds, and experiences fosters an atmosphere of acceptance and inclusion (Pless & Maak, 2004). Employees may learn from one another and interact successfully, resulting in greater job satisfaction and decreased turnover rates.

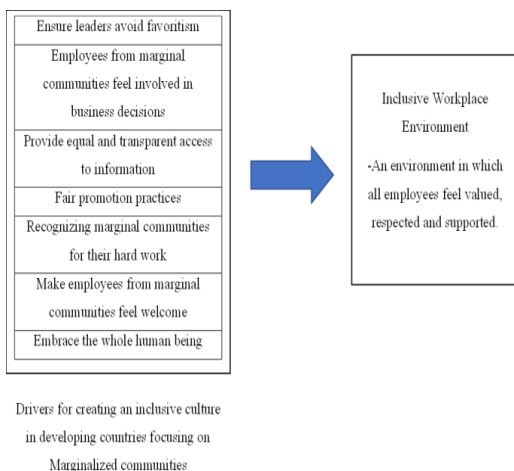


Figure 1: Inclusive Workplace model

7. DISCUSSION AND CONCLUSION

Every firm should promote diversity and inclusion as essential values in all aspects of the business, including recruiting procedures, internal rules, and leadership roles. Inclusion improves the experience of marginalized communities, fosters creativity, boosts participation among underrepresented populations, and strengthens leadership skills and capabilities.

Leaders must have a culture of inclusion in place if they want to successfully operate a business, non-profit, or university in a developing nation. In addition to cultivating a sense of purpose and belonging, creating an environment where every marginalized employee individual feels accepted improves effectiveness and improves the experience for everyone. A movement toward appreciating and accepting diversity in third-world societies has pushed the boundaries for businesses and employers worldwide to develop Inclusive workplaces.

The process of developing a diversified workplace and an Inclusive varies significantly. A diverse organization includes people of many racial, religious, gendered, and sexual orientations. However, merely being different is insufficient. Organizations in developing nations

that succeed progress to become Inclusive, where the atmosphere also fosters a sense of belonging, importance, and worth for everyone.

In large part, businesses in poor nations are starting to understand how successful it is to use inclusion-focused initiatives. Leadership at the top is where it all begins, and it eventually filters down the ladder. When an organizational structure lends itself to inclusion, its employees feel at ease, appreciated, and championed - leading to a more productive environment for underrepresented populations. Leaders both present and future must take the required efforts today to offer a well-rounded, Inclusive workplace.

REFERENCES

- Alloush, M., & Wu, S. (2021). Income Improves Subjective Well-being: Evidence from South Africa. *Economic Development And Cultural Change*.
<https://doi.org/10.1086/716056>
- Amaram, D. (2007). Cultural Diversity: Implications For Workplace Management. *Journal Of Diversity Management (JDM)*, 2(4), 1-6.
<https://doi.org/10.19030/jdm.v2i4.5017>
- Arbaiza, L., & Guillén, J. (2016). Subordinate responses to leadership: Evidence from an emerging market firm. *International Journal Of Organizational Leadership*, 5(4), 433-442.
<https://doi.org/10.33844/ijol.2016.60343>
- Asongu, S., & Odhiambo, N. (2019). Inequality Thresholds, Governance and Gender Economic Inclusion in sub-Saharan Africa. *SSRN Electronic Journal*.
<https://doi.org/10.2139/ssrn.3401332>
- Ayalon, A. (2004). Successful Urban School Reform for Marginalized Groups – A Case Comparison. *Curriculum And Teaching*, 19(1), 83-103.
<https://doi.org/10.7459/ct/19.1.06>
- Bayram, L. (2007). The benefits of a diverse workforce. *Early Years Educator*, 9(8), 7-7.
<https://doi.org/10.12968/eyed.2007.9.8.285>

- Bich, V. (2012). Vietnam: Activities Targeting Marginalized Women's Groups for Gender Equality and Development. *Curator: The Museum Journal*, 55(3), 301-312. <https://doi.org/10.1111/j.2151-6952.2012.00154.x>
- Birdthistle, N., Eversole, R., & Walo, M. (2022). Creating an inclusive entrepreneurial ecosystem for women entrepreneurs in a rural region. *Journal Of Business Venturing Insights*, 18, e00341. <https://doi.org/10.1016/j.jbvi.2022.e00341>
- Bourgault, A., & Goforth, C. (2021). Embrace Teamwork to Create and Maintain a Positive Workplace Culture. *Critical Care Nurse*, 41(3), 8-10. <https://doi.org/10.4037/ccn2021662>
- Boswijk, A. (2017). Transforming Business Value through Digitalized Networks: A Case Study on the Value Drivers of Airbnb. *Journal Of Creating Value*, 3(1), 104- 114. <https://doi.org/10.1177/2394964317697736>
- Cahyani, D., & Widaningsih, L. (2019). Identification of the Marginalized Urban Communities Characteristics and Preferences. *Kne Social Sciences*. <https://doi.org/10.18502/kss.v3i21.4967>
- Chakraborty, S. (2016). Vulnerability Assessment of Urban Marginalized Communities. *International Journal Of Civic Engagement And Social Change*, 3(4), 25-57. <https://doi.org/10.4018/ijcscs.2016100103>
- Chan, A., & Clegg, S. (2002). History, Culture and Organization Studies. *Culture And Organization*, 8(4), 259-273. <https://doi.org/10.1080/14759550215613>
- Chang, Y. (2017). Organizational Culture Change in the Non Profit Organization. *Korea Association Of Business Education*, 32(6), 23-43. <https://doi.org/10.23839/kabe.2017.32.6.23>
- Chuda, A., & Wyrwicka, M. (2016). Impact of organizational culture perception efficiency of workers enterprise – case study impact of organizational culture perception efficiency of workers enterprise – case study. *Research In Logistics And Production*, 6(5), 429-441. <https://doi.org/10.21008/j.2083-4950.2016.6.5.5>
- Coates, J. (2006). An increasingly diverse workforce makes traditional diversity programs passé. *Employment Relations Today*, 33(1), 1-8. <https://doi.org/10.1002/ert.20092>
- Dunn, N. (2021). An Inclusive Workplace Promotes Innovation. *Journal AWWA*, 113(9), 84-86. <https://doi.org/10.1002/awwa.1810>
- Faber, M. (2010). Nutrition in vulnerable communities in economically marginalized societies. *Livestock Science*, 130(1-3), 110-114. <https://doi.org/10.1016/j.livsci.2010.02.015>
- Fanggidae, R. (2018). Organizational Culture and Spirituality Workplace: Empirical Study of Influence of Organizational Culture and Spirituality Workplace. *E3S Web Of Conferences*, 73, 11017. <https://doi.org/10.1051/e3sconf/20187311017>
- Feliú-Mójer, M. (2020). Gene Editing Communication Must Center Marginalized Communities. *Environmental Communication*, 14(7), 877-880. <https://doi.org/10.1080/17524032.2020.1812274>
- Ferdman, B., Prime, J., & Riggio, R. (2020). Inclusive leadership. *Figueiredo, P. (2013). Planning and Developing Leadership within the Organization. Organizational Cultures: An International Journal*, 12(3), 31-48. <https://doi.org/10.18848/2327-8013/cgp/v12i03/50913>
- Garcia, B., & Soest, D. (2000). Facilitating Learning on Diversity. *Journal Of Ethnic And Cultural Diversity In Social Work*, 9(1-2), 21-39. https://doi.org/10.1300/j051v09n01_02
- Gatta, M. (2006). Public policy on democratizing access to education for marginalized groups. *Equal Opportunities International*, 25(7). <https://doi.org/10.1108/eoi.2006.03025gaa.001>
- Gelbman, S. (2022). Review essay: Advocacy by and for traditionally marginalized racial, ethnic, and religious communities. *Interest Groups & Advocacy*, 11(3), 438-441.

- <https://doi.org/10.1057/s41309-022-00158-z>
- Green, V., & Cherrington, S. (2010). *Delving into diversity*. Nova Science Publishers.
- Härri, A., Levänen, J., & Koistinen, K. (2020). Marginalized Small-Scale Farmers as Actors in Just Circular- Economy Transitions: Exploring Opportunities to Circulate Crop Residue as Raw Material in India. *Sustainability*, 12(24), 10355. <https://doi.org/10.3390/su122410355>
- Harris, P. (2004). Success in the European Union depends upon culture and business. *European Business Review*, 16(6), 556-563. <https://doi.org/10.1108/09555340410565387>
- Hargittai, E. (2007). The Social, Political, Economic, and Cultural Dimensions of Search Engines: An Introduction. *Journal Of Computer-Mediated Communication*, 12(3), 769-777. <https://doi.org/10.1111/j.1083-6101.2007.00349.x>
- Jayaram, A. (2020). Empowering Marginalized Communities. *The American Journal Of Bioethics*, 20(5), 80-81. <https://doi.org/10.1080/15265161.2020.1745937>
- Johnson, W. (2006). *The challenge of diversity*. Black RoseBooks.
- Khodzai, A. (2019). Criteria for determining the structural changes priorities in the economy. *Economic Bulletin Of The National Mining University*, 65, 73-85. <https://doi.org/10.33271/ev/65.073>
- Kornelakis, A., Veliziotis, M., & Voskeritsian, H. (2018). Improving Productivity: The Case for Employee Voice and Inclusive Workplace Practices. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3140262>
- Lewis, C. (2017). Creating Inclusive Campus Communities: The Vital Role of Peer Mentorship in Inclusive Higher Education. *Metropolitan Universities*, 28(3). <https://doi.org/10.18060/21540>
- Leshchuk, H. (2021). Inclusive communication as a tool for the formation of inclusive culture: terminological analysis. *Social Work And Education*, 8(3), 364-372. <https://doi.org/10.25128/2520-6230.21.3.5>
- Liew, J. (2012). Finding Common Ground: Charter Remedies and Challenges for Marginalized Persons in Public Spaces. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.2199689>
- Marques, J. (2007). Many businesses, but one mission (organizational culture). *Human Resource Management International Digest*, 15(1). <https://doi.org/10.1108/hrmid.2007.04415a.ad.003>
- Masket, S., Heaney, M., & Strolovitch, D. (2014). Mobilizing Marginalized Groups among Party Elites. *The Forum*, 12(2). <https://doi.org/10.1515/for-2014-5007>
- Meenakshi. (2011). Vulnerable Groups in India - Status, Schemes, Constitution of India. *Legalservicesindia.com*. Retrieved 29 September 2022, from <http://www.legalservicesindia.com/article/1079/Vulnerable-Groups-in-India---Status,-Schemes,-Constitution-of-India.html#:~:text=In%20India%2C%20the%20Scheduled%20Tribes,as%20land%2C%20forest%20and%20water>
- Melendres, M. (2020). Cultural competence in social work practice: Exploring the challenges of newly employed social work professionals. *Journal Of Ethnic & Cultural Diversity In Social Work*, 31(2), 108-120. <https://doi.org/10.1080/15313204.2020.1855492>
- Mikkelsen, C. (2001). Shift Change: Promoting Cultural Diversity in the Workplace. *AWHONN Lifelines*, 5(4), 55-56. <https://doi.org/10.1111/j.1552-6356.2001.tb01295.x>
- Mohammadi, A., Broström, A., & Franzoni, C. (2017). Workforce Composition and Innovation: How Diversity in Employees' Ethnic and Educational Backgrounds Facilitates Firm-Level Innovativeness. *Journal Of Product Innovation Management*,

- 34(4), 406-426.
<https://doi.org/10.1111/jpim.12388>
- Morris, C. (2005). Advocacy and Scholarship in Marginalized Communities. *Anthropology News*, 46(2), 23-23.
<https://doi.org/10.1525/an.2005.46.2.23.1>
- Munyoka, W. (2022). Inclusive Digital Innovation in South Africa: Perspectives from Disadvantaged and Marginalized Communities. *Sustainability*, 14(9), 5372.
<https://doi.org/10.3390/su14095372>
- Nkansah-Dwamena, E. (2022). How can we create a diverse, equitable and inclusive workplace in society without the voice of disability? Lessons from Ghana. *Journal Of International Development*, 34(5), 1028-1047.
<https://doi.org/10.1002/jid.3663>
- Nwagu, K. (2022). The Effect of Corporate Reputation on the Performance of Corporate Organizations in Developing Countries: Evidence from West Africa. *TEXILA INTERNATIONAL JOURNAL OF MANAGEMENT*, 8(1), 51-66.
<https://doi.org/10.21522/tijmg.2015.0801.art005>
- Otokwala, G. (2010). Whither Family Firms in Developing Countries?. *SSRN Electronic Journal*.
<https://doi.org/10.2139/ssrn.1714526>
- Packer, D., Miners, C., & Ungson, N. (2018). Benefiting from Diversity: How Groups' Coordinating Mechanisms Affect Leadership Opportunities for Marginalized Individuals. *Journal Of Social Issues*, 74(1), 56-74.
<https://doi.org/10.1111/josi.12256>
- Pathak, S., Laplume, A., & Xavier-Oliveira, E. (2015). Inbound foreign direct investment and domestic entrepreneurial activity. *Entrepreneurship & Regional Development*, 27(5-6), 334-356.
<https://doi.org/10.1080/08985626.2015.1058424>
- Peacock, A. (2014). How blended learning can create a more inclusive culture. *Strategic HR Review*, 13(3), 118-122.
<https://doi.org/10.1108/shr-01-2014-0005>
- Praveenadevi, D., & Girimurugan, D. (2019). Inclusive Organisational Culture – A Competing Strategy for Business Success. *International Journal Of Recent Technology And Engineering (IJRTE)*, 8(4), 5155-5159.
<https://doi.org/10.35940/ijrte.d7371.118419>
- Pritam, S. (2020). Analytical Study on Teams Ethnic Diversity and Workplace Organization. *International Journal Of Psychosocial Rehabilitation*, 24(5), 7276-7280.
<https://doi.org/10.37200/ijpr/v24i5/pr2020759>
- Sanders, E. (2016). Building an Inclusive Organizational Culture. *Academy Of Management Proceedings*, 2016(1), 13218.
<https://doi.org/10.5465/ambpp.2016.13218abstract>
- Selden, S., & Selden, F. (2001). Rethinking Diversity in Public Organizations for the 21st Century. *Administration & Society*, 33(3), 303-329.
<https://doi.org/10.1177/0095399012201978>
- Short, L. (2021). Expand beyond your current culture. Singley, D., & Sedlacek, W. (2009). Differences in Universal-Diverse Orientation by Race-Ethnicity and Gender. *Journal Of Counseling & Development*, 87(4), 404-411.
<https://doi.org/10.1002/j.1556-6678.2009.tb00124.x>
- Slukhai, S. (2016). Ukraine: Light of Hope's Work Improving Social Services for Marginalized Groups. *SSRN Electronic Journal*.
<https://doi.org/10.2139/ssrn.2926625>
- Sridhar, I., & JASROTIA, S. (2020). Inclusive Corporate Governance for Creating Shared Values: Indian Experience. *International Journal Of Indian Culture And Business Management*, 1(1), 1.
<https://doi.org/10.1504/ijicbm.2020.10030849>
- Srinivas, P. (2016). Affirmative Action and the Marginalized Population: A Study on the Creamy Layer and its Relevance Today. *Christ University Law Journal*, 5(2), 45-55.
<https://doi.org/10.12728/culj.9.5>
- Suarez-Balcazar, Y., Balcazar, F., & Taylor-Ritzler, T. (2009). Using the Internet to conduct research with culturally diverse

- populations: Challenges and opportunities. *Cultural Diversity And Ethnic Minority Psychology*, 15(1), 96-104.
<https://doi.org/10.1037/a0013179>
- Szabó-Bálint, B. (2019). Organizational career development versus employees' career needs in Hungary. *Strategic Management*, 24(4), 3-12.
<https://doi.org/10.5937/straman1904003s>
- van Knippenberg, D., & van Ginkel, W. (2021). A Diversity Mindset Perspective on Inclusive Leadership. *Group & Organization Management*, 47(4), 779-797.
<https://doi.org/10.1177/1059601121997229>
- Verma, S. (2013). Demographic Challenges and Opportunities in the economically marginalized economy. *IOSR Journal Of Business And Management*, 6(6), 18-29.
<https://doi.org/10.9790/487x-0661829>
- Verick, S. (2014). Female labor force participation in developing countries. *IZA World Of Labor*.
<https://doi.org/10.15185/izawol.87>
- Wevelsiep, C. (2019). Fundamentals and Limits of the Inclusive Culture and Inclusive Practise. *Education Journal*, 8(6), 320.
<https://doi.org/10.11648/j.edu.20190806.22>
- Widener, A. (2022). Nature journals adopt guidelines to protect marginalized groups. *Chemical & Engineering News*, 15-15.
<https://doi.org/10.47287/cen-10020-polcon3>
- Williams, S. (2018). Developing the capacity of culturally competent leaders to redress inequitable outcomes: Increasing opportunities for historically marginalized students. *Administrative Issues Journal: Education, Practice, And Research*, 8(1). <https://doi.org/10.5929/2018.8.1.3>
- Wisetsri, W. (2020). The Influence of Leadership, Work Motivation and Organizational Culture on Job Performance. *International Journal Of Psychosocial Rehabilitation*, 24(5), 7336-7350.
<https://doi.org/10.37200/ijpr/v24i5/pr2020768>
- World Bank. (2014). *Elaboration of Integration Strategies for Urban Marginalized Communities*. The World Bank.
- Yakubova, F. (2020). Inclusive culture – a key factor for success in inclusive education. *Science And School*, (1, 2020), 123-129.
<https://doi.org/10.31862/1819-463x-2020-1-123-129>
- Young, M. (2011). Create a great workplace. *Vital*, 8(3), 38-40.
<https://doi.org/10.1038/vital1412>

Do Sri Lankan Companies Disclose Sustainable Performance Satisfactorily?

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ABSTRACT

Disclosure in sustainability practices has gained a prominent place in corporate reporting due to its importance as a medium of flowing information to stakeholders. As a result, managers of commercial organizations no longer focus solely on reporting the business performance but its engagement in economic, social and environmental activities adhering to given standards. This paper attempts to analyse the state of sustainability reporting in Sri Lanka and measure the level of its compliance to GRI, G4 index in reporting. Accordingly, 18 listed Sri Lankan companies consecutively recognized for their sustainability reports by professional accounting bodies were selected and analysed for the past five years (2014/2015-2018/2019). The compliance to GRI – G4 core were analysed by deploying the scale developed by Dragmoir (2010) followed by a trend analysis for each selected. Based on the research findings of the study it was concluded that despite not having attained the expected state of sustainability reporting Sri Lanka is on a continuously improving journey to achieve the desired state. The level of sustainability reporting by the leading organizations recognized for sustainable practices were revealed by the study and this finding impose major implications to governing bodies of corporations, policy makers, stakeholders as well as the government. Further the study would be helpful to understand whether there is a gap between the desired state of sustainability reporting and the current state of sustainability reporting or not.

Key words: *Current State of sustainability reporting, Desired State of sustainability reporting, Trends in sustainability reporting, Sri Lanka*

1. INTRODUCTION

Accounting is used by organizations as a method of discharging their accountability to stakeholders. Traditionally, organizations issued financial reports to demonstrate the organizational financial performance of organizations to discharge the accountability to the immediate stakeholders of the organizations who were more concerned about the financial performance of organizations. However, with the turbulent changes in the environment, stakeholders started placing their attention on non-financial performance of organizations as well. With heavy attention placed on the environmental impacts, sustainability, corporate governance by society, organizations were obliged to disclose non-financial information to emancipate their accountability to the wider society beyond their immediate stakeholders (Roberts (2009)) The disclosure of non-financial information came as a series of new developments in organizational reporting practices. In the 1970's, "Social Reporting" developed with the intention of disclosing the social performance of organizations and in the 1980's "Environmental Reporting" emerged to report the Environmental performance of organizations and in the 1990's "Sustainability reporting" was developed with the intention of promoting the disclosure of information related to sustainability performance of an organization in terms of the triple bottom line (Lozano et al. (2016).

As per the Global Reporting Initiative (2000), (hereafter referred as the GRI), “A sustainability report is a report published by a company or organization about the economic, environmental and social impacts caused by its everyday activities. A sustainability report also presents the organization's values and governance model and demonstrates the link between its strategy and its commitment to a sustainable global economy.”

Even though, sustainability reporting is not a mandatory requirement but a voluntary practise in most countries including Sri Lanka, the number of companies that issue sustainability reports is increasing rapidly both in the global context as well as in the Sri Lankan context.

The heavy diffusion of sustainability reporting in the world is mostly due to the fact that organizations perceive sustainability reporting as a communication tool that provides them with a better media exposure that would establish trust in the society about the organization and to create a better corporate image about the organization in the public which would help an organization to attract more investment funds as well as Environmentally conscious customers thereby giving them a competitive advantage over their competitors who are not engaged in sustainability reporting (Lozano et al. (2016), Reverte (2009), and Deegan (2002).

As per the GRI, for a sustainability report to provide a true and fair view about the sustainability performance of an organization, the sustainability report should include transparent, credible, relevant and complete information about the sustainability performance of the organization and it should include both positive and negative incidents with regard to sustainability performance of the organization. However, sustainability reporting is a voluntary reporting practise in many countries and GRI is a principle-based organization which provides mere guidelines of best practices rather than stringent rules and regulations to be adhered. Therefore, the organizations are given the flexibility of deciding what to be included and what to be omitted in sustainability reports. Furthermore, as mentioned above, most

organizations engage in sustainability reporting to seem sustainable and to attract positive social reactions therefore it is likely that organizations are going to exaggerate about positive sustainability performance and soften negative sustainability performance.

Hence, it is likely that there is a practical gap between the sustainability performance and sustainability reporting of organizations. Therefore, it is probable that sustainability reporting has not yet reached the state that the GRI has expected and that there is a practical gap between the current state of sustainability reporting and the expected state of sustainability reporting.

This study primarily aims to analyse the current state of the sustainability reporting of listed companies in Sri Lanka and to identify the trends in sustainability reporting of listed companies in Sri Lanka. Henceforth, following objectives are derived and will be tested.

1. To find out the existing state of sustainability reporting practices of listed companies in Sri Lanka.
2. To identify the last five years' sustainability reporting trends, after the classification of disclosure categories.
3. To identify the dominant disclosure category in Sri Lanka and to analyse the reason for the dominance.

This study is expected to contribute to the existing literature by identifying the current state of sustainability reporting in Sri Lanka and the trend of sustainability reporting in Sri Lanka for the past five years which would be helpful to understand whether there is a gap between the desired state of sustainability reporting and the current state of sustainability reporting or not.

The study is based on 18 selected listed Sri Lankan companies representing various business industries including Manufacturing, Banking and Finance, Tourism and Leisure, Export, Engineering and construction, Power and etc who have been consecutively recognized and awarded for their sustainability reports by professional accounting bodies such as CIMA and ACCA and CA Sri Lanka etc.

The rest of this report is organized as follows. The next section reviews the existent literature on sustainability reporting followed by the methodology section. It will then present the research findings and discussion section. The last section of the paper will provide the conclusion and future direction of the research.

2. LITERATURE REVIEW

This chapter provides an overview of the extant empirical literature on sustainability reporting under the themes purpose of engaging in sustainability reporting, diffusion of sustainability reporting, the expected and the actual state of sustainability reporting and the state of sustainability reporting in Sri Lanka.

2.1 Sustainability Report and Purpose of Reporting on Sustainability

As per the GRI (2006), a sustainability report is a report issued by an entity about the Economic, Environmental and Social impacts caused by its actions and the magnitudes of those actions on the broader society. The GRI perceives that a sustainability report altruisms the organization's values and governance model and establishes the link between its strategy and its commitment to a sustainable global economy and converse its sustainability performance to the stakeholders. The key researchers in the areas have established that the purpose of a sustainability report is to provide assistance to firms in being accountable to various stakeholders, to meet stakeholder expectations, to demonstrate compliance with sustainability standards and to provide stakeholders with enhanced information to make informed decisions. (Roberts (2009), ISEA (Institute on Social and Ethical Accountability (2003), Unerman et al (2007) and (GRI 2013). GRI (2006) emphasizes that information and processes used in the preparation of sustainability reports should be gathered, recorded, complied, analysed, and disclosed in a manner establishes the quality and materiality of the information and improves the overall accountability of the organization.

The extant literature further suggests that the issued sustainability reports need to demonstrate

corporate acceptance of ethical, social and environmental responsibility for sustainability reports to be accountable (Adams (2004 and Unerman et al (2007)). Moreover, the Accountability AA1000AS standard on accountability for sustainability suggests that accountability is made up of three principles, i.e. transparency, responsiveness and compliance. Transparency in terms of disclosure of all material sustainability information which includes both positive and negative performances, responsiveness in terms of being responsive to societal expectations to cater the information needs of the users of sustainability reports and compliance in terms of adhering to the GRI guidelines and other regulations applicable.

Several key researchers in the area have suggested that the transparency of sustainability reports is related to the credibility, completeness and reliability of the information disclosed in the reports. (Menendez- Viso (2009), Livesey & Kearins (2002) and Dando & Swift (2003)).

However, the existing literature on the topic reveals that sustainability reports incline to bear a resemblance to marketing tools predominantly intended at improving the firm's image and social legitimacy rather than the improvement of accountability of the organization and as a result, lack the expected transparency. (Lauer (2003), Duchon & Drake (2009), Milne et al (2006), Deegan et al (2006) and Cho & Patten (2007).

However, as per, Lozano et al (2016), organisations arrive at the decision of engaging in sustainability reporting due to a combination of internal and external incentives and there is a wide diffusion of sustainability reporting all over the world.

Several key researchers in the area of sustainability reporting have established that organizations engage in sustainability reporting due to many reasons. Mainly, it is a belief that believes that managers have accountability of the organization to report the sustainability performance (Hasnas, 1998 Donaldson & Preston, 1995 and Freeman & Reed, 1983) and to comply with the expectations of the community (Deegan (2002). Another reason for

reporting sustainability is to comply with industry requirements or established codes of conduct within the industry (Deegan and Blomquist 2001). Many researchers found that organizations tend to report on sustainability in order to reduce agency costs and to claim legitimacy (Reverte, 2009), Watts and Zimmerman, 1978) and O' Dwyer, 2002) which result in developing and maintaining a healthy relationship with key stakeholders of the organization. (Lopez et al., 2007, Cortez and Cudia, 2011).

2.2 The Expected and the Actual State of Sustainability Reporting.

The available literature suggests that sustainability reports are flawed and fails to deliver the expected results and that the sustainability reports offer no evidence or reasoning that connects the operation of these organisations with the perilous state of the planet. (Laufer (2003), Cho et al (2010), Adams (2004), Gray (2006) and Milne et al (2006)).

The available literature reveals that most business engaged in sustainability reporting claiming to be sustainable entities actually have little or nothing to do with sustainability. (Beder, 1997, Gray & Milne, 2002, Milne, Tregida & Walton 2003, Gray, 2006-b and Milne and Kearins & Walton, 2006) and what is portrayed in sustainability reports fails to account of the actual sustainability performance of entities and are often used as mechanisms of manipulating the users. (Gray & Milne 2002, Gray & Milne, 2004 and Milne, Ball & Gray 2008).

Moreover, key contributors to the topic has further identified that the majority of the organizations who are engaged in sustainability reporting are often limited to reporting and does not actually perform what they report and that when an entity talks of "sustainability" it is not actually talking about sustainability but environmental management and some ill-defined form of social responsibility.(Gray, 2006, Young & Tilley, 2006 and Pataki, 2009).

The existing literature on the topic has identified that voluntary nature of sustainability reporting (Sisaye (2011a), Sisaye (2011b) and O'Dwyer (2003)) which provides organizations with leeway to engage in selective disclosures

(Henriques (2007), MacLean & Rebernak (2007)), lack of external verification methods for non-financial information disclosed in sustainability reports (Choi, Myers, Zang & Ziebart (2010), organizations being motivated to engage in sustainability through self-interested objectives rather than a genuine concern for transparency and accountability of sustainability performance(Laufer (2003), Cho et al (2010), Adams (2004), Gray (2006) and Milne et al (2006)), sustainability reporting being used as an impression management tool by organizations seduce and persuade stakeholders rather than to straightforwardly present the firm's actual situation with regard to the sustainability performance (Cerin (2002), Coupland (2006) and Hooghiemstra (2000)) has resulted in a gap between the expected level of disclosures in sustainability reports and the actual level of disclosures in sustainability reports issued by organizations.

As discussed above critics argue that the practise of sustainable reporting is flawed in the sense that there is a lack of confidence in the content of the report and the main challenges identified by these critics are accuracy, sincerity, and completeness (Doane (2000) or that the non- financial reports consist of mere images than the actual performance. (Bowers, 2010).

Researchers have emphasized on the fact that sustainability reports often do not meet the principles of balance, exhaustiveness and transparency and therefore the credibility of the disclosed information is questioned (Boiral & Henri 2015, Boiral, 2013) and Dingwerth & Eichinger, 2010). The accuracy of information is one of the main issues in sustainability reporting due to the lack of balance, completeness and transparency of the presented information. (Dando & Swift, 2003), Perez & Sanchez,2009) and Cho et al., 2012).

Key contributors to the area have further identified that the lack of full disclosure in sustainability reports, the lack of completeness of information and the little coverage of negative impacts of organizational activities in sustainability reports reveal that sustainable reports are issued to meet minimum requirements and the disclosure of performance indicators varies significantly even among firms with the

same level of application sustainability reporting principles. (Adams & Whelan, 2009 and Aktas et al., 2013).

Researchers have criticised the sustainability reports for their opacity, questionable connection with the firm's real situation and the superficial nature and have established that the sustainability reports are far from reality. (Moneva et al (2006, Unerman et al., 2007 and Gray, 2010).

Thus, with evidence provided extant literature, suggests that there is a gap between the expected state of disclosures in sustainability reporting and the actual state of disclosures in sustainability reporting.

2.3 The state of Sustainability Reporting in Sri Lanka

Dissanayake, Tilta, Lobob (2016) indicated that in Sri Lanka, there is a major focus on social indicators, despite the poor environmental record in the country when it comes to sustainability reporting in Sri Lanka. Furthermore, it is suggested that the economic context therefore appears to be a significant factor influencing how sustainability reporting develops in Sri Lanka.

The existing literature suggests that majority of Sri Lankan companies do not consider GRI Guidelines in reporting for sustainability and disclose sustainability information in annual reports in various manner without paying reference to the GRI guidelines (Senaratne & Liyanagedara, 2009 and Fernando & Pandey, 2012).

The extant literature further reveals that there is an expectation gap as to the information needs of stakeholders on sustainability reporting and the information disclosed in the annual reports of companies in the Sri Lankan context (Senaratne & Liyanagedara, 2009 and Wijesinghe, 2012). Moreover, the available literature reveals that there is long way forward for Sri Lankan companies in respect of sustainability reporting (Senaratne & Liyanagedara (2009) but despite the long way there is an attractive growth reported in the level of disclosures in sustainability parameters (Wijesinghe (2012) in last few years which could see as a green light for entire corporate reporting.

3. RESEARCH METHODOLOGY

This section presents an overview of the sources and the type of data used and the methods employed in order to achieve the desired research objectives.

3.1 Sample Selection

A sample of 18 Sri Lankan public listed companies that have been acknowledged for the quality of their sustainability reports various local and international professional accounting bodies including ACCA and ICASL was chosen. These 18 organizations who are considered to be the top practitioners of sustainability reporting in Sri Lanka was chosen because analysing the reports published by the best in class when it comes sustainability reporting would give a better understanding about the current state of sustainability reporting in Sri Lanka rather than taking all the listed companies into consideration.

3.2 Data Collection and Data analysis method

A content analysis was conducted to the sustainability reports published by all the selected companies for five years each from 2014/2015 – 2018/2019 to measure the state of sustainability reporting for each individual company for each year. This made 90 firm-year observations for the analysis.

The state of sustainability reporting in Sri Lanka for each company for each year was calculated by scoring the GRI – G4 core disclosures disclosed in sustainability reports using a five-level ordinal scale scoring scheme developed by Dragmoir (2010) for a maximum possible score of 220 where maximum possible scores for economic, environmental and social disclosures are 28, 68 and 124 each respectively.

The five-level ordinal scoring scale used is provided below.

0 – Performance data not present. (Including any non-quantitative references to performance)

1 – Performance and/or governance data is presented only for the current period.

2 - The report and the information contained within it can be compared on a year –to – year basis.

3 – The criteria above, plus the data measurement techniques and bases for calculations are

adequately described and can be replicated with similar results.

4 – The criteria above, plus the organization's performance can be compared with appropriate benchmarks.

4. FINDINGS AND DISCUSSION

This section covers the data analysis conducted and then discusses the findings derived from such analysis. The research findings will be discussed under the themes the state of sustainability reporting in Sri Lanka, the trends in sustainability reporting of Sri Lanka and the dominant disclosure category of sustainability reporting in Sri Lanka.

The collected data was analysed under three main phases in the study.

Under the first phase of the analysis, the state of sustainability reporting in Sri Lanka of each company for each year has been calculated by scoring the core disclosure elements of the GRI – G4 disclosures using the five-level ordinal scale scoring system developed by Dragmoir (2010). The calculated data is presented using a descriptive table.

Based on the findings of the first phase, the second phase and the third phase analyse the trends in sustainability reporting of the country over the past five years using both a graphical analysis and a percentage change analysis and the dominance of the disclosure categories through a descriptive table respectively

4.1 State of Sustainability Reporting

According to the scale of Dragmoir (2010), the maximum possible scores for a company for a year were 28, 72 and 124 for economic, environmental and social disclosures respectively and for 224 points for total sustainability reporting.

The total of the scores obtained by individual companies for each year was then calculated to identify the state of sustainability reporting in Sri Lanka for each period as demonstrated by Table 1. The maximum possible score for the country per annum was 504, 1296, 2232 and 4032 for economic, environmental, social and total sustainability reporting respectively.

Table 4: The State of Sustainability Disclosures in Sri Lanka

Country	The state of disclosures				
	Year	Economic	Environment	Social	Total Sustainability
Sri Lanka	2014/2015	213	283	518	1014
	2015/2016	236	398	621	1255
	2016/2017	281	476	748	1505
	2017/2018	326	553	855	1734
	2018/2019	373	628	934	1935

The current state of sustainability reporting in Sri Lanka can be analysed using the scores relevant for the financial year 2018/2019 since the latest publicly available sustainability information and financial information of listed companies are for the financial year 2018/2019. Therefore, when analysing the generated results it is visible that the current state of sustainability reporting in Sri Lanka can be identified as 1935 points out of 4032 maximum possible points as illustrated by Table 1.

Moreover, when both the tables are analysed it is visible that the state of sustainability reporting in Sri Lanka has not yet reached the expected level of disclosures which is backed by the findings of Senaratne & Liyanagedara (2009) and Wijesinghe (2012) and that organizations are not in the practise of wholly disclosing the sustainability information prescribed by the GRI – G4 standards.

Furthermore, it is possible that the above recognized gap between the expected state of sustainability reporting and the current state of sustainability reporting is due to the following factors. Sustainability reporting is a voluntary disclosure practise in Sri Lanka (Hummel & Schlick (2016) which gives more leeway to organizations in selecting the content, type and the timing of the disclosures included in sustainability reports (Choi, Myers, Zang & Ziebart (2010) which leads organisations to engage in selective reporting of information (Henriques, 2007, MacLean & Rebernak, 2007)

which hinders the completeness and transparency of the sustainability reports resulting in a gap between the expected state of sustainability reporting and the actual state of sustainability reporting.

4.2 The Trends in Sustainability Reporting of Sri Lanka

As the second phase of the analysis the calculated state of sustainability reporting of individual companies as well as the country as a whole were analysed both graphically and using a percentage analysis to identify the trends of sustainability reporting in Sri Lanka for the past 5 years.

Table 2 provides an year on year analysis of the state of sustainability for Sri Lanka by comparing the state of sustainability reporting in for the country as a whole for each year as a percentage of the state of sustainability reporting in Sri Lanka of the first year under review (2014/2015).

Table 5: Year on Year Comparison of the State of Sustainability Reporting in Sri Lanka

Country	As a % of base year (2014/2015)				
	Year	Economic	Environment	Social	Total Sustainability
Sri Lanka	2014/2015	100%	100%	100%	100%
	2015/2016	111%	141%	120%	124%
	2016/2017	132%	168%	144%	148%
	2017/2018	153%	195%	165%	171%
	2018/2019	175%	222%	180%	191%

Figure 1 graphically demonstrates the trend in the state of sustainability reporting in the selected companies as whole by plotting the state of disclosures for all the 18 companies for the past 5 years.

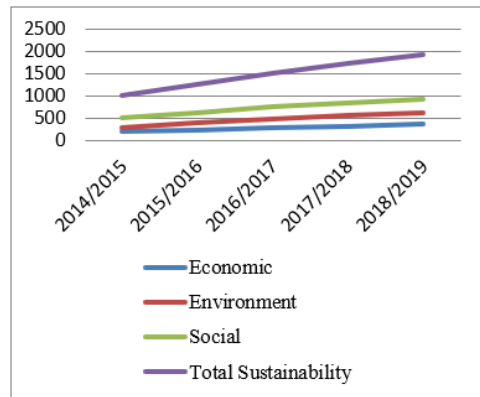


Figure 4: The State of Sustainability Reporting in Sri Lanka

When analysing table 2 and figure 1 it is evident that there is an upward trend in the state of sustainability reporting in Sri Lanka (Wijesinghe, 2012) and that the state of the individual disclosures in Sustainability reporting (Economic, Environmental and Social) have also enhanced continuously for the past five years. The researcher found out that the main reason for this continuous upward movement in the state of sustainability reporting is due to organizations increasing the number of core disclosures they disclose yearly and the quality of the information for the existing disclosures yearly.

Therefore, it can be predicted that the state of sustainability reporting in Sri Lanka would further advance in the future provided that this upward trend continues.

4.3 The Dominating Disclosure Category in Sri Lanka

The final phase of the research analysed how the scores given to individual disclosures were scattered among the three types of disclosures to identify the most dominating disclosure category in Sri Lanka when sustainability reporting is considered.

This was calculated for all the companies as a whole by calculating percentage composition of the scores obtained by disclosure categories when compared to the score obtained by the as a percentage of the total sustainability disclosures for each year.

Table 6: The Composition of Disclosures in Sustainability Reporting

Country	Year	As a % of state of total sustainability disclosure			
		Economic	Environment	Social	Total Sustainability
Sri Lanka	2014/2015	21.01%	27.91%	51.08%	100.00%
	2015/2016	18.80%	31.71%	49.48%	100.00%
	2016/2017	18.67%	31.63%	49.70%	100.00%
	2017/2018	18.80%	31.89%	49.31%	100.00%
	2018/2019	19.28%	32.45%	48.27%	100.00%

As indicated in Table 3, throughout the period, more prominence was given to “Social disclosures” when compared to Economic and Environment disclosures. Therefore, it is evident that the social indicators in the GRI – G4 index are more prominent than economic and environmental disclosures and as a result, Sri Lankan companies give more prominence to social indicators over economic and environmental disclosures. This finding is supported and further confirmed by the existing literature where critics argue that more prominence is given to social indicators over economic and Environmental indicators by Sri Lankan companies (Dissanayake, Tilta, Lobob (2016).

The researcher further analysed the composition of the GRI- G4 disclosures to identify whether the GRI – G4 index is biased towards any of the disclosure category.

Table 4 given below analyses the weightage given to each of the key sustainability element (economic, Environmental and Social) under the GRI – G4 index.

Table 7: Composition of GRI - G4 Sustainability Indicators

Description	As a % of state of total sustainability disclosure			
	Economic	Environment	Social	Total Sustainability
Composition of GRI - G4 disclosures	13%	31%	56%	100%

As depicted by Table 4 it was identified that the GRI – G4 index itself was stretched more towards Social Disclosures where the weightage given to social indicators were 56% when compared to the weightage given to environment and economic disclosures at 31% and 13% respectively. Hence, it is evident that social disclosure is the most dominant disclosure category when sustainability reporting is considered since the GRI- G4 core disclosures are more stretched towards the social indicator disclosures which compels organizations to report more on the social impact of their activities.

5. CONCLUSION

The research aimed to analyse the state of sustainability reporting in Sri Lanka through three research objectives. The first objective of identifying the current state of sustainability reporting in Sri Lanka was achieved through the scoring of sustainability disclosures included in annual reports using a scoring system developed by Dragmoir (2010). As per the research findings, the selected 18 companies as a whole, only managed to obtain a score of 1935 points out of 4032 maximum points for the latest financial year with published annual reports (2018/2019). Hence, it was concluded that Sri Lankan companies have not yet achieved the expected state of sustainability reporting which is in agreement with the similar literature available for the local context (Senaratne & Liyanagedara, 2009 and Wijesinghe, 2012) as well as the global context (Henriques, 2007 and MacLean & Rebernak, 2007).

The second objective of analysing the trends in sustainability reporting of Sri Lanka was achieved through conducting a graphical and a

percentage analysis where it established that there is an upward trend in the state of sustainability reporting in Sri Lanka and that companies have increased both the quantity and the quality of their sustainability disclosures over time. This finding was also in line with the available literature (Wijesinghe (2012)).

The third objective was to identify the dominating sustainability disclosure category in Sri Lanka and to identify the reasons for the dominance. It was identified that social disclosures dominate economic and Environmental disclosures and it was further identified that the high weightage given by the GRI – G4 core disclosures to social disclosures compared to economic and Environmental disclosures was the reason for social disclosures being the most dominant category when it came to sustainability reporting in Sri Lanka which is backed by the extant literature on the topic (Dissanayake, Tilta & Lobob (2016)).

Therefore, it can be determined that regardless of not having conquered the desired state of sustainability reporting Sri Lanka is on a continuously improving journey to attain the expected state and that social disclosures are given more prominence by Sri Lankan organizations with regard to sustainability reporting.

This study contributes to the existing literature in four ways. Firstly, the research quantified the current state of sustainability reporting in Sri Lanka in terms of adherence to the GRI- G4 guidelines. Secondly, the research identified that there is a practical gap between the desired state and the current state of sustainability reporting and the probable reasons for this practical gap. Thirdly, the research analysed the past trends in sustainability reporting with regard to the Sri Lankan context which would be assist in predicting how the state of sustainability reporting would improve in the future. Finally, the research analysed the most dominant disclosure category and the reasons for the dominance with regard to sustainability reporting which indicates that the GRI – G4 indicators should be balanced out to paint a fair picture of the triple bottom line in the future.

However, there are several limitations to the research. This research was limited only to 18

public listed Sri Lankan companies' representative of a wide a range of sectors that has consecutively won awards for their sustainability reports. Sri Lanka is a country where sustainability reporting is voluntary, thus the findings of this research might not be applicable to companies from countries where sustainability reporting is mandatory, companies that are not publicly listed and are not from the same industries as the companies in the sample represent.

Further, the study of the research created grounds for future research where the sample can be expanded to be more inclusive of companies ranging different industries, companies from countries with mandatory sustainability reporting and the variables used can be expanded to be inclusive of more performance indicators.

REFERENCES

- Atkins J., Atkins B.C., Thomson I., Maroun W. (2015). Good news from nowhere: imagining utopian sustainable accounting. *Accounting, Auditing & Accountability Journal*. vol. 28, no. 5, pp.651-670
- Bebbington J., Larrinaga C., Moneva J.M. (2008). Corporate social reporting and reputation risk management. *Accounting, Auditing & Accountability Journal*, vol. 21, 337-361.
- Bebbington J., Larrinaga-González C., Moneva-Abadía J.M. (2008). Legitimizing reputation/the reputation of legitimacy theory. *Accounting, Auditing & Accountability Journal*, vol. 21, pp. 371-374.
- Boiral, O. and Gendron, Y. (2011). Sustainable development and certification practices: lessons learned and prospects. *Business Strategy and the Environment*, vol. 20, no. 5, pp. 331-347.
- Cho, C.H., Line, M., Roberts, R.W. and Rodrigues, M. (2015). Organized hypocrisy, organizational façades, and sustainability reporting. *Accounting, Organizations and Society*, vol. 40, pp. 78-94.
- Cho, C.H., Michelon, G., Patten, D.M. (2012). Impression management in sustainability reports: an empirical investigation of the use

- of graphs Accounting and the Public Interest, vol. 12 no. 1, pp. 16-37.
- Cho, C.H., Patten, D.M. (2007). The role of Environmental disclosures as tools of legitimacy: a research note. *Accounting, Organizations and Society*, vol. 32, no. 7, pp. 639-647.
- Daub, C.H. (2007). Assessing the quality of sustainability reporting: an alternative methodological approach. *Journal of Cleaner Production*, vol. 15 no. 1, pp. 75-85.
- Deegan, C. (2002). Introduction: The legitimising effect of social and Environmental disclosures – a theoretical foundation. *Accounting, Auditing & Accountability Journal*, vol. 15 Issue: 3, pp.282-311.
- Deegan, C., Cooper, B.J., Shelly, M. (2006). An investigation of TBL report assurance statements: UK and European evidence. *Managerial Auditing Journal*, vol. 21 no. 4, pp. 329-371.
- Dienes D., Sassen R., Fischer J. (2016). What are the drivers of sustainability reporting? A systematic review. *Sustainability Accounting, Management and Policy Journal*, vol. 7 Issue: 2, pp.154-189.
- Dingwerth, K., Eichinger, M. (2010). Tamed transparency: how information disclosure under
- Diouf D, Boiral B. (2017). The quality of sustainability reports and impression management: A stakeholder perspective. *Accounting, Auditing & Accountability Journal*, vol. 30 Issue: 3, pp.643-667
- Dissanayake, D., Tilt, C., Xydias-Lobo, M. (2016). Sustainability reporting by publicly listed companies in Sri Lanka. *Journal of Cleaner Production*, vol. 129, pp.169-182.
- Dragomir V.D, (2010). Environmentally sensitive disclosures and financial performance in a European setting. *Journal of Accounting & Organizational Change*, vol. , no,3, pp.359-388.
- Galpin T., Whittington, J. L. Bell G., (2015). Is your sustainability strategy sustainable? Creating a culture of sustainability. *Corporate Governance*, vol. 15, no. 1, pp.1-17
- Global Reporting Initiative (2013), G4 sustainability reporting guidelines
- Gray R (2010). A re-evaluation of social, Environmental and sustainability accounting: An exploration of an emerging trans-disciplinary field?. *Sustainability Accounting, Management and Policy Journal*, vol. 1no. 1, pp.11-32
- Gray, R. (1992). Accounting and Environmentalism: an exploration of the challenge of gently accounting for accountability, transparency and sustainability. *Accounting, Organisations and Society*, vol. 17 no. 5, pp. 399-425.
- Gray, R. (2010). Is accounting for sustainability actually accounting for sustainability And how would we know? An exploration of narratives of organisations and the planet. *Accounting, Organisations and Society*, vol. 35 no. 1, pp. 47-62.
- Isaksson, R.B., Johnson, R.G.M. (2015). The crippled bottom line – measuring and managing sustainability. *International Journal of Productivity and Performance Management*, vol. 64 no: 3, pp.334-355
- Kend M., (2015). Governance, firm-level characteristics and their impact on the client's voluntary sustainability disclosures and assurance decisions. *Sustainability Accounting, Management and Policy Journal*, vol. 6 no: 1, pp.54-78
- Knebel S., Seele P. (2015). Quo vadis GRI? A (critical) assessment of GRI 3.1 A+ nonfinancial reports and implications for credibility and standardization. *Corporate Communications: An International Journal*, vol. 20, no 2, pp.196-212
- KPMG (2013). International survey of corporate responsibility reporting 2013, Amsterdam
- Laskar, N., Maji, S.G. (2016). Corporate sustainability reporting practices in India: myth or reality?. *Social Responsibility Journal*, vol. 12, no: 4, pp.625-641
- Laufer, W.S. (2003). Social accountability and corporate greenwashing. *Journal of Business Ethics*, vol. 43 no. 3, pp. 253-261.
- Leung, S., Parker, L., Curtis, J., (2015). Impression Management through Minimal Narrative Disclosure in Annual Reports, *The British Accounting Review*

- Manetti, G., Becatti, L. (2009). Assurance services for sustainability reports: standards and empirical evidence. *Journal of Business Ethics*, vol. 87 no. 1, pp. 289-298.
- Milne, M.J., Kearins, K., Walton, S. (2006), Creating adventures in wonderland: the journey metaphor. *Environmental sustainability, Organization*, vol. 13 no. 6, pp. 801-839.
- Moneva, J.M., Archel, P., Correa, C. (2006). GRI and the camouflaging of the corporate unsustainability, *Accounting Forum*, vol. 30 no. 2, pp. 121-137.
- O'Dwyer, B. (2002). Managerial perceptions of corporate social disclosure: an Irish story. *Accounting, Auditing & Accountability Journal*, vol. 15 no. 3, pp. 406-436.
- O'Dwyer, B. and Owen, D.L. (2005), "Assurance statement practice in Environmental, social and sustainability reporting: a critical evaluation", *The British Accounting Review*, Vol. 37 No. 2, pp. 205-229.
- Olivier Boiral, (2013). Sustainability reports as simulacra? A counter-account of A and A+ GRI reports, *Accounting, Auditing & Accountability Journal*, vol. 26, no 7, pp.1036-1071
- Olivier Boiral. (2016). "Accounting for the Unaccountable: Biodiversity Reporting and Impression Management". *Journal of Business Ethics* 135:4, 751-768.
- Owen, D. (2006). Emerging issues in sustainability reporting. *Business Strategy and the Environment*, vol. 15 no. 4, pp. 217-218.
- Rodrigue M. (2014). Contrasting realities: corporate Environmental disclosure and stakeholder-released information, *Accounting, Auditing & Accountability Journal*, vol. 27, no, 1, pp.119-149
- Sandberg M., Holmlund M., (2015). Impression management tactics in sustainability reportin. *Social Responsibility Journal*, vol. 11 no: 4, pp.677-689.
- Senaratne, S., Liyanagedara, K. (2009). Corporate Sustainability reporting in Sri Lanka
- Chen, W., (1991). *Nonlinear Analysis of Electronic Prognostics*. Doctoral dissertation. The Technical University of Napoli, Napoli, Italy.
- Ferrell, B. L. (1999), JSF Prognostics and Health Management. *Proceedings of IEEE Aerospace Conference*. March 6-13, Big Sky, MO. doi: 10.1109/AERO.1999.793190
- Hyndman, R. J., & Koehler, A. B. (2006). Another look at measures of forecast accuracy. *International Journal of Forecasting*, vol. 22, pp. 679-688. doi:10.1016/j.ijforecast.2006.03.001
- International Standards Organization (ISO) (2004). Condition Monitoring and Diagnostics of Machines - Prognostics part 1: General Guidelines. In ISO, *ISO13381-1:2004(e)*. vol. *ISO/IEC Directives Part 2, I. O. f. S. (ISO)*, (p. 14). Genève, Switzerland: International Standards Organization.
- Schwabacher, M., & Goebel, K. F. (2007). A survey of artificial intelligence for prognostics. *Proceedings of AAAI Fall Symposium*, November 9–11, Arlington, VA.
www.aaai.org/Library/Symposia/Fall/2007/fs07-02-016.php
- Vachtsevanos, G., Lewis, F. L., Roemer, M., Hess, A., & Wu, B. (2006). *Intelligent fault diagnosis and prognosis for engineering system*. Hoboken, NJ: John Wiley & Sons, Inc

Enterprise Risk Management and Addressing New Risks in The Post-Pandemic Economy

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ABSTRACT

Enterprise risk is an inevitable aspect of doing business. It is important to manage risks in a business organization. Although the risks faced by different companies may be fundamentally same to a greater extent, different types of companies and enterprises use different approaches in managing risks. The global pandemic in 2020 caused many industries to encounter new risks which impacted massively on the operations and finances of the companies. Different industries got adapted to this new situation in different speeds and this paper address the changes of risk management approaches followed by the Covid 19 pandemic.

1. INTRODUCTION

Risks are a common aspect of the businesses as well as in life. It is important to manage risks to minimize the losses that may incur in a business. It is not possible to avoid all the risks, due to cost implications and other practical matters. Therefore, it is important to address the risks based on the impact the risks may pose to the person or the organization if it substantiates.

During the early part of the year 2020 the world was stunned by an unexpected threat; Covid 19 pandemic. This was the first time the world experienced a global-scale pandemic since the dawn of the digital stage. Due to the interconnected globalized economies, the pandemic created several types of threats disrupting many industries in the global scale. Different types of industries faced and adopted to

the pandemic in different speeds and considerable number of organizations experienced significant losses due to the impacts of the pandemic.

In this paper, the risk management approaches of different types of enterprises are discussed. The main types of enterprises discussed are the family-owned companies, small and medium sized companies, and large companies. Different types of companies have both similarities and differences in risks and risk management approaches.

The primary impact of the pandemic was the people getting sick, however, the secondary and tertiary impacts caused enterprises face different challenges, which were managed using different means by different companies. Further, triggered by the pandemic, many companies have updated their business risk management approaches.

2. METHODOLOGY

“Risk” and “Managing risk” are two areas that has been the center of much research done in the past. Different researchers have focused their research on different areas of risk, from which the “business risk” has been an immensely popular research area due to the high impact the business risk plays in the lives of general population. Therefore, it is important to ensure that the new research done on business risk address the previously completed research. In other words, it is important that the new research do not replicate the previously addressed research questions. Further, collecting data firsthand would require an exceedingly high amount of resources, which is not very practical

to obtain. Therefore, the Systematic literature reviewing research methodology was used in this study.

Using several related keywords, Mendeley database with its tools and several other similar databases were tested, however, considering the output of the databases and the facilities offered, it was decided to prioritize the Mendeley database.

Business Risk is a highly evolving subject area. The types of risks that may have been prioritized few decades ago may now be less prioritized and the risks that may have been neglected in the past may now carry a considerable weight. Therefore, it was decided to limit the collection of research articles to 25 years.

First the key words “Risk Management” was used to filter the necessary articles, which gave over a hundred thousand search results, it was not realistic to filter them one by one. Therefore, the key words were changed to “Business risk management”, which narrowed down the list considerably.

Another search string was created using the key words “Post Pandemic Business” which also gave out a considerable amount of search results.

Considering the language barrier, several of the articles which came up using the above key word searches had to be weeded out, which were in languages other than English, since the author could only understand English.

The list of articles was sorted using the published year, and several articles which were replicated were removed from the list. To verify the above step, each article’s title was manually read to ensure that there was no repetition.

After filtering and selecting articles using the above procedures, the second level filtering was commenced. In this level it was found that some of the filtered articles were required to be purchased, however, since there was no budget

for this, these articles were also removed from the filtered list.

In this step, the abstracts of each article were manually read by the author and only the articles that are related to the research area were selected from this step. Further, several articles were removed in this step because the focus areas were similar to some other articles which had addressed the focus areas previously; in a better way, which was more suitable for the research topic. By this step majority of the articles which were not relevant to the research area were excluded from the filtered list.

Then finally, the remaining list was skimmed by the author and ensured that the remaining literature was not a repetition of the areas focused on a previous article. From this step several articles were removed, and this remaining list was considered for the research by the author.

3. LITERATURE REVIEW

3.1. INTRODUCTION TO RISK MANAGEMENT

Most scholars agree that there is no single definition to the word Risk or to the phrase Managing risk. However, it is widely recognized that the risk is the threat or possibility of occurring a loss whereas risk management is managing the threat or the possibility of an occurrence of a loss (Belinskaja et al. 2015). In other words, the risk is defined as the possibility of deviating from the expected outcome.

Some of the well-established definitions of risk are.

- “An uncertainty or a condition that if it occurs has a positive or negative effect on project objectives” by PMI, (Weaver 2008)
- British standard BS IEC 62198:2001 states that the risk is the “Combination of probability of an event occurring and its consequences on project objectives”
- Institute of Risk Management states that the risk is “the combination of a probability of an event and its consequences”

(Srinivas 2019)

They further states that although the word “risk” and “management of risk” have a negative undertone, the risk and risk management can obtain positive results towards a business (e.g., a competitive advantage can be obtained by successfully managing risks). (Belinskaja et al. 2015)

Different types of organizations and businesses manage risks differently (Dvorsky, Belas, Gavurova, & Brabenec 2020). This may depend on the organization’s capacity; larger organizations may approach risk management differently than the small and medium sized organizations. The risk management may depend on the type of industry that the organization is involved in, i.e., organization involved in financial services may have a different view on risk than an organization involved in trading. Since the risks that an organization encounter has a considerable impact from the outside world, the organization’s risk management strategy may vary depending on the geographical location that it operates in.

In the general approach to risk management, the risks are categorized into four categories as.

- Pure risk: Where the risk is the chance of happening a loss or no loss. One example for this is the risk of a fire damaging a building.
- Speculative risk: Where the risk is the chance of a gain or a loss. A builder’s risk of promoting a new building in a town can be put into this category. If the venture becomes successful, builder will profit and if not, it will be a loss.
- Fundamental risk: Where is the possibility of having massive, large-scale losses happening if the risk is materialized. Earthquakes can be considered as an example for this category.
- Particular risks: Where the risks are specific to the industry, project, location, or other specific criteria. Examples can be quality risks, legal risks, and safety risks.

(Srinivas 2019)

In this clarification the risks are divided based on the significance of the loss and gain when accepting the risk.

Further the business risks can be further divided depending on the level of risk. The levels of risks are the severity of the impact that the risks pose to the business. Kot and Dragon (2015) categorize the risks as Strategic risks, financial risks, and operational risks.

Kot and Dragon (2015) describe the said three categories as,

- Strategic risks are based on business environment, regulatory environment, organizational design, brand / commercial relationships, and strategic information and decision-making risks.
- Financial risks are the risks related to prices, financial products, cash flow, retirement commitments and counterplay.
- Operational risks are based on the risks that are related to the day-to-day operations, human resources, Information management and processing, natural risks, and governance and compliance ethics.

Traditionally the risk management is considered to be a four-step process which can be adopted to different industries and sectors depending on the requirement (Doval 2019).

- Risk Identification: In the first step of risk management process the risks are to be identified. This could be done by brainstorming, expert consultation, reviewing the historical information about the previously encountered risks in similar industries or similar projects. Basically, the final goal is to identify all the risks that may come across.
- Risk Analysis: In the second step of the risk management process, the risks are analyzed based on the probability of occurrence and the severity of the loss if the risk is materialized. This step addresses all the risks that were identified during the previous step.

- Risk Control: In this step the risks are arranged according to the risk score which was identified in the previous analysis. The risks are then treated depending on the priority order. There are typically four types of risk controls; eliminating the risk, reducing the probability of risk materializing, reducing the impact if the risk is materialized or risk is passed to another party (e.g., insurance)
- Risk monitoring: The continuous monitoring the risks (including the controlled risks) and reassessing the risks if needed to ensure a proper control of the risks.

(Doval 2019)

The risk management steps are further categorized into different sub sections in different industries and areas.

However, presently, a better approach to Enterprise Risk Management with a detailed structure is being promoted by the professionals (Kot & Dragon 2015). In this process, like the previous approach the process starts with Risk Identification, however, in the second step the risk owner is identified. Risk owner is the person who has the experience and skills to manage the said risks. Then the risks are grouped in a way that is practical for the risk owner to manage the risks. A person is then allocated to coordinate the risk functions between the parties and often this person is a person in the higher up in the organizational hierarchy. Creation of a storehouse of knowledge is the next step in this structure. It should allow the organization to take necessary decisions and share knowledge. In this structure, the next step contains the management board's involvement. This would allow the company to ensure a smooth decision-making process. Finally using the steps of the standard risk management process can be followed and the structure created in this scheme would allow a more transparent and efficient system in the enterprise risk management.

3.2. RISK MANAGEMENT APPROACH IN DIFFERENT ORGANIZATIONS

Different types of organizations approach the risk management differently. Different organizations can be categorized depending on the ownership structure, financial capacity, number of employees, geographical location, type of industries engaged in and many more criteria.

3.2.1. Family businesses

As per Poza (2014) family businesses constitute 80 – 98% of the whole businesses in the world and around 37% of the fortune five hundred companies are family controlled. Family businesses have no singular, unanimously agreed definition, however, most of the definitions address family businesses as businesses which are owned by families (as a whole or majority of the shares). However, contrary to widely held belief family businesses does not limit to small, sole ownership structured or even private companies. Family businesses can even be public companies with a major shareholding is done by a group of family members. i.e., controlling shareholding is done by family members. The definition for “family” may also have range of definitions in these explanations. Families may be related by blood, by law or even a very tightly knitted friendships that are beyond the constraints of a professional relationship (Ernesto J. Poza 2014)

Family businesses face almost all the risks that a non-family business face. However, being a family company, expose the organization to a set of unique risks. Often families limit their risk management approach to traditional dimensions such as investment, performance, and insurance risks (Visser & van Scheers 2018).

Ratten, (2015) explains that although the family businesses may be willing to risk losing financially, they may not be willing to give up control of a businesses. This means, when doing the risk management, they may give priority to maintaining the control within the company rather than addressing other risks that may be

prioritized in other organizations. In a family-owned company; specially in private companies where the management and ownership are not clearly separated, poses a risk to the company's long-term sustainability, however in some ways this benefits the organization as well. The owners may be willing to take high risks compared to other organizations in the areas that they seem to have more control over (Visser & van Scheers 2018) which may give the competitive advantage to the company in their operations.

One of the other critical risks that the family companies face is the "succession". Visser and van Scheers, (2018) explains in their journal publication that the succession planning in a family-owned company is a serious threat. In the context of a family company, nepotism plays a key role. This may result in unqualified personals to be allocated to key positions within the company. Visser and van Scheers, (2018) further explains that as per research done by "Family firm institute" in 2013, they have found that only 30% of the companies go onto the second generation of owners in the business and only 10% goes into the third generation. Only 3% of the family businesses continues to the fourth generation. They have also found that the average lifespan of a family company to be 24 years.

In majority of the companies that are run by families and are private; the owner's personal wealth is tight to the company. This may result in reduction of the "risk appetite". As some authors describe the biggest risk in business is not taking risk. This can cripple the long-term sustenance of the business when it comes to obtaining business and even in cost controlling. In considerable number of family businesses, a lack of innovation towards risk management is observed. (Visser & van Scheers 2018)

Since the basis of a family company is a nonprofessional relationship between the parties, it itself creates a unique set of risks within a company. unlike in a non-family company, in a family run company there are distinct set of internal power dynamic and a set of personal feelings involved. It is often seen that in a family

business, a considerable priority is given to seniority within the family and not to the expertise in the field of decision making or the business. Further, this also sometimes causes the family members to make decisions that may not be the best decision for the business, but to satisfy their egos. (Brandt, Zanievicz da Silva, & Beck 2021) Therefore, it is important to be independent of the internal family hierarchy and emotions as much as possible to manage risks better. Several experts suggest that the independent consultants or independent directors who are experts in the area to be included in the decision-making processes to mitigate the biased nature of the decision making and to prevent prioritizing personal egos rather than taking the best decision for the organization.

3.2.2. Small and Medium Enterprises

Similar to the family-owned enterprises, Small and Medium Enterprises (SME) do not have a universally accepted definition. Often the characteristics that define "SMEs" differ from country to country or in some cases, region to region. Generally, we can assume that the SMEs are small and medium organizations that are independent and not a subsidiary of a larger organization and has a relatively small number of employees, which is often 250 or below (Legg, Olsen, Laird, & Hasle 2015). The majority of the organizations in the world falls into this category, and in Europe alone, approximately 99% of the enterprises can be categorized as SME, which means SMEs play a significant role in the world economy (Decker, Schiefer, & Bulander 2006).

These SME type organizations face similar risks as typical organizations which are not SMEs. However, due to the unique features of these organizations, it is highlighted that these types of organizations have unique set of risks into which they are exposed. SMEs have a limited resources at their disposal compared to large scale companies and often are not diverse. Most SMEs specialized in one single focus area and are experts in it. (Decker, Schiefer, & Bulander 2006). Due to the limited resources at their disposal the role that owners or senior managers play is vital in successful risk management in the

organization (Dvorsky, Belas, Gavurova, & Brabenec 2020). The authors further explain that the attitude of the senior management and the risk management and risk taking directly correlates to the performances of the company.

Compared to other large companies, there are some risks that SMEs encounter more frequently or more severely due to the nature of the companies. Often SMEs have weaker financial structure compared to large companies, thus exposing them to high financial risks including difficulties of accessing funds and cash flow issues.

In the journal article by Dvorsky, Belas, Gavurova and Brabenec (2020), the authors state that the operational risk category is the most positively significant risk category for SMEs future of business. Successful management of operational risks would allow the companies to ensure a better resource management within the company.

In the journal published by Belinskaja et al., (2015) they state that majority of the SME owners overlook the risks with lower probability. Their major focus falls into the day-to-day routine activities and managing such risks by conventional means such as insurance.

Since most SMEs have a lower resource compared to the large companies and since most of the SMEs are not diversified, many authors including Belinskaja et al., (2015) believe that the impact on macroeconomic changes on the business is higher than that of large companies.

Dvorsky et al., (2020) explain how the biggest issue with risk management in businesses is the lack of information and compared to the large companies the SMEs have lower access to necessary information, which decreases successful preparation for risks by them.

On the other hand, some scholars such as Zoghi, (2017) believes that the SMEs are quick to response to threats and risks that may come across due to the smaller size and the flexibility they have within their organizations. While in the

matter of large organizations the risk management may address many areas that may not be addressed in SMEs, but when it comes to the quick response to threats, SMEs may be able to act swiftly compared to other organizations.

3.2.3. Large Enterprises

“Large enterprises” also have a vague definition; however, it is easier to establish as the organizations that are larger than SMEs. (Legg, Olsen, Laird, & Hasle 2015)

Often large enterprises are exposed to a bigger geographical area and if that organization operates in several countries (i.e., multinational company) the risks that the company may be exposed to are higher than that of an organization operating in a smaller region or one country (Chowdhry & Howe 1999). It is important to consider the differences in the culture, political stability, financial systems, and market situation in addition to the typically considered areas such as law, when managing risks in international companies which operates in different countries and regions (Kot & Dragon 2015).

Due to the globalization, complex markets, and the highly competitive nature of the present business world, it is important for every business to focus on risk management, however, for large companies, the exposure is considerably high and excessive. Therefore, it is important for a large company to have a proper risk management strategy (Blanco-Mesa, Rivera-Rubiano, Patiño-Hernandez, & Martinez-Montaña 2019).

Considering these reasons, often large enterprises maintain their defenses against risks using formalized and structured mechanisms complying with industry and legal requirements (Krüger & Meyer 2021). These defenses include risk management committees and separate divisions specifically allocated for the risk management activities to identify the risks and neutralize minimizing any negative impacts. With the large pools of resources at the disposal of these big organizations, they have a distinct

advantage against SME, and they use that to manage risks more efficiently.

Some scholars believe that the risk management in large scale companies is as much as about preventing disaster and about converting the risks into opportunities (Blanco-Mesa, Rivera-Rubiano, Patiño-Hernandez, & Martinez-Montaña 2019). They further state that the risk management protocols are not to be segregated to one part of the company, and they need to be communicated throughout the company and they are to be utilized in various levels of decision making. And this could improve the whole company's business and working culture significantly.

Depending on the industry, often large companies would have supply chains much more deeply embedded into different countries and regions. Therefore, although a company may not be operating in a country, it does not mean the economic conditions within a country would not affect a large company, if its supply chains have links within the country. It is important to consider these when addressing the risk management strategy for large companies (Sumarliah, Usmanova, Fauziyah, & Mousa 2021).

3.3. IMPACT OF PANDEMIC ON BUSINESSES

From time to time the world experience pandemic situations. Although the medical community has not unanimously defined the word "Pandemic" yet, one of the most commonly used definitions for pandemic is "*an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people*" (Qiu, Rutherford, Mao, & Chu 2017). There have been number of pandemics during the past affecting the health of billions and causing dents in the global economy, however, not all pandemics cause global economic crisis (Khovrak, Trynchuk, Klapkiv, & Volynets 2021).

Primarily in a pandemic people get sick. Depending on the severity of the sickness people may be taken out of the workforce temporally or

permanently (i.e., deaths). A country will have to spend significant amount of funds on health services in a pandemic situation. In addition to this people taking out of the workforce, temporally or permanently would impact the economy negatively as well (Qiu, Rutherford, Mao, & Chu 2017). Further, the authors describe the impact of pandemic on people's buying patterns or consumer behavior. For example, people may not travel much during a pandemic due to lockdowns and travel restrictions; or simply voluntarily minimize traveling, would negatively affect airports and airlines. Belas et al., (2021) explain how they found that, by analyzing information considering 2200 SMEs from five European countries; France, Germany, Spain, UK, and Italy that the revenues have significantly reduced in over 70% of the companies.

Sumarliah et al., (2021) state that in the globalized economy the entire world is interconnected in terms of economy. In most industries they use the supply chains that run deep into different countries and territories. For example, a resource may be mined in Africa, then brought to Asia to refine it, and taken to another country to make a component of a machine and then taken to Europe to assemble it into a machine which is then sold in Australia where the user may use the machine to make another product to be used in North America. So, in these complex processes most the countries and regions are interconnected in a business. Therefore, even if a pandemic has a minimal impact on one country, (i.e., the country a business may primarily operate), the business may be affected from a pandemic due to the supply chains. Further, Khovrak et al., (2021) states that in the history considerable number of pandemics have started or affected Asia, particularly China, which plays a massive part in most of the global supply chains.

Certain types of businesses are more prone to experience severe negative impacts than others. Shabir et al., (2021) explain in their article how an extremely popular clothing brand which has sales presence in over fifty countries and supply chains that runs through several other regions

was affected by the recent Covid 19 pandemic. The company experienced a significant loss of sales because; due to lockdowns people do not go out shopping and due to the same lockdowns and working from home initiatives, people did not need to buy clothes. While these were affecting sales, the other end of the line, the supply chains which mostly were though China seriously got negatively affected due to heavy travel restrictions imposed by the government, crippling the factories.

It is important to understand that due to these disturbances and issues that the supply chains and sales had to endure during a pandemic, it would be inevitable that smaller companies and parties with low capacities may go bankrupt. Sumarliah et al., (2021) explain that it is difficult and costly to find new suppliers for bigger companies who obtain supplies from these companies. Instead, he suggests as some companies did, supporting good suppliers to stay afloat, in crisis times which would be mutually beneficial. The authors further describe that, it is inevitable that the cost of materials and getting the supplies would increase in times of crisis, therefore, the focus should be made to ensure a steady supply even with higher costs. Methods suggested are dual sourcing of materials and maintaining storage to minimize the impact of delays in supply chains.

On the other hand, Sumarliah et al., (2021) explain how the demand for the products in some businesses was recovered by removing the need for physical presence to purchase the items. One of the most prominent methods suggested is to increase the online presence by the companies. This would allow the companies to ensure that the customers are free to shop and do their purchasing despite of the travel restrictions (voluntary or involuntary), provided that the delivery services are operational in a region. Shabir et al., (2021) explain how the sales were recovered to some extent using online shops which did not require the customers to go out of

their homes to purchase goods by an international clothing brand named “Zara”.

Some companies in several regions received government support to sustain in the troubled economic times, in forms of tax reliefs and payments to furloughed staff; specially to SMEs (Belas et al. 2021). However, authors further explain that the said supports from the government were often focused on short term relief rather than an assistance in long term recovery.

Many of the enterprises considered digitalizing their operations and using online modes for their internal and external operations. Which includes online meetings etc. however, this was highly dependent on the capacities of the company and the type of industry that they were in. In most SMEs, it was difficult for them to adopt, due to lack of the resources and capacities within the company (Belas et al. 2021).

Followed by the pandemic, a new set of risks have grown in terms of cyber security. When the pandemic hits the countries around the globe, one of the first responses was the lockdowns imposed by the governments. In addition to these lockdowns, some organizations took their voluntary decisions to allow employees to work from home, which means a digitalized working environment. Although a handful number of companies were ready for these changes, most of the companies were not ready for this change within a short period. This caused people to work from home using personal devices and networks rather than using secured networks that were available in workplaces. Cyber security risks immersed with these new sudden changes. (Pranggono & Arabo 2021)

In addition to the internal risks an external risk of company stock price fluctuation of publicly traded companies has occurred during the pandemic. Endri et al., (2021) state that the Covid 19 Pandemic caused a reduction of the performances of many stock exchanges around the globe. When the risk of stock price fluctuation increases, it directly poses a threat to the shareholder's net worth. However, on the

other hand some companies performed better in terms of stock prices in this period. One such example is the Chinese energy companies that were doing significant CSR work. Stock prices of such companies were not significantly affected due to the pandemic (Huang & Liu 2021).

In the research done by Khovrak et al., (2021), authors explain that the risk management strategies to different risk types are not the same for all the risks. They have divided the risks to three categories as Internal, Strategic and External. The authors state the risk management tool for internal risks is the corporate culture. This is done by rule-based approach. For the strategic risks, corporate strategies can be used as the tool, and the approach would be a control mechanism based on socio-psychological aspect. The external risks are to be managed by tools such as insurance and hedging. This is done with an approach using a control system including a control mechanism and a model.

4. DISCUSSION

The risk management approach in a business may vary depending on the type of the business, industry, capacity, and many other factors. However, in the simpler terms, the risk management approach includes four steps: as risk identification, risk analysis, risk control and risk monitoring.

In the companies which can be categorized as “large” with many employees and resources at their disposal, often has a specific division or specific committees to manage risks. In some industries such as banking, it is a mandatory requirement imposed by regulatory authorities to have a structured risk management procedure. In such industries it is common to see a dedicated divisions to manage risks and even committees within the board of directors to manage risks.

However, when it comes to the most common type of companies; small and medium level enterprises, it is not always common to see substantial amounts of resources dedicated for the risk management. It is often done by the same people who manage other things within the company. This is partly due to the low amounts of resources at their disposal and partly due to the fact that the losses may be less than the cost to

implement risk management strategies, especially in the lower spectrum of the SMEs.

Although Family companies can fall into the SME category or large category, compared to the other types of companies there is a difference in the approach when the risk management is considered. In family-owned enterprises a significant priority is often given to the family values and family goals rather than the corporate goals, as in a typical company. These may create a distinct set of issues compared to the other companies, especially in terms of long-term strategic planning including the succession planning.

From time to time the global businesses have to face challenges which may not be quite common, one of such events was the Covid 19 pandemic started in early 2020 (late 2019 for some countries). Covid 19 is a severe respiratory disease that spreads through a virus which can be transferred through small liquid particles a person spread when they speak, sneeze or breath (Pascarella et al. 2020). In the initial stages due to the unknown nature of the disease several waves of confusion fueled social panic waves passed through the society. Later it was controlled with vaccinations.

However, this pandemic made the entire world to focus on a better risk management approach in businesses resilient to future pandemics or similar events. In this sudden unexpected pandemic, majority of the industries, companies and even countries were caught off guard. Although the initial stages of the pandemic were disastrous due to unpreparedness, lack of information and misinformation throughout the society, gradually the society and the business adopted to deal with the pandemic. Depending on the industry, geographic location, capacities of the company, type of the company, these adaptations were in different phases.

The impact of the pandemic varies on the company, industry, country, and many other factors, but in general it is possible to categorize the impact into four categories. The first category is the supply chains, second is processing (factories, offices, work sites, etc.), the third category if the customers (access to customers, demand, etc.) and the fourth is financial.

With the present globalized economy, supply chains run throughout the world. Different countries and regions take part in producing a single piece of equipment or providing a simple service. When the pandemic hit globally, one of the first things done by governments around the world was to impose travel restrictions. In the beginning of the pandemic, some facilities related to logistics were closed down when they found infected people. Further, in some situations some countries did not allow ships sailing from high-risk areas to disembark in their ports. Some required mandatory quarantine periods which delayed material supply. Additionally, several mines and factories that produced raw materials required for some businesses to operate were shut down due to high infection rates among workers. These reasons combinedly caused disruptions in the supply chains. Additionally due to lack of materials, the cost of procurement has risen significantly in many areas.

As many scholars agreed, these types of disruptions were not expected to happen often, and risk management approaches of many businesses overlooked these risks before the pandemic. Since the pandemic, many industry professionals agree that business should address these risks in their risk management protocols. The most common risk management strategy to address these issues is to follow dual sourcing (or multiple sourcing). In this method, if one supplier (or supply channel) is compromised, the other supplier could provide the materials required. Ideally when selecting two suppliers, they should be from different parts of the world, or their sources should not be entangled together. For some products, local sourcing is also recommended, so that the impact on the business due to international crisis is limited, however, this is not always practical in most industries. One other method to address the risk of pandemic or similar crisis events on supply chains is to maintain stocks of raw materials. This can minimize the delays of supply chains and even allow time to adjust if the cost of procurement increased suddenly.

The next category of impact; processing, which includes factories, job sites and offices varies

highly depending on the product or the service the company provides. From local travel restrictions that may impact people from attending work, to people getting infected may cause disruptions in this. One of the most common ways to address this in the offices was to allow working from home. Although this is a successful method to address in some companies, most workers were not ready to such a change, and it also increased cybercrime risk or misusing of company data and resources. This risk can be addressed by training employees beforehand and keeping the working from home systems including distant IT access to secure networks in place without trying to implement these during a pandemic. This could be practical in offices, however, in factories and job sites (where the services are provided), working from home is not practical. Some methods used to manage risks in these locations were maintaining social distancing, mandating personal protective equipment, introducing hand sanitizing facilities and introducing shift and segregated work, where employees of different teams do not cross paths. These risk mitigation aspects were implemented when the pandemic hit the countries, however, considering the cost and the efficiency, most professionals agree that regular training on these aspects would assist in a long-term risk management approach.

One of the other suggested risk management approaches is to have factories in several geographical locations, ideally in different countries, which is not practical for most businesses, especially in the SME category, however, by doing this, if one operation is closed down due to a crisis, the other can be operated and the demand can be met to some level without the company losing the complete business.

The third category; customers are impacted by a pandemic is different areas. Customers may lose the access to the products or services that the company is offering. Depending on the product or service, this may be resolved by enabling online shopping facilities. However, for this to work, the customers must have the access to internet and the knowledge on online shopping. In the case of product delivery (clothes, electronics, etc.) a reliable delivery services in the area must also be available. However, on the

other hand, due to the lifestyle changes such as working from home, customers may have change in the demand; for example, without having to go to work, people may have a low requirement for new clothes. To mitigate this risk, the option is to have a diversified product or services list in the business.

Although the fourth category, the financial risk is connected to all sectors from increasing cost of production (or services) to lack of demand for the product or service. Since this pandemic and its ripple effects were not addressed in many companies' risk management protocols, the financial impact was caught off guard. One of the most common means of addressing this issue is to reduce the company's cost. This include reducing the number of employees (who may be idling) and cancelling of rent agreements that may cost the company. Some companies disposed some of their assets to get the financial support (cash inflow) needed. It would be better for companies to maintain insurance policies to address these issues however, due to the extremely low probability of a global scale pandemic, it was unheard of for people to buy insurance policies addressing these risks.

In most companies, in the crisis scenario, the main goal was to survive. This included cost reduction mechanisms including reduction of employees pay and number of employees, closing of factories, closing terminating rent / lease agreements for properties, etc... Although this was justifiable in the view of the company, many other stakeholders will be negatively affected by this. The negative impacts may run deep into different levels of the society, in addition to the primary levels, e.g., a closing down of a factory may negatively impact the community surrounding which provides products or services to the factory.

One of the key stakeholders of a business is the shareholders. In the public companies where the shares are listed in a stock exchange, the company stock prices fluctuations are more sensitive to the external factors such as crises. This is directly affecting the company's shareholder's wealth; therefore, it is important to take actions by the company; and directors of the company to mitigate the risk of sudden stock

price reductions. As explained in research done on Chinese Energy companies it has shown a significant relationship between the CSR works done by the company towards stability of the stock prices, which implies that it is possible to minimize the risk of stock price reduction in companies by significant engagement in CSR activities and this may be due to the positive public image generated about the company.

When the basics of Risk Management are considered, one of the vital steps is to analyze the risk in terms of severity and probability. Until the recent pandemic; Covid 19, much of the world had not seen the effects of a full on universal scale pandemic on the globalized economy. Therefore, majority of the risk assessments done by organizations have underestimated the severity of a pandemic before and the probability has also been assumed to be low, which were significantly changed followed by the Covid 19 pandemic.

However, it is important to understand the cost for risk management vs the cost of risk acceptance without managing in this scenario. For some industries and some companies (specially SMEs), some aspects of managing a pandemic risk may be too expensive compared to risk acceptance.

5. CONCLUSION

Risk Management is an especially important aspect of a business. Risks can be analyzed and prioritized considering the severity and the probability of occurrence. Comparing the cost of risk acceptance and the risk management it is possible to determine whether to manage the risk or accept the risk in an enterprise.

Diverse types of industries and organizations have different types of risk appetites and capacities to handle the risks. Therefore, different organizations handle risks and manage risks differently.

Followed by the Covid 19 pandemic, most of the industries got exposed to a new type of risks which they have not experienced before and had given a low priority. This significantly changed

the risk management protocols of many organizations. Internal impacted areas due to the pandemic were supply chains, operations, and customer relations. Additionally external aspects of a commercial organization, such as share prices were affected as well.

It is found that by diversification of supply chains and operations, the risk of a pandemic can be managed to some extent. Work from home procedures and online working procedures would minimize the impact on office works of a company. Similarly, by using online platforms for customer connections and providing the services or products distantly would reduce the risks that the pandemic poses on some businesses. Some risks: especially external risks can often be addressed by using insurance or hedging mechanisms; however, it would be difficult (or costly) to initiate these processes to address pandemic related risks while in the middle of a pandemic.

However, the success in risk management using the aforementioned approaches depends mostly on the type of industry, type and capacity of the enterprise, geography of operations and several other specific factors that may be unique to the organization.

6. FUTURE RESEARCH

Considering the variability of the risk management approaches in different enterprises, it would be suitable to continue the research on post pandemic risk management approaches in different types of enterprises in different industries for better understanding of the efficient methods of risk management.

REFERENCES

- Belas, J, Gavurova, B, Dvorsky, J, Cepel, M, & Durana, P, 2021, 'The impact of the COVID-19 pandemic on selected areas of a management system in SMEs', doi: 10.1080/1331677X.2021.2004187.
- Belinskaja, L, Professor, A, Velickiene, M, Account Manager, K, & Clients Division, C, 2015, *BUSINESS RISK MANAGEMENT: FEATURES AND PROBLEMS IN SMALL AND MEDIUM-SIZED TRADING AND MANUFACTURING ENTERPRISES*, vol. 2.
- Blanco-Mesa, F, Rivera-Rubiano, J, Patiño-Hernandez, X, & Martinez-Montaña, M, 2019, 'The importance of enterprise risk management in large companies in colombia', *Technological and Economic Development of Economy*, vol. 25, no. 4, pp. 600–633, doi: 10.3846/tede.2019.9380.
- Brandt, E, Zanievicz da Silva, M, & Beck, F, 2021, 'Influência da Cultura Familiar no Gerenciamento de Risco Empresarial em Empresas Brasileiras Influence of Family Culture on Enterprise Risk Management in Brazilian Companies', doi: 10.1590/1982-7849rac2021190082.en.
- Chowdhry, B & Howe, JTB, 1999, 'Corporate Risk Management for Multinational Corporations: Financial and Operational Hedging Policies', *European Finance Review*, vol. 2, pp. 229–246, Retrieved from <https://academic.oup.com/rof/article/2/2/229/1571861>.
- Decker, M, Schiefer, G, & Bulander, R, 2006, 'SPECIFIC CHALLENGES FOR SMALL AND MEDIUM-SIZED ENTERPRISES (SME) IN M-BUSINESS A SME-suitable Framework for Mobile Services', *Proceedings of the International Conference on E-Business*, pp. 169–174, Retrieved from <http://www.ice-b.org>.
- Doval, E, 2019, *RISK MANAGEMENT PROCESS IN PROJECTS*, *Review of General Management*, vol. 30.
- Dvorsky, J, Belas, J, Gavurova, B, & Brabenec, T, 2020, 'Business risk management in the context of small and medium-sized enterprises', doi: 10.1080/1331677X.2020.1844588.
- Endri, E, Aipama, W, Razak, A, Sari, L, & Septiano, R, 2021, '“Stock price volatility during the COVID-19 pandemic: The GARCH model”', *Investment Management and Financial Innovations*, vol. 18, no. 4, pp. 12–20, doi: 10.21511/imfi.18(4).2021.02.
- Ernesto J. Poza, 2014, 'Family Business', viewed 26 September 2022, <https://books.google.lk/books?hl=en&lr=&id=7dQWAAAAQBAJ&oi=fnd&pg=PP1&dq=family+business+definition&ots=fvKEMWLD9n&sig=qJEVyzZ2llsR->

- 6AF8mi4C1tRQm4&redir_esc=y#v=onepage&q=family%20business%20definition&f=false.
- Huang, S & Liu, H, 2021, 'Impact of COVID-19 on stock price crash risk: Evidence from Chinese energy firms', *Energy Economics*, vol. 101, doi: 10.1016/J.ENERCO.2021.105431.
- Khovrak, O, Trynchuk, I, Klapkiv, V, & Volynets, Y, 2021, 'Business Risk Management in Times of Crises and Pandemics', *Montenegrin Journal of Economics*, vol. 17, no. 3, pp. 99–110, doi: 10.14254/1800-5845/2021.17-3.8.
- Kot, S & Dragon, P, 2015, 'Business Risk Management in International Corporations', *Procedia Economics and Finance*, vol. 27, pp. 102–108, doi: 10.1016/s2212-5671(15)00978-8.
- Krüger, NA & Meyer, N, 2021, 'Risk and Financial Management The Development of a Small and Medium-Sized Business Risk Management Intervention Tool', doi: 10.3390/jrfm14070310.
- Legg, SJ, Olsen, KB, Laird, IS, & Hasle, P, 2015, 'Managing safety in small and medium enterprises', *Safety Science*, vol. 71, no. PC, pp. 189–196, doi: 10.1016/J.SSCI.2014.11.007.
- Pascarella, G, Strumia, A, Piliego, C, Bruno, F, del Buono, R, Costa, F, Scarlata, S, & Agrò, FE, 2020, 'COVID-19 diagnosis and management: a comprehensive review', *Journal of Internal Medicine*, vol. 288, no. 2, pp. 192–206, doi: 10.1111/JOIM.13091.
- Pranggono, B & Arabo, A, 2021, 'COVID -19 pandemic cybersecurity issues ', *Internet Technology Letters*, vol. 4, no. 2, doi: 10.1002/ITL2.247.
- Qiu, W, Rutherford, S, Mao, A, & Chu, C, 2017, 'The Pandemic and its Impacts', *Health, Culture and Society*, vol. 9, pp. 1–11, doi: 10.5195/hcs.2017.221.
- Ratten, V, 2015, 'Family business in sport organizations: Western experiences as lessons for transitional economies', *Family Businesses in Transition Economies: Management, Succession and Internationalization*, pp. 305–317, doi: 10.1007/978-3-319-14209-8_15.
- Shabir, S, Albishri, NA, Shabir, S, & Albishri, NA, 2021, 'Sustainable Retailing Performance of Zara during COVID-19 Pandemic', *Open Journal of Business and Management*, vol. 9, pp. 1013–1029, doi: 10.4236/ojbm.2021.93054.
- Srinivas, K, 2019, 'Process of Risk Management', in *Perspectives on Risk, Assessment and Management Paradigms*, IntechOpen, doi: 10.5772/intechopen.80804.
- Sumarlia, E, Usmanova, K, Fauziyah, F, & Mousa, K, 2021, 'Managing the Risks in the Clothing Supply Chain Considering the Coronavirus Pandemic', *OPERATIONS AND SUPPLY CHAIN MANAGEMENT*, vol. 14, no. 4, pp. 576–587.
- Visser, T & van Scheers, L, 2018, 'CAN FAMILY BUSINESS MANAGERS MANAGE FAMILY BUSINESS RISKS? ', *Journal of Contemporary Management Issues*, vol. 23, no. 1, pp. 123–137, doi: 10.30924/mjcmi/2018.23.1.123.
- Weaver, P, 2008, May, 'The meaning of risk in an uncertain world', PMI® Global Congress 2008—EMEA, St. Julian's, Malta, viewed 30 September 2022, <https://www.pmi.org/learning/library/project-risks-uncertain-world-8392>.
- Zoghi, FS, 2017, 'Risk Management Practices and SMEs: An empirical study on Turkish SMEs', *International Journal of Trade, Economics and Finance*, vol. 8, no. 2, pp. 123–127, doi: 10.18178/ijtef.2017.8.2.550.

Selection and Evaluation of a Third-Party Logistics Service Provider in Sri Lanka – Methodological Review

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ABSTRACT

This research paper is focused on a Methodological Review of the “Selection and Evaluation of a Logistics Service Provider in Sri Lanka”. This research paper has conducted a systematic Review for the methodology of the papers selected the data bases which the study was conducted are Plymouth university e data base library and google scholar using the Boolean search terms. This research has considered the time period of 2012 – 2022 for the search criteria and the steps which are followed in the process are detailed in this research paper. According to the research there were 40 research papers selected for this study which was stored under Mendeley referencing method for the articles collection of this systematic review. During the search it was noticed that there were no previous methodological reviews were conducted only literature review was conducted. Articles were reviewed on the complete methodology assessment such as research design, sampling criteria and methods, methods of data collection and the collected data analysis method and this whole process how its validated and being reliable. It was noticed that the Mixed method is widely utilized in this methodological review, based on majority of case study research while using non probability sampling methods for the data collection and the analysis of data being purely based on the Multi Criteria Decision making approaches. This research has also given overview on the future methods

1. INTRODUCTION

The logistics industry's future, which is on the cusp of the fifth industrial revolution, involves more than just moving goods from one place to another; it also involves managing the entire flow of goods, which requires careful planning,

strategic thinking, increasing speed to market, lowering total supply chain costs, and utilizing technology to stay ahead of the competition, as demonstrated by Germany's dominance of the LPI index. Sri Lanka ranks 53rd on the liner shipping connectivity index, which evaluates how well nations are connected to international shipping networks. As a result, we are a nation with more outstanding connectivity and growth potential (Sri Lanka Export Development Board, 2019).

It was listed that from the survey conducted for the 2021 Third-party logistics' study by the council of supply chain management that, the ability of 3PLs to transform the customer's supply chain, adoption of the automation, being proactive to customer needs, and more functional and robust customer relationships are the keys for the successful 3PLs. The relationships with the 3PL are no more transactional; they are looking for strategic partnerships, but however, these needs to be validated base on the SL context (Langley & Infosys, 2021).

The current Logistics market has an upsurge of 62% of outsourced LSP in the last year. It was only 57%. Although, it was noticed that there is a change in the percentage of the insourcing logistics activities as 37% have mentioned some of the activities they used to outsource will be inhouse and operated, which was 31% based on last year's research. This is a concern to be addressed and should be investigated as Logistics has a derived Demand. They are adding to insourcing percentage increase. The customers are also focusing on consolidating the 3PL providers and focusing on few players, identified in the Third-party logistics study (Langley & Infosys, 2021). During this circumstance, it was identified that some users do not outsource the exact reason why some parties outsource, which

contradicts and creates a dilemma in the decision. Triggers that the LSP should meticulously gauge the needs of the logistics services and the strategies and requirements which will fit the customer's needs.

3PL Service Providers should understand the expected value propositions of customers in terms of operational stratagems and value creation models to target different companies in different industries to be acknowledged on their 3PL service providers' preferred value proposition. In this mechanism, as logistics has a derived demand, 3PL service providers capabilities and the shipper's requirements being aligned would deliver the shippers/customer customized solutions, which will indirectly design the 3PL Industry in the county (Gino , Marco , Sara , Chiara , & Elena , 2017).

As previously mentioned, globalization influx the importance of thriving the requirement for the 3PL players in the market. Strategies such as lean practices and agile manufacturing sustainability-focused Supply Chains are more considered on the survivability of the supply chains. Hence the supply chains should be more focused on the digitization of industry 4.0, resilience, sustainability, and survivability, along with the artificial intelligence and integrated operations method should be applied to manage and control the ripple effects (Farooq, Hussain, Masood, & Habib, 2021) . Adding based on the Annual third-party logistics study, 68% of the 3PL users have mentioned that using an LSP has reduced the cost of the operation. 88% have mentioned that usage of the massive increase the service levels they provided.

The purpose of this research is to identify the logistics services offered by the Third-party logistics service provider and what is required by the customers and, based on that, identify the gaps in the perception of the required and supplied services and derive the right solution and the proper attribute levels to the clients. Based on this identification to formulate the marketing strategies to attract and retain the client. A model will be created to address this expectation of a 3PL role and provide insights for 3PL providers in their customer approached.

This paper is focused on the Methodological on the research goal on "Selection and Evaluation of Third-party Logistics service provider (3PL). In this paper the researcher is following the Systematic Literature Reviews to asses upon the Validity , reliability of the previous research. The chapters are aligned as follows: Methodology Litterateur review which will provide the introduction, Methods followed in the other researchers , Results and the Discussion format will be followed in this review.

2. METHODS

This research paper is going away from the conceptual paper and more focusing on the empirical method of approach to focus more on the prior studies by synthesizing the research paper with the currently available literature review and follow the lead and focus more on t he methodologies which have been applied in this research studies.

Empirical research concentrates on an environment that is observable and quantifiable. Surveys, lab work, interviews, and other forms of data col lection are used in this strategy. This is a methodical approach to looking into a knowledge gap. Using this technique, the validity and reliability of these research findings may be evaluated, an d hypotheses can be tested (Consultores, 2022)

Systematic Literature Review Was the basis of approached utilized to assess the peer reviewed journal articles published going a decade back in the research study. form the year 2012 to 2022. This research was conducted the PRIMO , the – Library offered by the University of Plymouth this search could go through various databases across the e- Library which are focused on the Selection and Evaluation of a Third party Logistics Service provider (3PL).

In this E-Library there was the advance search option hence the bullion algorithm search could be followed through this advanced search ("Selection OR Evaluation) AND Third Party Logistics OR 3PL) this meaning was entered in a more advanced manner. Title began with " Exact " Third Party Logistics OR Title on Exact 3PL and leading to And in the title search for Exact Selection And in the Title search Exact the

Evaluation from this search there were 712 results but from this the search has captured the articles since 1990 to 2022 hence this is not the criteria period we are looking at hence the search results were refined to the criteria of 2012 to 2022 and the results were 303 results which the full text online available results and from these only 182 was peer reviewed and from these only the articles and research proceedings were selected to the review which has the open access from this search refine there were 81 articles selected for this review. From this search results title and abstract scan and the conclusions were scanned and it was realized all did not fall under the criteria of the research goal and there were 24 articles to be followed by 2 articles were not in the English language and this were eliminated on the process and the list of the 22 articles selected to conduct the systematic literature review which are as follows (Adalı & Işık, 2016; Aguezzoul, 2014; Aguezzoul & Pires, 2016; Aigbavboa & Mbohwa, 2019; Asian, Pool, Nazarpour, & Tabaeian, 2019; Ecer, 2018; Fan, Guan, & Wu, 2020; Hwang & Shen, 2015; Jovčić & Průša, 2021; Jovčić, Průša, Dobrodolac, & Švadlenka, 2019; Jung, 2017; Karbassi Yazdi, Hanne, Osorio Gómez, & García Alcaraz, 2018; Karrapan, Sishange, Swanepoel, & Kilbourn, 2017; Liu, Zhou, Li, & Zhu, 2020; Min, 2013; Mocke, Niemann, & Kotzé, 2016; Rosiana, Garside, & Amallynda, 2021; Sremac, Stević, Pamučar, Arsić, & Matić, 2018; Ulutaş, 2021; Wang, Nguyen, Dang, & Lu, 2021; Xu & Li, 2017; Zhang, Su, Zhao, & Chen, 2021) all these 22 articles were included in the methodological review below table is the summary of the frequency of the sources utilized in this methodology referred to Table 1.

Table 1 Primo Sources list and frequency

Source	Frequency
<i>Management Science Letters</i>	1
<i>Elsevier Ltd.</i>	1
<i>Supply Chain Forum</i>	1
<i>Materials Science and Engineering</i>	1
<i>Benchmarking</i>	1
<i>Alphanumeric Journal.</i>	1
<i>Technological and Economic Development of Economy</i>	2
<i>IEEE Access</i>	1
<i>Mathematical Problems in Engineering</i>	2
<i>Mathematics</i>	2
<i>Sustainability (Switzerland)</i>	2
<i>Journal of Transport and Supply Chain Management</i>	1
<i>Symmetry</i>	2
<i>Logistics Research,</i>	1
<i>Acta Commercii,</i>	1
<i>Jurnal Teknik Industri</i>	1
<i>APAC INTI CORPORA. Journal SIMETRIS</i>	1
<i>South African Journal of Industrial Engineering</i>	1
<i>MATEC Web of Conferences</i>	1
Total	24

Table 2 PRIMO SLR Process

Step	Description - Stages in SLR Process
1	The Plymouth online Library was used as the source of data bases
2	From the Library Advanced Research was conducted as ("Selection OR Evaluation) AND Third Party Logistics OR 3PL) Then title began with " Exact " Third Party Logistics OR Title on Exact 3PL and leading to And in the title search for Exact Selection And in the Title search Exact the Evaluation - 712 Articles
3	Inclusion and Exclusion Criteria's are applied. Inclusion - Duration between 2012 - 2022 , peer reviewed , Full Text online , Peer Reviewed , Open access articles and proceedings were selected Exclusion. - 1990 - 2012 search results, which are beyond the PRIMO data base and the Newspaper articles, non peer revied , Thesis and reports were excluded in this research.
4	Papers were reviewed using the thematic reading guide summary is in Table 2

Further to this search, another search string was conducted in Google Scholar which is based on the bulleon search words in the search string for the articles which discuss upon the selection and evaluation of a Third-Party Logistics Service provider or the 3PL provider is used in the study. Using the main words in the research title of the paper accordingly in that direction this is included in the search string as follows (Selection AND Evaluation AND "Third Party Logistics" OR 3PL)

The search yielded, about 27,000 results from wide spectrum of resources. And then the search string was narrowed by the all in title search

which brought up to 45 research papers but as we conducted for the study over past decade so that this will be bringing only the valid results In this growing market where logistics plays a significant role in with this search the range of 2012 – 2022 the study was narrowed down to 24 articles which was captured in this paper all the sources which arrived In this search string was included in to Mendeley referencing management system and recorded the data for the methodology review.

Table 3 Google Scholar – Frequency

Source	Frequency
Journal of Software	1
Life Schience Journal	1
Journal of Electronic Commerce in Organizations	1
Benchmarking	3
ICTE 2015	1
Applied Mechanics and Materials	1
Supply Chain Forum	1
Sustainable Production and Consumption	1
International Journalof Hybrid Information Technology	1
Journal of Modelling in Management	1
AIP Conference Proceedings	1
Int. J. Business Excellence	1
Int. J. Services and Operations Management,	1
Applied Soft Computing	1
Annals of Operations Research	1
TRANSPORT	1
Scientific Journal on Transport and Logistics	1
	19

(Aguezzoul & Pires, 2016; Chen & Chen, 2015; Choudhury, Raut, Gardas, & Kharat, 2018; Ejem et al., 2021; Garside & Saputro, 2017; Haldar et al., 2017; Huang & Yin, 2014; Narkhede, Raut, Gardas, Luong, & Jha, 2017; Prakash & Barua, 2016; R. D. Raut, Kharat, Kamble, Kamble, & Desai, 2018; R. Raut, Kharat, Kamble, & Kumar, 2018; Rostamzadeh, Esmaeili, Sivilevičius, & Nobard, 2020; Roy, Pamučar, & Kar, 2020; Sahu, Datta, & Mahapatra, 2015; Sang, Wang,

Sun, & Li, 2015; Wei, Jia-lin, & Jun-liang, 2016; Zarbakhshnia, Soleimani, & Ghaderi, 2018; Zareinejad & Javanmard, 2013) These are the authors who will be contributing this paper.

According to this summary of the search frequencies it can be identified that Benchmarking and International journal , symmetry, Mathematics , Technology and economic development of economy , mathematical problems in engineering and mathematics are the journals which have more focused on the selection and evaluation of a third party logistics service provider

As this paper is mainly about a methodological review. Following the methodology overview structure of (De Alwis & Hernwall, 2021) this research paper would also use the method of (Casper et al., 2007) with this guide lines the research design, sampling methods, Data analysis methods and measure of validity and reliability will be disused upon and also with the guide line of the research onion will be utilized as well for the discussion and guidelines for the ethical issues which you will encounter in conducting this. First the research design will figure out whether to conduct. This research papers selected 40 research papers are analyzed using the excel based format which is depicted in the Appendix 1

2.1. Research Design

This is starting point where the research will be deciding upon how the research question will be answered, what are the resources, sources which will be utilized in gathering the information, how the gathered information will be analyzed and the method of selecting the qualitative, quantitative and Mixed method research will be decided at this point ,also the nature of your research will also be decided at the research design whether the research is expletory , explanatory , descriptive or combination of these research strategies will be used In the research , the study setting and the time period is also considered under this (Saunders, 2022).

Based on the research papers gathered to the study it was identified that mostly the researchers have followed the method of mixed multi criteria methods for the study and which is around 67%

form the research papers and only 22% have carried out the research based on quantitative method and there were two research papers which were focused on the literature review analysis and the rest of the two papers were focused on the qualitative research aspect. It was noticed that there were no researchers which were focused on cross-sectional based research as most of the research were focused on the case study method , which is over the 40 research articles there were 28 research papers which were based on a case study environment for the basis.

2.2. Sampling Methods

Decision on the sampling method need to be decided based on the research questions that will be addresses in the study. Sampling method will be deciding how many data points to be collected for your study to be able to replicable and generalized in the research spectrum, as the researcher are with the limited resources on time and the resources in conducting the research on the entire populations, there are two main criteria's which are probability and non-probability sampling methods. Probability sampling there is an equal chance of the selection from the population will be semiarid equal for all the cases and theses are getting along mostly with the surveys non probability Sampling, this method the generalizability of the study on statistical grounds are not possible hence there should be other methods to be addressed in searching for the reliability and validity of the study (Saunders, 2022).

In this selected research papers as the majority of the studies are based on non-probability sampling methods as the most of the research are based on case study method , most of the research papers have focused on the judgmental sampling methods which is around 32% of the research papers and the next sampling method was the convenience sampling methods are captured in the selected studies which is around 27% from the selected basis and there was one research paper which also used the non-probability sampling method of cross sectional sampling methods and tone paper was also considering the snow ball sampling method . There were two papers which utilized the homogenous sampling methods. Although most studies mentioned the

sampling methods 22% of the researcher papers did not mention specifically the sampling method that they have derived upon in the study and as per the research conducted by (De Alwis & Hernwall, 2021) we can make into assumption that if the sampling method is not available the research paper would have considered the convince sampling method

2.3. Data Collection Methods

According to the research papers in this study it can be identified that Questionnaires were utilized for 17% and survey method was utilized along with the. Questionnaires and as well as solely for a percentage of fifteen also there were interviews concentrating on quantitatively research method as well as semi structured interviews for the information gathering for the qualitative based information gathering methods also during the circumstance of the COVID time period some interviews were carried over the telephone conversations during this data collection method. During the supporting of the case study method which is compromised on this research papers for majority it was identified that focus group sessions and the brain storming sessions were carried out as methods of data collection. Meanwhile there are wide variety of data collection methods which are utilized. It is also identified most of the research papers used the real time data collection of the population as these are based on case studies during the study the data was collected on Realtime method in different aspects which were not clearly mentioned in the research papers for the author to distinguish which accumulated to 30% of the research papers.

2.4. Validation and Reliability

Validity and reliability provide an indication of the acceptability, quality of the research conducted in the quantitative research study mainly. Reliability is assessing the consistency of the study and validity measures the accuracy of and the and how it could be generalized among the population (Saunders, 2022).

In the selected research papers, there were few research papers which use the expert opinion to check the accuracy of the results, conducting the pilot testing in the research using the same

analysis matrix used in previous research in current research as those are validated and also it was also brought into the notice of increasing the sample size so that it can be closer to generalizing among the population for the validation

Reliability is asses via Cronbach test or the consistency assessment ratio which majority of the papers have utilized this method for 12% and 15% respectively, but rest of the papers did not mention about the reliability test which need to be carried out.

2.5. Data Analysis methods

In this research most of the data analysis methods are more into numerical methods of Multi criteria decision making methods in research data analysis the methods which are selected in this studies are for instance, ANP, AHP, Fuzzy based ANP and AHP, IVFN, ELECTRE, IRP, DEA, SWARA, FARS, TOPSIS, DEMATEL, WASPAS, DELPHI, HMCMD, MABC, CPT, TODIM, FVIKOR, CODAS, COPRAS, EAMR, EDAS, FARS, IVFRN-FARE-MABAC, VRS,

CRS, GREY, DEA-TOPSIS and Nonadditive Fuzzy Integral Approach these are the methods used under the multi criteria decision making process but adding to this it is also identifies that multi-index decision and evaluation based on Relative Approximation, supplier evaluation Index system, visual basics, sensitivity analysis, average frequency of criteria utilized, KPI based performance measurement methods, thematic analysis, Factor analysis method, kano method and most importantly there are four studies which utilized the sensitivity analysis in the data analysis process.

3. DISCUSSION

Selection and evaluation of a third-party logistics service provider is based on the main decision of an organization in the first step of the outsourcing decision which is based on transaction cost economics. This theory makes it possible to derive a conclusion whether some activities to be outsourced or whether some activities to be operated in house (Williamson, 1981) "Transaction cost are the costs of running the systems" (Xu, 2009). According to the TCE, the

boundary of firm's decision is enlightened as outsourcing decision (Xu, 2009). There are three scopes of Transaction cost which is as follows as asset specificity, uncertainty, and Frequency. Higher the asset specificity will not take the decision of outsourcing, when the uncertainty is

low companies outsource the logistics activities as buyers will try to identify the ways in which uncertainty can be minimized. Frequency of occurrence is high then the transaction should be outsourced (Ivanj & Franzil, Outsourcing logistics activities: a transaction cost economics perspectiv, 2006). Hence the selection a 3PL provider detriments on the basis of cost and risk perceiving competencies among the plethora of service providers (Anderson, Coltman, Devinney, & Keating, 2011). Nevertheless, this theory itself will not make the decision to select the service provider. Selection of a supplier is based on the relationship between the buyer supplier and their exertions in generating a value will also be concerned in the selection process (Terpend, Tyler, Karuse, & Handfield, 2008). This theory provides an indication of the origin of the outsourcing decision, where the decision of outsourcing was based on the asset specify, uncertainty and frequency of the operation. This is where the firms or customers decide on the make or buy decision, where the most efficient organization which has the ability of getting the organization of exchanges between companies without incurring transaction costs which leads to selection of the right service provider. This is the reason why firms seek to minimize the uncertainty in the operation by taking the outsourcing decision .In the third party logistics service provider selection based on the cost and the method of balancing and preventing the risks the client will be taking a decision on a the selection of a service provider.

Resource based view explained as the main drivers of performance. Resources and capabilities which are hard to imitate are impetus for sustainable competitive advantage. RBV advances that capabilities have developed from resources. Firms compromise of many resources which implements and the foundation for strategies. Resources comes in tangible and intangible forms. For instance, resources include

capabilities, assets, process in organization, information technology and knowledge and attributes of firm (Ding & Kam, 2012).

Above mentioned are the basis for the Logistics Outsourcing which is called as Third Party Logistics service providers which the company select and evaluate the Logistics' service provider based on the cost benefit analysis as well as the resources and capabilities required to operate in the logistics spectrum in order for the companies end objective of profit and loss and the customer order fulfillment to be active. This is the basis for the methods which the selection and evaluation will be based upon the ultimate root and the analysis will be based on this foundation.

Selection and evaluation of logistics service provider is a decision making done by the customer, and in this decision making the major concentration is on the how the selection and evaluation will be conducted upon. 3PL supplier selection is revolving around a lot criteria's to be concerned and this composite of quantitative and qualitative criteria's in the evaluation process, these criteria's should be identified, defined , analyzed , weighted based on the circumstance and with other options available for the selection

, when these criteria's are considered this could be supported in the decision making of a 3PL selection hence this is the reason most researchers have considered the Multi criteria decision making (MCDM) in there analysis but not only based on the basic MCDM methods to be considered , this research should consider other criteria's for a proper analysis and selection which will be discussed in the next steps of this paper(Hwang & Shen, 2015).

Quantitative and qualitative are the two general research methods approaches in designing a research (Saunders, 2022). To support, general and accurate evidence quantitative research methodology was nominated. If the research is applying in a real atmosphere it is called as qualitative research. Qualitative research wants a comprehensive and compound environment to be arranged for the interested existence.

Entirely contradictory of quantitative research will be conducted in qualitative research method.

Quantitative research method analyses a research problem, the method finds a theory and this is tested through measuring and analysis tools such as statistical techniques. Quantitative research classifies and see in a different standpoint for social and humanistic problems. In order to come into an assumption of social phenomena

quantitative research method is used (Lex, Streit, Partl, Kashofer, & Schmalstieg, 2010).

This approach of multiple methods addresses multi method and Mixed method (Saunders, Lewis, & Thornhill, 2009). The Mutli method is controlled in the either quantitative or qualitative method and allow to use different methods of data collection in either quantitative or qualitative method ; however in the mixed method there are mixed method research and mixed method research model , in the mixed method research this use both qualitative and quantitative method of data collection method and do the analysis simultaneously or do it one after the other but in short quantitative data will be analyzed in quantitative way and qualitative data will be analyzed in qualitative way but in mixed model research it will used with at their stage qualitative and quantitative data will be analyzed together and even at the research question, in this method you will qualifies quantitative data and qualitative data will be quantities (Saunders, Lewis, & Thornhill, 2009). This method of mixed method application is required in the research data analysis but whether it will be multiple research method or mixed model research will be yet to decide.

Most of the researches and in this research we will be selecting a mixed method research design approach for the reason of triangulation which can utilize different methods of research data collection methods to support the research, complementary as the both methods usage will be able to complement to answer the research gaps in the information so it will also solve puzzling issues , qualitative data explains the relations hips in the qualitative data findings and each methods facilitate and compliments each method (Bryman, 2012)

Based on the research papers collected on the methodological reviwew based on PRIMO and

Google Schor basis. Selection and Evaluation of a logistics service provider most preferred method utilized is the Case Study Method and all these are based on the real time study analysis for there selection of a service provider which they encounter. There was a one research method on Exploratory study and empirical study and few field study's. As this is a real time research

question to be answered the multiple researchers in this study being selecting a Case study method is acceptable and hence the Author , decided to conduct on the same basis but as per the limitations also the researchers mentioned as this is only considered in a one environment the applicability in other research basis will be a questionable so it was also suggested that in this study to consider on another industry to verify the study results.

Most of the researchers have conducted the mixed method as this is a multi-criteria decision making in this method it was identified that the traditional judgmental methods could not be reached and with this methods the decision makers fuzziness also could be captured in to the results when both methods are considered the criteria's which are included for the selection and evaluation could be expanded , the calculation process will more reasonable if both the criteria's are included in the research.

Most of the representatives which was called to this analysis are based from the 3PI provider perspective or the decision makers in the industry who had the relevant expertise in the analysis and there might be biasness in this criteria's selection hence most of the researcher the providers are kept anonymous and the sample should not be able to be clearly identifiable for the decision makers. Some researchers the experts have been selected form the academia as well and also once the selection was also conducted by the applicants for the tenders and then the analysis of the participants which based on this guide the Author for this research criteria all the 3PI service providers in the country and also based on a one case study company their decision makers will be considered in this study.

Based on the case study method as well, the majority of the sampling method was based on non probability sampling which is also the generalizing of the researchers was questionable in majority of the researchers it was also mentioned that this as a limitation for their study that only to the case study but among larger samples across the country to be considered upon. Based on the sample selected the opinions are based on this limited no of people hence the results might not be giving the entire overview of the circumstance and also even with the samples the link between the samples also not considered In the data analysis methods, as identified in the research spectrum over the decade, do not limit the research only to traditional MCDM methods always on top this method and fuzzy settings as well to overcome the uncertainty, linguistics decision making and if a one criteria is lacking add another criteria to nullify the impact. When utilizing the mixed method of research approach using the extended versions of the MCDM Methods such as ANP, AHP and FAHP, QFD methods AHP- VIKOR for several approaches and several criteria's will be covered with this methods to provide a wide area of the analysis methods or either these methods are mentioned to be utilized in future studies as well such as ELECTRE, TOPSIS, IRP. Although these methods are applied it is also suggested that the sensitivity analysis also to be conducted for the checking the consistency and validity of the research gathered data to address how much more the model can be absorbed in some instances if some more criteria and weights are added which is a positive impact on the identified method.

Some researchers also go into the selection and evaluation in a step by step method so that one drawback of a one method will be eliminated and another point of view is added for the decision making. In the selection criteria's another aspects of budget limitations, finance capability, marketing budget these criteria's also need to be captured in the decision making which is addressed in some researchers this is another aspect no matter the service quality is met the viability of the finance capability and other objectives in the organization cannot be met.

Despite all these mathematical models discussed for the analysis methods and data collection form questionnaire, focus groups, brain storming sessions, interviews, semi structured interviews and also real time data collection form the case study methods also should be considered when including this research data collected to the analysis model, hence this is a one flow process to achieve a one objective of selection and evaluation of 3PI providers.

Validity and reliability is not much being applied in the research study and even during the instances that the research is applied these criteria's the validity is measured via experts and there opinions which is again being the sample members in the research study will be a question and as usual the consistency ratio and the Cronbach alpha were utilized for the reliability test assessment which this could also be an example a researcher could arrive upon adding to this conducting the sensitivity analysis also considered to further validate the studies.

In the research study of the author is planning to conduct The population will be from the third-party logistics service providers, there are main top seven Third Party logistics service providers in Sri Lanka which will be considered in the entire population for the survey but for the case study only one company will be selected based on the convenient sampling. From the manufacturing establishments which will retrieve form Department of census and statistics in Sri Lanka at the 95% confidence level. But the researcher's sample unit will be organizations who will go into selection of sample based on "Judgmental Sampling" this is due to the basis of selection of the sample based on the researcher's judgement. This may be not the entire representation of the population. This is the sample process which will be supported for the judgment based on the availability of the information the customers of the current logistics service providers as well which was arrived based on the methodological reviews

Primary data collection method is via survey method, Key contacts are persons employed in the logistics service providers in the company as a CEO/ Director, Head of operation, Business Development manager, and operations manager.

Key participants are capable of commuting the relevant questions asked in the research . From the Manufacturing Organizations side decision makers such as the procurement department, operations team and the CEO of the company will be asked to participate in the survey interview and case study. These data gathered will be kept for period of two years during the research and 8 years after the research

4. CONCLUSION LIMITATIONS AND FUTURE STUDY

In this research methodological review although the case study method was the majority selected method the sampling method based on the case study was not adequate also there are some events the sampling method is not detailed or not mentioned and always have utilized non probability sampling , but in future researches to eliminate the considerations of the generalizability doubt inclusion of more to the sampling method and also conducting and testing the case study on different instances would be considered. Also, all these methods are considered into MCDM and extended method on year on year there were developments but consideration on other criteria's such as budget considerations, marketing and other directly non relatable criteria should be able to address in this selection method. In the research in future if it can be added with proper validity and reliability measures would be considered. Data collection methods possibility of expanding to quantitative and qualitative should be considered. This study is mainly focus on them methodological review only based on the database's selected from Plymouth library and the google scholar and if further databases could be added and also as this was limited to peer review and open access articles eliminating those criteria and including more papers would provide a another overview of the study but the quality and acceptability of those papers should also be validated.

REFERENCES

- Adalı, E. A., & Işık, A. T. (2016). Integration of DEMATEL, ANP and DEA methods for third party logistics providers' selection. *Management Science Letters*, 325–340. <https://doi.org/10.5267/j.msl.2016.3.004>
- Aguezzoul, A. (2014). Third-party logistics selection problem: A literature review on criteria and methods. *Omega (United Kingdom)*. Elsevier Ltd <https://doi.org/10.1016/j.omega.2014.05.009>
- Aguezzoul, A., & Pires, S. (2016a). 3PL performance evaluation and selection: A MCDM method. *Supply Chain Forum*, 17(2), 87–94. <https://doi.org/10.1080/16258312.2016.1176302>
- Aguezzoul, A., & Pires, S. (2016b). 3PL performance evaluation and selection: A MCDM method. *Supply Chain Forum*, 17(2), 87–94. <https://doi.org/10.1080/16258312.2016.1176302>
- Aigbavboa, S., & Mbohwa, C. (2019). Going the extra mile: Vital third party logistics service providers'pre-selection activities by pharmaceutical organizations. In *IOP Conference Series: Materials Science and Engineering* (Vol. 640).Institute of Physics Publishing. <https://doi.org/10.1088/1757-99X/640/1/012126>
- Anderson, E., Coltman, T., Devinney, T., & Keating, B. (2011). What Drives the Choice of a Third Party Logistics Provider ? What Drives the Choice of a Third Party Logistics Provider ? ? *Journal of Supply Chain Management: a global review of purchasing and supply*, 47(April), 1-42.
- Asian, S., Pool, J. K., Nazarpour, A., & Tabaeian, R. A. (2019). On the importance of service performance and customer satisfaction in thirdparty logistics selection: An application of Kano model. *Benchmarking*, 26(5), 1550–1564. <https://doi.org/10.1108/BIJ-05-2018-0121>
- Asyçin, E. (2018). A Grey DEMATEL Integrated Approach to Determine Third Party Logistics Service Provider Selection Criteria Alphanumeric *Journal*.

<https://doi.org/10.17093/alphabetic.418829>

- Bryman, A. (2012, March 21). *Social Research Methods*, 4th Edition (4th ed.). Oxford University Press.
- Chen, L., & Chen, N. (2015). Evaluation and Selection of a Third Party Logistics Supplier in a Chemical Company. In *ICTE 2015* (pp. 691–696). Reston, VA: American Society of Civil Engineers.
<https://doi.org/10.1061/9780784479384.088>
- Choudhury, N., Raut, R. D., Gardas, B. B., & Kharat, M. G. (2018). Evaluation and selection of third party logistics services providers using data envelopment analysis: a sustainable approach. *Int. J. Business Excellence* (Vol. 14).
- De Alwis, S., & Hernwall, P. (2021, March). A Review of Methodological Choices Relating to WorkLife Boundary Research. *Managing Global Transitions*, 19(1), 73–101.
<https://doi.org/10.26493/1854-6935.19.73-101>
- Ding, M. J., & Kam, B. H. (2012). "Operational routines and supply chain competencies of Chinese logistics service providers. *The International Journal of Logistics Management*, 23(3), 383-407
- Ecer, F. (2018). Third-party logistics (3PLs) provider election via fuzzy AHP and EDAS integrated model. *Technological and Economic Development of Economy*, 24(2), 615–634
<https://doi.org/10.3846/20294913.2016.1213207>
- Ejem, E. A., Uka, C. M., Dike, D. N., Ikeogu, C. C., Igboanusi, C. C., & Chukwu, O. E. (2021). Evaluation and Selection of Nigerian Third-Party Logistics Service Providers Using Multi-Criteria Decision Models. *LOGI - Scientific Journal on Transport and Logistics*, 12(1), 135–146
<https://doi.org/10.2478/logi-2021-0013>
- Fan, J., Guan, R., & Wu, M. (2020). Z-MABAC method for the selection of third-party logistics suppliers in fuzzy environment. *IEEE Access*, 8, 199111–199119.
<https://doi.org/10.1109/ACCESS.2020.3035025>

Millennials Reshaping Organizational Culture: A Qualitative Systematic Literature Review

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ABSTRACT

In this article it is reported the derived findings of a systematic review of the literature on millennials reshaping organizational culture. Millennials also interpreted as generations Y. With the current rise of higher number of generation Y entering the corporates in each and every industry the ripple effect it has created to be immense. The main purpose of this systematic qualitative literature review was to further understand in regards to the cohort and how millennials are viewed and looked at in relation to the organizational culture and how the leaders of such entities understand and best enable ways to encourage the commitment of millennials. This study intend to discuss implications that could be used to encourage three generations of different demographic age groups to cultivate the organization culture and to reshape the organizational culture.

1. INTRODUCTION

It is often debated and discussed the millennials are currently reshaping the workplace. Millennials or also known as Gen Y is the talk of the town in the corporate world (Al-Asfour, A., & Lettau, L. 2014). Many institutions and organizations are facing major challenges in regards to understating the concepts ways of the new generations. With the increase of millennials in the workplace, there is a pragmatic change in the organizational cultures. This study try to analyze and observed at ways of how many generations such as Baby Boomers, Gen X and

Gen Y work hand in hand with each other. The worldwide view and the understanding each generation type has and viewed is different. The study try to make an understanding and provide implications on how leaders should focus on creating the organizational culture in a way that best fit all three generations.

Culture place a significant importance in the corporate world. This is the core of setting the business and alignment of the ways and how of the business. Culture drives the organization in other words. Yet one may say culture is not important as long as the business thrive. Another may argue that different generations have always worked together despite any culture (Edge, K. 2014). This is a debatable aspect. However with many researches over the years it has become a paramount importance to accept and believe the current world of corporate are dealing with an issue of understanding and getting the staff to co- exist with each other at workplace.

With the growing interest in understating generational difference in diverse workplace setting, where many organizations spend extensive research time in understanding, it is a crucial aspect to understand how the culture keeps changing with in the work place.

2. THEROTICAL FRAMEWORK

The research that was incorporated in the entire study is based on the research conducted by other researches in the field Human Resources,

Business Management and Organizational Culture management. In an organization if the employees is asked what is culture? Many will give different answers. Culture is defined and interested in different ways and views by many. It is arguable this is different from individual to individual.

According to scholars, Culture is defined as the ways of life which includes arts, beliefs and institutions of population. Eventually that are passed down from generation to another. The same culture was then derived in the form and introduced to the organization. Which latest defined as organization culture. Organization culture introduced as the way it defines the proper way to behave in an organization (Lewis, L, & Wescott, H. 2017). On the other hand, some authors defines it as the underlying beliefs, assumptions, values, and ways and means of interacting which each other. Which in result in unique social and psychological environment with in the organization. Simply it's the vision, norms, values, habits, systems, language, assumptions and beliefs which are practices and passed down.

In an organization the culture is revolving and gets created by the people. The employees, management teams and leaders are who create the culture. However the organization may consist and contain of different generations. Currently know as multiple generations. In context there are Baby boomers, Millennials and Gen Z in any workplace (Hall, A. 2016). The Human resource department generally defines the composition of the mix. This composition is what creates and drive the organization towards the success where it believe in the vision.

These doers are the creators of culture. It is vital to understand who are baby boomers, who are millennials and who are gen Z (Aharony, N., & Bronstein, J. 2013). In this study later, it will mainly focus on the millennials. Heavily the generation names are derived and created to culture and the demographics. The Baby Boomer name was drawn from the great spike in fertility. Began in 1964 and later, right after the end of World War II, and ended almost as abruptly in 1964, This is the time period the birth control pills were introduced to the market, It's an ideal

example of a demography-driven name. Next comes the Millennials. One may question who are millennial and what is the big deal about this generation.



Figure 1. Who are Millennials?

Millennials are defined and known as Gen Y, Generation Y, Generation Me, and Generation Net. As shown in fig 1. Millennials are considered to be born between the years of 1980 to 1996. According to Howe & Strauss 2000 and Edge 2014, they are described as the generation born all through the last two decades of the twentieth century. Ideal they have started there adulthood in a new millennia. There are mostly raise by Baby boomers. Making it even more interesting to further look at the schematics. Major characteristics or the difference between the rest of the generations are as follows. The grew during a period of economic boom, giving access to internet and smart phones. With that, they tend to prefer to use social media for all major steps in life. Use of Facebook and Instagram is the new norm for the cohorts. Researches has found them to be idealistic and much focused n having experience in life. This group tend to believe in enjoying and making memories. Idealistic and believe in generating new ideas and prefer to embrace and purchase brands that share similar values as them. High usage of Apple products by millennials is a classic example.

During the last few years, millennials was gaining quite a sever attention across the globe (Bodenhausen, C., & Curtis, C. 2016). With the entering to the workforce and the demands made

for change in methods who employee management and performance is measured and treated was challenge during the decade. In the field of reached this cohorts has gain major attention by demanding to identify and accept their ways of work, attitudes, behaviors (MacKenzie & Scherer, 2019).

As briefly discussed above, Millennials in the corporate world and workplace are classically characterized by a many of attributes, which are often adverse in nature. Even though they are recognized as multitasking, tech-savvy, and collaborative. Researches has deemed and mentions Millennials as fragile demanding and intolerant and impatient (Bodenhausen & Curtis, 2016). Through these many research's and studies has mentioned that working with millennials is chore, In the controversial side other studies have challenged these assumptions, predominantly those related to a lack of work ethics and commitment.

What makes it more interesting with the culture they bring in to the table they tend to demand a different style of leadership. While baby boomers place candid, honest, dependable and honest culture. Millennials does not place or treat these as high compared with other groups (Sessa et al., 2007, p. 60). A fact that is known is that the age category of Millennials are stated to be a category which requires constant validation and satisfaction. This is how their balance of work ethic is defined. (Bergman et al., 2011).

This could be further shown through the fact that certain studies think that this is how the millennial work ethic is driven. (Graybill, 2014; Nye, 2017). Yet it is also important to note that during the recent past, the leadership platforms have been substantially open to the Millennials to take up the challenge. (Al-Asfour & Lettau, 2014; Fore, 2013; Nye, 2017), Hence we state that in order to argue on this Business excellence and the Total of the Quality Management ground there are three factors that are required, we argue that more Total Quality Management & Business Excellence 3 empirical research is needed

3. METHOD

In this paper the main focus is given to qualitative study and a brief amount of quantitative study methods. Research methods such as survey and interviews are mainly used. The paper mainly flow along with a systematic review research (Gough, 2007). While aligning the research questioned mentioned above the "Are millennials reshaping the organization culture" this tend to look at the evidence which was found to analysis the statement. Mainly this paper look at research done by many other scholars and incorporating their findings in to this. In essence of the findings presented by other scholars it is deemed worthy to understand and research the findings of different article, journal paper and studies presented age boundaries of the coherent.

3.1. Systematic Literature Review

As preceding researchers have mentioned and presented, there is no one way to exact way to conduct a systematic review but it is fundamental to analyses and present how the search was accompanied in a transparent and in a much detailed method (Castillo & Hallinger, 2017).

A systematic literature review is a review of "a clearly formulated question that uses systematic and explicit methods to identify, select, and critically appraise relevant research and to collect and analyze data from the studies that are included in the review" (Moher, Liberati, Tetzlaff, & Altman, 2009, p. 264).

My purpose was to capture to which extended academic community was tapping and conducted extensive research in the concepts of Millennial and the effect they have on the change of the organizational culture. Accordingly, to broaden the base and the understanding the research was broaden to many databases. Close to 20 academic databases was used to derive and read many journal articles published over the years. Many areas and disciplines were used to obtain the articles. Academic databases such as Emerald, Sage, Taylor & Francis Online, Scopus, Google Scholar, JSTOR, Plymouth Library and Sciences Direct are few of it.

3.2. Search Terms

Throughout the search for many journals through many academic databases terms such as “Organizational Culture”, “Culture and Business”, “Millennials and Culture”, “Reshaping the culture”, “Baby boomers”, Millennials and Organizational Culture” was used. During the course of this closer to 6178 articles were derived. The search was then streamlined in consideration of the selection criteria. Further narrowing of the terms was more helpful in looking at the most suitable articles. This will be further explains in the Selection criteria section.

3.3. Selection Criteria

Followed by the understanding of the criteria, a substantive and a comprehensive search took place in between the times of 2000-2018, which encapsulate 18 years, of the English language on this topic. The main reason as to such years were chosen to the research is the mere fact that the Millennials do belong to this category of age and time. Where they progressively is entering the adulthood from the primary levels of life, which is the organizational and the formal platforms where the leadership and bearing of leadership roles would be done by them

In order to hold the clarity and to maintain the accuracy of the elements and the data obtained the researches were done by the Millennials but excluding the peer-reviewed articles. The cite of peer reviewed articles bear a corpus that divert the research area towards a more interesting outlooks.

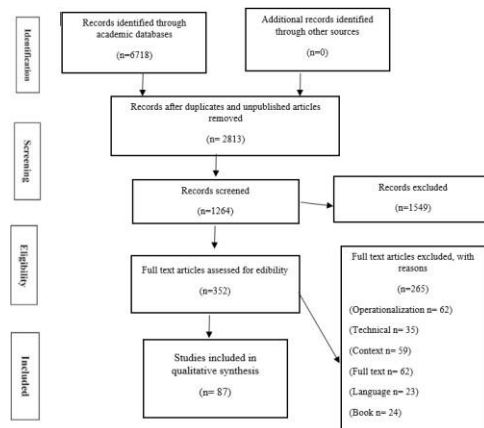


Figure 2. PRISMA Flowchart

As per the above-mentioned restrictions, PRISMA (Preferred Reporting Items for Systematic Reviews and Meta- Analyses) used to explain the process in four steps. This is an approach that entails evidence based checklist with 27 items in four stage flow diagram. This is not a tool used to justify the quality of the assessment but a tool merely used to aim at ensuring the clarity and transparency. Based on the search results derived 6178 articles were identified from the academic databases. There were no articles identified by other sources. After identifying the duplicated records and unpublished articles there were, 2813 articles identified. In the screening stage there were 1264 records were screened. Then 1549 articles were excluded. Further, in identifying eligibility 352 full text articles were assessed for edibility. Out of which 265 articles were excluded. Such articles were taken off based on certain reasons. 62 was excluded as operationalization, 35 was excluded as per the technical, 59 was excluded based on its context. 62 articles were taken off or discontinued due to its full text, 23 as per its language and 24 was taken off since they were books.

3.4. Study Selection

Article types which was reviewed were classified according in to 5 areas. Namely Conceptual, Empirical, Case studies, Review and Opinion. Under the category of empirical the articles which was further analyzed was where the it had an introduction to Millennials and Organization Culture. This was linked to reshaping through the

other articles, which was read and analyzed. Qualitative, quantitative and mixed research methods was used. In defining case studies these are papers which discussed about a certain organization and its practices and ways. Ideal case studies of select number of organization details was gathered. Mostly the organizations are with in Sri Lanka, USA, India, Canada and Australia. 'Review' consisted of those drawing on and existing body of literature on Culture and Millennials. While 'Opinion' was papers or journal articles which the authors interpreted their own perception and views based on the themes. Millennials, Reshaping and Organization culture as mix.

As bordered above, papers classified as 'empirical' contained the largest group of publications. Secondly, it was opinioned and case studies. Based on the research methods the empirical papers were classified. There were 46 'empirical' papers and out of these all were reviews and 24 are quantitative and 22 are qualitative. Out of the 24 quantitative articles 19 papers had conducted surveys. Generally looking at the papers qualitative articles were comparatively lesser. There were only 3 qualitative and 3 mix method studies. The qualitative papers had used interviewing as the methodology in most of the cases. In an overall picture what I discovered was (a) there is a relatively less number of papers academically produced in the areas of Millennials and Reshaping the Organization Culture. (b) most preferred method of research deems to be quantitative method. As mentioned by Lynos and Kuron 2014, It is evident further study is needed in greater qualitative understating in the area of Millennials and Organization Culture. I will return to this argument and intend to further elaborate this in discussion section.

3.5. Selection Bias and Limitations

Considering the fact this area of research in the field is limited it was considered to include reviewed and opinion paper literatures. Nevertheless, the variable quality of the literature reviewed is an vital limitation of this research article. The fact there is a limitation in the scope of a future review concerned with the Millennial

cohort and Organizational Culture created a need for the future researches to consider similar kind of work and to progressively publish. Another biasness and limitation, which came across was the fact the paper and journal articles which was reviewed was all written and published in English. It was important the research is limited to such criteria as this is the worldwide used language and the accepted language to publish. However literature written in an another authors native language will be useful and this could be considered the grey literature.

I believe it is vital for future researches to address the grey literature and in the meantime look at the limitations to create more fruitful and educated academic articles. Main limitations such as lack of empirical studies in this area of literature and is concerning. Especially with the development and the rise of the millennial workforce. Higher number of research need to be conducted in the area of Gen Y and reshaping of the organizational culture. More rigorous research will be an addition to the academic journals. Another fact which was clear through the systematic literature review was the fact many articles and many authors define the millennial birth year range has significant differences. There should be a proper classification for the age groups, which would help the researches to produce more accurate information.

Further qualitative research need to be conducted and encourage be conducted This will help in understating the more qualitative reasons and in depth details in regards to how the millennials are reshaping the organization culture. It will enable the future researches understand the statistical relationship. Most of the findings and research data had being gathered from developed countries. It is important to have a more broader geographical representation. Also organizations in different contexts and industries.

4. DISCUSSION

The body of the research was actually, and originally originated from the United States of America and few other countries. The studies of Millennial really took a bigger turn in the sectors like the healthcare, field of business and its management. Thompson and Gregory were able

to do a great research of this Millennial work patterns, and there showed this with their empirical researches.

However while doing the study one thing that was stringy understood was that the resource base for the Millennial study is quite constricted than any other study. There are only about 22% of this kind of research papers, that could be taken in to consideration. Another thing to add is that even though we worked together the way the millennials approach would be a problem.

Once again the factor that states that there would be peer reviewed journals gives insight in an angle that it was not received at first. Interestingly, the results that were found were quite related to the Millennial and there behaviors in the organization. One of the important aspects that were noted was the loyalty and the love towards the work place are not par with what it used to be.

As per the youngsters the concept of job security is not existent and has no weightage to it. These youngsters cannot fathom on the fact that the boomer bosses in reality spend more than 60 hours doing the job that they will constantly complain about. According to them there is a life after work, but for the boomers this was not the case.

It is important to note that these findings have its own way of clashing the ends of the research since the taken example is quite opposite and different. Karp et al. (1999) talked about the negative connotation attached with the Gen X how their work is perceived and how they are being viewed in the society in regards with the boomers. Most the time this generation is considered to be arrogant, heartless, and sometimes even rude, since they are not brought up the same way the old age was used to. The way they do certain things and thoughts have changed and evolved. However in one of the studies that were conducted on the platform of Teams, it was found that the Gen X is actually much more friendly and team oriented than the others.

Since they are taught a different perspective. Although they are seen to be tough and hard to work with in the beginning this is not really the

case once they start working. They are quick learners and especially tech savy which makes a great asset to the company. This systemic review show this exchange in its review and analogy.

According to the researches, the evidence produce was the millennials ways of doing things is completely different to what of Baby boomers. Gen Y is all about flexibility, tech savviness, idealistic nature. They want to be brand loyal and associate with brands which has similar values. This generation is big on values and quick to quite if the work culture is not what they deems fit. In the current context most of the organizations are looking at possible ways to adapt to the new culture that is being reshaped by the millennials.

5. CONCLUSION

Millennials have their roots in an increasingly technological and a digital age and they have the skills and required knowledge resources that would make them a very valuable asset to the company, since there are fast moving with fast developing technology. Most organizations tend to not really look at, but rather to overlook which results in failing to respond to the Gen X s. That will hamper their ability to grow into good cooperate leaders.

This in fact is a great mistake that could take place in the hand of the baby boomers due to their old patterns of thinking. Their main idea is that the millennial would start changing the culture of the working system. Although this could technically take place, the evolving is needed in the business and in the world. Organizations that recruit such millennials without a doubt, retain and also inspire millennials to acquire many significant competitive and useful advantages in the present. And also the future over their colleagues.

In conclusion, therefore the most optimal way to manage all these generations. This is linked with the distinct characteristic that take place in the workplace. In your workplace is linked to the distinct characteristics they display. The next step and is actually the real first step towards the understanding of these

characteristics and acting on them would be to acknowledge and to accept that generation gaps are present and that these should be educated upon. Measuring and then quantifying employee perception is the second step in making data-backed decisions to change the perception of the work place and also the potential of all the employees.

Overall, the researcher concludes that the organizational culture is reshaping with the increase in the workforce of millennial employees is to inculcate individual attitudes and also behaviors in shouldering their work roles by expressly expressing as completely physically, completely cognitively, affectively, and emotionally.

Millennial must individually search for the meaning in the team work and to get used to the way of working, and to make certain sacrifices to blend in well with the baby boomers. Their schedules should be likewise taken into account, and they should also be flexible to work with the baby boomers respecting them. Which would be the way to get through the vision and the mission of the company. Millennial employees will go an extra mile if needed and strive for what is not the most expected, and they would try to offer something better and good. which is characterized and identified by involvement, absorption, dedication and vigor.

REFERENCES

- Aesaert, K., & Van Braak, J. (2015). Gender and socioeconomic related differences in performance based ICT competences. *Computers & Education*, 84, 8e25. <http://dx.doi.org/10.1016/j.compedu.2014.12.017>
- Aharony, N., & Bronstein, J. (2013). Academic librarians' perceptions on information literacy: The Israeli perspective. *Portal*, 14(1), 103e119. <http://dx.doi.org/10.1353/pla.2013.0040>.
- Al-Asfour, A., & Lettau, L. (2014). Strategies for leadership styles for multi-generational workforce. *Journal of Leadership, Accountability and Ethics*, 11(2), 58.
- Barbuto, JE, & Gottfredson, RK. (2016). Human capital, the Millennial's reign, and the need for servant leadership. *Journal of Leadership Studies*, 10(2), 59–63.
- Bergman, S. M., Fearington, M. E., Davenport, S. W., & Bergman, J. Z. (2011). Millennials, narcissism, and social networking: What narcissists do on social networking sites and why. *Personality and Individual Differences*, 50(5), 706–711. <https://doi.org/10.1016/j.paid.2010.12.022>. <http://www.sciencedirect.com/science/article/pii/S0191886910006215>
- Bodenhausen, C., & Curtis, C. (2016). Transformational leadership and employee involvement: Perspectives from Millennial workforce entrants. *Journal of Quality Assurance in Hospitality and Tourism*, 17(3), 371–387. <https://doi.org/10.1080/1528008X.2015.1048920>
- Bogosian, R. (2011). Engaging organizational voice: A phenomenological study of employees' lived experiences of silence in work group settings (Doctoral dissertation). Retrieved from Proquest, UMI 3489788.
- Calvani, A., Fini, A., Ranieri, M., & Picci, P. (2012). Are young generations in secondary school digitally competent? A study on Italian teenagers. *Computers & Education*, 58(2), 797e807. <http://dx.doi.org/10.1016/j.compedu.2011.11.004>
- Carnevale, A. P., & Smith, N. (2013). Workplace basics: The skills employees need and employers want. *Human Resource Development International*, 16(5), 491e501. <http://dx.doi.org/10.1080/13678868.2013.821267>
- Castillo, F. A., & Hallinger, P. (2017). Systematic review of research on Educational leadership and management in Latin America, 1991–2017. *Educational Management Administration & Leadership*, 46(2). <https://doi.org/10.1177/1741143217745882>
- Costanza, D. P., Badger, J. M., Fraser, R. L., Severt, J. B., & Gade, P. A. (2012). Generational differences in work-related attitudes: A meta-analysis. *Journal of Business and Psychology*, 27(4), 375–394. <https://doi.org/10.1007/s10869-012-9259-4>

- Deal, J.J., Altman, D.J., & Rogelberg, S.G. (2010). Millennials at work. *Journal of Business Psychology*, 25, 191-199.
- Dwyer, C. P., Hogan, M. J., & Stewart, I. (2014). An integrated critical thinking framework for the 21st century. *Thinking Skills and Creativity*, 12, 43e52. <http://dx.doi.org/10.1016/j.tsc.2013.12.004>
- Edge, K. (2014). A review of the empirical generations at work research: Implications for school leaders and future research. *School Leadership & Management*, 34(2), 136–155. <https://doi.org/10.1080/13632434.2013.869206>
- Gobert, J. D., Kim, Y. J., Sao Pedro, M. A., Kennedy, M., & Betts, C. G. (2015). Using educational data mining to assess students' skills at designing and conducting experiments within a complex systems microworld. *Thinking Skills & Creativity*, 18, 81e90. <http://dx.doi.org/10.1016/j.tsc.2015.04.008>
- Gough, D. (2007). Weight of evidence: A framework for the Appraisal of the quality and relevance of evidence. *Research Papers in Education*, 22(2), 213–228. <https://doi.org/10.1080/02671520701296189>
- Greiff, S., Wüstenberg, S., & Funke, J. (2012). Dynamic problem solving: A new assessment perspective. *Applied Psychological Measurement*, 36(3), 189e213. <http://dx.doi.org/10.1177/0146621612439620>
- Graybill, J. O. (2014). Millennials among the professional workforce in academic libraries: Their perspective on leadership. *Journal of Academic Librarianship*, 40(1), 10–15. <https://doi.org/10.1016/j.acalib.2013.09.006>
- Hall, A. (2016). Exploring the workplace communication preferences of Millennials. *Journal of Organizational Culture*, 20(1), 35–44.
- Hershatter, A. & Epstein, M. (2010). Millennials and the world of work: An organization and management perspective. *Journal of Business and Psychology*, 25(2), 211-223.
- Hershatter, A. & Epstein, M. (2010). Millennials and the world of work: An organization and management perspective. *Journal of Business and Psychology*, 25(2), 211-223.
- Hinrichsen, J., & Coombs, A. (2013). The five resources of critical digital literacy: A framework for curriculum integration. *Research in Learning Technology*, 21, 1e16. <http://dx.doi.org/10.3402/rlt.v21.21334>.
- Holt, L., & Brockett, R. G. (2012). Self direction and factors influencing technology use: Examining the relationships for the 21st century workplace. *Computers in Human Behavior*, 28(6), 2075e2082. <http://dx.doi.org/10.1016/j.chb.2012.06.011>
- Howe, N., & Strauss, W. (2000). Millennials rising the next great generation. Vintage Books. <https://doi.org/10.1108/jcm.2002.19.3.282.4>
- Howe, N., & Strauss, W. (2007). The next 20 years how customer and workforce attitudes will evolve. *Harvard Business Review*, 85, 19–20. <internal-pdf://hbr-next-20-years-4273201976/HBRNext-20-Years.pdf>.
- Jara, I., Claro, M., Hinostroza, J. E., San Martín, E., Rodríguez, P., Cabello, T., et al. (2015). Understanding factors related to Chilean students' digital skills: A mixed methods analysis. *Computers & Education*, 88, 387e398. <http://dx.doi.org/10.1016/j.compedu.2015.07.016>.
- Jorgensen, B. (2003). Baby Boomers, Generation X and Generation Y? Policy implications for defence forces in the modern era. *Foresight*, 5(4), 41–49. <https://doi.org/10.1108/14636680310494753>
- Karp, H., Sirias, D., & Arnold, K. (1999). Teams: Why Generation X marks the spot. *Journal for Quality & Participation*, 22(4), 30. <http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=2068349&site=bsi-live&scope=site>
- Kingsley, T. L., & Grabner-Hagen, M. M. (2015). Gamification: Questing to integrate content knowledge, literacy, and 21st-century learning.

Journal of Adolescent & Adult Literacy, 59(1), 51e61. <http://dx.doi.org/10.1002/jaal.426>.

- Lewis, L. & Wescott, H. (2017). Multi-generational workforce: four generations united in lean. *Journal of Business Studies Quarterly*, 8(3), 1–14.
- Lyons, ST, & Kuron, LK J. (2014). Generational differences in the workplace: A review of the evidence and directions for future research. *Journal of Organizational Behavior*, 35, 139–157.
- MacKenzie, W. I., & Scherer, R. F. (2019). Millennial research on fleek: Suggestions for improving generational research design. *Journal of Social Psychology*, 159(2), 119–124. <https://doi.org/10.1080/00224545.2019.1572967>
- Myers, K.K. & Sadaghiani, K. (2010) Millennials in the workplace: A communication perspective on Millennials' organizational relationships and performance. *Journal of Business Psychology*, 25, 225-238.
- Sessa, V. I., Kabacoff, R. I., Deal, J., & Brown, H. (2007). Generational differences in leader values and leadership behaviors. *The Psychologist-Manager Journal*, 10(1), 47–74. <https://doi.org/10.1080/10887150709336612>
- Smith, C. & Turner, S. (2015). The radical transformation of diversity and inclusion: The Millennial influence. Deloitte.

Collective Leadership Unleashed: from Concept to a Reality : A Case Study from Dankotuwa Porcelain

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ABSTRACT

Can Collective Leadership actually work in a Business Setting ? Will individuals work outside of a hierarchical setting without dismantling the structure and developing a new one ? Can a profit making organisation truly embrace the idea and notion of leadership being completely outside of the titles and designations, and institutionalise leadership teams that are fully responsible and accountable for profits ?

Till now, though Collective Leadership has been discussed conceptually, it has largely been something that looked at distributing power, sharing power and collaborating without really having full authority outside of the structures. Though the inverting of the hierarchical pyramid has been discussed as a concept, no organisation has fully implemented it, and given full autonomy for a team to directly influence decisions outside of their hierarchy or purview.

Though elements of Collective Leadership has been studied in various non business settings, there is no evidence of Collective Leadership being fully embraced in a private sector setting.

This is what makes this case study unique : and truly exciting. It is the first time where a Public Listed Company embraced Collective Leadership fully. It is even more exciting because it has unbelievable results to showcase as well, achieving the best ever financial

performance since inception after the adoption of Collective Leadership.

The contribution to both academia and practitioners become self evident. The case study opens a new vista of research from both an academic and practitioner perspective to understand how Collective Leadership can be institutionalised, and what key frameworks and elements are needed to be in place for it to work. It will also offer a starting point to investigate Collective Leadership from a practical and implementable perspective, given that there is a success story to begin with, which hitherto was unavailable.

Key words: Collective Leadership, Business Performance

1. INTRODUCTION

This research paper was born because of a bold decision by the CEO of Dankotuwa Porcelain to break the entire management team (Senior Managers and Middle Managers, from General Managers to Assistant Managers) to six cross functional teams and giving them full and total accountability of business performance for a period two months each. As far as the researcher is aware, this is the first time in the world where such a decision has been made and seen through. The results of the first quarter after institutionalising Collective Leadership the organisation posted superlative financial results, giving rise to a close study of the organisation to understand the contributions it can make to the

field of Leadership studies, as well as to enable practitioners to learn from its experience.

This research aims to identify three key factors. Firstly, it aims to understand how this transformation took place, and what factors contributed to the never before seen financial results of the organisation. Secondly, it aims to explore key themes and nuances that emerged after Collective Leadership was institutionalised. Finally, it aims to develop some concepts and frameworks that capture how Collective Leadership was institutionalised in order to assist other organisations who may want to institutionalise Collective Leadership themselves.

Leadership - did we always get it wrong ?

History has done a great disservice to the propagation of leadership thought : in that : history has always celebrated one leader who historians attribute the success (or failure) solely to. It has always been about one individuals' efforts and brilliance. From Alexander The Great to Caesar, from Genghis Khan to Nelson Mandela, from Churchill to Shaka Zulu, the narrative has been the same : ONE person, comes along, and with their Vision, sheer personality and charisma drives others towards their Vision. It is this ONE person that makes all the difference. The fascination with leaders have not abated : and often follow the same pattern : and much of the leadership literature from trait theories to behavioural theories to more recent situational and contingent theories follow a rather similar pattern - in that - it all looks at how 'a person' needs to behave/ act or do if they want to become that truly awesome leader (Uslu, 2019).

However, closer study and simple observations will be able to tell you that one person never really makes all this possible. Alexander the Great had his personal body guard that safeguarded him when he rushed into battle (Wasson, 2014). Churchill relied on brilliant Generals (Encyclopedia Britannica, n.d). Genghis Khan had a council to offer guidance and in many cases, insights to technologies and tactics that enabled his victories (Encyclopedia Britannica, 2022). It was never just one person

that made it all happen - it was always a collective. For sure - there was the 'Visionary at the top' but 'leadership' was a collective effort (Brun et al., 2019). 'Too many Chiefs not enough Indians' type misunderstanding of collective leadership has meant that many assume that one person should call all the shots, and others must simply comply and follow (Brun et al., 2019).

The dynamic interplay between leading and following is often lost in the study of leadership. The appreciation that leadership is a role and a responsibility and not a title is often talked about but almost never practically applied as a framework within an organisational setting (Alsaedi, 2022). For all intentions and purposes, organisational hierarchies dictate who are leaders and who are not - and it is almost always pegged to the title you have (Wilson, 2013). Though management and leadership are discussed as two different concepts for academic purposes, practically, ultimately it is the manager who is expected to have leadership as well (Azad et al., 2017). Being a leader outside of the hierarchical constraint is virtually impossible - and there is no real framework developed to be able to facilitate the situational leadership model in an organisational setting. Even if situational leaders do arise, it is in a very limited sense, and almost never around core business outcomes. Emerging Leaders are often given opportunities to hone leadership skills and competencies only by being part of small projects and initiatives, and even when this happens, it is almost always within the confines of the hierarchy (Bajaba et al., 2021).

Collective and Distributed Leadership : Utopian concepts doomed to be impractical ?

Though the concepts of Collective Leadership and Distributed Leadership has been around for some time, there are no real case studies to look at these as viable models for business settings.

Most examples are from outlier organisations rather than mainstream business settings. As such, even though the 'type' of leader that is needed has been hotly debated, the fundamental paradigm that 'leadership is about a person' has not changed (Khan, Nawas, Khan, 2016). Collective Leadership is based on the principle that leadership is an activity that more than one

person needs to be involved in (Raelin, 2018). Often though this is limited to a certain tier within the organisation. Distributed Leadership takes the premise that leadership needs to be cutting across the hierarchy and that each level needs to contribute towards the leadership activity (Harris, 2008). Together, collective and distributed leadership argues that we need to have leaders across the organisation and that it needs to be something that happens fluidly and interchangeably (Goksoy, 2016). Each situation, context and circumstance gives an opportunity for a leader to step in and contribute : provided that the culture supports it (Goksoy, 2016). Often times, this is likened to a soccer or rugby team playing on the field. Who takes charge is depended on the circumstance. Hierarchy still exists : but it is contextual. Everyone contributes towards leadership. The Captain or the Vice Captain is not the only ones who take leadership - everyone does.

Can this actually work in mainstream business and organisational settings? Can you actually get junior members within an organisation to take the helm - and become equal and active participants in the process of leadership? Can leadership be truly collective - and truly distributed? Without the traditional hierarchy weighing in and taking control will organisations be able to really drive towards a common objective? Will collective leadership lead to chaos without any real responsibility being vested on a specific person ? These are all legitimate fears, and certainly, legitimate concerns. These concerns have all resulted in just one thing : leadership has never quite moved from the individual to the collective domain. Till now.

The disasters that befall when there is too much power on one person is evident to see in the many examples across the globe of failed nations. Leaders across the globe who have abused their authority and power simply because it is centralised needs no introduction. The catastrophic failure in Sri Lanka is one of the most topical examples (Perera, 2022) : but it is in Sri Lanka itself that we can find the antidote - in the form of collective leadership actually working.

2. METHODOLOGY

Before deciding on the methodology, the author undertook a literature review that looked at over 3000 article titles, over 1000 abstracts and over 300 skimming of peer reviewed articles on Collective Leadership, Distributed Leadership and Shared Leadership in order to look at possible frameworks and previous studies done. Even though the author found many studies done in Health Services, Education, the Military as well as Government and Non Governmental Settings, the author couldn't find a single peer reviewed article of a case study that identified Collective Leadership being rolled out in a Public Limited Company (PLC).

Since the author could not find a theory, framework or concept that directly resembled the practices that Dankotuwa had adopted it was decided to take on a more Inductive approach to the study (Thimas, 2006). In many ways, this was a dive into the unknown. The research involved being inside the organisation over a period of time and through observations as well as other qualitative research methodologies aimed to understand the inner workings of how the Collective Leadership phenomena took place : and how it enabled the radically improved performance in an extremely short period of time. The researcher aimed to sense make based on the findings, and develop frameworks that will enable practitioners adopt Collective Leadership as a viable alternative to the traditional hierarchy.

From a research strategy perspective, this paper is based on a series of qualitative researches conducted over a 18 month period (and is still ongoing). This longitudinal approach to the Dankotuwa Case Study was undertaken for two main reasons. Firstly, initial financial success (within the first quarter) was deemed inadequate to pin any serious conclusions on whether it was Collective Leadership that was the key determinant of financial success (Calman, Brunton & Molassiotis, 2013). Secondly, given that the core aim was to look at concepts and frameworks around Collective Leadership, understanding how they evolved and matured

within the organisation would offer the researcher a more in-depth perspective along with the ability to refine the frameworks as they matured. Given that the aim was to explore, understand and conceptualise, the qualitative focus was required and necessary. For this initial work, no quantitative research elements were incorporated. However, given that this is an ongoing piece of research, as the second phase, quantitative studies regarding demonstrated behaviour of leader, follower and intersections as well as linking behavior to performance by each group and extrapolating significant correlations are considered (Sheard, 2018).

During the 18 month period, the author had a series of unstructured conversations and Sri structured interviews with the CEO, focusing on his perspectives to why he adopted a Collective Leadership approach to the business, as well as the considerations factored when making this rather unique decision. The first 3 conversations were semi structured aimed at exploring the CEOs key assumptions as well as key challenges (McIntosh & Morse, 2015)). The next 2 were more exploratory where the author and the CEO brainstormed in order to sense make the behaviors within the team, and the runaway success the business has had upon implementing Collective Leadership principles, structures and frameworks. The final discussion was around future proofing the experiment (as the CEO calls it) and structures and frameworks required to ensure sustaining the momentum and performance whilst maintaining the Collective Leadership principals.

During the same 18 months the author was invited to observe 4 of the strategy planning forums the organisation had, one of which he was invited to present insights around current concepts and frameworks with regards to Collective Leadership, Distributed Leadership and Leaderless Organisations based on the book *The Spider and the Starfish*. During these 4 observations there were informal discussions with almost all members of the Collective Leadership Team as well as some semi structured interviews with key Senior Managers to understand their perspectives and possible

anxieties regarding their position, their power being challenged and also, possible fears around failing in this new method of working. These were used to identify fail safes and change imperatives in model building.

During the same period the author was also privy to 3 celebrations, 4 monthly team meetings and brainstorming sessions held within the organisations which offered invaluable inputs in observing the behaviors and the levels of autonomy that was provided for them. These observations were used to look at framing outlines for structures, guidelines for behavior as well as the identification of core competencies that were deemed useful to propagate the Collective Leadership framework already in place.

This Longitudinal Case Study has features of both an extreme or unique case as well as being a revelatory case (Burt, Lundgren & Schroetter, 2017) : given that this is possibly the first time in the world where a Public Quoted Company gave a collective group of people, allowing them to go outside the hierarchical structure, the full control and decisions over the P&L of the organisation. As such, studying multiple facets and angles was critical to understand how they went about it, and also, what emerges out of it that can be made use of to develop tools, concepts and guidelines for other organisations to replicate it in their own organisational settings.

3. SUMMARY OF THE STUDY

Table 1: Intervention, participants and focus areas

Type of intervention	Participants involved	Occasions and direct time spent	Key Focus Areas
Interviews	CEO	6 discussions (totalling 7 hours)	<ul style="list-style-type: none"> - Reasons for experimenting with Collective Leadership - Key challenges faced and how they were overcome - Perspectives on why it worked
	Collective Leadership Teams	1 discussion with all 6 core teams of averaging 40 minutes each. 2 follow up meetings with 3 of the 6 groups totalling approximately 30 minutes each	<ul style="list-style-type: none"> - Feelings about the 'experiment' - Key fears - How fears were overcome - Lessons learnt - Key changes in paradigm about leadership and results
Brainstorming	CEO + Collective Leadership Team	2 forums. 1 six hour brainstorming on future plans. 1 three hour insights sharing on trends and frameworks in Collective Leadership, Distributed Leadership and Leaderless organisations	<ul style="list-style-type: none"> - Linking Collective Leadership Frameworks to Structure, Strategy and Performance - Aligning the second and third tiers to the Collective Leadership Framework - Core concepts on Distributed Leadership and Leaderless Organisations, and how to incorporate them into future initiatives
Observations	Collective Leadership Teams	4 occasions amounting to approximately 6 hours. Observed problem solving, idea generation and meetings.	<ul style="list-style-type: none"> - How problems were solved - How new ideas were discussed - How conflicts happened and how they were resolved - Understand key challenges being faced - Understand the behaviors at play and derive possible competencies for propagation

A quick introduction to Dankotuwa Porcelain : and the radical experiment in Collective Leadership

Dankotuwa Porcelain is a 30+ year old organisation, and a household brand (Ambeon, 2022). For nearly a decade the business has not achieved profits, and for over half a decade they had not shared a bonus nor offer any increments for its employees. It has also changed hands a few times (Dankotuwa, 2022). A public quoted company, the organisation is not even considered a stock worth trading by many in the stock broking industry. Channa Gunawardena was brought in as CEO about two years ago, and no one really expected much from him. Then came the first quarter results, which showed some glimmer of hope. By the second quarter it was clear that he was onto something. By the third quarter it was clear the company was having a major turn around (Dankotuwa Porcelain PLC, 2022). By the fourth quarter there was no mistaking that whatever he was doing was radically altering the organisation's fortunes (Dankotuwa Porcelain PLC, 2022). The business posted it's highest profits in the history of the organisation in 2021 - and this, in a year with lock downs due to Covid and worsening macro economic conditions (Dankotuwa, 2022). All this was also without restructuring or bringing in an entirely new senior management team. Channa managed to turn around the business with pretty much exactly the same team he inherited when he took over the business.

Dankotuwa Porcelain's runaway success continues. This year, they have achieved the top line and bottomline numbers for nearly 6 months in just 3-4 months. If trajectories are anything to go by, they will post the best profits in the history of the organisation once again, bettering their huge success last year. In the month of August, they were able to achieve top line which was equal to almost that of the 2022 financial year. The organisations' success is a shining example of a radical experiment Channa gambled with. Even though he never called it 'Collective Leadership' it is exactly what it was. The author was involved from the first quarter of 2022 onwards, and was called in to take a look at how

he could support the CEO sustain the success of the first quarter, and ensure a different leadership/team model was developed.

Channa broke the company's Senior Management into 6 groups. Each group was cross functional by design. He purposefully put those who didn't necessarily work together well enough to be on the same team. He then brought all members together and collectively discussed the way forward, and designed a strategy plan that they will take ownership for. He went into the nuts and bolts of the strategy too - with clear financials and key milestones. Then, much to the absolute incredulity of all gathered, he told them that each team was responsible for overall business performance for 2 months. Each group will support the other to achieve the overall business results : but were responsible as a small group for the 2 months they were assigned. The bonus was agreed before the year started out. It was a simple formula. No one (including him) got a bonus if the overall result was not achieved. However, each individual group only got their bonus if they achieved their allotted 2 months' targets. The groups were given complete and total control of what they did - or did not do. They could do absolutely anything within those two months to achieve the targets set. They were not controlled by anyone. The bonus criteria was later changed : ensuring the entire Senior Team was equally rewarded : which was decided after a conversation and reaching consensus from the entire team.

Each team was told to support each other. Channa as the CEO will only intervene if they could not solve something by themselves. He told them that he will not intervene for personal conflicts or inter group rivalries : and simply told them that no one will benefit if they don't perform. Without too much structure or formality, simply believing that people can work together if they had enough of a compelling reason to, he left them to it. Each group not only worked with each other - but they also shared their learnings with the other teams. Some teams did better than the others - but no one really cared. They were invested in making sure the overall objective was met. When the year ended,

they all told Channa to ensure that everyone was rewarded equally - and that they unanimously agreed that nothing else mattered as long as the numbers were met. This is what Channa therefore did - he paid the same bonus to the entire team who steered the organisation through.

Emboldened by the success, Channa brought in the second tier into the mix. He made 5 teams this time, with Seniors and Middle Managers together. He left the final 2 months open - for a team of 'juniors' to be brought in to manage the business for those 2 months. The team was to be selected by the 5 other teams, by nominating who they felt were at the more junior levels who could contribute positively. This time, Channa brought in a little more structure, and asked for plans from each team before they implemented them. Each team submitted plans, which were peer reviewed and agreed to collectively. Channa's role was to critique each of them before giving a final nod. Once again, each team passed the baton on to the other, and shared key learning. They also made a celebration out of this hand over - ensuring they felicitated the outgoing team and the one taking over in a small mock ceremony. The team is already discussing brining in a factory level team to run a 2 month stint in 2023, and inverting the proverbial pyramid by 2025 where those who are actually at the bottom end of the hierarchical pyramid are rotationally given the opportunity to literally run the business and for the Seniors to simply act as guides and mentors.

4. FINDINGS AND THEMATICS

There were many findings and thematics that emerged from the study, and what is presented in this paper is what the author considered of most significance to leadership practitioners and academics who are looking at the possibility of the viability of Collective Leadership in business settings.

Structure and Related Aspects

The first key finding is that the traditional hierarchy was not an impediment to the introduction of Collective Leadership within the organisation. Though traditionally it is believed

that the structure was the key issue, at Dankotuwa the formal structure was almost irrelevant.

The superimposed leadership structure was the over riding factor, but the traditional hierarchy still existed for all administrative and control aspects. What was interesting to note was the coexistence of the traditional hierarchy side by side of the newly emerged leadership hierarchy. This was a novel insight as the usual challenges and problems of matrix structures did not exist here. No one had to report to anyone apart from their functional manager for anything including every day work. However, the team that was in charge of running the business for the allotted two months were given the autonomy and the authority to instruct, demand or challenge any functional manager if results were not in line with the targets, and to execute strategy already agreed to.

The reason as to why this overlapping structure was not a problem for the smooth functioning of the business was revealed in some of the discussions with the groups. Three key reasons is worthy of highlighting as these three reasons were given by all those who interviewed, though the exact words were not used by all. Firstly, it was clear that each group got an equal opportunity to lead : and therefore they understood very clearly the interdependency they had. Secondly, they all understood that unless the overall business result was achieved no one benefitted. Thirdly, given that all teams were cross functional, they understood the impacts of their decisions before they took them. Each team had a voice from the function which enabled decision making after careful consideration. One manager summed up their approach to the structure best "We didn't care about the structure : all we cared about was the results"

Another interesting observation was that the rest of the organisation almost automatically embraced this as the 'new normal' (Dankotuwa started the Collective Leadership approach during the Covid period after the second lockdowns were finished. The word 'New Normal' was being floated around a lot those

days, and they latched on to it to explain their own company's transition). Meetings were held, operations were run and decisions were made at the lower levels of the organisation without any change what so ever. In fact, no one even made an official announcement about the 'collective leadership team' until almost a year into the experiment.

However, what did happen was because the rest of the organisation observed that their senior managers and managers were working very differently, and the silo mentality was rooted out at the top, the teams almost instinctively aligned themselves to this new ethos. This enabled the entire organisation to focus on results : and not their functions or teams. They identified with the overall organisation and not their own unit. So, even though the hierarchy did not change, how the hierarchy functioned changed dramatically.

KPIs and Performance Related aspects

Traditionally, once the overall business objectives were set, each department looked at their own KPIs. However, in the new scheme of things, the departmental objectives and KPIs were made null and void. Departments did have KPIs but they were largely administrative in nature.

Everything was focused on overall business objectives and many departmental KPIs were redone to help the overall objectives.

No department was rewarded for meeting their own KPIs. All rewards and recognition was aligned to and focused on overall business performance. At each of the monthly reviews the CEO presided over, no departmental KPIs were mentioned nor reviewed. Each Collective Leadership Team presented the business results, and gave plans to improve performance where it was found lacking. Everyone contributed towards the finding of solutions to key problems, and domain specialists weighed in as subject matter experts.

An interesting theme that emerged was the collective ownership of KPIs and targets. Rather

than getting into a silo mentality, the teams seemed extremely open to suggestions and ideas. It was also interesting to observe that many seniors (based on tenure) listened to juniors, and did not over rule them. A good example of this was a young executive who had a set of rather radical ideas about increasing sales. The sales manager gave him the opportunity to try out his ideas, which resulted in a huge upsurge in sales in non traditional markets. The same phenomena was seen with regards to improving international sales. The often cliché statement that structure begets behavior was absolutely apt with regards to Dankotuwa.

Leading and Following: the dynamic interplay

Possibly the most interesting perspectives to the author was on the dynamic interplay between leading and following that was possible to be observed at Dankotuwa. Given that each team had to lead for two months, and the support and 'follow' the other teams for ten months meant that both leading and following had to be done by design. This meant that everyone had to support each other, lest they will not be supported in return. Given that the rewards were pegged to overall business performance, there was a direct incentive to ensure personal egos and rivalries were kept aside and the larger objective focused on.

Even within the individual teams, there was the same dynamics at play. Each team had a mix of seniors (by designation and tenure) and juniors. Even though it is common in cultures such as in Sri Lanka for the seniors to take charge and often hijack decision making in traditional team settings, it was quite the opposite at Dankotuwa : which was specially interesting given that Dankotuwa was very much a traditional dinosaur of an organisation. What the author observed was the 'storming and norming' stages of team development happened together and quite fast.

There were many heated conversations and debates early on, but it very soon fizzled out into much more collaborative conversations.

Today, it is common to see that leadership is very much a role individuals play whenever needed, and others instinctively follow. Leadership has stopped being pegged to hierarchy, and also, considered a permanent position or title. Leaders emerge whenever required, and it is also common to see two or three leaders taking on more complex initiatives together, rather than appointing a leader. There were times the author observed that leaders transitioned seamlessly even within initiatives at different stages. It was also common for those who volunteer for leadership roles stepping back and allowing someone else to take over when they feel they are not the best to contribute. During one of the interviews a Senior Manager offered this gem of a statement that encapsulates what the author observed:

“Leading and following became one. It was almost impossible to discern between the two. If you asked me whether I was leading or whether I was following, I will tell you I was doing both: at different times : and sometimes together also. It is difficult to explain: but I think what is happening is that we no longer look at it as leading or following : but rather how best we can contribute”

Trust and Collaboration

Another major focus for the author was how trust was built, propagated and augmented to enable the level of collaboration that was required to make this extreme example of Collective

Leadership work. Something that was clear from the outset was the almost absolute sense we look at trust under normal circumstances were not quite as straightforward inside the teams. There was also degrees of trust between individuals and groups. There were also many informal cliques. Even though traditional wisdom would dictate that trust must precede performance, the authors’ experience at Dankotuwa Porcelain was the polar opposite. This sentiment was shared by many the author spoke to :

“I didn’t trust many of the team I was in. We had been working for a long time : and I knew what

they were like, professionally and personally. However, when we started getting results, and hitting the numbers, something changed. We realised that many of the perceptions we held about each other wasn’t necessarily true. We realised we had a good team. Then trust started happening”

“I still don’t like many team members I work with them. However, I have seen for myself what happens when you trust others and work towards the same objective. I would have never said this a few months back: but even though I don’t still like them: I do trust them”

“I never thought this team could work together, leave alone lead together. Channa gave us no choice. We were in it - there was no going back. Then, we hit our first term numbers. That was the turning point. No one expected that level of performance: I think not even Channa. Trust happened after that.”

Collaboration happened by default because of the nature of the teams that were set up. Each team was consistent of most of the key departments, and as such had within them, access to and expertise in key functions and processes. Many considered this “forced” collaboration one of the biggest reasons for developing trust, and, superlative performance.

Rewards, Recognition and related aspects

Something that there was almost unanimously agreement on was aligning all financial rewards organisational performance and being collectively held responsible for it. Many spoke about how bonuses and increments were anyway pegged to performance: and therefore many believed they will not get any bonuses or increments for that year too. However, when they did perform, and a overly generous bonus was shared as promised, the whole organisation completely aligned towards the business and its results.

However, initially Channa had told the teams they will be rewarded proportionately based on each team's performance (provided overall business results were achieved.). However, almost seven months into the year, the Senior Management Team spoke to Channa and said they had agreed amongst themselves that they should be rewarded equally: and Channa accepted this.

This was a turning point in Channa's mind.

"The Senior Management Team was very fragmented. They almost never agreed on something. There was a lot of infighting. When they came to me collectively and told me that they wanted to be rewarded equally, I knew we will be successful. To me, that was huge."

There was a lot of recognition schemes that were all aligned towards performance and results. There was no real framework or policy for some of the celebrations: they were spontaneous by design and thought : it wasn't a chance per se.

"I honestly didn't know what we were getting into. I wasn't sure any of this will work in the first place. All I knew was that we had to reward people who were really making the effort, making the sacrifices, and bringing in the results. So, we organised events whenever we wanted to celebrate things : but made sure it wasn't regular events or predictable rewards. I didn't people to work only for the money : or for the reward. I didn't want to set that precedent."

However, something that became absolutely apparent was that everyone realised that they will be rewarded and recognised if they did their part and results were seen : and this created a surge of activity as well as proactive efforts rather than the reactive approach they took before. Many believed that the recognition was possibly more valued and appreciated than the financial rewards itself. One of the Assistant Managers encapsulated the sentiment quite succinctly when she said :

"We expected a bonus. We expected a salary. What we didn't expect was honest recognition for our efforts from our CEO and Senior Management. I think we changed our culture when we started truly appreciating individuals and teams"

Grooming Leaders at all levels

Another key thematic that emerged was the building of leaders across the organisation.

Rather than taking the traditional approach of conducting leadership development programs with the aim of increasing the leadership bench strength Channa's approach was that of learning by doing. Channa institutionalised a 'lessons learnt' forum where each of the teams that were in charge of the two months conducting a debrief in front of all other teams. In this forum the team that was completing their two months as leaders discussed their key achievements and also shared their failures. They presented what they learnt from their experience and offered insights about what they believe they could have done better. This enabled everyone to learn from both successes and failures.

Similarly, when the teams were operating, they encouraged those outside of the team to volunteer and come to the fore. Even factory floor employees who were traditionally only looked upon as operators who followed orders got involved in idea generation and also, importantly, idea execution. Many who were never seen as 'leaders' were coming into the fore : and many who were never offered an opportunity to lead took the opportunity offered and showcased their knowledge, skills and competencies, creating a strong impetus for others to follow in the same footsteps. 18 months on, there is a general sentiment that if you wanted an opportunity, the organisation was willing to give it.

“We never volunteered to lead anything” one Executive told the author. “We came to work, did our work, and went home. We didn’t expect to do anything more. Our promotions were mostly based on our tenure : and we always thought of leadership as a hierarchical thing.

However, after Channa came in, and we saw the freedom that we were getting, and how differently the business was run, many of us got excited to give our ideas and inputs. We had a lot of ideas, but we never bothered to share it. When I saw one of my friends give an idea and given the opportunity to execute that idea, I also decided to give it a go. Most of us now are actively engaged in doing improvements wherever we can”

The organisation invested in some formal training initiatives as well. Several professionals from different fields came into offer insights, including the author. These knowledge sharing forums always ended with the teams documenting one or two ideas they thought they could implement based on the talk/forum/workshop. This bias for action was instrumental in ensuring knowledge was made use of practically.

Managing Change and Related Aspects

Managing Change was one of the only thematic that saw a lot of conflicting view points coming in. There were two main opinions that came through. One group felt that the change happened because it was forced at the beginning. Though everyone agreed that there were no threats made or restructuring used as a scare tactic, most felt that Channa took a very strong and decisive stance, and that there was “no democracy” in creating the new collective structures.

One Senior Manager told the author :

“We were called in and Channa explained what he had in mind. He never quite asked us for our opinions about the matter. I think he knew if he asked us we would never quite think it was a good idea. So, rather than discuss with us, he told us exactly how it will be in the future. He broke us into 6 teams - and told us that each team was in charge of 2 months. He also told us that the team could make all the decisions they wanted : provided it was in line with he strategy.”

Even though no one differed in their thinking about what happened, how it was perceived was different in the others. Though everyone agreed that Channa never sought “permission” to do his experiment on Collective Leadership, some told the author that the process by which it was implemented and change came through was very much consultative apart from the decision to split the senior and middle management into cross functional teams.

“The strategy was developed together. Channa facilitated these sessions. But we all chipped in. Some were of course silent. Some I think were too much in a shock. But to be fair by Channa, he did ask for opinions and views : if people don’t give it chat can Channa do ?”

The classic Force Field Analysis at play could be observed within Dankotuwa in the early stages. There was definitely a camp that was for change : which was initially only a handful. However, the detractors and nay sayers were won over by what many believed the success that came through during the first quarter. The ‘quick wins’ that Kotter spoke of in the 8 step model of change was seen quite distinctively here. Once again, even though not planned this way, it was also apparent that as the ‘style’ was changed, the systems, the skills of the management teams, the structures as well as the corresponding shared values also changed in what becomes reflective of a McKinsey 7 S model at play.

Engagement, Motivation and Job Satisfaction related aspects

There were very differing sentiments shared about the level of engagement, motivation and satisfaction the teams felt initially. However, this became much more congruent over the 18 months. Initially, many were extremely uncomfortable with the change, and also, skeptical about results. There was also genuine fear of failure : and the repercussions thereof. Many felt that this was simply a ruse to do downsizing or restructuring.

However, about a year in, most if not all shifted their perspective. They all agreed that the CEO was not brought in with the aim of conducting a witch hunt. There was enough trust about the sincerity of purpose. There was also a confidence that was built amongst themselves that any target before them can be accomplished. No one saw targets as the enemy : they saw targets as a challenge to be overcome. The emotions of change, in line with the Kubler Ross Model was seen, and many overcame the grief curve though the pace at which each person went through it varied significantly. However, once the majority were over the curve and came into the acceptance phase, engagement too was correspondingly more, and motivation became more intrinsic.

What was clear to observe was that there was a definitive relationship between how change is viewed and engagement, motivation and job satisfaction. Those who viewed the change as good and became change agents had a much more positive outlook. Those who viewed change negatively were more disengaged and dissatisfied.

However, rather than having to motivate or engage through different means in a top down manner, at Dankotuwa the author observed a different dynamic. In each team there were the agents of change and the detractors. However, both parties understood that unless results were brought in, they will all suffer the consequences. Early on, there was a heavy skewness of the

workloads each carried. A few were absolutely disgruntled with the shameless shirking of responsibilities early on.

“Some of us had to do all the work. Some simply became passengers and observers rather than contributors. It was really frustrating at first”

However, this evened out later on, and almost everyone started contributing and carrying their load. They also understood that the contributions people make can differ from time to time, and also, from context to context. Rather than being judgemental, many shifted towards being supportive and tolerant. The same person who gave the comment above told the author the following about 7 months afterwards:

“Many of those who were simply passengers at times did more work than me. They really got involved. I saw parts to them I never thought possible. Some actually went above and beyond.

Some are still slow and are resisting : but I thought to myself that’s ok. We are all in this together. So, now, I help them...”

Conceptualizing Emerging Frameworks

The Dankotuwa ‘experiment’ gives us some wonderful insights on how to institutionalise collective leadership within a traditional hierarchical setting.

Firstly, it is important for the Board and the CEO to believe in the collective leadership and distributed leadership ethos. Remember - Channa had no idea of what collective leadership actually was : all he knew was that if the organisation was to truly turn around he needed the support and buy in from everyone. He also truly believed that people have potential and that unleashing this means believing in them and giving them an opportunity to shine, and as importantly, be masters of their own destinies. So, as much as having the traditional hierarchy, the leadership pyramid needs to be essentially inverted.

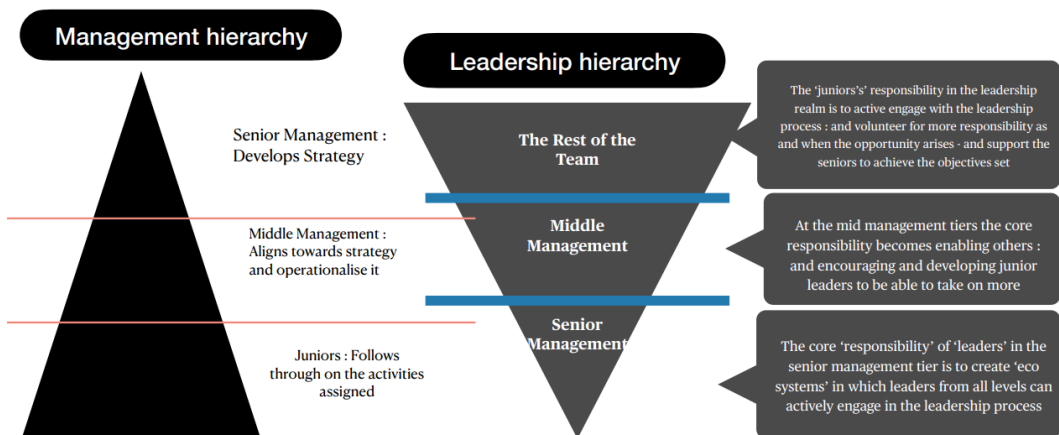


Figure 1. The inverting of the Hierarchical Pyramid to give way to a 'Leadership Inverted Pyramid' as

Secondly, it is important to create an eco system for the Collective Leadership ethos to work. Simply creating teams will not do. You need to facilitate the leadership process by ensuring the groups actually work with each other. This eco system is something that goes beyond culture per se : as culture, initially at least, may actually work against this, given that it is something alien and different to what is set as a paradigm within the organisation. What was observed is the creation of an eco system that enables leaders to grow within it, and creating spaces for leading and following to both take place without the cumbrances of the traditional hierarchy. As was discussed earlier paragraphs, the hierarchy still remained : but activity was centred around leadership. And leadership was very much a collective exercise outside the rigidity of a title or a job description. Enabling this behavior was the primary function of the eco system.

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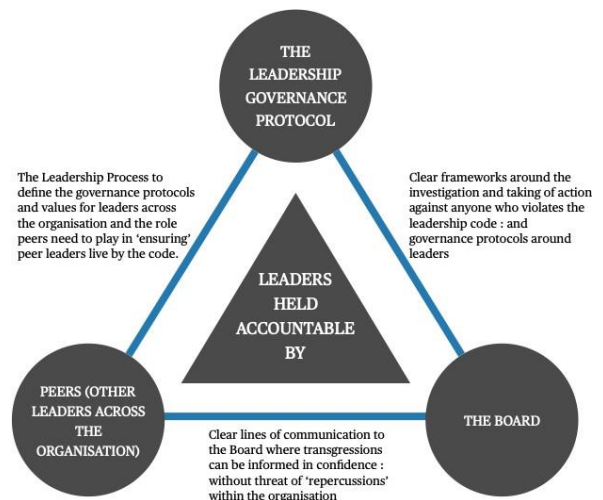


Figure 2. The Leadership Eco System : as observed within Dankotuwa Porcelain

Notice that at Dankotuwa the structure was supported fully by the CEO and the Board. The opportunity to lead and take any decision was sanctioned and given legitimacy. The bonus, increment and related reward and recognition policy frameworks were all aligned and aligned to support the collective leadership ethos. Finally, through sharing lessons learnt and hands on peer learning there was a development of leadership skills and competencies across all groups. All of these elements coming together created an eco system for the collective leadership and leadership ethos and paradigm to take root, and not be hijacked by the traditional hierarchy.

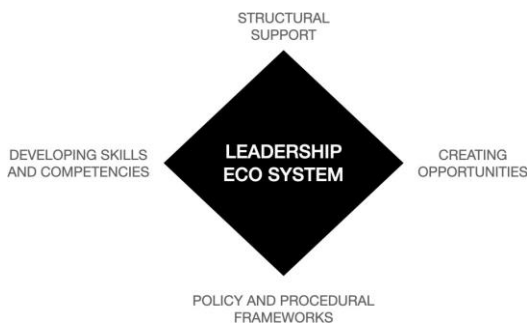


Figure 3. How Leaders are held accountable within Dankotuwa Porcelain

Thirdly, there was a multi layered accountability framework being put in place. There was a small 'agreement' that Channa got everyone to sign on - where everyone understood that they were collectively responsible for the success of the business. There was also a discussion on what they must do to support each other - and this was agreed to as much as the 'numbers.'

Note that peers held other peers accountable and responsible. It was not a hierarchical framework - each group was responsible for 2 months of performance - but they were also responsible for others when they are not in charge. So, each group not only led but also followed. Finally, note that the Board never interfered - and allowed the collective frameworks put in place to work itself out. Not all teams performed the same - but the collective ensured the

collective objective was met. More importantly, they were directly running the business - all aspects of it - and collectively supporting each other. They were not in silos working for a department of a section - each head of department and middle manager was working for business results - not for departmental KPIs. In fact, there are no departmental KPIs at Dankotuwa.

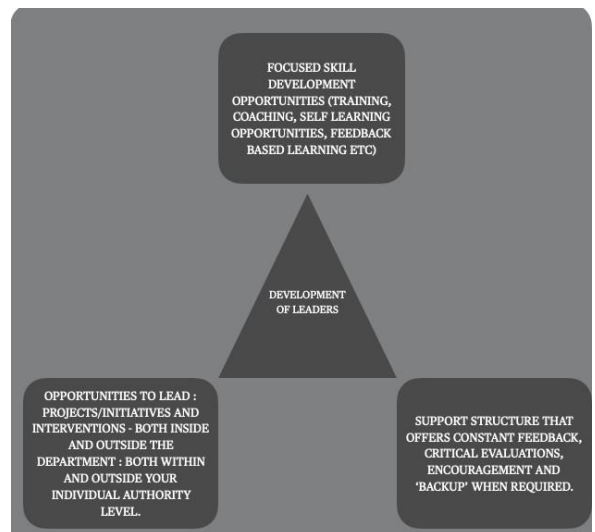


Figure 4. Leadership Development, governed by a Leadership Process within a culture of Collective Leadership

Finally, though not designed as what is neatly presented by the author, there was a definitive focus on developing leaders within the business. Rather than looking development as a 'training' intervention, Dankotuwa took a more holistic and all encompassing approach to developing leaders across the organisation. There was a lot of focus on mentoring, coaching and knowledge sharing, all done internally. Infact for the duration of nearly 15 months there was no external training program on any form of leadership or soft skill development. They taught each other - ensuring they augmented each others skills and competencies. There was a definitive support structure for anyone and everyone to contribute. Infact, each group gave

the charge of certain initiatives to many junior members - encouraging them to boldly take charge - as they were doing. There was also many opportunities created to lead - at different levels and tiers. Some factory level staff lead quality circles.

Some junior executives led marketing initiatives. Some employees who were not part of finance led cost initiatives and some who were not manufacturing based led productivity initiatives. Hierarchy didn't matter - if you were keen, interested and willing to lead, you were always given an opportunity.

5. LIMITATIONS, CONCLUSIONS AND FURTHER RESEARCH CONSIDERATIONS

Dankotuwa Porcelain offers a wonderfully delightful opportunity to understand how Collective Leadership can and will work in the most traditional hierarchical business settings. Without too much fanfare nor any major restructuring, a simple shift in focus from individual departmental and management focus to a more collective leadership focus, an entire organisation transformed. What is also important to note is that it also busts the myth that leadership is not for everyone - and that leaders need to be taught how to lead. Dankotuwa demonstrates the very real opportunity for all organisations have to gain superlative results by shifting focus from developing individual leaders to focusing on taking a collective approach to leadership. It also demonstrates that individuals instinctively know how to organise themselves around complex structures and shift and change when required. Rather than overcomplicated structures, a simple focus on what needs to be achieved rather than how it needs to be achieved seems to have resulted in an amazing display of both performance and engagement.

Dankotuwa shows us that the problem was never with the people per se : but the eco systems we create and propagate. It is a great example of how people can and will change almost instinctively when the eco systems shift. As such, looking at leadership as an 'activity' that the entire organisation can and should get involved in

becomes not only a viable option but a desirable one.

The 2022/2023 will be able to ascertain whether the Royal Porcelain experiment is sustainable and scalable. With the organisation expanding, and working towards aggressive and extremely ambitious targets, in a macro economic environment that is hugely adverse (given Sri Lanka's financial crisis and resulting challenges) the results will be able to demonstrate whether the 'Collective Leadership' approach will either strengthen or fall apart. If it strengthens, and the business delivers on the financial results projected, this becomes possibly one of the most illustrious case examples of Collective Leadership anywhere in the world.

Given the significance of the financial success, and the ability to see a direct relationship with Collective Leadership and business performance, a much more detailed, structured and in-depth study needs to be undertaken to not only understand the key levers and nuances at play, but also, develop models and frameworks that would offer invaluable insights to organisations who are considering Collective Leadership as a viable alternative to the traditional hierarchy but does not have a path to follow on. Research will need to include much more structured interviews, more detailed and ongoing observations, as well as complex modelling of behavior and its linkage to performance as well as factoring or taking out other variables at play such as market anomalies or other macro environmental determinants. It is important to see this study for what it is. It is a one of a kind, and there may well be distinctive reasons for it working within the organisation. No real focus was put into understanding conditions that led to it, nuances with regards to the CEO and the Leadership Team or the unique circumstances surrounding the organisation. As such, if Collective Leadership is to be a mainstream possibility, the research will need to understand if Dankotuwa Porcelain is a 'unique anomaly' or not : which will play a big role in either enabling Collective Leadership to be taken seriously or it once again moving into obscurity.

Dankotuwa Porcelain will become a wonderful opportunity for academics and practitioners alike to study not only the surface level frameworks but the more deeper level eco systems that are being put in place, with the view of being able to replicate this, and hopefully, make Collective Leadership something that can finally be mainstreamed as an alternative to the 'GREAT MAN/WOMAN' leadership approach that has taken root for so long.

REFERENCES

- Alsaedi, F. (2022). The Important Role of Collective Leadership in the Face of Change: Literature Review. *Open Journal of Leadership*, 11(1). 10.4236/ojl.2022.111001. Ambeon Holdings PLC. (2022). Dankotuwa. <https://ambeonholdings.com/our-purpose/>.
- Azad N, Anderson HG Jr, Brooks A, Garza O, O'Neil C, Stutz MM, Sobotka JL. (2017). Leadership and Management Are One and the Same. *American Journal of Pharmaceutical Education*, 1(6). 10.5688/ajpe816102. PMID: 28970603; PMCID: PMC5607712.
- Bajaba, A., Bajaba, S., Basahal, A. & Basahel, S. (2021). Adaptive Managers as Emerging Leaders During the COVID-19 Crisis. *Frontiers in Psychology*. <https://www.frontiersin.org/articles/10.3389/fpsyg.2021.661628/full>.
- Burt, A., Lundgren, K. & Schaletter, J. (2017). Learning From Within: A Longitudinal Case Study of An Education Research Group. *Studies in graduate and Postdoctoral Education*, 8(2)128-143. DOI:10.1108/SGPE-D-17-00002
- Calman L, Brunton L, Molassiotis A. (2013). Developing Longitudinal Qualitative Designs: Lessons Learned and Recommendations For Health Services Research. *BMC Medical Research Methodology*, 6. doi: 10.1186/1471-2288-13-14.
- Dankotuwa. (2019). Dankotuwa porcelain annual report. Available from https://cdn.cse.lk/cmt/upload_report_file/669_1604889827801.pdf.
- Dankotuwa. (2021). Dankotuwa porcelain annual report. Available from https://cdn.cse.lk/cmt/upload_report_file/669_1630553848794.pdf.
- Dankotuwa. (2022). Dankotuwa. Available from <https://www.dankotuwa.com/#main/Plating>.
- De Brun A, Rogers L, O'Shea M, McAuliffe E. (2019). Understanding the impact of a collective leadership intervention on team working and safety culture in healthcare teams: a realist evaluation protocol. *HRB Open Res*, 2(5).
- Encyclopaedia Britannica. (N.d). <https://www.britannica.com/biography/Winston-Churchill/Leadership-during-World-War-II>.
- Goksoy, S. (2016). Analysis of the relationship between shared leadership and distributed leadership. *Eurasian Journal of Educational Research*, 65, 295-312. <http://dx.doi.org/10.14689/ejer.2016.65.17>.
- Harris, A. (2008). Distributed leadership through the looking glass. *Journal of Educational Administration*, 46(2). 10.1108/jea.2008.07446baa.001.
- Khan, A.Z., Nawaz, A. & Khan, U.I. (2016). Leadership Theories and Styles: A Literature Review. *Study of Organizational Behaviour in Pakistan*. https://www.researchgate.net/publication/293885908_Leadership_Theories_and_Styles_A_Literature_Review.
- McIntosh, M.J. & Morse, J. M. (2015). Situating and Constructing Diversity in Semi-Structured Interviews. *Global Qualitative Nursing Research*, 2. doi:10.1177/2333393615597674
- Perera, A. (14th July 2022). Sri Lanka: Why is the country in an economic crisis? BBC.

<https://www.bbc.com/news/world-61028138>

Raelin, J.A. (2018). What are you afraid of: Collective leadership and its learning implications. *Management Learning*, 49(1), 59-66. DOI:10.1177/1350507617729974.

Sheard, J. (2018). *Research Methods*. (2nd Edition). Chandos Publishing. <https://doi.org/> Sunday times. (4th June, 2012). Dankotuwa rewards Kaizen suggestions. Sunday Times.

<https://www.sundaytimes.lk/120624/business-times/dankotuwa-rewards-kaizen-suggestions-3818.html>.

Uslu, O. (2019). A General overview to Leadership theories from a critical perspective. *Marketing and Management of Innovation*, 1. Available from <http://doi.org/10.21272/mmi.2019.1-13>.

Wasson, L.D. (2019). The Army of Alexander the Great. *Encyclopaedia of World*

History.

<https://www.worldhistory.org/article/676/the-army-of-alexander-the-great/>.

Wilson, S. (2013). Thinking differently about leadership: A critical history of the form and formation of leadership studies. *Research Gate*.

https://www.researchgate.net/publication/265208344_Thinking_differently_about_leadership_A_critical_history_of_the_form_and_formation_of_leadership_studies

A Study about Foreign Direct Investments to Colombo Stock Market: Determinants and Impact - A Review of methodological Approaches

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ABSTRACT

The paper indicates the research findings of a systematic literature review (SLR) of key factors about Foreign Direct Investments to Colombo Stock Market: Determinants and Impact. The paper considers 22 journals over a 15-year period from year 2009 to year 2022. The SLR focuses on the key issues faced by the foreign investors and the methodological approaches critically explore the type of methodological approaches needed in future scholarship to overcome the prevailing operational bottlenecks and macro level key issues. Findings emphasis on areas needs high priority increase the foreign investors' confidence and the studies focus on comparison other regional equity capital market development comparisons. Colombo stock exchange can be considered as the only stock exchange in Sri Lanka where all the listed companies of Sri Lanka get traded on both all share index (ASI) and S&P 20. The study will examine and emphasis the key factors affecting and influencing foreign direct investments decisions to Colombo Stock Exchange.

1. INTRODUCTION

The stock market is one of the key indicators that represent the status of a given economy as it covers wide variety of business sectors that contributes to the macro economy of a county. Research studies confirm that the stock market performance has a positive correlation with the macro- economic growth of a country (e.g.: Nwagu,2020; Herath, 2020).

Given the current context of the Sri Lankan economy in September 2022, it appears, that it is critically important to identify dollar inflow avenues and strengthen such dollar inflows with

long term sustainability to reinstate the overall economy and reinstate the normal day today life of the general public of Sri Lanka. This study will focus on the key drivers of foreign direct investments to Colombo Stock Market. Therefore, the area of study critically evaluates and emphasis on the prevailing common gaps, bottlenecks, and barriers in implementing strategies within the Colombo Stock Market and the stock brokering industry in Sri Lanka to attract new foreign direct investments to Sri

Lanka. Further this study will focus and highlight the contribution, benefits, use of BOTs as Equity advisors for stock brokering industry in Sri Lanka for further studies in this area. The study will consider the investment requirements and the expected level of infrastructure by the foreign investors when considering an equity investment in Sri Lanka.

Studies has revealed that Stock Exchangers and Stock Exchange commissions of high income developed counties are very efficient and proactive however many of the of Stock Exchangers and Stock Exchange commissions in lower middle-income countries are functioning with bare minimum competence level, efficiencies, and future focus. Especially new developments in those markets are neglected or completely postponed for many years due to various management reasons. The fundamental objective of Stock Exchangers and Stock Exchange commissions to build investor confidence through creating a regulated and transparent trading platform while developing an investor's relationship and then convert these relationships into business transactions.

Equity market basically provide two key options to involve in the stock market namely through the

secondary market and through initial public offerings. In addition to this equity market may offer rights issues, warrant conversions, and private placements with the shareholder approvals to attract equity capital for those companies which are on the listings of each exchange. This inflow of funds allows listed entities to expand and develop their business in a more efficient manner which then directly and indirectly contribute to the national GDP of Sri Lanka. More importantly in the long run Foreign Direct Investments (FDI's) will contribute to individual business sectors by sharing industry knowledge, know how, together with latest technological knowledge directly and indirectly. Such contributes drive from the FDI's will contribute to the overall countries economic growth therefore it is critically important that policies relating to capital markets adopt latest, modern world market friendly regulatory framework which attract & encourage more Foreign Direct Investments (FDI's) to Sri Lanka.

The paper indicates the research findings of a systematic literature review (SLR) of key factors about Foreign Direct Investments to Colombo Stock Market: Determinants and Impact. The paper considers 22 journals over a 15-year period from year 2009 to year 2022. The SLR focuses on the key issues faced by the foreign investors and the methodological approaches critically explore the type of methodological approaches needed in future scholarship to overcome the prevailing operational bottlenecks and macro level key issues. Findings emphasis on areas needs high priority increase the foreign investors' confidence and the studies focus on comparison other regional equity capital market development comparisons. Colombo stock exchange can be considered as the only stock exchange in Sri Lanka where all the listed companies of Sri Lanka get traded on both all share index (ASI) and S&P 20. The study will examine and emphasis the key factors affecting and influencing foreign direct investments decisions to Colombo Stock Exchange.

2. RESEARCH CONTEXT

As of September 2022, it clearly appears that the country is facing its worst crisis since independence in 1948. Where it is quite evident

that Sri Lankan economy is struggling ensure minimum dollar reserves even to facilitate the essentials of the country. To ease out the current economic pressure and accelerate the growth, country needs to find fresh capital particularly thorough foreign direct investments (FDI) to support domestic investments and reinstate a fully functional economy. Therefore, it is critically important to identify dollar inflowing avenues for the Sri Lankan economy and ensure that such avenues are sustainable. Such successful efforts to increase foreign income will ease the tremendous pressure building up on the public to get their daily essentials to survive. Notably due to the prevailing economic crisis many middle classes and lower middle-class families have already fallen below the poverty line and are struggling to survive with their current earnings. "Theory regarding the characteristics of FDI emphasizes the stability, long-term motivation and flexibility of this type of capital investment, even during financial crises" (Lipsey, 2001).

Poor rates of economic growth can be largely contributed by lower level of savings observed in countries like Sri Lanka which consequently reduce the economic growth as the country is lacking the required capital for its developments and increase the dependency on foreign direct investments for major economic activities and developments of the country as a capital generating avenue. It has been observed that many developed economies have successfully utilized the foreign direct investments (FDI) though their transition period to become a developed economy. Further it should be noted that major component of such foreign capital inflow has been in the form of foreign direct investments (FDI), which has been attracted and mobilized through centrally planned clear transparent mechanisms to boost such foreign investors' confidence. Such positive characteristics can largely influence and convince foreign investors to host significant investments to an economy (Blomström, Lipsay and Zejan, 1992; Borensztein, De Gregorio and Lee, 1998; Bosworth and Collins, 1999; Loungani and Razin, 2001; etc.). Theory regarding the characteristics of FDI emphasizes the stability, long-term motivation, and

flexibility of this type of capital investment, even during financial crises (Lipsey, 2001). Elwell (2012),

Studies indicate that foreign investors are very particular and concern on the currency stability of a country when considering foreign investments. In an environment where the domestic currency has devalued quite significantly, similar to the prevailing status in Sri Lanka during September 2022 foreign investors may find many investments at absolute bargain levels however the domestic currency is one of the key aspects to consider as none of the foreign investors are not willing to hold any type of asset class when the currency experiencing a sharp decline. Which intern bring down the return on the investment and further can expose to have an impact of the capital invested if there's a sharp currency depreciation exposing the investors to currency exchange risk. Such macroeconomic indicators will influence foreign investors to refrain from investing in domestic asset classes including stocks. According to Elwell (2012), "foreign investors are unwilling to hold assets in a depreciating currency as that would diminish the return on their investment".

However, the exchange rate movements impact is affected differently for industry to industry and company to company depending on their exposure international trades in their respective business model. Large export-oriented companies may largely get benefited and companies with larger imports may heavily impacted from the domestic currency depreciation which will result in high cost of production, reduction in profit margins, reduction in reported earnings. Which then will reflect on the company share prices with price decline. (Krugman and Obstfeld, 2009) "Therefor it's important to identify the stock market performance affected by the foreign exchange market returns".

3. BACKGROUND

When considering the capital market development of Sri Lanka during the last two decades it is quite evident that it consisted of many well intended and excellent strategic plans. However, implementation has been a major

concern and criticism throughout. Most strategies were highly ambitious and not supported to overcome the practical barriers together with poor inconsistent implementation strategies. Periodic government changers that we have experienced in Sri Lanka during the last two decades has largely contributed to inconsistency in policy making particularly in national level economic and financial reform strategies. It has been quite evident these reform strategies were highly influenced by the political parties and their respective ideology rather than a consistent long term national economic policy. "The political events adversely affect the confidence of both domestic and foreign investors as the volatility of stock market is increased which lead to the uncertainty of the investment expected cash flows" (Kongprajya, 2010).

4. METHODOLOGY

The study about Foreign Direct Investments to Colombo Stock Market: Determinants and Impact is really focusing on the factors that inuence foreign direct investments to Sri Lankan stock market. Market capitalization of the Colombo stock market as a proportion to GDP of Sri Lanka is considered in this study. The reasoning for this inclusion is discussed below.

Stock Market Development in Sri Lanka

Sri Lankan stock market development is measured as a proportion of the GDP of a given financial year in Sri Lanka as follows.

Sri Lankan stock

market development = $\frac{\text{CSE market capitalization}}{\text{Sri Lanka GDP of a given financial Year}}$

CSE market capitalization represents the total value of the listed companies listed at Colombo stock exchange. "The assumption behind this measure is that it is less arbitrary than any other measure of stock market development" (Demirguc-Kunt and Levine, 1996). The annual data has been collected through the central bank reports of Sri Lanka, CSE official publications. Basic data investigation carried out based on empirical evidence available from previous studies carried out in the same subject area.

4.1 METHOD

Literature selection and criteria for study inclusion Searching for relevant data bases in stock market related studies done through a constructed searches in standard databases. A systematic literature search was conducted to identify peer reviewed journal articles published from 2009 to 2022. Since every data base has a different focus, it is always better to search more than one source to obtain an increased number of relevant materials for the study area. Mainly two manual searches were performed in Google scholar and Plymouth library data base.

5. GOOGLE SEARCH RESEARCH

Google scholar is very commonly used data base with many financial industry related articles. However, searching continued on Google scholar for 'Foreign Direct Investments to Sri Lankan stock market' & 'Foreign Direct Investments to Sri Lanka' also, to include additional titles, relating to Colombo stock market and investor related study materials.

Initial search was carried out as per the guidelines provided on google scholar and in this search the focus was to find articles related foreign direct investments to Sri Lankan stock market. Therefore, key search words included Foreign Direct Investments to Sri Lankan stock market, Foreign Direct Investments to Colombo stock market, Foreign Direct Investments Sri Lanka, Factors that influence Foreign Direct Investments Sri Lanka. ('Foreign Direct Investments to Sri Lankan stock market' or 'Foreign Direct Investments to Sri Lanka' or 'Foreign Direct Investments to Colombo stock market' or 'Foreign Investments to Sri Lanka' 'Factors that influence Foreign Direct Investments Sri Lanka')

Initial search results of this consisted of 27,900 results totaling from various sources and related articles under the search topic foreign direct investments to Colombo stock market. As the next step the search results were shortlisted based on the published date after 2009. Which reduced the initial number to 17,700. This marginal reduction clearly indicates that Foreign Direct Investments to Sri Lanka has been discussed widely during the last fifteen years. One of the

key reasoning is the thirty-year war ending in Sri Lanka and the increasing interest on Sri Lanka by many foreign individuals and institutions. Inclusion criteria has been considered to further filter the results. The following journals were selected based on the inclusion criteria. Further when sorted with dates it was down to 4,530 results and then it was further concentrated on journal articles results were down to 293 results.

International Journal of Scientific and Research Publications (IJSRP)

IIARD International Journal of Economics and Business Management

International Journal of Economics and Finance
Journal of Economics and Sustainable Development
Vidyodaya Journal of Humanities and Social Sciences

The Journal of Financial Research and Studies
Journal of the University of Ruhuna

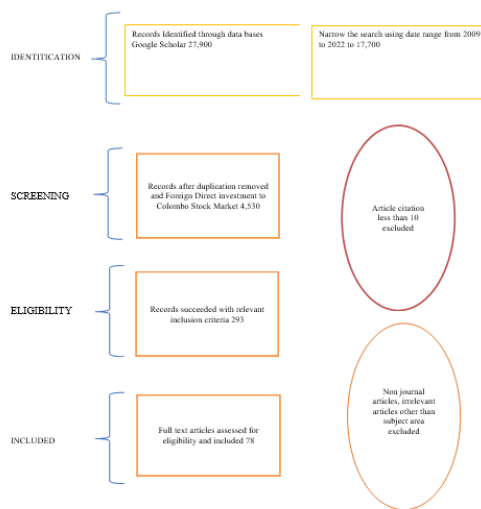
Global Journals Online

International Journal of Accountancy (IJA) Sage Publications India Pvt

Sri Lanka Journals Online (JOL) Global Journals Online

South Asia Economic Journal

Journal title	Frequency
International Journal of Scientific and Research Publications (IJSRP)	32
IIARD International Journal of Economics and Business Management	08
International Journal of Economics and Finance	12
Journal of Economics and Sustainable Development	06
Vidyodaya Journal of Humanities and Social Sciences	02
The Journal of Financial Research and Studies	04
Journal of the University of Ruhuna	01
Global Journals Online	02
International Journal of Accountancy (IJA)	04
Sage Publications India Pvt	02
Sri Lanka Journals Online (JOL)	01
Global Journals Online	01
South Asia Economic Journal	02
Total	77



Comparability of the results have been improved with the inclusion criteria in the above search process. Google Scholar key word search carried out with search results are presented in the table 01. Which resulted in 78 total articles, then the articles were rescanned to establish direct link to Colombo Stock Market and foreign direct investments in Sri Lanka. Finally, 18 articles were selected for the final analysis through Google Scholar.

(1996_WBER_Stylized Facts, n.d.; 2020 ;The Journal of Faculty of Business Studies and Finance, 2020; Adam & Tweneboah, n.d.-b, n.d.-a, n.d.-c; Amaresh et al., 2020a, 2020b; Boateng et al., 2015; Deyshappriya, 2014a, 2014b; Hailu, n.d.-a, n.d.-b; Jayasekara, 2014a, 2014b; Kengatharan L & Vanajah S, 2021a, 2021b; Lebbe & Rauf, 2016a, 2016b; Lewis, n.d.-a, n.d.-b; Mudiyansele et al., 2013; Rajapakse, 2018a, 2018b, 2019a, 2019b; Ramesh & Rajumesh, 2015a, 2015b; Ravinthirakumaran et al., 2015a, 2015b; Somathilake, 2020a, 2020b, 2020c; Wang et al., n.d.; ZENGİN et al., 2018a, 2018b)

6. PLYMOUTH UNIVERSITY LIBRARY BASE

Plymouth University library search considered as the second search used for the study. This search allowed to access many wide range of data bases through one gate way. Further the Plymouth library use to access materials that directly

related Foreign Direct Investments in country context. Data base search consist of some combination of terms to cover the different stages, phases related to foreign direct investments. Following statements were run to find related journal articles relating to foreign direct investments in Colombo stock market.

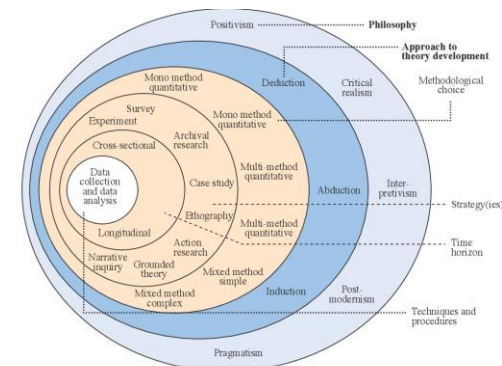
(‘Foreign Direct Investments to Sri Lankan stock market’ or ‘Foreign Direct Investments to Sri Lanka’ or ‘Foreign Direct Investments to Colombo stock market’ or ‘Foreign Investments to Sri Lanka’ ‘Factors that influence Foreign Direct Investments Sri Lanka’ or ‘Colombo stock market or foreign investments to Sri Lanka’)

Initial search on Plymouth University library search results of this consisted of 124 results totaling from various sources and related articles. As the next step the search results were further refined and shortlisted based on the published date after 2009. Which reduced the initial number to 18. This search also indicates that Foreign Direct Investments to Sri Lanka has been discussed widely during the last fifteen years post war era of Sri Lanka. Inclusion criteria has been considered to further filter the results. The following subject terms where journals were selected based on the inclusion criteria. Foreign Direct Investments to Sri Lankan stock market, Foreign Direct Investments to Sri Lanka, Foreign Direct Investments to Colombo stock market, Foreign Investments to Sri Lanka, Factors that influence Foreign Direct Investments Sri Lanka, Foreign Direct investments, Capital market developments, Colombo stock exchange macroeconomic impact Stock market efficiency Performance of stock market. Further when sorted with dates it was down to 13 results and then it was further concentrated on journal articles results were down to 4 results.

Journal title	Frequency
Studies in Business and Economics	01
Kelaniya Journal of Management	01
South Asia Economic Journal	01
Journal of Asian Finance, Economics and Business	01
Total	04

The search short listed and filtered only the articles with were in English language only. This narrowed down the results for 124 then the subjected titles were considered, and such inclusion reduced the search results to 18 Articles prior to war ended period has been excluded from the selected list. Therefore, finally 4 articles were selected from the Plymouth University library search for the final analysis of this review. (Mohamed Mustafa, 2019; Ravinthirakumaran et al., 2015c; Senarathne & Jianguo, 2018; Wijesinghe & de Silva, 2021)

Finally, 22 articles were selected and included in the final analysis which derived from the above two search process.



e J. Research onion¹

This methodological review is carried out considering the learnings of “research onion” model by Saunders. However, the coding process carried out mainly considering, Research

design, Sampling Methods, Data Collection methods, Data Analysis methods, variable measurement, validity and reliability. This analysis considered as a benchmark to identify the prevailing gaps in this research process.

7. RESEARCH DESIGN

Research design attempts to establish relationships among the variables and provide overall strategy to consolidate different components of the research study area. This provides a clear path for the researcher to carry out data collection, measurements, and data analysis. Akhtar, D.M.I., 2016. Research design. Research Design (February 1, 2016).

8. SAMPLE METHODS

Sampling can be considered as the practical, manageable, and effective mechanism to collect data of an empirical study. Following eight sampling methods were used in the content analysis process: Snowball, random, clustered, systematic, stratified, convenience, quota, purposive.

9. DATA COLLECTION METHODS

In this review data collection has been specific to the industry and the research area. Therefore, the data collection included methods such as transactional tracking relating to foreign transactions (Buying / Selling) on the Colombo stock market. Interviews and focus groups relating to foreign investors, observations, online tracking, records, documents, and questioners

10. VARIABLE MEASUREMENTS, VALIDITY AND RELIABILITY

Validity of a research indicate to which extend the research results are applicable outside the study group or the target segment. On the other hand, reliability of a study establish test the ability to reproduce the same results multiple times.

11. RESULTS

Coding methodology has been considered in this data analysis process based on the articles which was selected from the search.

1. Simple inferential statistics (e.g.- correlation and serial correlation)

2. Unit root analysis of variables
3. Qualitative analysis
4. Reliability Analysis
5. Descriptive Analysis
6. Regression Analysis

12. RESEARCH DESIGN

“The principal methods employed to analyze the time series behavior of the data involves cointegration together with two short-run analyses including impulse response function and variance decomposition from a VECM. Cointegration technique introduced by Granger (1981) and developed by Engle and Granger (1987) has become a useful framework for analyzing long-run relationships amongst series”

Unit Root Since the cointegration methodology requires that the variables should be integrated of the same order, we test for unit roots by using the Augmented Dickey- Fuller (ADF) and Philips-Perron (PP) approaches. These tests are performed on the variables in levels and first differences. The study employed the Autoregressive Distributed Lag (ARDL) approach to cointegration to institute the relationship between foreign direct investment (FDI) and stock market development.

13 SAMPLING METHODS

Validity and Reliability

In the research study using the correct tools are quite important to assess the concepts relating to the study area. The generalisability of research findings mainly lies Volume 19 · Number 1 · 2021 84 Sulakshana De Alwis and Patrik Hernwall with the validity and reliability of information collected (Bryman 2012). Based on the available evidence validity and reliability is measured and coded separately for the study.

14. DATA ANALYSIS METHODS

In this study different techniques were used in analyzing the data relating to the Foreign Direct Investments to Colombo Stock Market. The main techniques included Unit root test, Co-integration test, optimal lag length, Vector Auto-

Regression (VAR) and Granger causality will be employed in this research in order to investigate the relationship between, FDI and CSE turnovers.

When considering the Simple inferential statistics ninety- one percent (20 articles) of the 22 review papers considered Simple inferential statistics, where correlations and serial correlation being widely discussed and considered to establish the relationship between variables and report data. Many articles have used serial correlations to explain and establish the degree of correlation of the same variables between different time intervals. This research study focuses on time series data collected from secondary sorceress related to foreign direct investments to Colombo stock market. The annual published CSE reports, annual reports of central bank of Sri Lanka, reports from department of census and statistics, reports of monetary fund reports considered as main sources for the study during year 2009 to 2022.

“Economic growth was a dependent variable which was measured as growth in the Gross Domestic Product while stock market capitalization ratio, stock value traded ratio, and foreign direct investment ratio were used as independent variables to measure the stock market development and inflation was used as the control variable” (Kengatharan L & Vanajah S, 2021c)

15 MIX METHODS

Mixed methods research combines elements of quantitative research and qualitative research to answer a research area. Mixed methods can help us gain a more complete picture than a standalone quantitative or qualitative study, as it integrates benefits of both methods. Mixed methods research may be the right choice if your research process suggests that quantitative or qualitative data alone will not sufficiently answer your research question. combining quantitative and qualitative approaches can balance out the limitations of each method. it can provide stronger evidence and more confidence in your findings. it can give you more granular results than each individual method.

However, it should be noted that in this current review none of the papers has followed the mixed methodologies. mix method increases the complexity of the research design and by mixing both qualitative and quantitative approaches to research leads to more time for the findings and analysis of the research. Other main issue with mix method research is that the complexity that the researcher must go through when integrating both qualitative and quantitative methods in a single project particularly during the data analysis and interpretation of the study area. Further challenge of using both qualitative and quantitative methods would lead to increase the requirement of expertise knowledge as the complexity of the study area increases with the usage of both methods. Which will then lead to high level of resources utilization as well as increase of cost of financial resources.

When considering the challenge of using both qualitative and quantitative methods it can be noticed that many has experienced issues such as paradigm mixing, interpretation of conflicting results etc. Due to such practical issues some research findings yet to be finalized or taken much longer than originally expected.

16 DATA AND METHODOLOGY

When considering the time series data statistics seventy- seven percent (17 articles) of the 22 review papers considered unit root test, to investigate whether the time series data contain unit root or not. where unit root test widely discussed and considered to establish the relationship between variables and report data. Many articles have used unit root test to explain and establish the degree of correlation of the same variables between different time intervals. This research study focuses on time series data collected from secondary sorceress related to foreign direct investments to Colombo stock market. Unit Root Test: To investigate whether the time series data contain unit root or not. Augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979) and Phillips-Perron (PP) (Phillips & Perron, 1988)

Methodology The principal methods employed to analyze the time series behavior of the data involves cointegration together with two short-run analyses including impulse response function and variance decomposition from a VECM. Cointegration technique introduced by Granger (1981) and developed by Engle and Granger (1987) has become a useful framework for analyzing long-run relationships amongst series, which overcomes the problem of non-stationarity and allows the investigation into both the levels and first differences of series. In the current study, we apply the multivariate cointegration analysis of Johansen (1988, 1991) and generalized impulse response function (GIRF) from Vector Error Correction Model (VECM) to investigate the linkages between factors that influence FDI to Colombo stock market development in Sri Lanka.

17 FINDINGS

Findings in this research methodology paper is towards the clarification of the so far rather unclear relationship between the factors that influence foreign direct investments to stock market in Sri Lanka. Methodologies have been focused on the key characteristics that contribute to influence foreign direct investments and determinates the possible impacts for both long term and short term. The study proceeds with methodological testing such as unit root test and accepted theoretical assumptions to establish empirical evidence of the factors that directly related to foreign investment decisions which could be critically important for policy making decisions particularly considering the prevailing status of the Sri Lanka.

18 DISCUSSION

As the dollar inflow avenues gain increasing importance, this study tries to identify the Colombo Stock Market as an avenue to attract foreign direct investments to Sri Lanka. Therefore, this study will focus on the key drivers of foreign direct investments to Colombo Stock Market. In order to achieve this objective, the area of study critically identifies and evaluates the prevailing gaps, bottlenecks, and barriers in implementing strategies within the Colombo Stock Market and the stock brokering industry in

Sri Lanka to attract new foreign direct investments to Sri Lanka. Further there are key factors such as good governance, transparency, overall economic stability, political stability, clear investment procedures and clear exit mechanisms considered when making an investment decision. In the research study it was quite visible that the time series data statistics seventy-seven percent (17 articles) of the 22 review papers considered unit root test, to investigate whether the time series data contain unit root or not. Further multivariate cointegration analysis of Johansen (1988, 1991) and generalized impulse response function (GIRF) from Vector Error Correction Model (VECM) to investigate the linkages between factors to establish Foreign Direct Investments to Colombo Stock Market: Determinants and Impact

19. CONCLUSION

Sri Lanka is an emerging economy in Asia with unique cultural characteristics which has evolved with different ethnicities in the country. In this study researcher focused on Foreign Direct Investments to Colombo Stock Market: Determinants and Impact. Which involves establishing the relationship between the key factors that influence FDI to Colombo stock market as an avenue to bring in big scale FDI with structural, with clear transparency and with a proper exit mechanism. Literature indicate that these factors have a long-term trend of influencing foreign direct investments to Sri Lanka. Therefore, Sri Lankan government and respective government Authorities should consider these influencing factors and use it to promote FDI's to Sri Lankan stock market as along term dollar investment avenue. Various methodological approaches have been considered to investigate the relationship between the main factors that influence foreign direct investments to Colombo Stock Market. To have a conclusion, in the methodology investigations have carried out based on 22 journal articles in the same subject area with similar assessments. Researcher has found out that similar analysis done in other countries to establish similar studies and used Ghana's Evidence as a benchmark to carry out the

methodology based on the similar studies carried out. Therefore, it can be concluded that Foreign Direct Investments to Colombo Stock Market: Determinants and Impact can be measured and establish the relationship with clear methodology with empirical evidence justifications with similar studies has progressed in other countries and other capital markets in the world.

20. TOWARDS FUTURE RESEARCH

However, it should be noted that a success of a research methodology can be largely depends on the effective communication of the researcher, level of critical thinking involved, observation skills together with research data analyzing skills. Whether these characters being featured and to what extend these being considered during this research can be identified as one of the critical success factors of the systematic review methodology relating to this case study. Further in this research methodology refers to electronic sources of material bases which has developed in the past. Such data could be outdated and might not be really represents the exact situation prevailing at the present economic crisis context of the economy of Sri Lanka. therefore, today's investment decisions and concerns can be far different to concerns 5 to 10 years ago due to the fast-changing economic and political behaviors of the society of Sri Lanka. This review has several limitations and several methodological gaps that future researchers could adopt to develop the related research field into a more matured field of inquiry. Particularly in this methodology focus is narrow down to Foreign Direct Investments related to Colombo Stock Market only in other words only listed companies being show cased as investment opportunities in this study. However, there can be many other companies, projects, business sectors that could attract Foreign Direct Investments to Sri Lankan economy to enhance its current economic position.

REFERENCES

- Adam, A. M., & Tweneboah, G. (n.d.-c). Munich Personal RePEc Archive Foreign Direct Investment and Stock market Development: Ghana's Evidence Foreign Direct

Investment and Stock market Development: Ghana's Evidence.

- Amaresh, M., Anandasayanan, S., & Ramesh, S. (2020a). Macro-Economic Variables and Stock Market Performance: Empirical Evidence from Colombo Stock Exchange. *Vidyodaya Journal of Humanities and Social Sciences*, 05(02), 106–118. <https://doi.org/10.31357/fhss/vjhss.v05i02.08>
- Amaresh, M., Anandasayanan, S., & Ramesh, S. (2020b). Macro-Economic Variables and Stock Market Performance: Empirical Evidence from Colombo Stock Exchange. *Vidyodaya Journal of Humanities and Social Sciences*, 05(02), 106–118. <https://doi.org/10.31357/fhss/vjhss.v05i02.08>
- Boateng, A., Hua, X., Nisar, S., & Wu, J. (2015). Examining the determinants of inward FDI: Evidence from Norway. *Economic Modelling*, 47, 118–127. <https://doi.org/10.1016/j.econmod.2015.02.018>
- Deyshappriya, N. P. R. (2014a). An Empirical Investigation on Stock Market Anomalies: The Evidence from Colombo Stock Exchange in Sri Lanka. *International Journal of Economics and Finance*, 6(3), 177–187. <https://doi.org/10.5539/ijef.v6n3p177>
- Deyshappriya, N. P. R. (2014b). An Empirical Investigation on Stock Market Anomalies: The Evidence from Colombo Stock Exchange in Sri Lanka. *International Journal of Economics and Finance*, 6(3). <https://doi.org/10.5539/ijef.v6n3p177>
- Hailu, Z. A. (n.d.-a). Demand Side Factors Affecting the Inflow of Foreign Direct Investment to African Countries: Does Capital Market Matter?
- Hailu, Z. A. (n.d.-b). Demand Side Factors Affecting the Inflow of Foreign Direct Investment to African Countries: Does Capital Market Matter? www.ccsenet.org/ijbm
- Jayasekara, S. (2014a). Determinants of foreign direct investment in Sri Lanka. *Journal of the University of Ruhuna*, 2(1–2), 4. <https://doi.org/10.4038/jur.v2i1-2.7849>
- Jayasekara, S. (2014b). Determinants of foreign direct investment in Sri Lanka. *Journal of the University of Ruhuna*, 2(1–2), 4. <https://doi.org/10.4038/jur.v2i1-2.7849>
- Kengatharan L., & Vanajah S. (2021a). Stock Market Development and Economic Growth: Empirical Evidence from Sri Lanka. In *International Journal of Accountancy (IJA)* (Vol. 1, Issue 1).
- Kengatharan L., & Vanajah S. (2021b). Stock Market Development and Economic Growth: Empirical Evidence from Sri Lanka. In *International Journal of Accountancy (IJA)* (Vol. 1, Issue 1).
- Kengatharan L., & Vanajah S. (2021c). Stock Market Development and Economic Growth: Empirical Evidence from Sri Lanka. In *International Journal of Accountancy (IJA)* (Vol. 1, Issue 1).
- Lebbe, A., & Rauf, A. (2016a). FOREIGN DIRECT INVESTMENT AS A DETERMINANT OF PERFORMANCE OF SHARE MARKET IN SRI LANKA. In *IIARD International Journal of Economics and Business Management* (Vol. 2, Issue 2). www.iiardpub.org
- Lebbe, A., & Rauf, A. (2016b). FOREIGN DIRECT INVESTMENT AS A DETERMINANT OF PERFORMANCE OF SHARE MARKET IN SRI LANKA. In *IIARD International Journal of Economics and Business Management* (Vol. 2, Issue 2). www.iiardpub.org
- Lewis, J. (n.d.-a). Factors Influencing Foreign Direct Investment in Lesser Developed Countries.

- Lewis, J. (n.d.-b). Factors Influencing Foreign Direct Investment in Lesser Developed Countries.
- Mohamed Mustafa, A. M. (2019). Contribution of tourism and foreign direct investment to gross domestic product: Econometric analysis in the case of Sri Lanka. *Journal of Asian Finance, Economics and Business*, 6(4), 109–114. <https://doi.org/10.13106/jafeb.2019.vol6.no4.109>
- Mudiyansele, K., Senarath, P., & Konara, B. (2013). Foreign Direct Investment in Sri Lanka: Determinants and Impact.
- Rajapakse, C. R. (2018a). The Relationship between the Stock Market and Foreign Direct Investment (FDI) in Sri Lanka-Evidence from VAR and Co-Integration Analysis. Type: Double Blind Peer Reviewed International Research Journal Publisher: Global Journals Online, 18.
- Rajapakse, C. R. (2018b). The Relationship between the Stock Market and Foreign Direct Investment (FDI) in Sri Lanka-Evidence from VAR and Co-Integration Analysis. Type: Double Blind Peer Reviewed International Research Journal Publisher: Global Journals Online, 18.
- Rajapakse, C. R. (2019a). STOCK MARKET PERFORMANCE, EXCHANGE RATE VOLATILITY AND FOREIGN DIRECT INVESTMENT TO SRI LANKA. In *Asia Proceedings of Social Sciences* (Vol. 4, Issue 3). APSS. <http://www.utm.my/asia/our-team/>
- Rajapakse, C. R. (2019b). STOCK MARKET PERFORMANCE, EXCHANGE RATE VOLATILITY AND FOREIGN DIRECT INVESTMENT TO SRI LANKA. In *Asia Proceedings of Social Sciences* (Vol. 4, Issue 3). APSS. <http://www.utm.my/asia/our-team/>
- Ramesh, S., & Rajumesh, S. (2015a). Stock Market Reaction to Political Events: A Study of Listed Companies in Colombo Stock Exchange of Sri Lanka. *Journal of Economics and Sustainable Development*, 6(3).
- Ramesh, S., & Rajumesh, S. (2015b). Stock Market Reaction to Political Events: A Study of Listed Companies in Colombo Stock Exchange of Sri Lanka. In *Journal of Economics and Sustainable Development* www.iiste.org ISSN (Vol. 6, Issue 3). Online. www.iiste.org
- Ravinthirakumaran, K., Selvanathan, E. A., Selvanathan, S., & Singh, T. (2015a). Determinants of foreign direct investment in Sri Lanka. *South Asia Economic Journal*, 16(2), 233–256. <https://doi.org/10.1177/1391561415598458>
- Ravinthirakumaran, K., Selvanathan, E. A., Selvanathan, S., & Singh, T. (2015b). Determinants of foreign direct investment in Sri Lanka. *South Asia Economic Journal*, 16(2), 233–256. <https://doi.org/10.1177/1391561415598458>
- Ravinthirakumaran, K., Selvanathan, E. A., Selvanathan, S., & Singh, T. (2015c). Determinants of foreign direct investment in Sri Lanka. *South Asia Economic Journal*, 16(2), 233–256. <https://doi.org/10.1177/1391561415598458>
- Senarathne, W. C., & Jianguo, W. (2018). Do Investors Mimic Trading Strategies of Foreign Investors or the Market: Implications for Capital Asset Pricing. *Studies in Business and Economics*, 13(3), 171–205. <https://doi.org/10.2478/sbe-2018-0042>
- Somathilake, H. (2020a). Factors Influencing Individual Investment Decisions In Colombo Stock Exchange. *International Journal of Scientific and Research Publications (IJSRP)*, 10(05), 579–585.

<https://doi.org/10.29322/ijserp.10.05.2020.p10166>

Çalışmalar Dergisi, 177–192.
<https://doi.org/10.14784/marufacd.460693>

Somathilake, H. (2020b). Factors Influencing Individual Investment Decisions in Colombo Stock Exchange. *International Journal of Scientific and Research Publications (IJSRP)*, 10(05), 579–585.
<https://doi.org/10.29322/ijserp.10.05.2020.p10166>

Somathilake, H. (2020c). Factors Influencing Individual Investment Decisions In Colombo Stock Exchange. *International Journal of Scientific and Research Publications (IJSRP)*, 10(05), 579–585.
<https://doi.org/10.29322/ijserp.10.05.2020.p10166>

Wang, X., Garti, E., & Chibsah, R. (n.d.). The impact of Foreign Direct Investment on Stock Market Development: Evidence from Ghana International Journal of Economics, Commerce and Management United Kingdom THE IMPACT OF FOREIGN DIRECT INVESTMENT ON STOCK MARKET DEVELOPMENT: EVIDENCE FROM GHANA. <http://ijecm.co.uk/>

Wijesinghe, M. R. P., & de Silva, A. L. C. M. (2021). Foreign Portfolio Investment and Earnings Quality: Evidence from Sri Lanka. *Kelaniya Journal of Management*, 10(0), 1.
<https://doi.org/10.4038/kjm.v10i0.7680>

ZENGİN, S., YÜKSEL, S., & KARTAL, M. T. (2018a). Understanding the Factors That Affect Foreign Direct Investment in Turkey by Using Mars Method. *Finansal Araştırmalar ve Çalışmalar Dergisi*, 177–192.
<https://doi.org/10.14784/marufacd.460693>

ZENGİN, S., YÜKSEL, S., & KARTAL, M. T. (2018b). Understanding the Factors That Affect Foreign Direct Investment in Turkey by Using Mars Method. *Finansal Araştırmalar ve*

Which Presentation Format of Hotel Online Reviews Appears to be More Trustworthy for Generation Z Travellers? An Analysis of Trusting Attitudes and Behavioural Intentions in Sri Lanka Context

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ABSTRACT

Research on trust in Electronic Word of Mouth (eWOM) is in its infancy. The issues of fake online reviews and promotional online reviews in the tourism and hospitality businesses stressed the significance of the credibility of online consumer reviews, as the decisions of Generation Z travellers are significantly influenced by reviews from different social media channels. The study aims to determine how Generation Z travellers in Sri Lanka perceive trustworthiness on the negative hotel online reviews presented in five different formats including text, image, video, text + image, and text + video.

Following a positivist research design, a well-scanned secondary dataset of 286 valid responses was used to examine the relationship between presentation formats of genuine consumer reviews and perceived trustworthiness measured by trusting attitudes and behavioural intentions.

Drawing from source credibility theory and dual coding theory, we discovered that hotel online reviews in combined presentation formats (text + image and text + video) appear to be more trustworthy than that in single presentation formats (text, image, and video) and will also have a greater impact on consumer decision making. Tangible (physical facilities and environment) and intangible (client-staff relationship) aspects highlighted in hotel online reviews also influence consumer behavioural intentions, where consumers' behavioural

intentions tend to be the strongest when these tangible features are presented in combined formats.

This study contributed both conceptually and practically to the field of hospitality marketing, as well as generating inter-disciplinary knowledge in this area.

1. INTRODUCTION

Electronic Word of Mouth (eWOM) has always been a popular research topic for tourism and hospitality scholars. eWOM is defined as “any positive or negative statement made by potential, actual or former consumers about a product or company, which is made available to a multitude of people and institutions via the Internet” (Hennig-Thurau et al., 2004). eWOM has emerged as a major source for travellers to share and seek recommendations using digital platforms in which online consumer reviews (OCRs) is one of its manifestations (Dwivedi et al., 2021).

The rapid adoption of social media led to a significant impact of online reviews on the consumer decision-making process (Ismagilova et al., 2020). Scholars have studied the impact of online reviews on a variety of factors, including sales (Chevalier and Mayzlin, 2006), brand image (Floyd et al., 2014), attitudes (Lee et al., 2008), and purchase intentions (Filieri, 2015). With the fact that an overwhelming majority of consumers consider online reviews before

making any purchase decisions due to their reliability and usefulness (Cheung and Thadani, 2012), it is important to evaluate the credibility of online reviews because some companies post fake online reviews themselves to promote their products (Zhuang et al., 2018), while some others hire fake reviewers to write positive reviews (Maheshwari, 2019) or provide discounts to consumers in exchange for glowing reviews (Filieri, 2016).

In the research on eWOM, the source credibility theory has been extensively used to describe what makes a source trustworthy and the impact of credible sources on consumer attitudes towards the product and consumer behaviours such as purchase intentions. Source trustworthiness is one of the core dimensions in this theory, emphasising on the degree of confidence of the information provider on communicating the information that he considers most valid (Hovland et al., 1953). As research on trust in eWOM is in its infancy (Dwivedi et al., 2021), this study will focus on source trustworthiness to provide more exploratory findings on the trustworthiness of online consumer reviews.

Some scholars explored what determines trustworthiness of online consumer reviews (Filieri, 2016), while others focused on the impact of various factors on trustworthiness. From the perspective of the review reader, excluding their personal traits, the review provider, the message, the medium, and the context might influence the credibility of information in the online environment (Wathen and Burkell, 2002). In terms of the impact of the online review message on trustworthiness, scholars have investigated how presentation formats (Wu et al., 2021, Çelik et al., 2022, Li et al., 2021), length and depth of the information (Mudambi and Schuff, 2010), review extremity and valence (Wang et al., 2015, Huang and Liang, 2021), language (Baker and Kim, 2019), grammar and mechanics (Ketron, 2017) influence perceived trustworthiness and exert influence on consumers' purchase intentions.

With the focus on the impact of presentation formats of online reviews on trustworthiness, a growing number of literatures examine how

textual-only and visual-only presentation of online reviews influence trustworthiness (Carbonell et al., 2019, Baker and Kim, 2019, De Pelsmacker et al., 2018, Filieri et al., 2021, Filieri, 2016, Ketron, 2017, Lin et al., 2012, Mudambi and Schuff, 2010, Wang et al., 2015, Huang and Liang, 2021, Çelik et al., 2022), but yet limited studies on how combination of textual and visual presentation of online reviews influence trustworthiness (Li et al., 2021, Wu et al., 2021).

As a direct response to Raffaele Filieri's call "...scholars could analyze whether the combination of different formats can increase review trustworthiness..." (Dwivedi et al., 2021), this study aims to bridge a knowledge vacuum about how five different presentation formats (text, image, video, text + image, and text + video) of online reviews influence perceived trustworthiness by Generation Z travellers in Sri Lanka, with a particular focus on negative hotel online reviews.

According to the literature review of trustworthiness, trusting attitudes and trusting behavioural intentions have been identified as key components of perceived trustworthiness, and their interaction with presentation formats will be investigated further.

The travel industry is heavily impacted by online reviews as numerous customers check posted opinions of others before making their decisions (Nguyen and Coudounaris, 2015), in which hotels are most likely to be affected by online reviews (Serra Cantallops and Salvi, 2014), and consumer-generated online reviews are considered the most influential source of travel information before making a purchase (Sotiriadis and van Zyl, 2013). Especially for Generation Z travellers born in the year 1995 and later (Bassiouni and Hackley, 2014), whose lives are largely shaped by extensive technology and social media (Yussof et al., 2018), reviews of celebrities and influencers could have a significant impact on their decision-making process (Csobanka, 2016), and referring to online reviews prior to travel is an integral part of their lives, as they typically start off their travel without a set destination in mind (Robinson and Schänzel, 2019).

Paul Redmond, an expert on generation cohorts, observed that Generation Z is considered a critically important cohort representing the market of the future and it has only recently attracted the attention of tourism academic journals as the generation has just begun to mature and take centre stage as adults. Therefore, this study would reveal certain fundamental insights into the views and behavioural intentions of Generation Z travellers.

Drawing from source credibility theory and dual coding theory, this research aims to address four questions: if single presentation formats (text, image, and video) or combined presentation formats (text + image and text + video) of hotel online reviews appear more trustworthy? Whether a stronger trusting attitude will result in a higher trusting behavioural intention for hotel online reviews in both single and combined formats? Whether tangible (physical facilities and surroundings) and intangible (client-staff relationship) aspects emphasised in hotel online reviews affect perceived trustworthiness? And whether online reviews highlighting certain element of the hotel product presented in certain formats tend to be more trustworthy and have a greater influence on consumer decisions?

By analysing secondary data, our four hypotheses based on aforementioned four research questions are all shown to be true. We found that hotel online reviews in combined presentation formats (text + image and text + video) appear to be more trustworthy than that in single presentation formats (text, image, and video) and will also have a greater impact on consumer decision making. And similarly to positive online reviews (Wang et al., 2015, Xu et al., 2015, Filieri et al., 2021), stronger trusting attitudes towards negative online reviews will likewise enhance behavioural intentions. In addition, tangible (physical facilities and environment) and intangible (client-staff relationship) aspects highlighted in hotel online reviews also influence consumer behavioural intentions, where consumers are typically influenced by the tangible aspects mentioned in hotel online reviews regardless of presentation formats. We found that consumers' behavioural intentions tend to be the strongest when these

tangible features are presented in combined formats.

This study will add to the theoretical understanding of the impact of presentation formats of online reviews on trustworthiness, advancing the literature on trust in eWOM and enhancing the understanding of Generation Z travellers in the tourism and hospitality domains. Empirically, this study will provide insights for practitioners marketing experience goods to predict consumer behaviours and strategically manage replies to online reviews. In addition, by combining the disciplines of marketing and hospitality, this study aims to generate interdisciplinary knowledge about hospitality marketing.

This study is structured as follows. In Section 2, we review pertinent literature. In Section 3, we outline the methodology of this study. In Section 4, we present and discuss the results. In the final two sections, we summarise the findings and discuss practical implications of this study.

2. LITERATURE REVIEW

2.1. Trustworthiness in source credibility theory

In the research on eWOM, the source credibility theory has been used extensively to describe what makes a source trustworthy and the impact of credible sources on consumer behaviours such as purchase intentions. According to Wathen and Burkell, factors that can influence the credibility of information in the online environment include the information provider, the reader, the message, the medium, and the context (Wathen and Burkell, 2002), and these factors are linked to the major two core dimensions of the source credibility theory, source expertise and source trustworthiness, where the former emphasizes the extent to which a source is considered to be an expert, while the latter emphasizes on the degree of confidence of the information provider on communicating the information that he considers most valid (Hovland et al., 1953). This study will concentrate on source trustworthiness.

Liang et al. analysed institution-based trust which refers to the initial trust of consumers on the specific medium (Airbnb) in their study

(Liang et al., 2018), in addition, Mariani et al. drew attention to the online review submission device (Mariani et al., 2019). Bae claims that cultural context plays a role in forming perceptions on trustworthiness of online reviews, and similar reviews may appear different level of trustworthiness for people from different cultural groups (Bae, 2020).

However, source trustworthiness may also be related to the information provider and the recipient. Unlike face-to-face communications, the information provider of eWOM communication on UGC websites are typically unknown, therefore, their identity could play a role on the trustworthiness of online reviews, where Kusumasondjaja et al. demonstrated that when the identity of the information provider is disclosed, a positive online review leads to a greater initial trust than a negative one, however, there are no significant differences when the identity remains unknown (Kusumasondjaja et al., 2012). The reader may also exhibit varying levels of trust based on his or her own personality, with high-trust individuals being more influenced by online consumer reviews (Utz et al., 2011).

Therefore, in this study, only the effects of message (online reviews) on the trustworthiness-related consumer decision-making process are explored.

2.2. Dual coding theory

According to the dual coding theory (Paivio, 1990), the memory stores two distinct and interrelated coding systems, the verbal code system and the non-verbal code system, with text information belonging to the former and image or video information belonging to the latter. People may remember images better than words (Kirkpatrick, 1894) and superiority of images in conceptual and perceptual memory is observed (Stenberg, 2006). Both the right and left hemispheres of the brain are activated when two systems simultaneously analyse information (Paivio et al., 1971, Li et al., 2021), making it easier to acquire information (Buckner et al., 1999). This suggests that a combination of textual and visual presentation of the material could give the readers with more information.

2.3. Textual-only and visual-only presentation of online reviews and trustworthiness

Online consumer reviews generally consists of numerical ratings and text reviews (Huang and Liang, 2021) where the latter are found to have a stronger impact on review readers' evaluative responses such as perceived trustworthiness than the former (De Pelsmacker et al., 2018).

By analysing the effects of textual features on trustworthiness of hotel online consumer reviews, Huang and Liang discovered that attribute salience affects review trustworthiness only for hotels but not restaurants; consequently, the perceived trustworthiness of readers is not significantly influenced by text reviews of either key attributes or general attributes of the product (Huang and Liang, 2021).

Wang et al. found that message characteristics such as message type and message valence influence the persuasiveness of online consumer reviews (Wang et al., 2015) where consumers tend to trust reviewers more and have higher purchase intentions in positive-only and neutral reviews compared to the negative-only ones in terms of the message valence, and benefit-centric reviews involving reviewers' personal feelings rather than attribute-centric reviews appear more credible. Likewise, Huang and Liang reinforced the notion that positive and concrete reviews are more trustworthy than negative and abstract reviews (Huang and Liang, 2021). Mudambi and Schuff also discovered that the length and depth of the online review will also influence its perceived helpfulness and trustworthiness, with longer reviews appearing more helpful and trustworthy than shorter ones, and the level of detail with which consumers describe their experience having a substantial impact on the usefulness of the review for experience goods such as tourism products (Mudambi and Schuff, 2010).

In addition, Baker and Kim argued that written emotional expressions and language complexity are the most effective content criteria for customers to identify the trustworthiness of an online review and customers tend to find it less trustworthy and have less purchase intention when emotions expressed in the online review

(Baker and Kim, 2019, Carbonell et al., 2019). Moreover, the explicit endorsement language (e.g., "I recommend it") used in the online review tends to have greater persuasion (Packard and Berger, 2017).

In conclusion, the content, writing style (degree of detail, type of information, length), review extremity and valence, grammar and mechanics (spelling, punctuation, capitalization, and organizational elements of writing such as paragraphs) (Ketron, 2017) would influence perceived trustworthiness and exert influence on consumers' purchase intentions.

In addition to text, images and videos can be used to effectively convey product information and consumption-related experiences. With an emphasis on image-only content, Lin et al. discovered that eWOM information with images might increase product interest and purchase intentions during the product-searching process (Lin et al., 2012). Similarly, Filieri argues that images of online reviews are as convincing as texts in terms of establishing review trustworthiness and providing evidence of the purchase and the actual consumption of the products and services (Filieri, 2016).

The proverb "a picture is worth a thousand words" (Larkin and Simon, 1987) enables consumers to easily absorb information that cannot be stated simply in words, and it appears more believable when it is uploaded by other customers as opposed to the business itself (Filieri, 2015). And by studying the tourism environment, Filieri et al. discovered that consumers' intentions and decisions are primarily influenced by the visual features of eWOM message (Filieri et al., 2021).

Xu et al. emphasised the visual presentation of online reviews to increase the credibility, where it was discovered that video format intends to be more credible and persuasive compared to text-only ones and consumers perceive these reviews as more trustworthy, especially for experience goods (Xu et al., 2015) such as travel products where consumers will need to rely on the statements given by other consumers because it is not possible for them to evaluate the product

quality until they consume it themselves (Mudambi and Schuff, 2010).

Through comparisons of text, image and video-based online reviews on e-commerce websites, Çelik et al. discovered that the perceived trustworthiness provided by video-based product online reviews can result in a more positive purchase intention (Çelik et al., 2022).

2.4. Combination of textual and visual presentation of online reviews and trustworthiness

Visual features associated with review texts are also presented simultaneously to the readers (Li et al., 2019). Through experiments on hybrid online reviews (verbal reviews accompanied by images) and word-only reviews of tangible goods and intangible services, Wu et al. found that images were particularly effective in providing additional information to moderate reviews and they appear to be more informative when customers are in the stage of browsing phase as opposed to the purchasing phase (Wu et al., 2021).

Li et al. observed that video + text reviews have the greatest impact on purchase intention followed by image + text reviews, however, product type moderates this effect where the above findings are applicable to sensory products such as clothing, whereas text-only reviews were appropriate for non-sensory products such as books (Li et al., 2021).

2.5. Tangible and intangible elements of a hotel product

According to the Search, Experience, Credence (SEC) classification of goods and services, hotels are experience goods featured with multiple unobservable characteristics prior to consumption (Nelson, 1970, Litvin et al., 2018) and a hotel product consists of a variety of separate, but mutually linked elements including both tangible and intangible elements (Xu, 2010). Tangible elements refer to the external appearance, accommodation, and restaurant facilities (Marić et al., 2016) such as cleanliness or tidiness and the physical comfort of the environment where services are provided

(Johnston, 1995), and they are more easily renewed or modified than intangible elements (Albayrak et al., 2010). Intangible elements, on the other hand, concentrate more on the staff-client interaction (Johnston, 1995) such as staff's helpfulness, personal attention, and accuracy of service (Marić et al., 2016). In addition, the aforementioned aspects of the hotel's goods, including rooms, meals, the general environment and atmosphere, and staff service, have been represented in online consumer reviews.

3. METHODOLOGY

This study employs a positivist research design to examine Generation Z travellers' trusting attitudes and trusting behavioural intentions of negative hotel online reviews presented in five formats (text, image, video, text + image, and text + video), the relationship between trusting attitudes and trusting behavioural intentions, and the joint effects of presentation formats and hotel product element types highlighted in the online reviews on trustworthiness through a secondary data analysis in Sri Lanka context.

3.1. Research aim

The aim of this study is to produce knowledge on how different presentation formats of hotel online reviews influence perceived trustworthiness and subsequent behavioural intentions of readers and potential consumers.

3.2. Research objectives and research questions

The first research objective is to determine how the five presentation formats of online reviews (text, image, video, text + image, and text + video) affect the perceived trustworthiness of readers. Therefore, my first research question is whether single presentation formats (text, image, and video) or combined presentation formats (text + image and text + video) of hotel online reviews appear more trustworthy.

The second research objective is to examine the relationship between trusting attitudes and trusting behavioural intentions, thus, my second research question is whether a higher trusting attitude will lead to a higher trusting behavioural intention for both single and combined formats.

The last research objective is to explore the joint effects of presentation formats and highlighted element types (tangible and intangible) in hotel online reviews followed by my last research question, whether online reviews highlighting certain element of the hotel product presented in certain formats tend to be more trustworthy and have a greater influence on consumer decision making.

3.3. Research gap and hypotheses

In light of the literature review in the previous section, it has been demonstrated that there is a correlation between attitudes of the online review readers and their behavioural intentions. The online reviews selected for research are often positive (Li et al., 2021) or a combination of positive and negative (Wang et al., 2015), therefore, it is vital to investigate whether negative reviews will generate the same outcomes, and this study will particularly focus on negative hotel online reviews to fulfill this research gap (Li et al., 2021).

In direct response to Raffaele Filieri's call "...Scholars could analyze whether the combination of different formats can increase review trustworthiness..." (Dwivedi et al., 2021), this study will examine trusting attitudes of five types of presentation formats (text, image, video, text + image, and text + video) as well as the relationship between these attitudes and behavioural intentions, particularly for negative online reviews.

Based on the literature review and research questions beforementioned, I hypothesise that Generation Z travellers see combined format of presentation of hotel online reviews as more trustworthy than single presentation of online reviews (Hypothesis 1), and that higher trusting attitudes will lead to higher behavioural intentions for negative reviews as well (Hypothesis 2).

In addition, I assume that besides presentation formats, elements types highlighted in the hotel online reviews, including tangible (physical facilities and surroundings) and intangible (client-staff relationship) aspects, also influence both the trusting attitudes and behavioural

intentions (Hypothesis 3), and hotel online reviews highlighted with tangible elements presented in combined formats appear to be the most trustworthy format among others (Hypothesis 4).

figures are legible at final size. All lines should be at least 0.1 mm (0.3 pt) wide. Scanned line drawings and line drawings in bitmap format should have a minimum resolution of 300 dpi. Color figures are acceptable but you must ensure that data are distinguishable in grayscale prints.

3.4. Data source

This study investigated cross-sectional data from two surveys done by professors from a local university in June 2022. Both surveys were administered to the same cohort of undergraduate students using the method of convenience sampling.

Both surveys featured authentic consumer reviews straight from internet platforms in order to examine the respondents' perceptions of usefulness, their sentiments toward the reviews, and their anticipated action after reading them. Included were both positive and negative reviews in various presentation formats. Multiple social media channels that are common in Sri Lanka context have been selected for scanning the online reviews suitable for the study including online consumer communities (i.e. TripAdvisor), social networking websites (i.e. Facebook), instant messaging apps (i.e. WhatsApp), blogging and microblogging websites (i.e. Twitter), photo sharing social networking (i.e. Instagram), and video-sharing platforms (i.e. YouTube, Tiktok). Each survey garnered 286 valid responses.

In survey A, respondents were initially questioned about their gender, age, and frequency of online review reading. Then, participants were randomly exposed to three different single presentation formats (text, image, and video) of both positive and negative reviews followed by questions of rating their agreement on the helpfulness, attitudes, and behavioural intentions using a seven-point Likert scale (1 = 'strongly disagree' to 7 = 'strongly agree'). In survey B, three additional online reviews have

been presented in combined presentation formats (text + image, text + video, and image + video) while maintaining the same structure.

3.5. Data relevance and reliability

3.5.1. Online reviews

A trustee's likelihood of being trustworthy is impacted by perceptions on the trustee, attributes of the trustee, and contextual features (Levine et al., 2018). In this study, both the online review provider as trustee and the site they use to post reviews are considered anonymous. Therefore, only impressions of the trustee as represented by their online reviews through the lens of presentation formats will be evaluated, given that the online reviews analysed for this study lacked information about the online review provider and the media they used to deliver reviews.

The original study's text online reviews and text-related online reviews are further analysed based on five criteria derived from the literature: a length of approximately 150 words, a concentrated topic (i.e. primarily about physical facilities or primarily about staff-client relationships), the absence of explicit endorsement language (i.e., "I recommend it."), the absence of emotions, and adequate descriptions. The photo online reviews and photo-related online reviews used in the original study met the criteria for clarity and focus, and the video online reviews and video-related online reviews are also within 2 minutes to assure the attention and focus (Fishman, 2016).

In this research, just five presentation formats will be examined for negative reviews, omitting the format of image + video in consideration of universality and popularity.

3.5.2. Independent variable and dependent variable

Attitude and behavioural intention variables have been selected for this research where the questions asked related to the attitude variable in the original study were further reexamined based on the literature of trust and trustworthiness.

The dominant model for understanding perceived trustworthiness is the ability, benevolence, and

integrity (ABI) model (Mayer et al., 1995), in which states that readers are most likely to trust online review providers whom they perceive to have high ability with the traits of being competent and capable, high benevolence with the traits of being kind and empathic, and high integrity with the traits of being ethical and principled. And these characteristics can be identified from textual and visual data (Sun et al., 2022).

The trustworthiness of readers would be evaluated using two scales: attitudes and intentions, where the former indicates the reader's conviction that the online review provider is trustworthy, and the latter focuses on readers' purpose to act in accordance with their attitudes.

Based on Interpersonal Trust Scale (Rotter, 1967, Johnson-George et al., 1982), questions pertaining to words and short phrases such as "I think", "I believe", "I tend to agree", "Honest", "Genuine", "Fair information", and "Reliable" (Evans and Revelle, 2008, Levi and Stoker, 2000, Corritore et al., 2005, Hetherington, 1998) were considered with special focus on general trust in people who do not have direct relations instead of that in a specific person.

The internal consistency of the selected questions pertaining to trusting attitudes and behavioural intentions for both surveys is good, and the data are reliable, with Cronbach's Alpha (Table 1) greater than 0.80 and within the recommended maximum alpha value of 0.90 (Streiner, 2003). Therefore, trusting attitudes of single presentation formats and trusting attitudes of combined presentation formats are considered independent variables in this study, while behavioural intentions is considered dependent variable.

Table 1 Reliability analysis of the selected secondary dataset

Scales	Items	Cronbach's Alpha
Trusting attitudes of single formats (Survey A)	24	0.842
Trusting attitudes or combined formats (Survey B)	16	0.885
Behavioural intentions of single formats (Survey A)	24	0.860
Behavioural intentions of combined formats (Survey B)	16	0.897

3.6. Analytical strategy

Primarily, descriptive statistics were employed to assess the demographics of the secondary dataset in order to comprehend the fundamental characteristics of the acquired data. Second, Pearson correlation analysis was preformed to determine the relationships between independent variables and the dependent variable using SPSS 25.

4. DISCUSSION

4.1. Descriptive statistics

The demographic variables of 286 valid samples from the secondary dataset are summarised in table 2. It is noted that 47.9% of respondents are males and 52.4% are females, which is comparable with the gender data from the World Bank for Sri Lanka in 2021 where 48.1% of the population is male and 52.9% is female.

In addition, 58% of the respondents were aged from 18 to 22 and another 42% of the respondents from 23 to 27 which fulfills the requirement of the targeted sample of Generation Z travellers, and 81.2% of the respondents frequently read online reviews which shows that the sample is reliable to be further tested on their behavioural intentions.

Table 2 Descriptive statistics for demographic variables

Demographics	Categories	N	%
Gender	Male	136	47.6
	Female	150	52.4
	Total	286	100
Age	18-22	166	58
	23-27	120	42
	Total	286	100
Frequency of reading online reviews	Almost all the time	132	46.2
	Most of the time	100	35
	Sometimes	54	18.8
	Total	286	100

The descriptive statistical results of independent and dependent variables are shown in Table 3, according to Hair, if the absolute value of Skewness is less than 2 and the absolute value of Kurtosis is less than 7, the data conforms to the multivariate normal distribution (Hair, 2009). We could observe that the maximum absolute value of Skewness is 1.307 (<2) and Kurtosis is 0.928 (<7), thus we could conclude that the data obtained are normally distributed which sets fundamentals for further analysis.

Table 3 demonstrates that in terms of trusting attitudes, the mean value of combined formats (mean=4.943) is greater than that of single formats (mean=4.723), and the same result generated in behavioural intentions where the mean value of combined formats (mean=5.293) is more than that of single formats (mean=4.853). Among the top three formats text + image, video, and text + video, respondents view text + image format to be more trustworthy (mean=5.066) and capable of producing a greater influence on consumer decision making (mean=5.353).

Table 3 Descriptive statistics for variables

Items	Min.	Max.	Mean	SD	Skewness	Kurtosis
TA single formats	2.42	6.67	4.723	0.737		
Text	2.00	6.88	4.605	0.900	-0.602	-0.057
Image	1.25	7.00	4.610	1.121	-0.671	0.906
Video	1.50	7.00	4.954	1.059	-0.563	0.281
TA combined formats	1.56	6.88	4.943	1.016		
Text + image	1.00	7.00	5.066	1.264	-0.973	0.663
Text + video	1.38	7.00	4.820	1.069	-0.589	0.158

Items	Min.	Max.	Mean	SD	Skewness	Kurtosis
BI single formats	1.83	6.46	4.853	1.196		
Text	1.38	6.63	4.973	1.311	-1.263	0.928
Image	1.00	7.00	4.403	1.476	-0.430	-0.787
Video	1.88	7.00	5.184	1.266	-0.773	-0.015
BI combined formats	1.63	7.00	5.293	1.445		
Text + image	1.00	7.00	5.353	1.608	-1.307	0.610
Text + video	1.63	7.00	5.233	1.421	-1.100	0.439

TA refers to trusting attitudes, BI refers to behavioural intentions

4.2. Relationship analysis

Values between 0.7 and 1.0 indicate a strong positive relationship in Pearson correlation analysis (Ratner, 2009). Table 4 below demonstrates that independent variables trusting attitudes have a strong positive significant relationship with the dependent variable behavioural intentions, where trusting attitudes towards hotel online reviews in single formats ($r=0.772$, $p<0.01$) tend to have a stronger significant influence on consumer decision making than that in combined formats ($r=0.743$, $p<0.01$).

Table 4 Correlation matrix (N=286)

Variables	1	2	3
1.Trusting attitudes of single formats	1		
2.Trusting attitudes of combined formats	0.578**	1	
3.Behavioural intentions	0.772**	0.743**	1

** $p<0.01$

In addition, a two-way ANOVA analysis was conducted to examine how formats and element types influence trusting attitudes and behavioural intentions, as well as whether there is an interaction effect between formats and element types on trusting attitudes and behavioural intentions. In this analysis, formats and element types are categorical variables with two levels

each: single formats and combined formats for the variable of formats, and tangible and intangible elements for the variable of element types. In addition, gender, age, and habits of reading online reviews have also been included as the covariates of the model.

In terms of trusting attitudes demonstrated in table 5, the main effect from formats on trusting attitudes is statistically significant ($F=14.110$, $p=0.000<0.01$), indicating that formats will statistically affect and create differences in trusting attitudes. In contrast, the main effect of element types is not statistically significant ($F=1.531$, $p=0.216>0.05$), and there are no interaction effects between formats and elements ($F=1.882$, $p=0.170>0.05$).

Table 5 Two-way Anova analysis on trusting attitudes

Source	Sum of Squares	df	Mean Square	F	p
(Intercept)	1267.423	1	1267.423	1298.955	0.000**
Formats	13.768	1	13.768	14.110	0.000**
Element Types	1.493	1	1.493	1.531	0.216
Formats*Element Types	1.836	1	1.836	1.882	0.170
Gender	1.519	1	1.519	1.557	0.212
Age	0.660	1	0.660	0.676	0.411
Habits	10.149	1	10.149	10.402	0.001**
Residuals	1109.399	1137	0.976	null	null

$R^2: 0.025$ (Adjusted $R^2 = 0.020$)

** $p<0.01$

In regard to behavioural intentions demonstrated in table 6, The main effects of formats ($F=28.170$, $p=0.000<0.01$) and element types ($F=15.581$, $p=0.000<0.01$) on behavioural intentions are both statistically significant, showing that both formats and element types will statistically affect and produce differences in behavioural intentions. However, there are no interaction effects between formats and elements ($F=0.920$, $p=0.338>0.05$).

Table 6 Two-way Anova analysis on behavioural intentions

Source	Sum of Squares	df	Mean Square	F	p
(Intercept)	1531.257	1	1531.257	781.197	0.000**
Formats	55.217	1	55.217	28.170	0.000**
Elements	30.540	1	30.540	15.581	0.000**
Formats*Elements	1.803	1	1.803	0.920	0.338
Gender	8.887	1	8.887	4.534	0.033*
Age	5.659	1	5.659	2.887	0.090
Habits	8.744	1	8.744	4.461	0.035*
Residuals	2228.682	1137	1.960	null	null

$R^2: 0.047$ (Adjusted $R^2 = 0.042$)

* $p<0.05$; ** $p<0.01$

According to table 7, when hotel online reviews are provided in single formats, emphasising tangible features (mean=5.057, SD=1.324) has a substantially greater impact on consumer behaviour than emphasising intangible features (mean=4.650, SD=1.276). And when given in combined formats, hotel online reviews that emphasise tangible elements (mean=5.417, SD=1.486) are perceived to have a bigger impact on consumer decision making than those that emphasise intangible elements (mean=5.169, SD=1.520). Therefore, consumers are typically influenced by the tangible aspects mentioned in hotel online reviews regardless of formats when making their purchase decisions.

Table 7 Descriptive statistics for behavioural intentions disaggregated by formats and element types

Element Types/Formats	Tangible			Intangible		
	Mean	SD	N	Mean	SD	N
Single	5.057	1.324	286	4.650	1.276	286
Combined	5.417	1.486	286	5.169	1.520	286
Total	5.237	1.417	572	4.910	1.426	572

4.3. Results

This study investigated how the five presentation formats of online reviews (text, image, video, text + image, and text + video) affect readers' perceptions of trustworthiness and their intentions to engage in a purchase behaviour. We found through secondary data analysis that presentation formats statistically affect and produce differences in trusting attitudes and behavioural intentions, such that hotel online reviews in combined presentation formats (text + image and text + video) appear to be more trustworthy than that in single presentation formats (text, image, and video) and will also have a greater impact on consumer decision making, which proved that hypothesis 1 is valid and the findings are consistent with the observations of Wu et al. where they found text + image presentation format appears to be more informative and trustworthy than text only format (Wu et al., 2021).

Among the top three formats text + image, video, and text + video, respondents view text + image format to be more trustworthy (mean=5.066) and capable of exerting a bigger impact on consumer decision making (mean=5.353). This finding

contradicts the observations of Li et al. where they observed text + video format of online reviews has the greatest impact on purchase intentions followed by that in text + image format (Li et al., 2021). In this study, we selected online reviews of experience goods, whereas Li et al. evaluated online reviews of sensory goods on e-commerce websites. Therefore, we assume that the categories of commodities described in the online reviews might yield different results.

Same as positive online reviews (Wang et al., 2015, Xu et al., 2015, Filieri et al., 2021), higher trusting attitudes towards negative online reviews will also lead to increased behavioural intentions, which supported the hypothesis 2. And we also found that trusting attitudes towards hotel online reviews in single presentation formats ($r=0.772$, $p<0.01$) tend to have a stronger significant influence on consumer decision making than that in combined formats ($r=0.743$, $p<0.01$).

Similar to how product types moderate the effects of online review presentation formats on consumer purchase intentions (Li et al., 2021), we found that tangible (physical facilities and environment) and intangible (client-staff relationship) aspects highlighted in hotel online reviews also influence consumer behavioural intentions, where consumers are typically influenced by the tangible aspects mentioned in hotel online reviews regardless of presentation formats. In addition, we observed that consumers tend to have the highest behavioural intentions when these tangible characteristics are offered in combined formats (mean=5.417, SD=1.486), as combined formats are able to supply more information to the objective components of the hotel product, making it more convincing and trustworthy. Therefore, hypothesis 4 is also valid where hotel online reviews highlighted with tangible elements presented in combined formats appear to be the most trustworthy format among others.

This study also has some limitations. First, in this research, the presentation formats merely considered the negative reviews due to data constraints. Therefore, further studies can take both positive and negative hotel online reviews into account conducting a primary data analysis

to extend this research. Second, image + video presentation format has not been examined in this study, therefore, further studies can include this particular format through an eye-tracking experiment to investigate which combined presentation format appear more trustworthy for consumers.

5. CONCLUSION

Electronic Word of Mouth (eWOM) plays a vital role in tourism and hospitality industry. eWOM created from many social media channels has a significant impact on the decision-making of travellers, particularly those of Generation Z who are digital natives. Online consumer reviews of hotels, as one of the manifestations of eWOM, are examined in this study. Due to the reliability and usefulness of online reviews, an overwhelming majority of consumers consider them before making purchase decisions, however, the issues of fake reviews and promotional reviews have also been reported within the tourism and hospitality industry which stressed the importance of credibility of online consumer reviews.

Source trustworthiness is one of the fundamental components of source credibility theory, and from the perspective of the review reader, disregarding their personal traits, the review provider, the message, the medium, and the context may influence the source trustworthiness. This study focuses on the influence of online review message presentation formats on perceived trustworthiness, with a particular emphasis on negative hotel online reviews.

Using source credibility theory and dual coding theory, we aim to determine how the five presentation formats of online reviews (text, image, video, text + image, and text + video) influence the perceived trustworthiness of readers, to examine the relationship between trusting attitudes and trusting behavioural intentions, and to investigate the joint effects of presentation formats and highlighted element types (tangible and intangible) in hotel online reviews.

By analysing secondary data, we discovered that hotel online reviews in combined presentation formats (text + image and text + video) appear to be more trustworthy than that in single presentation formats (text, image, and video) and will also have a greater impact on consumer decision making. And stronger trusting attitudes towards negative online reviews will likewise enhance behavioural intentions. In addition, tangible (physical facilities and environment) and intangible (client-staff relationship) aspects highlighted in hotel online reviews also influence consumer behavioural intentions, where consumers are typically influenced by the tangible aspects mentioned in hotel online reviews regardless of presentation formats. We found that consumers' behavioural intentions tend to be the strongest when these tangible features are presented in combined formats.

This study contributes to the theoretical knowledge of the impact of presentation formats of online reviews on trustworthiness, expanding the literature on trust in eWOM and enhancing the understanding our understanding of Generation Z travellers in the tourism and hospitality domains. Empirically, this study will equip practitioners marketing experience goods with insights for predicting consumer behaviours and strategically managing replies to online reviews. In addition, this work contributed both conceptually and practically to the field of hospitality marketing, as well as generating interdisciplinary knowledge in this area.

REFERENCES

- Albayrak, T., Caber, M., & Aksoy, S. (2010). Relationships of the Tangible and Intangible Elements of Tourism Products with Overall Customer Satisfaction. *International Journal of Trade, Economics and Finance*, 1, 140-143. doi:10.7763/IJTEF.2010.V1.25
- Bae, S. Y. H. J. H. (2020). Considering Cultural Consonance in Trustworthiness of Online Hotel Reviews among Generation Y. for Sustainable Tourism An Extended T. A. M. Model. *Sustainability*, 12(7). doi:10.3390/su12072942
- Baker, M. A., & Kim, K. (2019). Value destruction in exaggerated online reviews.

- International Journal of Contemporary Hospitality Management, 31(4), 1956-1976. doi:10.1108/IJCHM-03-2018-0247
- Bassiouni, D. H., & Hackley, C. (2014). 'Generation Z' children's adaptation to digital consumer culture: A critical literature review. *Journal of Customer Behaviour*, 13(2), 113-133. doi:10.1362/147539214X14024779483591
- Buckner, R. L., Kelley, W. M., & Petersen, S. E. J. N. n. (1999). Frontal cortex contributes to human memory formation. 2(4), 311-314.
- Carbonell, G., Barbu, C.-M., Vorgerd, L., & Brand, M. (2019). The impact of emotionality and trust cues on the perceived trustworthiness of online reviews. *Cogent Business & Management*, 6(1), 1586062. doi:10.1080/23311975.2019.1586062
- Çelik, Z., Kabak, A., & Uslu, A. (2022). The Effect of Text, Image and Video-Based Product Review Presentation Formats on Online Purchasing Intention. *Anadolu Üniversitesi Sosyal Bilimler Dergisi*, 22, 489-516. doi:10.18037/ausbd.1136341
- Cheung, C. M. K., & Thadani, D. R. (2012). The impact of electronic word-of-mouth communication: A literature analysis and integrative model. *Decision Support Systems*, 54(1), 461-470. doi:https://doi.org/10.1016/j.dss.2012.06.008
- Chevalier, J. A., & Mayzlin, D. (2006). The Effect of Word of Mouth on Sales: Online Book Reviews. *Journal of Marketing Research*, 43(3), 345-354. doi:10.1509/jmkr.43.3.345
- Corritore, C. L., Marble, R. P., Wiedenbeck, S., Kracher, B., & Chandran, A. (2005). Measuring online trust of websites: Credibility, perceived ease of use, and risk.
- Csobanka, Z. E. (2016). The Z Generation. *Acta Educationis Generalis*, 6(2), 63-76. doi:doi:10.1515/atd-2016-0012
- De Pelsmacker, P., Dens, N., & Kolomiiets, A. (2018). The impact of text valence, star rating and rated usefulness in online reviews. *International Journal of Advertising*, 37(3), 340-359. doi:10.1080/02650487.2018.1424792
- Dwivedi, Y. K., Ismagilova, E., Hughes, D. L., Carlson, J., Filieri, R., Jacobson, J., . . . Wang, Y. (2021). Setting the future of digital and social media marketing research: Perspectives and research propositions. *International Journal of Information Management*, 59, 102168. doi:https://doi.org/10.1016/j.ijinfomgt.2020.102168
- Evans, A. M., & Revelle, W. (2008). Survey and behavioral measurements of interpersonal trust. *Journal of Research in Personality*, 42(6), 1585-1593. doi:https://doi.org/10.1016/j.jrp.2008.07.011
- Filieri, R. (2015). What makes online reviews helpful? A diagnosticity-adoption framework to explain informational and normative influences in e-WOM. *Journal of Business Research*, 68(6), 1261-1270. doi:https://doi.org/10.1016/j.jbusres.2014.11.006
- Filieri, R. (2016). What makes an online consumer review trustworthy? *Annals of Tourism Research*, 58, 46-64. doi:https://doi.org/10.1016/j.annals.2015.12.019
- Filieri, R., Lin, Z., Pino, G., Alguezaui, S., & Inversini, A. (2021). The role of visual cues in eWOM on consumers' behavioral intention and decisions. *Journal of Business Research*, 135, 663-675. doi:https://doi.org/10.1016/j.jbusres.2021.06.055
- Fishman, E. (2016). How long should your next video be. *Wistia Blog*.
- Floyd, K., Freling, R., Alhoqail, S., Cho, H. Y., & Freling, T. (2014). How Online Product Reviews Affect Retail Sales: A Meta-analysis. *Journal of Retailing*, 90(2), 217-232. doi:https://doi.org/10.1016/j.jretai.2014.04.004
- Hair, J. F. (2009). Multivariate data analysis.
- Hennig-Thurau, T., Gwinner, K. P., Walsh, G., & Gremler, D. D. (2004). Electronic word-of-mouth via consumer-opinion platforms: What motivates consumers to articulate themselves on the Internet? *Journal of*

- Interactive Marketing, 18(1), 38-52. doi:https://doi.org/10.1002/dir.10073
- Hetherington, M. J. J. A. p. s. r. (1998). The political relevance of political trust. 92(4), 791-808.
- Hovland, C. I., Janis, I. L., & Kelley, H. H. (1953). Communication and persuasion. New Haven, CT, US: Yale University Press.
- Huang, G., & Liang, H. (2021). Uncovering the effects of textual features on trustworthiness of online consumer reviews: A computational-experimental approach. Journal of Business Research, 126, 1-11. doi:https://doi.org/10.1016/j.jbusres.2020.12.052
- Ismagilova, E., Slade, E. L., Rana, N. P., & Dwivedi, Y. K. (2020). The Effect of Electronic Word of Mouth Communications on Intention to Buy: A Meta-Analysis. Information Systems Frontiers, 22(5), 1203-1226. doi:10.1007/s10796-019-09924-y
- Johnson-George, C., Swap, W. C. J. J. o. p., & psychology, s. (1982). Measurement of specific interpersonal trust: Construction and validation of a scale to assess trust in a specific other. 43(6), 1306.
- Johnston, R. (1995). The zone of tolerance. International Journal of Service Industry Management, 6(2), 46-61. doi:10.1108/09564239510084941
- Ketron, S. (2017). Investigating the effect of quality of grammar and mechanics (QGAM) in online reviews: The mediating role of reviewer credibility. Journal of Business Research, 81, 51-59. doi:https://doi.org/10.1016/j.jbusres.2017.08.008
- Kirkpatrick, E. A. J. P. R. (1894). An experimental study of memory. 1(6), 602.
- Kusumasondjaja, S., Shanka, T., & Marchegiani, C. J. J. o. V. M. (2012). Credibility of online reviews and initial trust: The roles of reviewer's identity and review valence. 18(3), 185-195.
- Larkin, J. H., & Simon, H. A. (1987). Why a Diagram is (Sometimes) Worth Ten Thousand Words. Cognitive Science, 11(1), 65-100. doi:https://doi.org/10.1016/S0364-0213(87)80026-5
- Lee, J., Park, D.-H., & Han, I. (2008). The effect of negative online consumer reviews on product attitude: An information processing view. Electronic Commerce Research and Applications, 7(3), 341-352. doi:https://doi.org/10.1016/j.elerap.2007.05.004
- Levi, M., & Stoker, L. J. A. r. o. p. s. (2000). Political trust and trustworthiness. 3(1), 475-507.
- Levine, E. E., Bitterly, T. B., Cohen, T. R., Schweitzer, M. E. J. J. o. p., & psychology, s. (2018). Who is trustworthy? Predicting trustworthy intentions and behavior. 115(3), 468.
- Li, C., Liu, Y., & Du, R. (2021). The Effects of Review Presentation Formats on Consumers' Purchase Intention. Journal of Global Information Management (JGIM), 29(6), 1-20. doi:10.4018/JGIM.20211101.0a46
- Li, L., Ren, G., Hong, T., & Yang, S.-B. (2019). Exploring Simultaneous Presentation in Online Restaurant Reviews : An Analysis of Textual and Visual Content. Asia Pacific Journal of Information Systems, 29, 181-202. doi:10.14329/apjis.2019.29.2.181
- Liang, L. J., Choi, H. C., & Joppe, M. J. I. J. o. H. M. (2018). Exploring the relationship between satisfaction, trust and switching intention, repurchase intention in the context of Airbnb. 69, 41-48.
- Lin, T. M. Y., Lu, K. Y., & Wu, J. J. (2012). The effects of visual information in eWOM communication. Journal of Research in Interactive Marketing, 6(1), 7-26. doi:10.1108/17505931211241341
- Litvin, S. W., Goldsmith, R. E., & Pan, B. (2018). A retrospective view of electronic word-of-mouth in hospitality and tourism management. International Journal of Contemporary Hospitality Management, 30(1), 313-325. doi:10.1108/IJCHM-08-2016-0461
- Mariani, M. M., Borghi, M., & Gretzel, U. (2019). Online reviews: Differences by submission device. Tourism Management, 70, 295-298. doi:https://doi.org/10.1016/j.tourman.2018.08.022

- Marić, D., Marinković, V., Marić, R., & Dimitrovski, D. (2016). Analysis of tangible and intangible hotel service quality components. *Industrija*, 44, 7-25. doi:10.5937/industrija1-8437
- Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). An Integrative Model of Organizational Trust. *The Academy of Management Review*, 20(3), 709-734. doi:10.2307/258792
- Mudambi, S. M., & Schuff, D. (2010). Research Note: What Makes a Helpful Online Review? A Study of Customer Reviews on Amazon.com. *MIS Quarterly*, 34(1), 185-200. doi:10.2307/20721420
- Nelson, P. J. J. o. p. e. (1970). Information and consumer behavior. 78(2), 311-329.
- Nguyen, K. A., & Coudounaris, D. N. (2015). The mechanism of online review management: A qualitative study. *Tourism Management Perspectives*, 16, 163-175. doi:https://doi.org/10.1016/j.tmp.2015.08.002
- Packard, G., & Berger, J. (2017). How language shapes word of mouth's impact. *Journal of Marketing Research*, 54(4), 572-588. doi:10.1509/jmr.15.0248
- Paivio, A. (1990). Mental Representations: A dual coding approach. In. Retrieved from <https://doi.org/10.1093/acprof:oso/9780195066661.001.0001>
- Paivio, A., Ernest, C. H. J. P., & Psychophysics. (1971). Imagery ability and visual perception of verbal and nonverbal stimuli. 10(6), 429-432.
- Ratner, B. (2009). The correlation coefficient: Its values range between +1/-1, or do they? *Journal of Targeting, Measurement and Analysis for Marketing*, 17(2), 139-142. doi:10.1057/jt.2009.5
- Robinson, V. M., & Schänzel, H. A. (2019). A tourism influx: Generation Z travel experiences. *Journal of Tourism Futures*, 5(2), 127-141. doi:10.1108/JTF-01-2019-0014
- Rotter, J. B. (1967). A new scale for the measurement of interpersonal trust. *Journal of Personality*.
- Serra Cantallops, A., & Salvi, F. (2014). New consumer behavior: A review of research on eWOM and hotels. *International Journal of Hospitality Management*, 36, 41-51. doi:https://doi.org/10.1016/j.ijhm.2013.08.007
- Sotiriadis, M. D., & van Zyl, C. (2013). Electronic word-of-mouth and online reviews in tourism services: the use of twitter by tourists. *Electronic Commerce Research*, 13(1), 103-124. doi:10.1007/s10660-013-9108-1
- Stenberg, G. (2006). Conceptual and perceptual factors in the picture superiority effect. *European Journal of Cognitive Psychology*, 18(6), 813-847. doi:10.1080/09541440500412361
- Streiner, D. L. (2003). Starting at the Beginning: An Introduction to Coefficient Alpha and Internal Consistency. *Journal of Personality Assessment*, 80(1), 99-103. doi:10.1207/S15327752JPA8001_18
- Sun, X., Liu, B., Ai, L., Liu, D., Meng, Q., & Cao, J. (2022). In Your Eyes: Modality Disentangling for Personality Analysis in Short Video. *IEEE Transactions on Computational Social Systems*, 1-12. doi:10.1109/TCSS.2022.3161708
- Utz, S., Kerkhof, P., & Bos, J. (2011). Consumers rule: How consumer reviews influence perceived trustworthiness of online stores. *Electronic Commerce Research and Applications*. doi:10.1016/j.elerap.2011.07.010
- Wang, S., Cunningham, N. R., & Eastin, M. S. (2015). The Impact of eWOM Message Characteristics on the Perceived Effectiveness of Online Consumer Reviews. *Journal of Interactive Advertising*, 15(2), 151-159. doi:10.1080/15252019.2015.1091755
- Wathen, C. N., & Burkell, J. (2002). Believe it or not: Factors influencing credibility on the Web. *Journal of the American Society for Information Science and Technology*, 53(2), 134-144. doi:https://doi.org/10.1002/asi.10016
- Wu, R., Wu, H.-H., & Wang, C. L. (2021). Why is a picture 'worth a thousand words'? Pictures as information in perceived

- helpfulness of online reviews. *International Journal of Consumer Studies*, 45(3), 364-378. doi:<https://doi.org/10.1111/ijcs.12627>
- Xu, J. B. J. T. m. (2010). Perceptions of tourism products. 31(5), 607-610.
- Xu, P., Chen, L., & Santhanam, R. (2015). Will video be the next generation of e-commerce product reviews? Presentation format and the role of product type. *Decision Support Systems*, 73, 85-96. doi:<https://doi.org/10.1016/j.dss.2015.03.001>
- Yussof, F. M., Harun, A., Norizan, N. S., Durani, N., Jamil, I., & Salleh, S. M. (2018). The influence of social media consumption on gen Z consumers' attitude. *Journal of Fundamental and Applied Sciences*, 10(6S), 1288-1299.
- Zhuang, M., Cui, G., & Peng, L. (2018). Manufactured opinions: The effect of manipulating online product reviews. *Journal of Business Research*, 87, 24-35. doi:<https://doi.org/10.1016/j.jbusres.2018.02.016>

Psychosocial Stressors and Construction Labor Productivity: A Review

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ABSTRACT

Stress caused when exposed to various psychosocial risks/hazards at work is simply known to be psychosocial stressors. Worker productivity is considered as a crucial element within any organization as it measures the rate at which work is performed. It is generally a known fact that regardless of the cause, any worker experiencing stress in the workplace will showcase a decreased productivity. The paper presents a review of psychosocial stressors and its impact on construction labor productivity from the year 2005 to 2022. Applying content analysis with systematically selected six journal articles, it reviews empirical studies on how the psychosocial stressors have an impact on the construction labor productivity. The objective of this research is to understand what psychosocial risks exist within a workplace and how it impacts on the labor productivity of the workers. This review explored on the mediating role of health, specifically mental and social disorders between psychosocial stressors and labor productivity in accordance with the empirical link. This paper will contribute to the literature on labor productivity, since there is a scarcity of literature related to the impact of the psychosocial stressors on Labor productivity.

1. INTRODUCTION

At present stress is a commonly witnessed issue by everyone. Stress is often encountered by an individual, who must experience unbearable pressure which leads to inability to cope up with the unstable mental and emotional pressure (Mental Health Foundation, 2021). Stress can be

either a positive or a negative condition that respond to a stressor, which lead to affect an individual's physical and mental wellbeing (International Labor Organizations, 2016). In general, stress can be caused if the individual is facing unbearable financial problems, family conflicts which can lead to family stress, losing a job and marital issues etc. Stress in common can have one or many origins. One such origin is stress in a workplace or what is called as "occupational stress". Workplace stress or occupational stress is accepted as a major health hazard (Fortes, A.M., Tian, L., Huebner, E.S., 2020) in any workplace due to its harmful physical and emotional responses that can happen due to unbearable work that an employee has to undergo in the workplace, when there is less or no autonomy over the work and the situation (Canadian Centre for Occupational Health and Safety, 2018). According to ILO, work related stress can be caused when there is an imbalance between the perceived demand, perceived resources and the abilities of the employee to cope with the demand to meet its expectations (International Labor Organizations, 2016). If something causes stress, a challenge or threat is aroused when employees respond to these situations (stressors) (Mustafa et al., 2015). It is a known fact that stress at a workplace causes threats and challenges to an individual's health physically and mentally. Health, which is a vital element of life, plays an important role which contributes to the wellbeing of an employee and the society as well. Without proper health, there is no productivity at work, socio-economic development and the perceived outcomes cannot be achieved (Mustafa et al., 2015). At present,

health is generally accepted as a combination of biological, psychological, and social factors, which are beneficial elements to build up good health (Mustafa et al., 2015). Labor productivity is considered as an important objective to any organization or industry. Work related stress is a major cost to the organization as it immensely affects the productivity (EU-OSHA, 2012). In a workplace, workers might develop stress when they are exposed to various psychological and social related risks, hazards or factors. Recently, these psychosocial risks have made an impact on health and wellbeing of the employees (Galletta et al., 2016) which has resulted in reducing the labor productivity. Due to the presence of work-related stress, psychological and social aspects will lead to creating psychosocial stress which critically influence the employee productivity (Safdar, U., Badir, Y. F., & Afsar, B. (2017).

Although there are previous research findings conducted related to other industries including construction industries regarding the workplace stressors and labor productivity, there is lack of studies assessing how health which includes physical, mental, and social well-being mediates between the independent and dependent variables in the Sri Lankan Construction Industry; in the workplace and how that can directly have an impact on the labor productivity. The objective of this research is to identify and investigate the impact of psychosocial stressors and Construction Labor Productivity. Further, how the presence of the psychosocial stressors will lead to development of health disorders and how it will directly effect on productivity will be analyzed. The outcome of this study will immensely contribute to the literature on labor productivity, since there is a scarcity of literature related to the impact of the psychosocial stressors on Construction Labour Productivity in the construction industry in Sri Lanka.

2. METHODOLOGY

A content analysis is done with 6 articles published in variety of sources between 2005 and 2022. This review is based upon studies published in some of the leading mainstream journals such as: *International Journal of Workplace Health Management*, *American Journal of Epidemiology*, *Journal of Affective*

Disorders, *International journal of environmental research and public health*, *Journal of Construction Engineering and Management*, *Indian Journal of Psychiatry*, *Psychology Research and Behavior Management*, *The Journal of Mental Health Policy and Economics*, *International Journal of Occupational and Environmental Health*, *Kelaniya Journal of Human Resource Management*. These journals were selected because their studies are widely cited, which made those published in those outlets had divergent influence on showcasing the review of psychosocial stressors and labor productivity.

3. RESULTS

3.1. Psychosocial Stressors

The international labor organization defines psychosocial stressors as “the interactions between and among the work environment, job content, organizational conditions and worker’s capacities, needs and culture, a person’s extra job considerations that vary through perceptions and experience, influence health, work performance and job satisfaction” (International Labor Office, 1986). This definition highlights the dynamic interaction and the inter-relationship between the work environment and the human resources (International Labor Organizations, 2016). The term “stressors” has been evolved throughout as psychosocial factors, psychosocial adversity, psychosocial hazards or psychosocial risks. Experts agree and found that the psychosocial risks can cause psychological or physical harm (International Labor Organizations, 2016). Tuveson and Eklund described psychosocial work environment as a multi-factorial system that encompasses the work, workers and the environment (Hanna, T. and Mona, E., 2014). Psychosocial stress refers to the emotional reaction caused due to an imbalance of objective requirements and coping ability, under the stimulation of the environment, life events and other factors (Ke, P. et al. 2021 & Washington, T.D. 2009). Another author mentioned that psychosocial stressors as stressors reflecting the psychological and social aspects of workers and

his surrounding environment (Maqsoom, A., Mughees, A., Khan, A.K., et al. 2018).

Maqsoom, A. et al, (2018), mentioned that psychosocial stress as a condition that leads to stress at the work which can cause issues related to health, performance, and safety problems. Psychosocial stressors can be experienced by a worker in situations like social threats, social evaluation, social exclusion and claiming for the goal-oriented performance (Pruessner, J.C. et al. 2010 & Kogler, L. et al. 2015). If the basic psychosocial needs like maintaining good attachments with the co-workers and maintaining the social self is lost or threatened then social threat and stress will be induced (Kogler, L. et al. 2015). Psychosocial stress also refers to an emotional reaction caused by an imbalance of objective requirements and coping ability under the stimulation of environment, life event and other factors (Washington, T.D. 2009), (Ke, P. et al. 2021). Similarly, psychosocial stressors may be defined as “certain aspects of work design relating to the organization, management of work, and their social and environmental contexts, which have the potential for causing psychological, social or physical harm to the worker” (Cox, T., Griffiths, A., & Rial-Gonzalez, E. 2000).

3.2. Construction Labor Productivity

For any industry, labor productivity is considered as one of the critically important factors in determining the profitability (Yi and Chan, 2014). Productivity could be defined in many ways. Productivity is considered as one of the important factors which effects the overall performance of any construction project. This is a frequently used performance indicator to measure the success of the construction project (Yi and Chan, 2014). According to the Concise Oxford Dictionary, productivity is defined as the power of being productive, efficient and the rate at which goods are produced ((Yi and Chan, 2014). Within the concept of productivity there are 2 distinct components (Yi and Chan, 2014); namely

1. Efficiency is a measure of how well the factors are carefully utilized

2. The rate is a measure of the outputs produced over a period of time

According to Yi and Chan (2014), productivity is a relationship between the output and the inputs in the production process. Construction productivity can also be considered as the measure of outputs which could be obtained by a combination of inputs (Yi and Chan, 2014). Construction industries are labor-intensive, where manpower is the most dominant productive resource, therefore the construction productivity is mainly dependent on human effort and the worker performance (Jarkas, 2010), (Yi and Chan, 2014). According to the American Association of cost engineers, productivity is defined as a relative measure of labor efficiency, either good or bad, when compared to an established base or norm (Yi and Chan, 2014).

Economists and accountants defined labor productivity as the ratio between total resource input and the total product output (Yi and Chan, 2014). In the construction industry, productivity is taken as labor productivity, which basically means the units of work placed, or produced per man hour (Shehata and El-Gohary, 2011). Productivity is defined as the ratio of earned to actual hours (Shehata and El-Gohary, 2011). A research finding defined productivity as the relationship between the output generated by a production or a service system and the input provided to create this output (Prokopenko, J., 1987)

Employee productivity is essential to any industry. To improve the worker productivity, the workplace stressors should be reduced (Javad, M., & Aghajeri, V., 2014). Occupational stress is treated as a property of the work environment (Cox, T., Griffiths, A., & Rial-Gonzalez, E. 2000). The concern for occupational stress focus on 2 scenarios; firstly, stress associated with exposure to physical hazards at work, secondly stress which rises from exposure to psychosocial hazards/factors (Cox, T., Griffiths, A., & Rial-Gonzalez, E. 2000). This research would focus on the second scenario. Psychosocial factors can impact health conditions through indirect stress mechanisms.

Psychological and social stress within a workplace, will make an impact on the health and wellbeing (Galletta, M., Portoghese, I., D'Aloja, E., Mereu, A., Contu, P., Coppola, R. C., & Campagna, M., 2016) of the laborers in the construction industry. If a worker is experiencing stress both psychologically and socially, then that causes psychosocial stress that will critically influence on the performance and productivity of the laborers (Safdar, U., Badir, Y. F., & Afsar, B., 2017).

3.3. Impact of Psychosocial stressors on Construction Labor Productivity

Since construction industry involves a lot of work, psychosocial risks may be present like tight deadlines, heavy workload, difficulty in maintaining social relationships etc. Psychosocial stressors in the construction industry are an important area to focus on as it heavily influences the worker's productivity (Maqsoom, A., Mughees, A. & Khan, A.K., et al. 2018). Identified psychosocial stressors in the construction industry are job insecurity, high demands, low control over the job, inadequate rewards for the efforts are associated with health-related risks (International Labor Organizations, 2016). Due to these stressors, workers tend to develop sleep disorders, eating disorders, depression, bipolar, heavy alcohol consumption, and personality disorders which are known to be mental and social disorders. Several studies show how sleep disorders can be caused due to the psychosocial stressors such as job stressors, higher levels of demand, lower levels of social support, long working hours etc., (Åkerstedt, T. et al. (2012). Developing these mental and social disorders due to the impact of these stressors will lead to affecting the levels of productivity within the construction laborers.

Burnout syndrome is considered a mental disorder which is a result of psychosocial risks such as high workload, poor interpersonal relationships with the co-workers, lower job satisfaction, unsuitable work life balances and their workplace violence's such as harassment and bullying (International Labor Organizations, 2016). Burnout is a state of mental exhaustion

(International Labor Organizations, 2016), and could be occurred due to a disconnection between the laborer and the organization when there are unfair treatments, in equal effort reward balance etc. Eating disorders, insomnia, emotional instability, and rigidity in social relationships are some of the symptoms associated with burnout (International Labor Organizations, 2016). Depression is another well-known mental disorder. Studies conducted shows that depression is developed due to psychosocial stressors in the workplace and shows how depression would predict the labor productivity levels in the workplace (International Labor Organizations, 2016). Depression is caused due to the impact of psychosocial stressors such as low support from co-workers, effort reward imbalance, compromised work life imbalance, poor justice at work (International Labor Organizations, 2016). These psychosocial stressors could be seen heavily in construction sites. The presence of these stressors can led to health related impairments mainly mental and social, within the construction workers. This could hugely effect on the productivity since the construction workers are not in their best health.

According to WHO (World Health Organization, 2005), mental disorders such as personality disorders, depression, anxiety, tension, alcohol abuse can affect the workers level of performance and lower the levels of productivity (Lim, S. et al. (2017). According to Maqsoom, A. *et al.* (2018), various stress variables are grouped into 3 main types of stressors for better understanding (Refer table 1). Same can be adapted as psychosocial stressors existing in construction sites which can be taken into consideration to investigate what mental and social disorders that are aroused within the workers which could directly impact on the labor productivity.

Table 1. Summary of Psychosocial stressors related to workplace stress

Psychosocial stressors related to workplace stress	Measurement Variables
Career development related stressors	higher workload
	lack of training programs
	Not giving credit and due respect on time for work achieved
	Different allowances
	Less control over the work
Motivation related stressors	effort- reward imbalance
	failure to recognize the good job done
	Poor injustice at work
Social related stressors	lack of interactions with the co-workers
	unhealthy interpersonal relationships with family members, co-workers
	Social isolation and work family life imbalance

Source: Maqsoom, A. *et al.* (2018)

The variables discussed in the literature review was categorized under 3 main stressors namely career development, motivation and social related stressors which could be observed within a construction industry (Maqsoom, A. *et al.* 2018). Career development is a key factor which helps the construction workers to set realistic goals to acquire and achieve the necessary skills. Providing career growth opportunities, internal promotions etc. will motivate the construction laborers to enhance the productivity. The absence of these opportunities will lead to create stressors related to career

development which will lead to impact on the productivity levels (Maqsoom, A. *et al.* (2018), where laborers will develop certain mental and social disorders since they are unhappy with the work. Motivation is a key factor which pushes workers to achieve the goals. Monetary rewards like money is considered as a key motivator since it plays an important role in the worker's productivity (Maqsoom, A. *et al.* (2018). Presence of motivation related stressors will lead to reduced productivity since laborers develop mental disorders like depression, tension (International Labor Organizations, 2016), due to not providing proper rewards for the efforts and absence of equality and fairness in the construction sites. Social support is needed to a worker so that he believes he is being cared, loved and respected by his coworkers and the supervisors. Having healthy and supportive interactions between the co- workers and the supervisors have a positive effect on the productivity (Maqsoom, A. *et al.* (2018). Absence of these positive variables will lead to develop social disorders like personality changes, work life imbalance, less support from co-workers, usage of alcohol etc. (International Labor Organizations, 2016), ultimately impact on the labor productivity. The world health organization's healthy workplace framework and model has emphasized that "psychosocial work stressors" is one of the important avenues in creating a conducive workplace (Burton, J., 2010). The stressors or the factors could be termed "psychosocial" because there is a combination of psychological and social aspects in the workplace (Lavoie-Tremblay, M. *et al.* (2005). A developing country like Sri Lanka, faces a lot of problems associated with the laborers productivity due to the psychosocial stressors in the workplace, which leads in developing health impairments which directly impacts on productivity.

The term stressors are evolved over the years as stress, stress factors, stressors, psychosocial factors, psychosocial hazards and psychosocial risks (International Labor Organizations, 2016). When explaining the literature, mostly used term are psychosocial risks and psychosocial hazards instead of psychosocial stressors (International Labour Organizations, 2016). Some Experts

define “psychosocial hazards” as the way of how the management work and the organizational context have been designed, which have the potential for causing psychological, social disorders and physical harm (International Labour Organizations, 2016). Due to the changing world and globalization, there can be instances where there will be room to rise potential psychosocial hazards at the workplace due to the changes in the workplace environment (International Labor Organizations, 2016). Therefore, Cox, Griffiths & Rial-Gonzalez (2000) suggested some of the stressors at work (psychosocial hazards). Below Table 2 shows the main types of psychosocial stressors along with the variables.

3.4. Empirical Findings

The world Health Organization has mentioned the definition of health as” the inclusion of physical and as well as mental health” (Li *et al.*, 2019). A similar study was conducted to explore the relationship of psychosocial work stressors on the health service productivity in a hospital at Brunei. This study showed that an increase in time demand led to an increased risk in developing adverse health outcomes like work related musculoskeletal disorders, stress and other outcomes like absenteeism and demotivation (Adib Ibrahim, M. *et al.* 2019), which has resulted in decreased worker productivity, which shows how mental and social health has a direct impact on the productivity. In the construction industry, many research studies have shown that the construction workers mental health is one of the influencing factor on productivity (Lim, S. *et al.* 2017). Emotional disturbances such as depression and anxiety (Lim, S. *et al.* 2017) which are mental disorders have crucial impact on the labor productivity. Haslam et al, founded out that depression and anxiety which are considered as mental disorders will lack the worker’s concentration, cause emotional distress, reduce motivation and will lead to reduced productivity (HASLAM, C. *et al.* (2005).

Table 2. Categories of Psychosocial Stressors

Categories of Psychosocial Stressors	Stress Variables
Organizational culture and function related stressors	Poor communication, low levels of support for problem-solving and personal development, lack of definition of organizational objectives
Career development related stressors	Career stagnation and uncertainty, under-promotion or over-promotion, poor pay, job insecurity, low social value of work, low control over the job.
Interpersonal relationships at work (social related stressors)	Social or physical isolation, poor relationships with superiors, interpersonal conflict, lack of social support.
Home-work interface	Conflicting demands of work and home, low support at home, dual career problems
Decision latitude / Control	Low participation in decision-making, lack of control over work

Source: Cox, Griffiths & Rial-Gonzalez (2000)

It is found out that depression is the most serious mental health problem among the Korean construction industry (Lim, S. *et al.* 2017) as a result of these psychosocial stressors. Workload is considered as one of the psychosocial stressor to receive attention on its impact on the workers’ health. Presence of heavy workload will lower the self-esteem and will increase the chances of smoking which is considered as a psychological disorder(mental) since the worker believes that alcohol consumption reduces stress (Stavroula Leka, A. J., 2010). There is a strong evidence to

prove that heavy workload offers a threat to both physically and psychologically (mental) health which can lower the worker productivity (Stavroula Leka, A. J., 2010).

Individuals who have less control or no control over the work and has a lower decision latitude has repeatedly associated with stress, anxiety, depression, low self-esteem and other physical health (Stavroula Leka, A. J., 2010). It is also found that career development stressors like high job demands, conflicting demands will give rise to the development of mental disorders (Stavroula Leka, A. J., 2010) which can impact on the labor productivity. Effort-reward imbalance will lead to arising of physical health issues and mental disorders like psychiatric disorders (Stavroula Leka, A. J., 2010). Due to effort reward imbalance many workers especially, in construction sites, will depend on alcohol, which is a social disorder, which is done to reduce the stress (Stavroula Leka, A. J., 2010).

Inability of having social relationships with the supervisors, subordinates and colleagues are stressors which give rise to psychosocial risks. Workers will develop adverse effects due to the exposure of these psychosocial stressors. It's found out that workers develop depression, psychiatric disorders and other health issues (Stavroula Leka, A. J., 2010). Lack of social support will lead to people to be immune to various social and mental disorders as mentioned.

If a worker doesn't exceed in their career or lack of expected career development may be a source of stress. Two main identified elements of potential stress are lack of job security and secondly over or under promotion (Stavroula Leka, A. J., 2010). The career development stressors have an adverse psychological (mental) effect along with physical health. It's found that depressive symptoms and decline in health are raised due to career development stressors (Stavroula Leka, A. J., 2010).

From the empirical findings we can identify the gap on how health related mental and social disorders are developed due to psychosocial risks

which mediates between the independent and the dependent variable causing a direct impact on the labor productivity.

Psychosocial stressors have a major impact on stress related disorders like depression, acute and post-traumatic stress, anxiety, panic and other common mental disorders (Jacob, K. 2013). Psychosocial stress is linked to health behaviors and potential health outcomes (Beutel, T.F., Zwerenz, R. and Michal, M. (2018). There is a previous study which was conducted on the migrants on the south-north water division in china which showed that mental health as an important part of the health migrants (Ke, P. et al. 2021). Evidence also shows that physical, psychological factors, environmental factors influence the migrant's mental health (Ke, P. et al. 2021). Study conducted by Lim, D., et al, shows that lose in worker's productivity is associated with mental and social disorders (Lim, D., Sanderson, K. and Andrews, G. 2000). A study also shows how a group of psychosocial stressors like interpersonal conflicts, communication problems, heavy workload, lack of participation in decision making, insufficient job control was highly correlated to the worker productivity in the South Korean construction industry (Lim, S. et al. 2017). When workers are exposed to the psychosocial stressors in the workplace, it may affect psychologically, socially as well as physically (Cox, T., Griffiths, A., & Rial-Gonzalez, E. 2000). Research was conducted with a group of Chinese female nurses to explore whether health act as a mediating variable between workplace stress and productivity (Li et al., 2019). It was founded that health which includes both physical and mental health acted as a mediating variable between the dependent and independent variable and showed how the mediating variable made a direct impact on the productivity (Li et al., 2019). Health mediates the effect between the workplace stressors and the work ability or the productivity of the workers (van Schaaik et al., 2020). Since health is a combination of physical and mental, it is founded that this mediating variable is stronger with the older workers (van Schaaik et al., 2020). Without proper health, workers cannot perform up to the expectations.

Maintaining healthy, strong and good relationships among the workers and work groups is essential for the workers in any industry. According to a survey conducted by the ministry of labor in Japan, it was revealed that workers experience anxiety and stress at the workplace, due to unsatisfactory interpersonal relationships (social stress) at work (Cox, T., Griffiths, A., & Rial-Gonzalez, E. 2000). Lower interpersonal relationships and support at work will cause social and mental disorders like anxiety, emotional exhaustion and other physical issues (Cox, T., Griffiths, A., & Rial-Gonzalez, E. 2000). There are many studies which show that how the presence of psychosocial stressors leads to developing mental and social disorders, which will directly impact on the worker productivity levels as they are not in their best health. There is strong evidence to show the association between work related health complaints arises due to the exposure to psychosocial risks and how individuals result in health outcomes which impacts on the worker physically, mentally and socially (EU-OSHA, 2012).

Psychosocial risks may have an effect on both psychological and physical health directly through the stress experienced in the workplace. These research findings were conducted in different industries in other countries, however they lack findings on investigating that as a result of psychosocial stressors how health impairments like mental and social disorders arise and lead to reduction of the productivity levels in the Sri Lankan construction industry. Findings mention that how mental and social disorders are emerged as a result of psychosocial stressors which can impact on the worker productivity. Therefore, there is a gap on research findings conducted on Sri Lankan construction industries, investigating how health related impairments like mental and social disorders arise due to psychosocial stressors and how it mediates between the independent and the dependent variable and how it directly impacts on the labor productivity.

Therefore, based on the conceptual framework developed by the author below (Figure 1), it will be possible to deduce that psychosocial stressors

can led to mental and social disorders within the construction workers which then act as a mediating variable to cause an impact of the labor productivity.

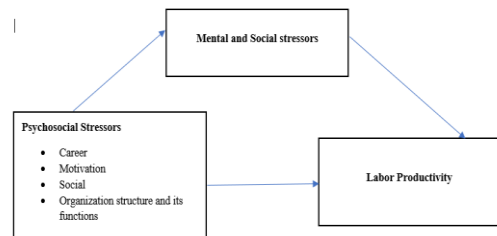


Figure 1: Conceptual framework

4. CONCLUSION

Stress which arises due to exposure to psychosocial risks are a major concern in the construction industry organization nowadays. The literature identified different psychosocial risks experienced by the construction workers and the impact it has on labor productivity. Also, it examined what sort of health impairments such as mental and social disorders are developed due to the psychosocial stress which intervenes as a mediating variable between the dependent and the independent variable which leads to determining the outcome of the dependent variable which is labor productivity. Accordingly, based on the theoretical framework developed through this systematic literature review, future researchers will be able to explore the impact of psychosocial stressors on the construction labor productivity while examining the mediating nature of mental and social disorders.

REFERENCES

- Abbe, O.O. *et al.* (2011) 'Modeling the relationship between occupational stressors, psychosocial/physical symptoms and injuries in the construction industry', *International Journal of Industrial Ergonomics*, 41(2), pp. 106–117. doi:10.1016/j.ergon.2010.12.002.

- Adib Ibrahim, M. *et al.* (2019) 'A Study into Psychosocial Work Stressors and Health Care Productivity', *The International Journal of Occupational and Environmental Medicine*, 10(4), pp. 185–193. doi:10.15171/ijoem.2019.1610.
- Åkerstedt, T. *et al.* (2012) 'Predicting sleep quality from stress and prior sleep – A study of day-to-day covariation across six weeks', *Sleep Medicine*, 13(6), pp. 674–679. doi:10.1016/j.sleep.2011.12.013.
- Beutel, T.F., Zwerenz, R. and Michal, M. (2018) 'Psychosocial stress impairs health behavior in patients with mental disorders', *BMC Psychiatry*, 18(1), p. 375. doi:10.1186/s12888-018-1956-8.
- Burton, J., 2010. *WHO Healthy Workplace Framework and Model: Background and supporting Literature and practise*, Geneva: WHO Press, World Health Organization.
- Campbell, F., 2006. Occupational Stress in the Construction Industry. *CIOB*.
- CASSEL, J. (1976) 'THE CONTRIBUTION OF THE SOCIAL ENVIRONMENT TO HOST RESISTANCE1', *American Journal of Epidemiology*, 104(2), pp. 107–123. doi:10.1093/oxfordjournals.aje.a112281.
- Cattell, K.S. *et al.* (2017) *The state of well-being in the construction industry*. Bracknell: Chartered Institute of Building (CIOB).
- Cox, T., Griffiths, A., & Rial-Gonzalez, E. 2000. *Research on Work Related Stress. European Agency for Safety and Health at Work*, Luxembourg, Office for Official Publications of the European Communities
- European Agency for Safety and Health at Work (EU-OSHA), 2012. *Drivers and barriers for psychosocial risk management: an analysis of the findings of the European Survey of Enterprises on New and Emerging Risks (ESENER)*, Luxembourg: Luxembourg: Publications Office of the European Union.
- Folkman, S. *et al.* (1986) 'Appraisal, coping, health status, and psychological symptoms.', *Journal of Personality and Social Psychology*, 50(3), pp. 571–579. doi:10.1037/00223514.50.3.571.
- Fortes, A.M., Tian, L., Huebner, E.S., 2020. Occupational stress and employees complete mental health: A cross-cultural empirical study. *International Journal of Environmental Research and Public Health* 17. doi:10.3390/ijerph17103629
- Faragher, E.B., Cooper, C.L. and Cartwright, S. (2004) 'A shortened stress evaluation tool (ASSET)', *Stress and Health*, 20(4), pp. 189–201. doi:10.1002/smi.1010.
- Galletta, M., Portoghese, I., D'Aloja, E., Mereu, A., Contu, P., Coppola, R. C., & Campagna, M. (2016). Relationship between job burnout, psychosocial factors and health care-associated infections in critical care units. *Intensive and Critical Care Nursing*, 34, 59–66
- Hanna, T. and Mona, E., 2014. Psychosocial work environment, stress factors and individual characteristics among nursing staff in psychiatric in-patient care. *International journal of environmental research and public health*, 11(1), pp. 1161–1175
- Hashmi, IM. *et al.* (2015) 'Causes and Prevention of Occupational Stress', *IOSR Journal of Dental and Medical Sciences*, 14, 11 Ver. VIII, pp. 98–104. Available at:

- <https://www.researchgate.net/publication/321019697>(Accessed 02 June 2022).
- HASLAM, C. *et al.* (2005) 'Anxiety and depression in the workplace: Effects on the individual and organisation (a focus group investigation)', *Journal of Affective Disorders*, 88(2), pp. 209– 215. doi: 10.1016/j.jad.2005.07.009.
- International Labour Organizations, 2016. *Workplace Stress: A collective challenge*, Geneva: ILO Publications.
- International Labor Office (ILO). (1986). Psychosocial factors at work: Recognition and control. Report of the Joint ILO/WHO Committee on Occupational Health, Geneva.
- Jarkas, A.M. (2010) 'Critical Investigation into the Applicability of the Learning Curve Theory to Rebar Fixing Labor Productivity', *Journal of Construction Engineering and Management*, 136(12), pp. 1279–1288. doi:10.1061/(ASCE)CO.1943-7862.0000236.
- Maqsoom, A. *et al.* (2018) 'Intrinsic psychosocial stressors and construction worker productivity: impact of employee age and industry experience', *Economic Research-Ekonomska Istrazivanja*, 31(1), pp. 1880–1902. doi:10.1080/1331677X.2018.1495571.
- Jacob, K. (2013) 'Psychosocial adversity and mental illness: Differentiating distress, contextualizing diagnosis', *Indian Journal of Psychiatry*, 55(2), p. 106. doi:10.4103/00195545.111444.
- Jarkas, A.M. (2010) 'Critical Investigation into the Applicability of the Learning Curve Theory to Rebar Fixing Labor Productivity', *Journal of Construction Engineering and Management*, 136(12), pp. 1279–1288. doi:10.1061/(ASCE)CO.1943-7862.0000236.
- Javad, M., & Aghajeri, V. (2014). Investigating factors affecting labor productivity: A case study in Eghtesad-e-Novin Bank, Iran. *European Online Journal of Natural and Social Sciences*, 2(3), 3301–3310.
- Ke, P. *et al.* (2021) 'The Relationship Between Mental Health and Psychosocial Stress of Reservoir Migrants in the Middle Route of China's South-to-North Water Diversion Project (SNWDP): The Mediating Role of Social Support', *Psychology Research and Behavior Management*, Volume 14, pp. 299–306. doi:10.2147/PRBM.S297416.
- Kogler, L. *et al.* (2015) 'Psychosocial versus physiological stress — Meta-analyses on deactivations and activations of the neural correlates of stress reactions', *NeuroImage*, 119, pp. 235–251. doi:10.1016/j.neuroimage.2015.06.059.
- Lim, D., Sanderson, K. and Andrews, G. (2000) 'Lost productivity among full-time workers with mental disorders', *The Journal of Mental Health Policy and Economics*, 3(3), pp. 139–146. doi:10.1002/mhp.93
- Li, Y. *et al.* (2019) 'The Effect of Presentism on Productivity Loss in Nurses: The Mediation of Health and the Moderation of General Self-Efficacy', *Frontiers in Psychology*, 10. doi:10.3389/fpsyg.2019.01745.
- Lim, S. *et al.* (2017) 'Analyzing psychological conditions of field-workers in the construction industry', *International Journal of Occupational and Environmental Health*, 23(4), pp. 261–281. doi:10.1080/10773525.2018.1474419
- Lavoie-Tremblay, M. *et al.* (2005) 'Improving the psychosocial work environment', *Journal of Advanced Nursing*, 49(6), pp. 655–664. doi:10.1111/j.1365-2648.2004.03339.x.
- Maqsoom, A., Mughees, A., Khan, A.K., *et al.* (2018) 'Labor Productivity in Construction Industry: Investigating the Influence of

- Internal Psychosocial Stressors', in *ICCREM 2018: Analysis of Real Estate and the Construction Industry - Proceedings of the International Conference on Construction and Real Estate Management 2018*. Reston, VA: American Society of Civil Engineers, pp. 10–17
- Maqsoom, A. *et al.* (2018) 'Intrinsic psychosocial stressors and construction worker productivity: impact of employee age and industry experience', *Economic Research-Ekonomska Istrazivanja*, 31(1), pp. 1880–1902. doi:10.1080/1331677X.2018.1495571
- Mental Health Foundation, 2021. *Stress*. [Online] Available at: <https://www.mentalhealth.org.uk/about/s/stress#:~:text=Stress%20is%20the%20feeling%20of,with%20mental%20or%20emotional%20pressure>. [Accessed 18 June 2022].
- Mustafa, M., Illzam, E.M., Muniandy, R.K., Hashmi, M.I., Sharifa, A.M. and Nang, M.K., 2015. Causes and prevention of occupational stress. *IOSR Journal of Dental and Medical Sciences*, 14(11), pp.98-104
- Prokopenko, J., 1987. *Productivity Management: A practical handbook*, Geneva: International Labour Organisation.
- Pruessner, J.C. *et al.* (2010) 'Stress regulation in the central nervous system: evidence from structural and functional neuroimaging studies in human populations - 2008 Curt Richter Award Winner', *Psychoneuroendocrinology*, 35(1), pp. 179–191. doi:10.1016/j.psyneuen.2009.02.016
- Safdar, U., Badir, Y. F., & Afsar, B. (2017). Who can I ask? How psychological safety affects knowledge sourcing among new product development team members. *The Journal of High Technology Management Research*, 28(1), 79–92
- Shehata, M.E. and El-Gohary, K.M. (2011) 'Towards improving construction labor productivity and projects' performance', *Alexandria Engineering Journal*, 50(4), pp. 321–330. doi:10.1016/j.aej.2012.02.001.
- Stavroula Leka, A. J., 2010. *Health Impact of Psychosocial Hazards at Work: An Overview*, Geneva: World Health Organization.
- Thilakasiri, K. K., De Silva, R.D. (2014). Analysis of Stress on Employees' Productivity: A Study based on Air Force Officers in Sri Lanka. *Kelaniya Journal of Human Resource Management*, 09(2), p. 20.
- Van Schaaik, A. *et al.* (2020) 'Mediating Factors for the Relationship between Stress and Work ability over Time in Young Adults', *International Journal of Environmental Research and Public Health*, 17(7), p. 2530. doi:10.3390/ijerph17072530.
- World Health Organisation, 2005. *Mental Health Policies and Programmes in the Workplace*, Geneva: WHO Press.
- Washington, T.D. (2009) 'Psychological Stress and Anxiety in Middle to Late Childhood and Early Adolescence: Manifestations and Management', *Journal of Pediatric Nursing*, 24(4), pp. 302–313. doi:10.1016/j.pedn.2008.04.011.
- Wickramasinghe, V. (2012) 'Supervisor support as a moderator between work schedule flexibility and job stress', *International Journal of Workplace Health Management*, 5(1), pp. 44–55. doi:10.1108/17538351211215384.
- Yi, W. and Chan, A.P.C. (2014) 'Critical Review of Labor Productivity Research in Construction Journals', *Journal of Management in Engineering*, 30(2), pp.

Impact of Macro-Economic Factors on the International Tourist Arrivals: An Analysis of Sri Lanka and its Regional Competitors

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ABSTRACT

Globally, tourism has become one of the most rapidly expanding industries because of its economic and cultural importance. Understanding how dynamic economic conditions affect tourism development in Sri Lanka is crucial in achieving the future development goals of the country. This paper investigates the impact of the Gross Domestic Product (GDP), Foreign Direct Investment (FDI), and Inflation Rate (IR) on International Tourist Arrivals (ITA) of Sri Lanka and its two regional competitors, i.e., Malaysia and Singapore. Annual data of variables were extracted from the World Banks Database for the period of 1995 to 2019. The Descriptive analysis was carried out to compare the behavior of the different variables among the selected countries. The effect of macroeconomic variables on tourist arrivals in each country was examined by employing multiple linear regression analysis. It was identified that GDP contributes positively to tourism visits in each country. Further, in Singapore, FDI positively impacts tourist arrivals, whereas Sri Lanka and Malaysia haven't experienced any significant changes due to FDI. However, fluctuations in tourist arrivals in any country did not correlate with changes in national

inflation. Importantly, the growing FDI sector in Singapore has been found to contribute to the increase in the demand for tourism. In conclusion, the economic growth of a country could be identified as an important factor that should be a primary concern for tourism development. The findings of the study assists in developing policies and regulations to achieve sustainable tourism development in Sri Lanka.

Keywords: *Foreign Direct Investment, Gross Domestic Product, Inflation Rate, Macroeconomic Factors, Tourist Arrivals, Regional Tourism Competitors*

1. INTRODUCTION

The travel and tourism industry has been accepted as one of the largest service industries in the world and tourism receipts caused by tourism arrivals provide an important source of foreign exchange for countries around the world (The World Bank Group, 2017). With the understanding of the enormous economic benefits gained through tourism, many countries focus on tourism development and attracting tourists.

It is important to explore the impact of the economic sector on the tourism industry, which can cause a huge contribution to the development of the industry. Worth USD 7.6 trillion, the travel and tourism sector accounts for more than 10% of global GDP, represents 7% of all international

trade, and 30% of the world's export in services. Also, tourism has been identified as the third largest global export, after chemicals and fuels, and ranked ahead of automotive products and food. From 2010 to 2015, export earnings from international tourism grew by nearly 25% providing an important source of foreign exchange for countries around the world and supporting economic growth (The World Bank Group, 2017). Tourism has been identified as the second fastest-growing industry in terms of foreign direct investment (FDI) attraction. Also, FDI is considered as a better source of financing for the tourism sector (Rajapakse, 2016; The World Bank Group, 2017).

Similarly, Foreign Direct Investment (FDI), Inflation Rate (IR), and Gross Domestic Product (GDP) have been used by many researches to understand the nature of the economy of a country (Cho, 2001; Croes & Vanegas, 2005; Rajapakse, 2016; Witt & Turner, 2002). Along with that, many studies have focused on various factors that affect the tourism arrivals towards a particular destination emphasizing the importance of different Macroeconomic variables (Croes & Vanegas, 2005; Witt & Turner, 2002).

The tourism industry of Sri Lanka became the third export income earner of the country respectively in 2018 and 2019 (Sri Lanka Tourism Development Authority, 2019) and Sri Lanka has been identified as the world's best destination to travel to in 2019 by Lonely Planet, i.e., a popular travel guidebook publisher (Daily News, 2018) supporting the promotion of Sri Lanka tourism in the global market. However, according to the Travel and Tourism Competitiveness Index, Sri Lanka has secured the rank 77 and regional competitors like Singapore (rank 17th), Malaysia (29th), Thailand (31st), India (34th), Indonesia (40th) and Vietnam (63rd) have ranked well ahead of Sri Lanka in 2019 (Daily FT, 2020; World Economic Forum, 2019).

Hence, the present study focused on how macro-economic factors, i.e., Foreign Direct Investment (FDI), Inflation Rate (IR), and Gross Domestic Product (GDP) impact on the Number of International Tourist Arrivals (ITA) of Sri

Lanka, and its top two regional competitors, i.e.; Singapore and Malaysia. To achieve the aim of the study, the following research objectives have been formulated:

- i. To understand the changing patterns of the selected Macroeconomic factors and the Number of International Tourist Arrivals of the three selected countries.
- ii. To understand the impact of Macroeconomic factors on the Number of International Tourist Arrivals of three selected countries.
- iii. To comparatively understand the impact of Macroeconomic factors on the Number of International Tourist Arrivals of Sri Lanka and its regional competitors, i.e., Singapore and Malaysia.

Thus, the present study serves as the basis for supporting tourism strategies, investment, management, and enabling sustainable tourism development in Sri Lanka to gain competitive advantage among its regional competitors.

2. LITERATURE REVIEW

Many studies have been undertaken to understand the causal relationship between GDP and International Tourist Arrivals. Rajapakse (2016) identified that GDP has a unidirectional effect on International Tourist Arrivals for Sri Lanka. Dhungel (2015) revealed that there is a unidirectional causality relationship from GDP to tourism of Nepal in the long run using econometrics methods. According to Altaf (2021), GDP per capita is a significant positive determinant of tourists' arrival to India. In the reverse, Sulasmiyati (2019) proved that tourist arrivals significantly contribute to the growth of economic activities and also TERZİ (2015) showed that the effect of tourism revenue promotes the economic growth in Turkey. Further, Lee et al. (2008) implemented the new heterogeneous panel cointegration method and found the unidirectional causality running from tourism to growth of economy in Organization for Economic Co-operation and Development (OECD) countries, and bidirectional causality in non OECD countries for the period of 1990-2002. However, a negative bidirectional causality between real GDP and international

tourist arrival in the short-run as well as in the long run was identified by Ben Jebli et al. (2018) for the top ten international tourism destinations using panel cointegration and Granger causality test.

The previous studies also have argued that FDI to be one of the most impactful way for developing countries to boost their tourism sectors. Peri et al. (2011) investigated that FDI has a significant positive influence on the tourist arrivals. It concluded that FDI plays a crucial role in the development of the tourism industry in developing countries. Similarly, Garcia-flores et al. (2008) and Samimi et al. (2013) emphasized the need for FDI in expanding the tourism sector in the countries. Perić et al. (2015) also found that FDI has a significant impact on the tourism productivity of Croatia through regression analysis. The result showed that the stock FDI in tourism affected tourism productivity growth by agreeing with the study of Tondl et al. (2008). Therefore, the positive relationship from FDI to tourism indicates the requirement of FDI for the tourism development of a country. However, the previous studies have suggested a reverse causal relationship between FDI and tourism. Fauzel (2020) revealed a bidirectional causality between FDI and tourism development for the long run. Also Fereidouni & Al-mulali (2014) found that FDI in real estate in OECD countries has a bidirectional causal relationship with international tourism in the long run. Samimi et al. (2013) identified a bidirectional long-run causality between tourism related FDI and tourism growth in developing countries by applying panel-cointegration tests. Using the homogenous and instantaneous causality tests, Craigwell et al. (2008) determined a bidirectional causal relationship between FDI and tourism in Small Island Developing States (SIDS). Accordingly, it could be identified that FDI plays a significant role in tourism growth, while tourism development significantly attracts FDI.

Meanwhile, literature reveals that national inflation is also a critical economic factor that affect the tourism sector. According to Sulasmiyati (2019), inflation factors negatively affected foreign tourist arrivals in Indonesia,

which emphasized the need for controlling inflation. Furthermore, a study by Khan et al. (2022) examined the impact of inflation on tourist inflows and concluded that a high inflation rate exacerbates the problem of declining tourism by making everything more costly and deterring investors and tourists. This aligns with the findings of Huseynli (2022) and Achyar et al. (2021). According to the study by Meo et al. (2018), a decrease in inflation as well as an increase in inflation negatively affects tourism in the long run. Additionally, it demonstrated that an decline in inflation is more likely to affect tourism demand than an increase in it. Therefore, inflation also could be identified as an influencing factor towards the tourism sector of a country.

3. RESEARCH METHODOLOGY

The present study has used annual time series data on the four variables namely Number of International Tourist Arrivals (ITA), Gross Domestic Product (GDP), Inflation Rate (IR) and Foreign Direct Investment (FDI) for the period of 1995 to 2019. The data for these variables were considered from the three countries selecting Sri Lanka as the country of consideration, and Singapore and Malaysia as its top regional competitors in South Asia and South East Asia. Accordingly, the present study is based on secondary data, and were taken from the World Banks Database from 1995 to 2019 based on the availability of data (The World Bank, 2021). Graphical interpretation and descriptive analysis were carried out to compare the behavior of each variable over the period among the selected countries. Multiple linear regression was employed to examine the macroeconomic variables' impact on ITA in each country. The model used in this study can be specified as,

$$ITA=f(GDP, FDI, IR) \quad (1)$$

where, ITA = Number of International Tourist Arrivals (thousand), GDP = Gross Domestic Product (billion US\$), FDI = Foreign direct investment (million US\$), IR = Inflation (%).

The multiple linear regression model can be written as,

$$ITA_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 FDI_{it} + \beta_3 IR_{it} + \varepsilon_i \quad (2)$$

where, ITA_{it} = number of international tourist arrivals of each country, $\beta_0, \beta_1, \beta_2, \beta_3$ = regression coefficients, and ε_i = random error term.

3.1. Conceptual Framework

The conceptual framework of the present study represents the impact of the selected independent variables, i.e., FDI, IR, GDP on the dependent variable, i.e., Number of International Tourism Arrivals.

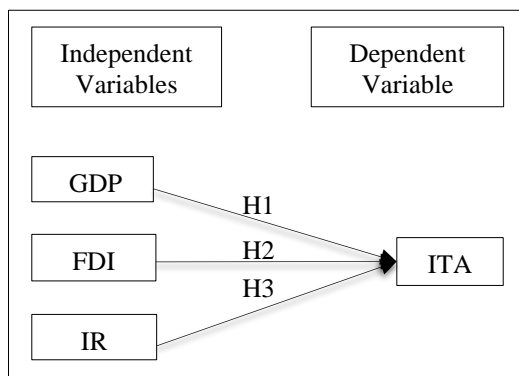


Figure 5: Conceptual Framework

3.2. Hypotheses Formulation

In order to recognize the impact of the independent variables on the dependent variable, testable propositions were developed based on the objectives of the present study. Accordingly, the following hypotheses were drawn.

H1: There is a significant impact of Gross Domestic Product on Number of International Tourist Arrivals.

H2: There is a significant impact of Foreign Direct Investment on Number of International Tourist Arrivals.

H3: There is a significant impact of Inflation Rate on Number of International Tourist Arrivals.

4. FINDINGS OF THE STUDY

4.1. Descriptive Analysis

A comparative analysis of the selected variables over the period between 1995-2019 were analyzed using line charts and the descriptive statistics by comparing each country as follows.

4.1.1. Number of International Tourist Arrivals of the Selected Countries

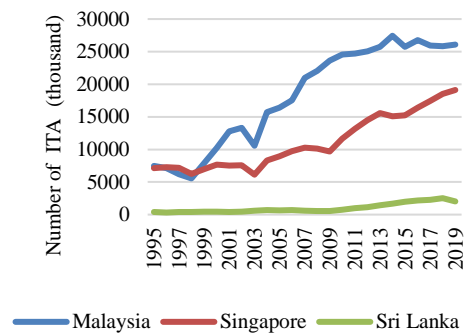


Figure 6: Number of International Tourist Arrivals, from 1995 to 2019

Figure 2 illustrates that the number of tourist arrivals to Malaysia and Singapore has gradually increased during the period of 1995 to 2019, while Sri Lanka showed a slight increase. In the beginning, Malaysia and Singapore have showed a similar pattern from 1995 to 1998, but after 1998 Malaysia remained significantly higher than the other two countries. However, Sri Lanka have showed a very lower number of arrivals compared to the Malaysia and Singapore over the period.

4.1.2. GDP of the Selected Countries

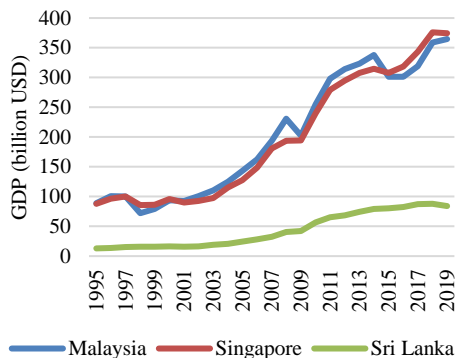


Figure 7: Gross Domestic Product, from 1995 to 2019

According to the figure 3, GDP in Malaysia and Singapore both have gradually increased over the timeframe showing similar patterns. However, during the last 5 years, Singapore has obtained a higher GDP value compared to Malaysia. When focusing to Sri Lanka, the GDP has slightly increased over the years. However, when comparing with the other two countries, a huge gap could be identified where the GDP remained significantly lower than Singapore and Malaysia.

4.1.3. FDI of the Selected Countries

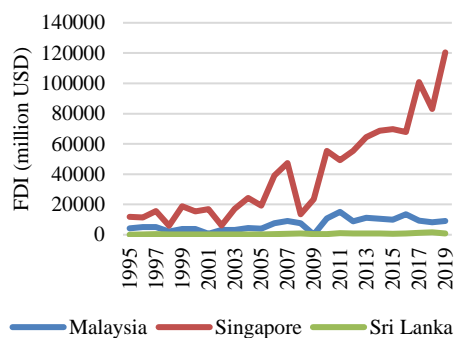


Figure 8: Foreign Direct Investment, from 1995 to 2019

Figure 4 indicates that, FDI in Singapore was significantly higher than compared to other two countries and it has reached its maximum value in 2019. Moreover, Malaysia has shown slight

fluctuations over the years and FDI in Sri Lanka was well below of both Singapore and Malaysia.

4.1.4. Inflation Rate of the Selected Countries

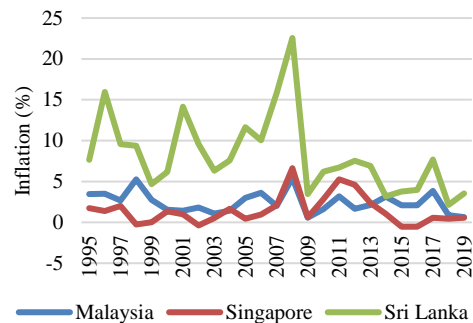


Figure 9: Inflation Rate, from 1995 to 2019

Figure 5 indicates that, IR in Sri Lanka was comparatively higher than the other countries and it has increased to its maximum value in 2008. Moreover, Singapore and Malaysia showed fluctuations in IR over the years and showed a similar behavior in the years of 2007 to 2009 period. However, in most of the years, IR of Malaysia seems to be higher than the IR of Singapore.

4.2. Descriptive Summary Statistics

Table 8: Descriptive Summary Statistics - Malaysia, Singapore, and Sri Lanka

	Mean	Std. Dev.	Minimum	Maximum
<i>Malaysia</i>				
ITA	18214.1	7815.68	5551	27437
GDP	202.8	104.46	72.17	364.68
FDI	6834.93	3952.39	114.66	15119.4
IR	2.43	1.29	0.58	5.44
<i>Singapore</i>				
ITA	11099.9	4193.18	6127	19116
GDP	197.98	105.88	85.73	375.98
FDI	40869.1	31583	5958.65	120439
IR	1.45	1.79	-0.53	6.63
<i>Sri Lanka</i>				
ITA	979.04	702.17	315	2521
GDP	43.84	29	13.03	87.95
FDI	560.49	410.56	56	1614.04
IR	8.25	4.8	2.14	22.56

According to Table 1, the average tourist arrivals to Malaysia during the period from 1995 to 2019, was 18,214.12 thousand tourists which is approximately 2 times higher than the average arrivals in Sri Lanka. A large standard deviation of 7815.68 thousand for Malaysia indicates that the number of tourist arrivals is highly fluctuated in Malaysia. The mean values of GDP in Malaysia and Singapore are close to each other, while the average GDP in Sri Lanka is approximately 5 times lower than them. When focusing to FDI, Singapore averages 40869.1 million US\$ which is far better than other two countries. When focusing to the IR, the average inflation in Sri Lanka is 8.25% which is significantly higher than that in other countries, and Singapore shows a much lower average of inflation compared to others.

4.3. Multiple Linear Regression (MLR) Analysis

4.3.1. The results of MLR analysis for Sri Lanka

Table 9: MLR Analysis - Sri Lanka

Variables	Coefficient	S.E	t - stats (p-value)
Constant	289.40	186.526	1.552 (0.136)
GDP	15.53	4.746	3.272 (0.004)
FDI	0.385	0.308	1.252 (0.224)
IR	-25.105	13.668	-1.837 (0.080)
R ²	0.875		
Adjusted R ²	0.857		
Std. Error	265.171		
Durbin-Watson	1.763		
F- stats (prob.)	49.095 (0.000)		

Table 2 shows the strength of the relationship between the independent variables and dependent variable related to Sri Lanka. It is identified that the independent variables altogether explain the 87.5% of variance ($R^2=0.875$) in the number of tourist arrivals to Sri Lanka. Further, according to the adjusted R^2 value (0.857), 85.7% of the variation in the tourist arrivals is still explained by the equation

without the influence of the explanatory variables. The F- statistics with a p-value (0.000) less than 0.05 indicates that the model has a good fit at 5% level of significance. The t-test results reveal that GDP has a significant positive effect on the number of tourist arrivals to Sri Lanka, while FDI and IR have no any significant effect.

4.3.2. The results of MLR analysis for Malaysia

According to the Table 3, the value of R^2 (0.888) of this model indicates a strong linear relationship between the number of tourist arrivals and independent variables related to Malaysia. It implies that 88.8% of the variation in the number of tourist arrivals in Malaysia is explained by the model. The significance value of the F-statistic ($F=55.328$) is less than 0.05, which explains that the model has a good fit. According to the t test, GDP has a significant positive effect on the tourist arrivals to Malaysia, where β (69.899) is significant with p-value (0.00) less than 0.05. But the effect of FDI and inflation are not significant at 5% level of significance.

Table 10: MLR Analysis - Malaysia

Variables	Coefficient	S.E	t - stats (p-value)
Constant	5191.280	1830.741	2.836 (0.010)
GDP	69.899	9.713	7.197 (0.000)
FDI	-0.019	0.253	-0.075 (0.941)
IR	-420.505	484.69	-0.868 (0.395)
R ²	0.888		
Adjusted R ²	0.872		
Std. Error	2800.77		
Durbin-Watson	1.704		
F- stats (prob.)	55.328 (0.000)		

4.3.3. The results of MLR analysis for Singapore

Table 4 shows that the GDP and FDI in Singapore have the significant positive effect on the number of tourist arrivals to the country, where the model ($F=427.745$) is significant with the p-value (0.000) less than 0.05. Moreover,

98.4% of variation in the number of arrivals is explained by the variation in the independent variables and this shows a very strong relationship between variables. Further, Durbin-Watson test result (1.844) shows the absence of autocorrelation in the residuals.

Table 11: MLR Analysis - Singapore

Variables	Coefficient	S.E	t - stats (p-value)
Constant	3839.744	281.382	13.646 (0.000)
GDP	31.807	3.336	9.536 (0.000)
FDI	0.027	0.011	2.409 (0.025)
IR	-93.229	73.715	-1.265 (0.220)
R ²	0.984		
Adjusted R ²	0.982		
Std. Error	568.815		
Durbin-Watson	1.844		
F- stats (prob.)	427.745 .000		

4.4. Hypothesis Testing and Comparative Analysis

Hypotheses of the present study were tested using the P-value (sig level) of each coefficient of the independent variables. The confident interval of accepting hypotheses was taken as 95% and therefore, P value required to be less than 0.05 (Saunders et al., 2008).

When focusing to the H1, the alternative hypotheses were accepted for all three countries as P-values were less than 0.05. This implies, GDP has a significant impact on the International Tourist Arrivals in all three countries, i.e. Sri Lanka, Malaysia and Singapore. Accordingly, it emphasized that the impact of the GDP is approximately two times higher in Singapore and four times higher in Malaysia, compared to Sri Lanka.

Looking at the results obtained for H2, the alternative hypotheses for Sri Lanka and Malaysia were rejected since P-values were greater than 0.05, which means FDI does not have a significant impact on the International Tourist Arrivals in Sri Lanka and Malaysia. But

a significant impact could be identified for the International Tourist Arrivals of Singapore as its alternative hypothesis was accepted at 5% level of significance. According to the test of H3, the alternative hypotheses belong to all three countries were rejected as P-values were greater than 0.05. Therefore, it could be concluded that Inflation Rate does not have a significant impact on the International Tourist Arrivals in Sri Lanka as well as in Malaysia and Singapore.

5. DISCUSSION

According to the analysis of the present study, it was identified that GDP positively affects the Tourist Arrivals in all the three countries. This finding is in agreement with the previous studies done by Rajapakse (2016) and Akal (2004) emphasizing that, if the country needs to attract more tourists, it must grow GDP that enables better goods and services, facilities and infrastructure for tourists. Therefore, higher the quality of services and hospitality would affect in higher number of tourists and vice-versa.

In terms of FDI, the findings for Singapore are in agreement with the findings of Fauzel (2020), which emphasize a positive and direct relationship between FDI and tourists' arrivals. FDI brings financial capital, technological and managerial expertise beneficial for the tourism development in a country. Further, the implementation of FDI related appropriate policies to explore tourism resources and plan tourism development in terms of accommodation and other facilities to meet the increasing demand of tourism can encourage the international tourist arrivals to a country (Tang, Sumei; Selvanathan, E.A; Selvanathan, 2007). In contrast, any significant effect from FDI on tourist arrivals was not identified in Sri Lanka, and Malaysia which is in agreement with the findings of Rajapakse (2016). Accordingly, unavailability of a favourable climate for investments can discourage the attraction of FDI towards the country. Further, investment projects that are not directly related to the tourism development can have no or less impact on the tourism arrivals.

Inflation has a negative influence on the number of tourists arrivals emphasizing that the price increase of domestic goods, lower the number of

tourists arrivals to Indonesia (Sulasmiyati, 2019). However, findings of the present study revealed that the Inflation Rate has no any significant impact on Tourist Arrivals of Sri Lanka and a similar association in other two countries too. Researcher's view on the possible reasons for this disagreement is that, association of Inflation Rate towards the Number of International Tourist arrivals depends on the economic profile of the top tourist arriving countries, currency of the respective countries and the currency exchange rates. For an example, the top 5 tourist source markets to Sri Lanka in 2019 are India (18.6% of total arrivals), UK (10.4% of total arrivals), China (8.8% of total arrivals), Germany (7% of total arrivals) and France (4.6% of total arrivals) (Sri Lanka Tourism Development Authority, 2019) where the currency and the exchange rates of the respective countries are varying towards one another. This idea is in conformity to Eilat & Einav (2004) which suggests that tourism to developed countries is price elastic, while tourism to less-developed countries is largely unresponsive to price fluctuations.

Additionally, developing countries like Sri Lanka have invested on development projects based on foreign debts rather than FDI. Further, the exchange rates of the host country's currency with other foreign currencies can influence the purchasing power of the tourists that can create impacts on the international tourism arrivals to the considering destinations. Therefore, this study can further be extended by incorporating other macro-economic variables such as exchange rate and foreign debts into the model and accessing how they affect the tourist flow.

6. CONCLUSION

Findings of this study emphasize the effects of the macro-economic factors; GDP, FDI and IR on tourist arrivals vary from country to country. Further, a country's economic growth is one of the top concerns for tourism development. Additionally, the study provides insights towards the directions for the tourism industry and the policy makers for developing strategies, policies, and regulations in line with tourism planning and sustainable tourism development.

7. REFERENCES

- Akal, M. (2004). Forecasting Turkey's tourism revenues by ARMAX model. *Tourism Management*, 25(5), 565–580. <https://doi.org/10.1016/j.tourman.2003.08.001>
- Altat, N. (2021). Modelling the International Tourist Arrivals in India. *Tourism Planning and Development*, 18(6), 699–708. <https://doi.org/10.1080/21568316.2021.1887346>
- Ben Jebli, M., & Hadhri, W. (2018). The dynamic causal links between CO2 emissions from transport, real GDP, energy use and international tourism. *International Journal of Sustainable Development and World Ecology*, 25(6), 568–577. <https://doi.org/10.1080/13504509.2018.1434572>
- Cho, V. (2001). Tourism Forecasting and its Relationship with Leading Economic Indicators. *Journal of Hospitality and Tourism Research*, 25(4), 399–420. <https://doi.org/10.1177/109634800102500404>
- Craigwell, R., & Moore, W. R. (2008). *Foreign Direct Investment and Tourism in Sids : Evidence from Panel Causality Tests Foreign Direct Investment and Tourism in SIDS: Evidence from Panel Causality Tests Roland Craigwell Central Bank of Barbados Barbados Email : rccraigwell@centralbank.org.* (January 2014).
- Croes, R. R., & Vanegas, M. (2005). An econometric study of tourist arrivals in Aruba and its implications. *Tourism Management*, 26(6), 879–890. <https://doi.org/10.1016/j.tourman.2004.04.007>
- Daily FT. (2020). *Sri Lanka tourism – The story untapped.*
- Daily News. (2018). Lonely Planet ranks Sri Lanka as world's #1 travel destination

2019.

013

- Dhungel, K. R. (2015). An Econometric Analysis on the Relationship between Tourism and Economic Growth: Empirical Evidence from Nepal. *International Journal of Econometrics and Financial Management*, 3(2), 84–90. <https://doi.org/10.12691/ijefm-3-2-5>
- Eilat, Y., & Einav, L. (2004). Determinants of international tourism: A three-dimensional panel data analysis. *Applied Economics*, 36(12), 1315–1327. <https://doi.org/10.1080/000368404000180897>
- Fauzel, S. (2020). FDI and tourism futures: a dynamic investigation for a panel of small island economies. *Journal of Tourism Futures*, 7(1), 98–110. <https://doi.org/10.1108/JTF-05-2018-0026>
- Fereidouni, H. G., & Al-mulali, U. (2014). The interaction between tourism and FDI in real estate in OECD countries. *Current Issues in Tourism*, 17(2), 105–113. <https://doi.org/10.1080/13683500.2012.733359>
- Garcia-flores, F., Pérez-Cirera, V., World Wildlife Fund, Martin, P., Alanis, G., Centro Mexicano de Derecho Ambiental, & Guadarrama, L. (2008). Tourism, Trade and the Environment: Tourism and Coastal Development in the Mexican Portion of the Mesoamerican Reef. *Fourth North American Symposium on Assessing the Environmental Effects of Trade Research Paper*, 8(April 2008), 1–19.
- Khan, N. U., Alim, W., Begum, A., Han, H., & Mohamed, A. (2022). Examining Factors That Influence the International Tourism in Pakistan and Its Nexus with Economic Growth: Evidence from ARDL Approach. *Sustainability (Switzerland)*, 14(15). <https://doi.org/10.3390/su14159763>
- Lee, C. C., & Chang, C. P. (2008). Tourism development and economic growth: A closer look at panels. *Tourism Management*, 29(1), 180–192. <https://doi.org/10.1016/j.tourman.2007.02.013>
- Meo, M. S., Chowdhury, M. A. F., Shaikh, G. M., Ali, M., & Masood Sheikh, S. (2018). Asymmetric impact of oil prices, exchange rate, and inflation on tourism demand in Pakistan: new evidence from nonlinear ARDL. *Asia Pacific Journal of Tourism Research*, 23(4), 408–422. <https://doi.org/10.1080/10941665.2018.1445652>
- Peri, J., & Nikši, M. (2011). *Sustainable Foreign Direct Investment in*. 263–278.
- Perić, J., & Radić, M. N. (2015). Tourism productivity and tourism FDI in Croatia. *Mediterranean Journal of Social Sciences*, 6(5S2), 425–433. <https://doi.org/10.5901/mjss.2015.v6n5s2p425>
- Rajapakse, R. P. C. R. (2016). The relationship among FDI, GDP and international tourist arrivals for Sri Lanka: An analysis of granger causality. *Imperial Journal of Interdisciplinary Research (UIR)*, 2(6), 987–993.
- Samimi, A. J., Sadeghi, S., & Sadeghi, S. (2013). The relationship between foreign direct investment and tourism development: Evidence from developing countries. *Institutions and Economics*, 5(2), 59–68.
- Sri Lanka Tourism Development Authority. (2019). Tourism Development Levy.
- Sulasmiyati, S. (2019). Analyzing Inflation Influence Toward the Number of Foreign Tourists Visiting Indonesia and Their Impact on Indonesia'S Economic Growth. *Media Bina Ilmiah*, 14(3), 2181. <https://doi.org/10.33758/mbi.v14i3.321>
- Tang, Sumei; Selvanathan, E.A; Selvanathan, S. (2007). The relationship between foreign direct investment and tourism development: Evidence from developing countries. *Tourism Economics*, 13(1), 25–39.
- TERZİ, H. (2015). Is the Tourism-Led Growth Hypothesis (TLGH) Valid for Turkey. *Doğuş Üniversitesi Dergisi*, 2(16), 165–

178.

<https://doi.org/10.31671/dogus.2018.68>

The World Bank. (2021). DataBank.

The World Bank Group. (2017). *Tourism for development*. Washington.

Tondl, G., & Fornero, J. A. (2008). *Sectoral productivity and spillover effects of FDI in Latin America* *. 1–30.

Witt, S. F., & Turner, L. W. (2002). Trends and forecasts for inbound tourism to China. *Journal of Travel and Tourism Marketing*, 13(1–2), 97–107.
https://doi.org/10.1300/J073v13n01_07

World Economic Forum. (2019). Travel and Tourism Competitiveness Index.

The Migration Intention of the Youth of Sri Lanka: A Concept Paper

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ABSTRACT

The idea that migration is at least partially about 'choice' is deeply ingrained in both academic thought and public policy. Recent contributions have viewed migration choice as a step-by-step process, with a distinction between "aspiration" and "ability" to migrate, while emphasizing a variety of economic and non-economic factors that influence migration choices. One of the major issues in Sri Lanka is youth emigration, which is defined as the act of leaving one's home country with the intention of settling elsewhere. Sri Lankan youth primarily emigrate to developed countries in search of better living conditions. Emigration from Sri Lanka is a continuous process caused by a variety of factors. Studies related to youth migration are acute in Sri Lankan context. The concept paper proposes to conduct a study to investigate migration intention of Sri Lankan youth.

Keywords: *Migration, Migration Choices, Youth Migration*

1. BACKGROUND OF THE STUDY

Migration is old as humankind. Migration is known as a temporary or permanent move of individuals or groups of people from one place to another due to several reasons ranging from persecution to employable possibilities (Haden - Zanker, 2008). People in search of better living conditions for themselves or their loved ones and escaping from the dramatic situation in their

homeland have always been a major cause of migration (Casteli, 2018).

According to the International Organization for Migration (IOM), a migrant is 'any person who is moving or has moved across an international border or within a State away from his/ her habitual place of residence, regardless of (1) the person's legal status; (2) whether the movement is voluntary or involuntary; (3) what the causes for the movement are; or (4) what the length of the stay is.

Migration can be an alternative strategy to get out of the poverty trap (Purwatiningsih, 2021). It is also can be regarded as an effort to increase income which will help to position oneself in the higher status of society. (Purwatiningsih, 2021)

According to the International Organization for Migration (IOM), 272 million migrants have been reported in the year 2019. This means 3.50% of the population. The UN Department of Economics and Social affairs claimed a figure of 281 million in 2020 which is 3.60% of the population. 52% of international migrants being male and 48% being female is a point to be highlighted. Meanwhile, most importantly the fact that 17.5 million out of 272 million migrants are from India followed by Mexico 11.8 million, and China 10.7 million respectively should also be emphasized. 74% of all international migrants are reported to be of the working-age which is 20 – 64 years. It is also a fact that the top destination country remained the United States with a figure of 50.7 million international migrants.

2. THEORIES RELATED TO MIGRATION

Migration theories can be classified into three main categories. They are namely, micro, macro, and meso level theories. Micro-level theories basically focus on individual-level migration. Aggregate migration trends are looked at in Macro-level theories where the Meso level focus between Macro and Micro level which is simply on the household or community perpetuation of migration. (Haden - Zanker, 2008). The table below consists of an overview of migration theories.

Table: 01

Micro-level	Meso-level	Macro-level
Lee's Push/ Pull Factors	Social Capital Theory	Neoclassical macro migration Theory
Neoclassical micro migration Theory	Institutional Theory	Migration as a system
Behavioral Models	Network Theory	Dual Labor Market Theory
Theory of Social Systems	Cumulative Causation	World Systems Theory
	New Economics of Labor Migration	Mobility Transition

Source: Synthesized from Faist (2000)

Neoclassical macro migration is describing migration as a piece of economic development. As a result of geographical differences in the supply and demand of labor, internal migration occurs. (Haden - Zanker, 2008). Dual Labor market theory describes migration as a cause of a temporary pull factor which is precisely a strong

structured labor demand in a developed country (Priore, 1979). As a result of colonialism and the capitalist expansion of neoclassical governments and multinationals, the role of destruction and dislocation happened in the peripheral parts of the world. It is also known as a historical structure approach and in other words, it is the world system theory (Wallerstein 1974). According to Zelinsky (1971) migration is a part of economic and social changes which is again emphasized in the modernization process. He argues that the patterns and rates of migration can be linked with the process of modernization. He further mentions that preferences for personal freedom are a part of the modernization process.

Meso-level theories and factors are particularly focused on access to knowledge about living abroad. This can be related to various personal, community, and diaspora ties, work-based networks as well as recruitment channels for both those in employment and students. Networks, including those established online, play a key role in migration decisions (Boyd, 1989; Epstein and Gang, 2006), by facilitating access to accommodation and employment, easing the initial stress after the arrival.

People moving from one country to another due to better living conditions or to escape from dramatic situations in a homeland are major two drivers of the push and pull theory which has been introduced by Lee in 1966. (Casteli, 2018). This theory mentions that an individual can be pushed by economic, environmental, social, and political factors of the homeland and attract him/her to the destination. Neoclassical micro migration theory explains the human capital approach in which migration is treated as an individual investment decision to increase the productivity of human capital. (Haden - Zanker, 2008). Behavioral models leave out some of the unrealistic assumptions of the human capital approach. The behavioral approach considers non-economic factors and also societal influences which could be vague and rational decision-making is still assumed. (Haden - Zanker, 2008). According to the Theory of Social Systems, migration can be a result of resolving power questions which in other words structural

tensions and agnominal tensions which are prestige questions (Hoffmann-Novotny, 1981).

3. YOUTH MIGRATION

A review of literature indicate that the latest publications are mostly focused on student groups rather than the general population. It is also said that the groups enrolled in education tend to be mobile with a high willingness (Williams et al., 2017). To explain high variations in mobility intentions, Docquier et al., (2014) reveal in their large cross-country study that college-educated individuals are more likely to become actual migrants because of better opportunities to realize their migration potential.

The concern of having less employment as a motivation to migrate is also raised by Minza (2012), that for young people, employment may be a more relevant indicator of perceptions about mobility among them. Moreover, Minza (2012) also suggested that groups of young people from the middle class and simpler backgrounds expect that a better level of education will be a ticket for them from an informality in rural or urban areas to a better future through professional jobs. Young people with mobility intentions are mostly to have siblings or friends abroad (Cairns and Smyth, 2011). Having a family with migration experience is also can influence young people to migrate (Purwatiningsih, 2021).

The main purpose of the proposed study is to identify and understand how the young generation perceive international migration and working abroad. This study will also examine aspirations of the youth towards international migration.

4. MIGRATION IN SRI LANKA

The dominant feature in migration from Sri Lanka is employment. It is driven by economic and labor market differentials. Sri Lanka's total number of emigrants at mid-year 2020 is around 2 million (UN DESA, 2020). The growth and the trend have increased from 1990 to 2020 at an increasing speed.

Sri Lanka had sent migrant workers to around 108 countries in 2017 and almost 90% of them are employed in the middle east which is again to

be known as a dominant migrant destination (Bureau, 2017).

Irregular migration is commonly taken place in Sri Lanka. Trafficking of persons remains a serious concern, although data and information are scarce. Sri Lanka is particularly vulnerable to rapid-onset and slow-onset natural disasters, climate change, and environmental degradation. Further long-standing conflict, political instability, violence, and repression can be identified as significant sources of displacement. In 2019, Sri Lanka recorded 87,000 new displacements as a result of disasters, 1,700 new displacements, and 27,000 internally displaced persons in total as a result of conflict and violence (IDMC, 2019).

Migration intention of Sri Lankans have been increased recently due to various factors. If given the opportunity, 27% of Sri Lankans would like to emigrate, with the young and educated wanting to migrate the most. The percentage is more than 50% for the people who achieved a degree or above (Institute for Health Policy, 2021). According to a recent study conducted by Ekanayake and Amirthalingam (2022), the majority of Sri Lankan professionals in Qatar have extended their stay in the country. Furthermore, a significant number of these professionals intend to permanently relocate to OECD countries rather than return to Sri Lanka, preventing the country from benefiting from their skills. These facts are alarming considering the potential brain-drain that Sri Lanka would have to face in future.

Sri Lanka had to experience the impacts of catastrophic events such as Easter bombings in 2019, Covid -19 during 2020 and 2021 and the worst economic crisis since its independence. Many citizens ponder about migration to a country where they can experience a better quality of life. Migration studies related to Sri Lankan context mostly focused on labor migration (Dissanayake & Samarakoon, 2021). Studies related to youth migration are acute in Sri Lankan context.

Therefore, this concept paper proposes a study which intends to examine the migration intention

of the youth of Sri Lanka. This study will mainly focus on answering the following questions.

1. How do young people perceive international migration and work abroad?
2. What are the aspirations of young people towards international migration?

5. CONCLUSION

This concept paper proposes to conduct research on the migration intention of the youth of Sri Lanka. By the meaning of youth, it is the future of a country. Hence, it is vital to understand the intention of them about sustain of the country and the longevity. There can be several reasons that a youngster may stay in a country. Family commitments, sound financial background, cultural barriers, not having enough funds are few of them. Meanwhile there can be several other aspirations of a youth to leave the country. Therefore, this study aims to analyze through descriptive statistics and quantitative data on the intentions of the youth. Further this study the authors suggest to study on the cultural barriers and peer influence on migration intention.

REFERENCES

- Anoji Ekanayake & Kopalapillai Amirthalingam (2022) Impact of migration of Sri Lankan professionals to Qatar on skill acquisition and brain drain, *Migration and Development*, 11:3, 450-468, DOI: 10.1080/21632324.2020.1787106
- Boyd M. 1989. Family and personal networks in international migration: recent developments and new agendas. *International Migration Review* 23: 638–670.
- Bureau, S. L. (2017). Annual Statistical Report of Foreign Employment . Koswatte, Baththaramulla : Sri Lanka Foreign Employment Bureau.
- Cairns D, Smyth J. 2011. I wouldn't mind moving actually: exploring student mobility in Northern Ireland. *International Migration* 49: 135–161.
- Casteli, F. (2018). Drivers of migration: Why do people move? *International Society of Travel Medicine* , 1-7.
- Dates . (2020, January 20). Migration Data Portal. Retrieved May 1, 2022, from https://www.migrationdataportal.org/data?t=2020&i=stock_abs_origin&cm49=144
- Dissanayake, L. and Samarakoon, I. (2021) “The pattern of temporary international migration in Sri Lanka,” *Colombo Journal of Multi-Disciplinary Research*, 6(1), p. 97. Available at: <https://doi.org/10.4038/cjmr.v6i1.62>.
- Docquier F, Peri G, Ruysen I. 2014. The cross-country determinants of potential and actual migration. *International Migration Review* 48: S37–S99.
- Epstein GS, Gang IN. 2006. The influence of others on migration plans. *Review of Development Economics* 10: 652–665.
- GDP (current US\$) - Sri Lanka | Dates . (2020). The World Bank Group. Retrieved May 1, 2022, from <https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=LK>
- GDP and spending - Gross domestic product (GDP) - OECD Data . (2020). theOECD. Retrieved May 1, 2022, from <https://data.oecd.org/gdp/gross-domestic-product-gdp.htm>
- Haden - Zanker, J. (2008). Why do people migrate? A review of the theoretical literature . Munich Personal RePEc Archive .
- Hoffmann-Nowotny, H.-J. (1981). A Sociological Approach Toward a General Theory of Migration. *Global Trends in Migration*. M. Kritz, L. L. Lim and H. Zlotnik. New York, Centre for Migration Studies.
- Institute for Health Policy, (2021), “Increasing Numbers of Sri Lankans Want to Migrate, especially Youth and Disenchanted Government Voters”, SLOTS Report #2021-01
- Minza, Wenty Marina. 2012. “Young Migrants and Education-to-Work Transitions in Pontianak, West Kalimantan” in *The Asia*

Pacific Journal of Anthropology, 13(1), 64-75.

Piore, M. J. (1979). *Birds of passage: migrant labor and industrial societies*:Cambridge University Press.

Purwatiningsih, S. (2021). International Migration and Aspiration among Young People: Who Desire to migrate? . *Populasi* , 31-45.

Role of foreign employment in Sri Lanka's economic revival: Challenges and opportunities | Daily FT. (2020, 8 juli). DailyFT. Geraadpleegd op 1 mei 2022, van <https://www.ft.lk/opinion/Role-of-foreign-employment-in-Sri-Lanka-s-economic-revival-Challenges-and-opportunities/14-702756>

Sri Lanka . (2019). IDMC. Retrieved May 1, 2022, from <https://www.internal-displacement.org/countries/sri-lanka>

Wallerstein, I. (1974). *The Modern World-system*: Academic Press New York.

Williams, A. M., Jephcote, C., Janta, H., & Li, G. (2017). The migration intentions of young adults in Europe: A comparative, multilevel analysis. *Population, Space and Place*, 24(1), e2123. <https://doi.org/10.1002/psp.2123>

A Review of Methodological Choices in Green Human Resource Management Research

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1. INTRODUCTION

ABSTRACT

The paper presents a methodological review of Green Human Resource Management (Green HRM) research published from the year 2017 to 2022. Applying content analysis with systematically selected 18 journal articles, it reviews methodological choices of empirical studies done in the field of Green HRM based on research design, methods of sampling, methods of data collection, variable measurement, validity, and reliability and methods of data analysis. Findings disclosed a variety of methodological choices utilized by researchers in Green HRM. Many of the studies followed quantitative approach with cross-sectional design. Lack of qualitative research was found in the field, and they followed grounded theory approach. Noteworthy methodological gaps were discovered that could inspire future studies. This review fills the absence of methodological reviews done in Green HRM research and provides an increased comprehension of the methodological stances in current research. Further it provides important future directions to the methodological advancement of Green HRM research.

Key Words: *Green Human Resource Management, Green HRM, Manufacturing, Methodological choices, Methodological review*

JEL Classification: *O15, C80*

The concern for the natural environment is rising in public, demanding the businesses to revise their existing business models towards green

management (Muisyo et al. 2022). During last two decades, sustainability became a powerful buzzword in the academic and policy literature (Ozili 2022). These increased concerns over sustainability pushed the practitioners and academics to consider Human Resource Management (HRM) as a strategic tool in greening organizations, then the economy and society at large (Benevene and Buonomo 2020).

Green Human Resources Management (Green HRM) refers to how human resources can be utilized efficiently and effectively to strengthen environmentally sustainable practices (Chaudhary 2020). Green HRM increase commitment on the issues related environmental sustainability among employees, embracing values of environmental management embedded in human resources initiatives contributing to environmental balance. Moreover, Green HRM contributes to social equity, health, wellness and well-being of both firms and its workforce, as well as the stability of the economy (Chaudhary 2020).

There had been an ever-growing corpus on reviews of Green HRM research in the recent past. Yet, all of them share the concern that, the theoretical, empirical, and methodological advancement in the area is still in need (Benevene and Buonomo 2020). According to Bainbridge et al. (2017), the progress in the field of HR would depend on the employment of

contemplative research designs, consistent measures, and suitable analysis techniques, as it makes a solid foundation for research in future. Powerful methodologies can acclimate challenging problems in the field of study and produce a vigorous body of knowledge (Welbourne 2012).

The objective of this paper is to review the methodological choices of research in Green Human Resource Management. Though there had been numerous systematic reviews done in the field of Green HRM, methodological reviews in Green HRM are almost none. Therefore, this review will systematically evaluate methodological choices utilized in most recent empirical studies carried out in manufacturing sector, in the field of Green HRM. Hence it fills the gap over the absence of methodological reviews in the Green HRM literature. This review aims to provide insights in the field of Green HRM informed by an explicit understanding of its methodological features. The paper is structured as follows: the next section is on reviews of research in the related field, followed by the methods section. Afterwards the result of the systematic review is presented. And at last conclusion is provided with limitations and future directions.

2. REVIEWS OF GREEN HUMAN RESOURCE MANAGEMENT RESEARCH

It was early 1990s, that studies on Green HRM was covered with a large variety of topics, and in the last decade a magnification of academic articles in the Green HRM field was published (Amrutha and Geetha 2020). Despite the popularity that the topic of Green HRM has gained in the recent past, it is noticeable that many of the reviews and studies of this field lack their focus on aligning Green HRM into corporate strategy (Bainbridge et al. 2017).

Though research in Green HRM has gained considerable attention in the current context, most of works in the past were related to awareness, adoption, and implementation of Green HRM practices in firms (Amrutha and Geetha 2020). Therefore, there is a noticeable number of systematic literature reviews, that explored various possible outcomes of adopting

Green HRM practices in organizations. Notwithstanding the expansion in the research which integrated Green HRM with various aspects of environmental performance, lack of attention is given on methods and measurements in Green HRM research (Ren, Tang, and Jackson 2018).

While searching literature for this study purpose, out of the 80 journal articles that narrowed subject to title scan, 13 were review papers in the Green HRM, including 3 bibliometric analyses done within last 5 years. Yet, the narrowed search did not discover any review of methodological choices in Green HRM research done during 2017 to 2022. Therefore, this paper will fill the gap of the absence of methodological reviews in the Green HRM literature during the recent past.

The reason for selecting empirical studies done only in the manufacturing sector is that manufacturing firms are perceived to be more sensitive to environmental issues compared to service firms (Muisyo et al. 2022). Additionally, as manufacturing industry is the most adjacent to the consumer, hence become an earlier adopter of any initiatives related to environment. Moreover, manufacturing industry is the topmost contributor regarding environmental concerns (Rasheed and Alam 2020). Therefore, research in Green HRM should be paid higher attention. With the understanding that environment is highly influenced by activities of human, the employment of Green HRM in the manufacturing industry is trusted to aid in sorting out environmental issues.

3. METHOD

The paper selection process was conducted in according to the PRISMA 2020 statement: an updated guideline for reporting systematic reviews (Page et al. 2021). Eligibility criteria were fixed so that studies published in peer reviewed full-text articles from 2017 to 2022, written in English were selected.

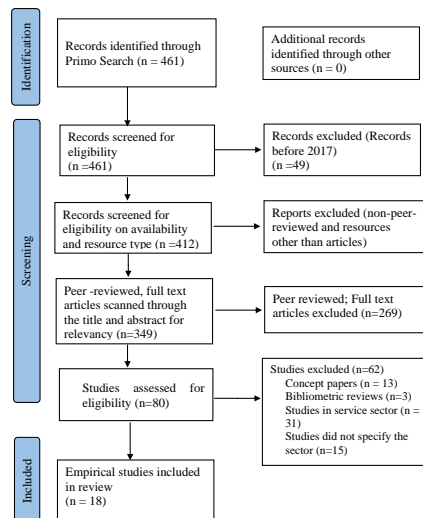
The systematic literature search was conducted in Primo digital library with the below search string ("Green HRM" OR GHRM OR "Green Human Resource Management")

The initial search yielded 461 results from numerous journals and other sources. Secondly, search results were limited to articles published after 2017, which reduced the number of articles to 412. This reduction clearly shows that Green HRM has been propelled in research in the last five years. In further refining the search, the keywords were searched in the publication title and the papers were reduced to 80. The focus was only limited to empirically based papers, thus excluded conceptual papers and pure literature reviews. Through the abstract search, empirical studies conducted only in manufacturing sector were selected. Though there found a plethora of empirical studies done in service sector (especially in tourism and hospitality and higher education), Green HRM scholars have overlooked the research in manufacturing sector. However, in analyzing the recent trend, most manufacturing firms have realized that green innovation is a critical factor that drives their success, hence, green development in the manufacturing sector has become nascent specially in developing countries in the world (Ghouri et al. 2020). Finally, after applying the inclusive and exclusive criteria, 18 papers were determined as eligible for the review of methodological choices (Figure 1).

This review is based upon studies published in twelve leading mainstream journals: The International Journal of Human Resource Management, International Journal of Productivity and Performance Management, International Journal of Manpower, International Journal of Production Economics, Journal of Cleaner Production, Business strategy and the environment, Frontiers in Psychology, Corporate Social Responsibility and Environmental Management, Journal of Manufacturing Technology Management, Journal of Management Development, Sustainability and Environmental Science and Pollution Research. These journals were selected because their studies are widely cited, which made those published in those outlets had divergent influence in the field of Green HRM.

Since content analysis is frequently utilized in examining methodological choices in research (Bainbridge et al. 2017), this study also

Figure 1 Study selection workflow



employed the content analysis using a hierarchical system of codes based on Aguinis et al. (2009) taxonomy of methodological choices (Aguinis et al., 2009). Therefore, each of these articles selected in this study, was coded using the following 5 dimensions: research design, methods of sampling, methods of data collection, variable measurement, validity and reliability, and methods of data analysis

A research design would provide the researcher a framework for the purpose of data collection and data analysis, and the research design choice will reflect decisions regarding the priorities given to the important dimensions of the research process (Bryman 2016). For this methodological review, choices on research design were coded based on research strategy (qualitative or quantitative) and the time horizon (cross-sectional or longitudinal).

The sampling method selected for a study is a significant factor on the generalizability of an empirical research study. Four codes: simple random sampling, convenience sampling, snowball sampling, and purposive sampling, were considered for the content analysis in this study, covering both probability and non-probability sampling methods. When specific information was not found on the sampling method, it was assumed that such studies had used a convenience sampling (Lapierre and McMullan 2015).

Data collection in research is the process where information is collected from all the relevant sources for the purpose of finding answers to research problem of study and to test the hypothesis. In this review, methods of data collection were coded as follows: online survey, questionnaire, semi-structured interviews, focus group. Moreover, coding was done according to the number of sources used for data collection as well. In case the study employed multiple sources in data collection, it was coded as 'multisource,' and when data collection was done using a single source, the code was 'single source.'

Any research should be evaluated for its quality of measurements used in the study. It is crucial to judge whether the study has used correct tools to measure the concepts. The following codes supported the analysis of the variable measurements: existing scale adapted, and the new scale used. According to Bryman (2016), validity and reliability measures ensure the research findings are generalizable. In this review, separate coding was used to review the availability of validity and reliability. Additionally, specific strategies related to validity and reliability concerns are also captured in this review.

In coding the methods of data analysis, Casper et al.'s (2007) coding process was adapted as it was widely used in methodological reviews in industrial-organizational psychology and organizational behaviour journals over in recent years. Following codes were identified accordingly.

1. Simple inferential statistics (e.g., correlation, t-tests).
2. Techniques to examine one dependent variable (e.g., Multiple regression, Anova).
3. Techniques to examine multiple relations (e.g., structural equation models).
4. Techniques to examine the structure of data (e.g., exploratory factor analysis).
5. Qualitative analysis (e.g., content analysis).

Specific statistical tests or analysis techniques used in the study were also recorded during the coding process.

This analysis would help effective understanding of the research methods used in empirical studies in Green HRM. Therefore, would act as a guide to discover the current methodological gaps in the area.

4. RESULTS

This section presents the results of the methodological search according to the five dimensions utilized in the coding process, i.e., Research design, Methods of sampling, Methods of data collection, Variable measurement, validity, and reliability, and Methods of data analysis. Also, it describes the results under each dimension with summary statistics where appropriate.

4.1. Research design

Majority of the investigations in the field of Green HRM used the quantitative approach as the research design. According to the study sample of this review it amounts to 94%. Yet 6% of studies utilized a qualitative approach. Regarding time horizon, 88% used the cross-sectional approach in which collection of data occur at a single point in time from different respondents, while 11% collected data from respondents more than once (i.e., longitudinal).

4.2. Methods of sampling

All reviewed papers discussed the sample and its characteristics comprehensively and 44% of them used convenience sampling method. Yet 28% used purposive sampling, 6% used the snowball method, and 11% utilized simple random sampling. One mixed-method study used both convenience and snowball sampling.

4.3. Methods of data collection

83% of the reviewed studies adopted survey method as the main data collection strategy and out of them 33% were online surveys. Only one study employed semi structured interviews as its method of data collection. Out of all studies, 11% had employed mixed methods to collect data. One study had used semi structured interviews along with focus group discussions and the other

study had used semi structured interviews along with an online survey.

Additionally, in reviewing the adaptation of different sources in the data collection process, it was found that, 72% of the studies did the data collection from a single source, while 28% used multiple sources in collecting data.

4.4. Variable measurement, validity, and reliability

In reviewing the measurement variables these studies have employed, it was found that 88% of the studies adapted the existing scales according to their study purposes, while 11% of the studies had developed new scales for the research.

83% of the studies were found with validity evidence, while 17% did not discuss any validity measures in their studies. 78% of the papers reported with reliability measures, while 22% failed to report any reliability evidence. 62% of the studies had measured both convergent and discriminant validity and widely adapted measures were Average Variance Extracted (AVE), Confirmatory Factor Analysis (CFA) and Heterotrait-monotrait ratio of correlations (HTMT). 33% of studies have employed pilot test in enhancing validity and reliability of the variable measurements. In terms of reliability concern, the researchers adopted Cronbach's alpha (55% of the sample) and the Composite Reliability (CR) in general. Some of the studies employed Exploratory Factor Analysis (EFA) to examine the internal reliability.

4.5. Methods of data analysis

62% of the reviewed papers utilized techniques to examine multiple relations (i.e., structural equation models) and 33% utilized simple inferential statistics analysis i.e., Mean, standard deviation, and correlation to report data. Twenty seven percent of the papers employed techniques such as multiple hierarchical regression and Anova to report the relationships with the dependent variable, while 11% of the papers used case analysis and thematic analysis in their qualitative analysis. Moreover, 11% of the reviewed papers used data structure assessment tools such as Exploratory Factor Analysis.

5. DISCUSSION

This section discusses the implications of results in the context of existing research and highlight limitations of the study. Interpretations and the discussion are structured according to the five dimensions identified in the coding process i.e., Research design, Methods of sampling, Methods of data collection, Variable measurement, validity, and reliability, and Methods of data analysis.

5.1. Research design

The selected papers for the review showed a high number of quantitative studies addressing the organizational consequences of implementing practices of Green HRM in various manufacturing organizations. According to Bryman (2016), researchers tend to follow the positivist approaches due to the preoccupied perceptions in the research community. Similar trend is evident in the papers those were selected in this review. These preoccupations usually are reflected along with epistemologically grounded beliefs (Bryman 2016) about acceptable knowledge in the given area of research. This argument is clearly visible in the review as 88% of the studies have adapted existing scales to measure the variables. Also, in most of the studies the content validity is supported by previous literature.

Only 6 percent of studies followed a qualitative design in and revealed several interesting findings in exploration of the influences on the employment of Green HRM in manufacturing companies. According to Bryman (2016), qualitative approach proclaims that the reality is socially constructed and meanings of it are interpreted by the participants. Therefore, qualitative research in Green HRM has been primarily conceptual, and help in developing theoretical propositions and related concepts or, empirical utilization of quantitative methods of data collection and analysis (Haddock-Millar, Sanyal, and Müller-Camen 2015; Chen and Chang 2012; Jabbour et al. 2015).

Most (88 percent) studies in the sample followed cross-sectional design. Utilization of cross-sectional analysis is often criticized in academia with the emphasis on its inability to bestow powerful information on causality (Bainbridge et al. 2017). This fact suggests that the capability in inferring causality in past research be bounded hence more prone to common method bias (Bryman 2016). Due to the nature of the research instrument, issues such as leniency, harshness, social desirability and recall errors could also rise as repercussions of common method bias (De Alwis and Hernwall 2021), at the same time resulting common method variance in cross-sectional surveys (Rogelberg 2017).

While the emphasis on cross-sectional design is frequently noted in Green HRM research, the high prevalence is still surprising given the extensive criticisms of this approach, and yet the review found little evidence for any shift toward longitudinal design. Only 11% (two articles) used longitudinal design and reported with lower response rate when repeated as was with many other management studies (O'Donohue and Torugsa 2016). According to Birch (2002), depressing response rates are common in repeated surveys, due to the 'survey fatigue' as in most of the organizations prioritize in managing day-to-day business operations, thus have little time to respond to surveys. This trend has reduced the capacity to describe a causal relationship between Green HRM practices and outcomes.

5.2. Methods of sampling

Only 11% of the sample used probability sampling in their studies even though it is such an important procedure in social survey research. Probability sampling enables to make inferences from information about a random sample to the population from which it was selected (Bryman 2016). Social researchers tend to frequently avoid probability sampling as it involves a lot of preparation, and difficulty and costs involved (Bryman 2016).

A significant majority (44 percent) of studies used convenience sampling as their method of sampling. Agreeing to Bryman (2016), it has been noted that convenience samples are

common and prominent in the field of organization studies due to practical comforts in recruiting respondents such as availability, willingness, and costs (De Alwis and Hernwall 2021). The main problem with convenience sampling strategy is the impossibility to generalize the findings as it is not possible to know of what population this sample is representative. Therefore, it is highly desirable to run a pilot test with the research instrument before utilizing it to the main study. Out of the studies that used non-probability sampling, 25% had employed a pilot test before the main investigation as it can be seen as a legitimate way of carrying out some preliminary analysis of such potential sampling related issues.

All qualitative and mixed studies in the study sample had chosen purposive sampling technique as it enables sampling of specific types of respondents who can provide the desired information according to their expertise (Sekaran and Bougie, 2016). In purposive sampling the researcher selects respondents based on the research goals in his or her mind whereas in convenience sampling, the sample is simply available by chance to the researcher. However, still the results based on convenience sampling will provide useful insights in research on Green HRM. Snowball sampling (used by 6% of the sample) is a type of purposive sampling in qualitative research (Bryman 2016). It has the strength of selecting a sample based of the relevance to the research questions and it be the most feasible method in sampling hard-to-reach populations due to the absence of a sampling frame (Bryman 2016).

5.3. Methods of data collection

The most prominent method of data collection in the study sample was the survey method, as it is seen as ideal in studies related to Green HRM due to its versatility in covering a large sample in a cheap and a quick manner (Cooper and Schindler 2006). Out of those who adopted survey method, 33% used online surveys. Due to the user friendliness and the possibility to collect data from geographically diverse sample in a shorter period, online surveys are gradually becoming more popular among contemporary researchers (De Alwis and Hernwall 2021). However, one

might question how sampling principles might apply to online surveys. The main limitation is that it is not practical to assume that everyone in any nation is online and they are with technical capabilities to manage online questionnaires (Bryman 2016). Nonetheless, there are free online survey sites which will help the researcher to significantly reduce the cost of data collection and they will also support data analysis through integration with statistical analysis software.

Majority (72 percent) studies in current review has done data collection from a single source. This might disclose potential threats to construct validity as it has the possibility of identifying a relationship erroneously whose existence is partially or totally due to the use of a common data source (Bainbridge et al. 2017). However, there was sufficient evidence in the reviewed papers, on how researchers have improved construct validity through numerous methodological choices. Yet, considering the complexity of the Green HRM field, it would be more beneficial if data can be gathered through multiple sources to avoid any possible biases.

5.4. Variable measurement, validity, and reliability

Establishment of measures to assess the reliability and validity of measurement variables is very important to ensure the quality of a research. Quantitative research is usually characterized to display certain preoccupations, predominantly on; measurement; causality; generalization; and replication (Bryman 2016).

Adaptation of existing scales to measure the variables were seen in majority of the studies in this review thus it ensures the usage of acceptable and rational measurement tools. The 11% of studies which developed new scales have done it when there was not an existing measurement instrument in the context. And the new scale items are developed following a comprehensive literature review, feedback from industry experts, and a pilot test been done before the main investigation (Zaid, Jaaron, and Talib Bon 2018).

In the current review, 83% of studies reported the validity evidence while 78% of the papers

reported reliability measures. According to Campbell and Fiske (1959) there are two aspects to assess the construct validity of a test i.e., convergent validity and discriminant validity. Both convergent validity and discriminant validity are essentials for an excellent construct validity (Sekaran and Bougie 2016). In this sample of studies, construct validity is discussed extensively in almost all studies along with convergent validity and discriminant validity. When the instrument is designed to measure the exact construct, it ensures the construct validity. Convergent validity is the degree of confidence on how well a trait is measured by its indicators. Conversely, discriminant validity is the degree to which measures of different traits are unrelated. In assessing validity in the selected papers, widely adapted measures were Average Variance Extracted (AVE), Confirmatory Factor Analysis (CFA) and Heterotrait-monotrait ratio of correlations (HTMT). According to the criterion of Fornell and Larcker (2018), the convergent validity of the measurement model can be assessed by the Average Variance Extracted (AVE) and Composite Reliability (CR). AVE measures the level of variance captured by a construct versus the level due to measurement error, values above 0.7 are considered very good, whereas the level of 0.5 is acceptable. According to the Fornell-Larcker testing system, discriminant validity can be assessed through a comparison between the variance of a particular construct and its shared variance with other constructs. Thus, the levels of square root of the AVE for each construct should be greater than the correlation involving the constructs. If not, AVE levels for each construct should be greater than the squared correlation involving the constructs (Fornell and Larcker 2018).

Heterotrait-monotrait ratio of the correlations (HTMT) approach is also identified as another method to assess discriminant validity (Henseler, Ringle, and Sarstedt et al. 2015). Yet, the studies that are chosen for this review shows its lack of popularity as a validity measure, because out of studies which reported validity evidence, only 13% have used HTMT approach to assess discriminant validity while all others have used Fornell-Larcker system. HTMT is the average of the heterotrait-heteromethod correlations relative

to the average of the monotrait-heteromethod correlations.

33% percent of studies which reported validity evidence had used confirmatory factor analysis (CFA) to measure construct validity. According to Jöreskog (1969), CFA is often used to assess convergent validity and discriminant validity in structural equation modelling, as it examines the degree to which measures of a latent variable shared their variance and how they differ from others.

Though many of studies in the review have used Cronbach alpha to measure reliability, Composite reliability (CR) is identified as a less biased estimate of reliability than Cronbach's Alpha, and the acceptable value of CR is 0.7 and above (Campbell and Fiske 1959). Using Cronbach's alpha to measure internal consistency is criticized widely when it is utilized as the sole measure, as it is possible to report a high alpha value even when data is not consistent in reality (Spiliotopoulou 2009; Vaske, Beaman, and Sponarski 2016). Further, though alpha computation presumes all constructs are unidimensional, it is not unidimensional all the time, so these critics suggest using other tools alongside Cronbach's alpha (Vaske, Beaman, and Sponarski 2016; Spiliotopoulou 2009). This trend could be seen in most studies of current review, that Cronbach alpha calculation is done along with composite reliability (CR). Additionally, it is advised to assess the unidimensionality of the scales first by using confirmatory factor analysis (CFA), and then apply Cronbach's alpha test to assess validity and reliability (O'Leary-Kelly and Vokurka, 1998).

In case of qualitative research, none of the reviewed studies of qualitative nature had done validity or reliability related methodological discussion. As qualitative research is flexible in its research design, positivist researchers challenge the generalizability of qualitative findings, proclaiming that the samples are nonrepresentative and the methodology is unstructured (Bryman 2016). The same argument is further strengthened by the current review results as well because, qualitative studies did not explicitly mention validity and reliability measures compared to quantitative studies.

However, any social science researcher should bear this fact in mind that, though reliability and validity are analytically distinguishable, they are related because validity deduces reliability. If the measure is not reliable, it cannot be valid. The three criteria of reliability discussed by Bryman (2016) convinces the same. An unstable measure over time, cannot provide a valid measure as it would not be tapping the related concept when measure is fluctuated. Conversely, a measure which lacks internal reliability, will measure two or more different things through a multiple-indicator measure, thus cannot be valid. Moreover, if inter-observer consistency lacks, observers may disagree on the meaning of what they observe, which causes a valid measure to deny in operation.

5.5. Methods of data analysis

Majority (62 percent) of the quantitative articles employed structural equation modelling (SEM) to analyze multiple relations between variables indicating a growing interest in SEM and path analysis utilized in data analysis. Since structural equation modelling enables higher capability in making inferences about relationships among variables, this growing interest can be perceived as a positive development (Williams, Vandenberg, and Edwards 2009). Structural equation modelling generally has advantages over regression, because of its capabilities to segregate measurement error and estimate complex models with multiple mediators and outcome variables (Nye et al. 2019).

Especially in quantitative analysis, significant employment of simple inferential statistics such as mean, standard deviation, and correlations was noticed. However, using correlations to infer causal relationships between variables is not possible (Bryman 2016) thus for that purpose, studies in this review have used multiple hierarchical regression as the analytic tool. Therefore, an adequate emphasis was found on regression analysis (27 percent). Regression analysis typically compel the number of outcomes considered in a study as many forms of regression allow only a single outcome to be considered (Bainbridge et al. 2017). Since a sequence of regressions can increase the likelihood of type 1 error, researchers avoid

examining of multiple outcomes (Bainbridge et al., 2017).

Minority of studies in the review used Exploratory factor analysis (EFA) to analyze the factorial structure of data. Multivariate statistical methods such as EFA, help researchers to identify the common factors that explain the order and structure among measured variables. However, in conducting EFA, there should be several methodological decisions a researcher has to make thoughtfully because numerous options are available for each of the methodological decision (Watkins 2018). As mentioned in Watkins (2018), methodological literature regularly discovered that most of EFA applications are marked by an imprudent choice of techniques and incomplete reports. Though EFA desktop software is readily available for all researchers, the quality of EFA practice does not seem to have improved (Watkins 2018; Henson and Roberts 2006)

Grounded theory has become the most widespread framework for qualitative data analysis (Bryman 2016), because of its capability of allowing the researcher to develop concepts about the discrete phenomena rooted out through data analysis. Those uncovered concepts are later built into a theory based on the revealed relationships through data. When it comes to research in Green HRM, it is identified that, employee engagement in addressing environmental concerns, as one of the most significant challenges faced by organizations today and, in the future, as well (Haddock-Millar, Sanyal, and Müller-Camen 2015). Thus, grounded theory is an excellent approach in capturing such complexities in contexts (De Alwis and Hernwall, 2021). Irrespective of its positive aspects, grounded theory come up with some critics as well (Bryman 2016). Some researchers argue that grounded theory contradicts the social constructionist view by trying to objectify experiences of people (Bryman 2016). Accordingly, a constructivist grounded theory has emerged as a new type of grounded theory (Mills, Bonner, and Francis 2016). In this review, selected qualitative articles used case study approach and thematic analysis in their data analysis. Hence, apart from

traditional grounded theory analysis, qualitative researchers have more ample avenues to follow in enhancing the quality of their data analysis process.

6. CONCLUSIONS, LIMITATIONS AND FUTURE DIRECTIONS

Overall, this review contributes to shed new light on methodological choices adapted by various researchers in their studies in the field of Green Human Resource Management. In conclusion, this methodological review revealed numerous stances which were employed by researchers in studying the Green HRM concept. It is expected that the methodological gaps identified in the review, would help the future researchers in the field to dive into a more flourished inquiry in future.

To ensure the generalizability of the findings in qualitative research, utilization of probabilistic sampling would be ideal given that it is practically feasible, to avoid any critique of sample representativeness. And in case where non-probabilistic sampling used, it is advised to run a pilot test with the instrument before the main investigation. Further, given the limitations of cross-sectional designs it is recommended to adapt longitudinal approach to mitigate issues relating to causal inferences in quantitative research. Also, given the complexity in studies in the field of Green HRM, it will be beneficial to gather data from multiple sources to avoid any potential threats of biases. Moreover, given the popularity and the prospective benefits of adapting online surveys for data collection, it is important to effectively apply sampling principles to avoid any biases in the process.

Indication of validity and reliability evidence in studies is identified as indispensable and it is important to understand though these two are analytically separable, they are related to one another. In the light of criticisms over using the Cronbach's alpha as the only reliability measure, it is favourable to interpret it along with another tool such as composite reliability. Also, it is better to firstly assess the unidimensionality of the scales using confirmatory factor analysis

(CFA), and then apply Cronbach's alpha test to assess validity and reliability. In case of qualitative studies, it is imperative to explicitly indicate validity and reliability measurements, to confront with potential arguments over non-representativeness of the sample and unstructured nature of methodology.

Despite the effort done in producing a comprehensive a review of methodological choices in Green HRM research, it is important to accede the limitations, due to several decisions made by the researcher to limit the scope of inquiry to ensure a sufficient breadth and depth in analysis. Additionally, as with any other review, the researcher acknowledges the inherent subjectivity of researchers' critique.

In limiting the variation in methodological techniques observed in relation to broader Green HRM literature, the review was limited to Green HRM related empirical studies done only in manufacturing industry within a five-year timespan. Though this emphasis presents clear parameters for interpreting the findings of current review, future research can expand this focus by incorporating studies done in different industries to investigate on multiplicity in methodologies adapted.

This review was focused on peer-reviewed full text journal articles only. If the sample was extended to include publications in a variety of other forms i.e., book chapters, conference proceedings, it would likely capture more studies with innovative methodologies. The decision to review only research in top-tier journals may result in publishing biases thus could create barriers for publication to research with nonnormative methodologies. Consequently, findings in the review may be an overly conservative view of the methodologies in Green HRM research. Furthermore, given that all selected journals were published in English, the findings are likely to more descriptive of methodological approaches of researchers publishing in the English language than of non-English speakers. Overall, despite the limitations, this review would help future researchers in effective decision making over the

methodological choices in the field of Green HRM.

REFERENCES

- Aguinis, H., C. A. Pierce, F. A. Bosco, and I. S. Muslin. 2009. 'First Decade of Organizational Research Methods: Trends in Design, Measurement, and Data-Analysis Topics.' *Organizational Research Methods* 12 (1): 69–112.
- De Alwis, S., and P. Hernwall. 2021. 'A Review of Methodological Choices Relating to Work-Life Boundary Research'. *Managing Global Transitions* 19 (1): 73–101.
- Amrutha, V. N., and S. N. Geetha. 2020. 'A Systematic Review on Green Human Resource Management: Implications for Social Sustainability'. *Journal of Cleaner Production* 247 (February).
- Bainbridge, H. T. J., K. Sanders, J. A. Cugin, and C.-H. Lin. 2017. 'The Pervasiveness And Trajectory Of Methodological Choices: A 20-Year Review Of Human Resource Management Research'. *Human Resource Management* 56 (6): 887–913.
- Benevene, P., and I. Buonomo. 2020. 'Green Human Resource Management: An Evidence-Based Systematic Literature Review'. *Sustainability* 12 (15): 5974.
- Birch, D. 2002. 'Corporate Citizenship in Australia: Some Ups, Some Downs'. *Journal of Corporate Citizenship* (5): 73–84.
- Bryman, A. 2016. *Social Research Methods*, Oxford, Oxford University Press.
- Campbell, D. T., and D. W. Fiske. 1959. 'Convergent and Discriminant Validation by the Multitrait-Multimethod Matrix'. *Psychological Bulletin* 56 (2): 81–105.
- Chaudhary, R. 2020. 'Green Human Resource Management and Employee Green Behavior: An Empirical Analysis'. *Corporate Social Responsibility and Environmental Management* 27 (2): 630–641.
- Chen, Y. S., and C.-H. Chang. 2012. 'The Determinants of Green Product Development Performance: Green Dynamic Capabilities, Green Transformational Leadership, and Green Creativity'. *Journal of Business Ethics* 116 (1): 107–119.

- Cooper, D. R., and P. S. Schindler. 2006. 'Business Research Methods, 9th Ed., McGraw-Hill.
- Fornell, Claes, and David F. Larcker. 2018. 'Evaluating Structural Equation Models with Unobservable Variables and Measurement Error'. *Journal of marketing research* 18 (1): 39–50.
- Ghouri, Arsalan Mujahid, Venkatesh Mani, Mustafa R. Khan, Naveed R. Khan, and Anugamani Priya Srivastava. 2020. 'Enhancing Business Performance through Green Human Resource Management Practices: An Empirical Evidence from Malaysian Manufacturing Industry'. *International Journal of Productivity and Performance Management* 69 (8): 1585–1607.
- Haddock-Millar, Julie, Chandana Sanyal, and Michael Müller-Camen. 2015. 'Green Human Resource Management: A Comparative Qualitative Case Study of a United States Multinational Corporation'. *The International Journal of Human Resource Management* 27 (2): 192–211.
- Henseler, Jörg, Christian M Ringle, and Marko Sarstedt 2015. 'A New Criterion for Assessing Discriminant Validity in Variance-Based Structural Equation Modeling'. *Journal of the academy of marketing science* 43 (1): 115–135.
- Henson, Robin K., and J. Kyle Roberts. 2006. 'Use of Exploratory Factor Analysis in Published Research'. *Educational and Psychological Measurement* 66 (3): 393–416.
- Jabbour, Charbel Jose Chiappetta, Daniel Jugend, Ana Beatriz Lopes de Sousa Jabbour, Angappa Gunasekaran, and Hengky Latan. 2015. 'Green Product Development and Performance of Brazilian Firms: Measuring the Role of Human and Technical Aspects'. *Journal of Cleaner Production* 87 (1): 442–451.
- Jöreskog, K. G. 1969. 'A General Approach to Confirmatory Maximum Likelihood Factor Analysis'. *Psychometrika* 34 (2): 183–202.
- Lapierre, Laurent M., and Alicia D. McMullan. 2016. "A review of methodological and measurement approaches to the study of work and family." *The Oxford handbook of work and family* : 36-50.
- Mills, Jane, Ann Bonner, and Karen Francis. 2016. 'The Development of Constructivist Grounded Theory'. *International journal of qualitative methods* 5 (1): 25–35.
- Muisyo, Paul Kivinda, Su Qin, Thu Hau Ho, and Mercy Muthoni Julius. 2022. 'The Effect of Green HRM Practices on Green Competitive Advantage of Manufacturing Firms'. *Journal of Manufacturing Technology Management* 33 (1): 22–40.
- Nye, Christopher D., Andrew A. Hanna, Troy Smith, Robert J. Vandenberg, and Aaron Williams. 2019. 'Current Research on Structural Equation Modeling in Management Research'. *Academy of Management Proceedings* 2019 (1): 19110.
- O'Donohue, Wayne, and Nuttaneeya Ann Torugsa. 2016. 'The Moderating Effect of "Green" HRM on the Association between Proactive Environmental Management and Financial Performance in Small Firms'. *International Journal of Human Resource Management* 27 (2): 239–261.
- O'Leary-Kelly, Scott W., and Robert J. Vokurka. 1998. 'The Empirical Assessment of Construct Validity'. *Journal of Operations Management* 16 (4): 387–405.
- Ozili, Peterson K. 2022. 'Sustainability and sustainable development research around the world.' *Managing Global Transitions* 20 (3): 259-293.
- Page, Matthew J., Joanne E. McKenzie, Patrick M. Bossuyt, Isabelle Boutron, Tammy C. Hoffmann, Cynthia D. Mulrow, Larissa Shamseer, et al. 2021. 'The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews'. *BMJ* 372 (March).
- Rasheed, Abdur, and Waqar Alam. 2020. . 'The Impact of Green Human Resource Management on Organizational Performance: A Case of Manufacturing Industry'. *City University Research Journal* 10 (2).
- Ren, Shuang, Guiyao Tang, and Susan E. Jackson. 2018. 'Green Human Resource Management Research in Emergence: A

- Review and Future Directions'. *Asia Pacific Journal of Management* 35 (3): 769–803.
- Rogelberg, Steven G. 2017. 'Common Method Variance'. *The SAGE Encyclopedia of Industrial and Organizational Psychology*, 2nd Edition, January.
- Rogelberg, Steven G., ed. *The SAGE Encyclopedia of Industrial and Organizational Psychology*, 2nd edition. Second Edition, 4 vols. Thousand Oaks, CA: SAGE Publications, Inc, 2017. <https://dx.doi.org/10.4135/9781483386874>. Chicago
- Sekaran, Uma, and Roger Bougie. 2016. 'Research Methods for Business: A Skill-Building Approach Fourth Business. John Wiley and Sons, New York'.
- Spiliotopoulou, Georgia. 2009. 'Reliability Reconsidered: Cronbach's Alpha and Paediatric Assessment in Occupational Therapy'. *Australian Occupational Therapy Journal* 56 (3): 150–155.
- Vaske, Jerry J., Jay Beaman, and Carly C. Sponarski. 2016. 'Rethinking Internal Consistency in Cronbach's Alpha'. *Leisure sciences* 39 (2): 163–173.
- Watkins, Marley W. 2018. 'Exploratory Factor Analysis: A Guide to Best Practice'. *Journal of Black Psychology* 44 (3): 219-246.
- Welbourne, Theresa M. 2012. 'Editor-in-Chief's Note: HRM: The Field of Dreams'. *Human Resource Management* 51 (3): 309–311.
- Williams, Larry J., Robert J. Vandenberg, and Jeffrey R. Edwards. 2009. '12 Structural Equation Modeling in Management Research: A Guide for Improved Analysis'. *Academy of Management Annals* 3 (1): 543–604.
- Zaid, Ahmed A., Ayham A.M. Jaaron, and Abdul Talib Bon. 2018. 'The Impact of Green Human Resource Management and Green Supply Chain Management Practices on Sustainable Performance: An Empirical Study'. *Journal of Cleaner Production* 204 (December): 965–979.

Beyond the Boundaries of Insurance Strategies: A case of NCD- related insurance policies in Sri Lanka

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ABSTRACT

Chronic Non-Communicable Diseases (NCDs) are the world's number one cause of death and disability. Forty-one million people die yearly due to NCDs, equivalent to 71% of all deaths globally due to a lack of treatments. Low spending power, unavailability of medicines, equipment, and facilities, and nonexistence of awareness can be considered as the causes for the lack of treatments.

The number of individuals in the general population, including younger age groups, who become victims of non-communicable diseases is also getting into alarming situations in Sri Lanka. As such, expenses for the health services and medical treatments they must bear are increasing. Thus, the general public who suffers from NCDs wishes to seek medical insurance coverage to mitigate the risk. However, quite unrealistic in the present scenario as the insurance company policies and procedures are still premature to treat such people as valuable customers.

This paper explains how lack of awareness of the insurers, the non-availability of insurance products for customers who suffer from NCDs, and the absence of SOPs (Standard Operating Procedures) create an uncomfortable situation. Later, by considering all these facts as a problem in the insurance industry in Sri Lanka, a set of

solutions has been proposed to overcome the circumstances. At the end of the analysis, the insurance company can recognize that the effort would be an opportunity-driven exercise rather than finding solutions to a problem.

1. INTRODUCTION

“NCDs refers to a group of conditions that are not mainly caused by an acute infection, result in long- term health consequences and often create a need for long-term treatment and care” (WHO, 2021). These conditions include many illnesses and situations. NCDs like high blood pressure, high cholesterol, and high blood sugar/ diabetes can be considered standard entry-level to most NCDs.

41 million people die each year worldwide due to NCDs, equivalent to 71% of all deaths globally (WHO, 2021). This is mainly due to a lack of treatments. Low spending power, unavailability of medicines, equipment, and facilities, and nonexistence of awareness can be considered as the causes for the lack of treatments.

The number of individuals in the general population who become victims of non-communicable diseases is also getting into alarming situations in Sri Lanka. Day by day, younger age groups are also becoming victims. As such, expenses for the health services and medical treatments they must bear are increasing.

To mitigate the risk, the general public who suffer from NCDs wishes to go for medical insurance coverage, but quite unrealistic in the present scenario (Wagner & Brath, 2012). Most of the time, those proposals are getting rejected as, yet, the insurance industry in Sri Lanka is not fully prepared to absorb such people into their streams and move forward. The policies and procedures are still at the premature level to treat such people as valuable customers. This research focuses on a selected insurance company in Sri Lanka (Company X) to study the status of the Sri Lankan NCD life insurance policies and suggest recommendations to overcome the existing issues.

The findings explain how lack of awareness, non-availability of insurance products for such customers, and absence of SOPs (Standard Operating Procedures) creates an uncomfortable situation for customers (Mayosi et al., 2009). Furthermore, by considering all these facts as a problem in the insurance industry in Sri Lanka, a set of solutions have been proposed to overcome the circumstances. At the end of the analysis, the insurance company can recognize that the effort would be an opportunity-driven exercise rather than finding solutions to a problem.

2. LITERATURE REVIEW

This section explains the literature review findings related to this study.

2.1. Insurance Industry in Sri Lanka

According to the Insurance Regulatory Commission of Sri Lanka, 28 licensed insurance companies in Sri Lanka cover both life and general insurance requirements (IRCSL, 2021). “The insurance industry in Sri Lanka is a major component of the economy by virtue of the number of premiums it collected in 2020 of Rs 209 bn, the value of assets on their balance sheets of Rs 796 bn, and, more fundamentally, the essential social and economic role it plays by covering personal and business risks” (KPMG, 2021).

Insurance corporations are financial intermediaries which offer direct insurance or reinsurance services, providing financial protection from possible hazards in the future. Life insurance coverages are mainly focusing on

the wealth of the human beings and protect them from the vulnerabilities as and when necessary. Insurance companies in Sri Lanka are controlled by the Regulation of Insurance Industry Act (Blackhall, 2021).

2.2. NCD Situation among General Public in Sri Lanka

According to the survey conducted by MOH (2015), “NCDs will potentially emerge as the biggest public health challenge in Sri Lanka due to the high prevalence of NCD risk factors, and the already existing gap between prevalence and treatment. However, if greater investments in NCD prevention and services are made through the right policies and public health measures, the imminent NCD epidemic could be controlled”. The main biological risk factors that support for NCDs are high blood pressure, high blood sugar/diabetes, high total cholesterol and overweight and obesity (Swinburn et al., 2013). Further to above analysis, key behavioral risk factors which cause for NCDs are tobacco use, alcohol consumption, unhealthy dietary habits and physical inactivity (Boutayeb, 2006). “Similar to many developing countries, Sri Lanka is undergoing an epidemiological transition with an increasing burden of NCDs. Deaths due to ischemic heart diseases and stroke rank high among the top causes of the mortality. This kind of NCD burden is likely to be even more problematic in the immediate future, considering the population’s high exposure to commonly known risk factors of NCDs such as tobacco use, excessive alcohol consumption, physical inactivity, unhealthy diet, and high salt consumption” (MOH, 2015).

More than 90% of the Sri Lankan adults were estimated to have at least one of the NCD risk factors (73.5% with 1-2 risk factors, and 18.3% with 3-5 risk factors), with similar prevalence in males and females (MOH, 2015). Throughout the analysis, it was highlighted that 3 main biological risk factors could be the causes of many other NCDs. Those were diabetic/high blood sugar, high cholesterol, and high blood pressure.

2.3. Role of reinsurance companies in NCDs

A reinsurer is a company that provides financial protection to insurance companies. Reinsurers handle risks that are too large for insurance companies to handle on their own and make it possible for insurers to obtain more business than they would otherwise be able to. The insurance industry depends on reinsurance, and it is like an invisible hand (Ghaffar et al., 2004). They have control over insurance companies to suggest what to do or not. Reinsurance companies were fearful about the South Asian region and were a bit reluctant to undertake NCD insurance in Sri Lanka also thinking that comparatively, the people were not getting the proper medical treatments for their NCDs. In foreign countries, NCD patients have a proper diet plan, and they have a dedicated doctor and was very carefully monitors the disease frequently. Due to this reason as an example if two people applied for the same policy one from Sri Lanka and one from England reinsurance company might charge double for the insurance from Sri Lanka. There were high rates and high rejections, too. Reinsurers have research teams who analyzed all the factors related to their business. They considered the South Asian region as a downturn market, so they charged high rates from Sri Lanka also.

Nonetheless, this mindset of the reinsurance companies was getting changed due to improvements in the medical sector and due to the behavioral change of the people such as

- People were more concerned about the diseases than before and got the treatments regularly
- Can monitor the level of risk due to advancement in medical diagnostic techniques and new methods of treatments

Further, reinsurance companies had realized that since the number of people with NCDs increasing, insurance companies had to develop a mechanism to take such people also into the insurance system.

3. RESEARCH METHODOLOGY

This study initially collected data about the current NCD insurance policy approval process in Sri Lanka based on the literature. Then a survey had been conducted to gather data and to get a clear understanding about the current status of NCDs among the general public and insurance policy related facts in Sri Lanka. 200 participants over 18 years, in different industry sectors and in different age groups had been taken a part of this survey. Figure 1 displays the research methodology followed.

This study initially collected data about the current NCD insurance policy approval process in Sri Lanka based on the literature. Then a survey had been conducted to gather data and to get a clear understanding about the current status of NCDs among the general public and insurance policy related facts in Sri Lanka. 200 participants over 18 years, in different industry sectors and in different age groups had been taken a part of this survey. Figure 1 displays the research methodology followed.

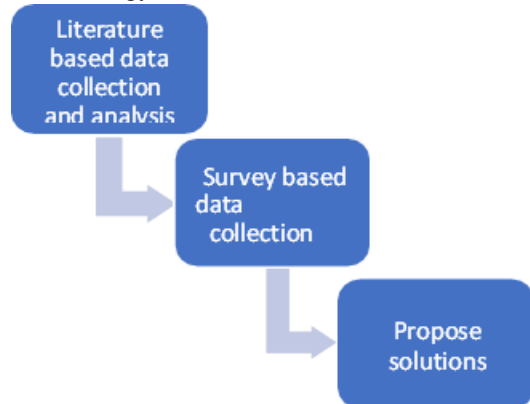


Figure 1: Research approach followed

4. FINDINGS OF THE STUDY

This section explains the findings identified by the literature driven data evaluation and survey data evaluation.

4.1 Findings based on literature driven data analysis

The following weaknesses were identified as existing in both insurance industry and the company.

- Sri Lankan insurance industry does not have a clear forecast about the number of victims of non- communicable diseases in each age group in imminent decades and about the impact on their business due to this situation. Day by day, younger age groups are also becoming victims.
- Regressive mindset of most of the Company X staff to establish a business relationship with such people. They do not realize that the NCD customer base was increasing gradually and soon, the company had to deal with that community also for businesses. Otherwise, it would be difficult to find customers without NCDs.
- Company X did not have dedicated insurance products/ policies for such people. As such, employees did not know to relate the incidents.
- Further, Company X did not have a defined SOP (Standard Operating Procedure) to handle such people. As such, employees did not know how to act under those circumstances.

4.2. FINDINGS OF THE SURVEY DATA ANALYSIS

Few key factors which had been highlighted through the survey as below.

- 9% of the participants were occasional or regular smokers. This could be a main cause for NCDs.
- 34.5% of the participants consumed alcohol occasionally or regularly. Consuming alcohol was also identified as a behavioral risk factor which helped to increase the NCDs.
- 58% of the participants did not do exercises as a practice. Only 17% did exercises more than 3 hours per week (as per the standard health guidelines a person should workout at least 3 hours per week). This could also be a risk and triggered to increase the NCDs.
- 56% participants were over weighted (BMI – Body Mass Index over 25). This was a major biological risk factor.

- Most of the occupations of the participants were office-based jobs. They did not have to move their bodies actively while they were working.

- 73.5% of the parents of the participants were suffering from the NCDs mentioned (diabetic / high blood sugar, high cholesterol, high blood

pressure). The possibility was there to inherit these biological risk factors from parents to children also.

All these indicators highlighted there was a significant potential of the general community would become the victims of NCDs. The survey had been further extended to identify the current NCD situation among the population and below points were identified.

- 30.5% of the participants were suffering from one or more of the NCDs which had been mentioned.

When above outcome was segregated based on the age groups below eye opening breakdown had been Discovered.

Table 1: Analysis of the NCD Situation by Age Groups

Age Group Years	No. of Participants	No. Who Suffered from NCDs	Percentage %
18 – 30	37	02	5.41
31 – 40	97	19	19.59
41 – 50	35	19	54.29
51 – 60	21	12	57.14
60 Above	10	09	90.00
Total	200	61	30.50

Table 1 explains the findings of the analysis of the NCD situation by age groups. Younger age groups like 31 – 40 years and 41 – 50 years (as a percentage 19.59% and 54.29% of the participants) were also become victims of the NCDs. These are the main target age groups of the insurance companies since the customers in those age groups are more stable with their incomes and they are the potential individuals who investigate for insurance life coverages. If those age groups are become victims of the NCDs, there is a massive risk for the insurance companies to find out the customers who are not suffering from the NCDs. As such, the insurance companies must move forward with the risk of

absorbing the customers who suffer from NCDs and would investigate suitable approaches to mitigate the risk.

5. RECOMMENDATIONS & SOLUTIONS Y

The researchers conducted a competitor analysis also and identified the different types of products offered by the insurance companies for the customers who were suffering from NCDs. The outcome was, even though there were few products available in the market all of them were in the introduction stage of the product life cycle. As such, there was a massive opportunity for a comprehensive product to be success in the given context. This study proposes below solutions that insurance companies in Sri Lanka could adhere with.

Option 01: Introduce health insurance cover with no claim bonus capability

The cover could be obtained by the adults who are suffering from 3 NCDs (diabetic/ high blood sugar, high cholesterol, high blood pressure) and between the ages of 18 to 59 years with the cover ceasing at the age of 60. This is a renewable contract, and the cover has to be obtained with a mandatory life insurance policy. This is like an add on to the existing policy. The special feature of this product is offering a no claim bonus by second year of the coverage. The steps are more similar which we carry out during the insuring process of a motor vehicle (Table 2).

Table 2: Vehicle No Claim Bonus vs Health Cover No Claim Bonus

Motor Insurance with No Claim Bonus	Health Insurance Cover with No Claim Bonus
Inspect and evaluate the vehicle	Investigate the medical condition of the customer
Finalize the add-ons	Finalize the add-ons
Offer the insurance premium based on the required coverage	Offer the premium based on the condition and required coverage
Finalize transactions	Finalize transactions
Renew the insurance annually with a reinspection of the vehicle while offering no claim bonus based on the non-usage of claims	Renew the insurance annually reinvestigating the medical condition of the customer while offering no claim bonus based on the non-usage of insurance.

A no claim bonus is a remunerative benefit offered to the policy holder in their health insurance policy. It is a modest way through which an insurance company could reward the policy holder for having a claim-free year. Under this, a monitory benefit is provided to the insured if no claims were raised during the previous tenure. This could be done in two ways.

- **Cumulative Bonus** – if there was a claim free tenure, coverage amount of the sum insured of the policy is increased by a certain percentage. However, the premium of the policy remains same.
- **Discount on premium** – the renewal premium rate of the policy decreases by a specific percentage for every claim-free year. However, there are no changes made to the sum insured of the policy

The other benefit of this cover is that the customers could undergo a comprehensive health checkup by annually with a discounted rate which would be arranged by the collaboration of the insurance company and hospitals. If the health condition of the customer is getting worse, the firm has the right not to continue with the annual cover.

Terms and conditions for the newly proposed product and the premium could be determined according to the rules and regulations under insurance act and requirement of the insurance company.

Option 02: Introduce a life insurance policy that covering NCDs

This life insurance policy could be obtained by the adults who are suffering from 3 NCDs (diabetic/ high blood sugar, high cholesterol, high blood pressure) and between the ages of 18 to 60 years with the cover ceasing at the age of 65. This plan helps the customers to gain access to the best hospitals and medical treatment for the NCDs mentioned. Further, this product would ensure the peace of mind and financial assistance to the policyholder. The Comprehensive plan offers financial reimbursement up to a pre-

specified maximum amount from the total hospitalization bill. Policy period could be defined as 3 – 5 years. Benefit amounts payable to policyholder could be,

- o First Year - A maximum of 50% of the basic sum assured
- o Second Year - A maximum of 75% of the basic sum assured
- o Third Year onwards - A maximum of 100% of the basic sum assured

The other benefit of this cover is that the customers could undergo a comprehensive health checkup by completing the policy period with a discounted rate which would be arranged by the collaboration of the insurance company and hospitals. If the health condition of the customer is getting worse, the firm has the right not to continue with the policy for a new term.

Terms and conditions for the newly proposed product and the premium could be determined according to the rules and regulations under insurance act and requirement of the insurance company.

Furthermore, below recommendations can also be provided.

- **Collaboration with Hospitals**

According to the 02 options proposed above, the customers have to face for medical tests as and when required. As such, it would be better if insurance companies could collaborate with the hospitals and offer discounted prices for the medical checkups. Standard medical checkup check list/ package would be developed by the firm with the help of the medical associates. The same could be communicated to the customers as well as to the hospitals.

As an option to promote this new product to the potential customers, a comprehensive marketing

campaign could be arranged at NCD clinics in the hospitals.

- **HR Plan When Executing the New Insurance Products**

When a new product launched, the entire staff of insurance company would have a clear idea about those and they are needed to be prepared accordingly. As such, 03 basic approaches could be proposed in order to prepare the human capital to cater the new product.

- o Recruiting employees with necessary competencies
- o Assigning the existing work force to the new product activities after studying their profile.
- o Develop and facilitate the research and development team and provide relevant trainings for the staff.

6. CONCLUSION

The number of individuals in the general population who become victims of non-communicable diseases is getting into an alarming situation in Sri Lanka also. Day by day, younger age groups are also become victims. As such, expenses for the health services and medical treatments which must be borne by them are getting increased. In order to mitigate the risk, general public who suffer from NCDs wish to go for a medical insurance coverage, but quite unrealistic in the present scenario. Most of the times, those proposals are getting rejected as yet, the insurance industry in Sri Lanka is not fully prepared to absorb such people into their streams and move forward. The policies and procedures are still in the premature level to treat such people as valuable customers. In the light of above analysis and proposed solutions, insurance companies could be able to understand the current situation of the country as well as the industry properly and would be able to move forward by designing new products for the customer segment who suffer from NCDs.

REFERENCES

- Blackhall. (2021). Regulation Of Insurance Industry Act. Retrieved 12 November from <https://www.srilankalaw.lk/Volume-VII/regulation-of-insurance-industry-act.html>
- Boutayeb, A. (2006). The double burden of communicable and non-communicable diseases in developing countries. *Transactions of The Royal Society of Tropical Medicine and Hygiene*, 100(3), 191-199.
<https://doi.org/10.1016/j.trstmh.2005.07.021>
- Ghaffar, A., Reddy, K. S., & Singhi, M. (2004). Burden of non-communicable diseases in South Asia. *BMJ*, 328(7443), 807.
<https://doi.org/10.1136/bmj.328.7443.807>
- IRCSL. (2021). Insurance Companies. Retrieved 10 Dec from <https://ircsl.gov.lk/insurance-companies/>
- KPMG. (2021). Sri Lanka Insurance Report 5). Mayosi, B. M., Flisher, A. J., Lalloo, U. G., Sitas, F.,
- Tollman, S. M., & Bradshaw, D. (2009). The burden of non-communicable diseases in South Africa. *The Lancet*, 374(9693), 934-947.
[https://doi.org/https://doi.org/10.1016/S0140-6736\(09\)61087-4](https://doi.org/https://doi.org/10.1016/S0140-6736(09)61087-4)
- MOH. (2015). STEPS Survey Sri Lanka 2015. Swinburn, B., Sacks, G., Vandevijvere, S., Kumanyika, S., Lobstein, T., Neal, B., . . .
- Informas. (2013). INFORMAS (International Network for Food and Obesity/non-communicable diseases Research, Monitoring and Action Support): overview and key principles [<https://doi.org/10.1111/obr.12087>]. *Obesity Reviews*, 14(S1), 1-12.
<https://doi.org/https://doi.org/10.1111/obr.12087>
- Wagner, K.-H., & Brath, H. (2012). A global view on the development of non communicable diseases. *Preventive Medicine*, 54, S38-S41.
<https://doi.org/https://doi.org/10.1016/j.ypmed.2011.11.012>
- WHO. (2021). Noncommunicable Diseases. Retrieved 21 Dec from <https://www.paho.org/en/topics/noncommunicable-diseases>

Career Nextgen: Uplifting the Career by Improving People's Professional Capabilities and Competencies

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ABSTRACT

Acquiring a successful career is the biggest hope of any individual and all the other expectations or everything that they wish for depends on how they are going to perform in their professional life. If one doesn't have a triumphant profession, it becomes complicated to achieve supplementary targets. Accordingly, since career has become a major aspect of our lives, an appropriate guidance methodology should be available. But in the current context, the problem of not having a mechanism to bridge the industry and the students who look for employment opportunities and also the circumstances where students who are not equipped with proper professional skills struggle a lot with the career are major complications.

The aim of this research is to address these issues by assisting students through stepwise career guidance and development solutions with the help of emerging technology and in a way that suits the modern digital era. The proposed solution is focusing on implementing a web-based system for facilitating the interaction of students with industry experts, university-industry collaboration, mentorship and guidance, and many more provisions through a single platform. The solution is developed by analyzing the requirements and the expectations of the users through conducting various surveys and questionnaires where the validity and the need of developing such a system were ensured by the verified results obtained from those methodologies. Thereby, this research elaborates how the solution is suggested to resolve the above-mentioned complexities and to uplift the

students' career life effectively, guiding them towards success.

Keywords: *Career development, Career guidance, University-industry Collaboration, Web application, Programming*

1. INTRODUCTION

A common problem that exists in Sri Lankan context is that there are not many proper online platform that provides career development guidance for school leavers, undergraduates or fresh graduates who are new to their professional career. Most of people cannot think about how they should proceed with their careers because they won't get proper guidance after passing out from schools or universities about how to get ahead in the job successfully and due to lack of that assistance, they face a lot of complexities. The main reason is that unlike in the past, at present, skills matter a lot more than the paper qualifications to be engaged in proper jobs and now the job competition is so high. (Vincent Vickey Victor, Jyoti, Dheya careers, Rahul Sharma, Sndra Jones, A Sudarshan, 2016-2022) So, there should be a way for them to develop their professional skills with proper assistance. Even school leavers and university students struggle a lot when choosing their career path finding suitable opportunities which suit their passion. Also, people face problems when facing interviews because they lack essential skills even though they have educational qualifications. So, there should be a way for them to get continuous guidance from mentors and solve out their doubts related to their career journey, at the same time develop skills and go up in the career ladder. (Maree, 2018) Therefore, by considering these issues, a career development application that addresses and caters the above-discussed

problem by facilitating users with properly articulated career development plans.

As the skills matter a lot more than qualifications in present, it is highly recommended to be equipped with the required skills sets to face the job competition successfully and confidently. (Peters, 2021) Therefore, as a solution, the "Career NextGen" which is a web-based application is implemented in order to improve people's capabilities and competencies related to occupational aspects. Further, this provides career guidance and the assistance to acquire the knowledge, abilities, and experience which are important to distinguish right profession for them to succeed in the work environment.

The significant stimulation behind the application is to offer online assistance to its main user group (students) notwithstanding geographical limitations or some other related issues, for example, time constraints, voyaging issues and so on. (Mustafa Serbes, Mustafa Albay, 2017). The students will be benefited a lot and they will not have to search here and there to obtain career guidance and to get guaranteed career development.

2. LITERATURE REVIEW

Currently, the career development processes happening in the country have many loopholes. One of the main is that continuous guidance is not provided to the students to go up in their career ladder. Though some authorities and institutions launch career development programs, most of the time, they are limited to 1month/3months/6months or 1 year and nothing beyond. Some of the other significant gaps in prevailing procedures can be identified as follows: (Policy, 2012)

- Failed to reach a large, targeted user group.
- Insufficient information systems regarding the job demands.
- Deficiency in giving professional training and necessary skills through an online platform.
- Less attention is paid on career improvement of school leavers.
- Lack of joint effort of universities and companies and interaction among those parties and students is very low.
- The involvement of industries in the career guidance sector is considerably less.
- No proper methodology for career mentoring and counseling, job placements, competency growth etc.

According to the recent research statistics, the unemployment rate in Sri Lanka is notably high. (ColomboPage News Desk, 2020) One of the foremost reasons for this is that efficient career development plans and guidance methodologies are not implemented and hence students are left with complications.

Table 1: Unemployment rates by age groups and gender – 2019

Age group (years)	Number	Unemployment Rate (%)		
		Gender		
		Sri Lanka	Male	Female
Total	411,318	4.8	3.3	7.4
15-24	201,698	21.5	17.6	28.7
25-29	93,793	11.0	6.6	18.5
20-39	59,009	3.2	1.3	6.3
Over 40	56,818	1.2	0.9	1.7

Table 2: Unemployment rates by level of education and gender -2019

Level of Education	Number	Unemployment Rate (%)		
		Gender		
		Sri Lanka	Male	Female
Total	411,318	4.8	3.3	7.4
Grade 10 & below	140,781	2.8	2.4	3.8

G.C.E(O/ L)	98,346	6.5	4.9	9.6
G.C.E(A/ L) & above	172,191	8.5	5.0	11.9

In Sri Lanka, a few amounts of standard career guidance/career development applications exist in the current context. A thorough study is done regarding those applications to get an idea about the procedure and even the method of how manual career guidance processes are happening in various institutions are examined. One of the main applications which exist is "Career Me" (CareerMe, n.d.) which is a system that gives a detailed report of what careers match the users based on a questionnaire given to them at the beginning and then that application allows to find certain job vacancies and meet advisors.

Another app called "CareerGuide" (CareerGuide.com, 2018) which is based in India also operates and it's all about student career counselling only.

Those are the major applications that can be identified but there are some institutions and companies in both public and private sector which provides career advice. Some of them are government centers like NYSC-National Youth Service Council (Council, 1978-2022), NAITA-National Apprentice and Industrial Training Authority (Authority., 1981- Present), VTA - Vocational Training Authority (VTA, n.d.), National Career Guidance and Counselling center and private centers like Pathfinder Career Consultancy Service (PVT) Ltd (Pathfinder, n.d.). Also, some universities have their career guidance and skills development unit which are solely for the particular university's students which other students are not benefited.

Furthermore, as per the study carried out before the project initiation, a few research done on the topic of career guidance could be identified.

- A research paper on "Digital System and Application for Career Guidance for students" (Aditya Biala, Sharmistha Banerjee, 2021)

- A research based on online career counselling through video conferencing (Team, 2014)

- Article which describes ensuring career readiness through career development and guidance. (Vanessa Dodd, Jill Hanson & Tristram Hooley, 2021)

- Article on career guidance provisions in Sri Lanka (Career Connect (Sheila Clark, Kath Waykne)

- Article on importance of career guidance (Verma, 2020)

According to the study done, a clear realization could be made on the fact that the existing application on the selected project is completely different from the developed system. The main reason is that, almost all the applications that are investigated focuses only on one main aspect of the project domain. For example, certain applications such as "Career Guide" mentioned above is focused only on career counselling. But the developed project contains various other aspects other than career coaching though career advisors. Therefore, it will be benefited a lot in almost all the aspects related to the domain.

3. THE PROPOSED SYSTEM

The initial point of the study carried out about the existing procedures of career guidance and development in Sri Lanka and get understanding of how some similar applications related to that work in the current context. Through that comprehensive study, the researcher identified certain areas and gaps which should be addressed throughout and then developed the scope accordingly to cater all the required functionalities. The scope is suggested in a way that there are clear and unique differences between the prevailing career development apps and the new system.

"Career NextGen" can be considered as an application that works with professional skill advancement, communication and interaction of students with industry specialists, university-industry coordination, mentorship plus guidance and a lot more arrangements through a one single platform. The students (undergraduates, school

leavers, graduates) will be benefited lot through this application since different essential components are incorporated there.

As the name "Career development and guidance application" proposes, the undertaking depends on two methodologies as indicated by how the researcher interprets it. The first approach is career guidance, and the other is career development. However, those two add to a typical last objective despite there being a few slight contrasts distinguished between them. In the career guidance module, the researcher is intending to bring universities and certain organizations to one stage where they would set a cooperative effort to lay down an appropriate career guidance for the designated client gatherings. Consequently, the career development module mentioned above will be actually acting a self-learning/self-development mechanism where no professional parties given above are not involved. The students will be helped a great deal and they won't need to look to a great extent to get career guidance and to get ensured regarding the professional improvement. They will get the opportunity to obtain all the services related to career guidance from this single platform without searching much in various sources.

3.1. Objectives and Deliverables

The main objective is to supply an effective and usable product to the user which is focused on career guidance aspect with the intention of eliminating the hassles that students come cross in building the professional career. Other than that, the following objectives are satisfied,

- Providing a better and more reliable way to interact with industry experts and staff to pave the way to a victorious career.
- Providing a Comprehensive solution which is simple and user friendly to bring all the related parties together (university, industry, student)
- To serve the users a platform to discuss the issues related to the career and to enable

users to get hired for jobs by directly interacting with the companies

- Pushing students and even universities towards digitalized platforms rather than manual system

The users will not require high educational levels, technical skills or advanced computer expertise to deal with this system functions. This platform is designed in a way that we can expand rapidly and add more functionalities and extensions efficiently. The specification of the proposed system can be summarized as an accurate system without any data redundancy, efficient data handling , better graphical user interfaces , saving time and money via the computerization and providing solutions for existing problem.

A proper study has also been carried out:

- To analyze how universities and companies can work collaboratively to provide career guidance for the students.
- To implement new methods to reduce the existing problems by giving better solutions which suits the modern era
- To analyze existing career development processes and provide recommendations and suggestions for improvement

The deliverables include a fully featured web application which can be accessed through web browsers such as Google Chrome, Microsoft Edge which could be used as the student-professionals communication platform whereas the professional parties are interconnected with real-time functionalities.

3.2. Potential failures

The system potentially focuses on major functionalities including the Career Guidance course management, Job Portal, University-industry collaboration, Career guidance tips/files uploading and downloading, Student forum, Interaction with career advisors, Payment gateway integration, FAQ section, profile management and chat platform. All the

mentioned functional requirements are enabled based on the user group who are accessing the system.

4. SYSTEM DEVELOPMENT APPROACH

4.1. Requirement Elicitation

The requirement gathering was done in order to identify the current processes and require improvements in the career guidance and development area. Gathering information from various related parties helped immensely to develop the project to give the maximum benefit to its users. Certain requirement gathering techniques were allowed at the initial stage of the project.

4.1.1. Questionnaire

Before conducting the project, a short questionnaire was designed for friends to informally participate within. conducting a questionnaire not only allowed me to understand the issues with existing career guidance, but also what functionality should be prioritized and included. From analyzing the questionnaire results, it made me understand that more than 8% of people who attempted the questionnaire has no clear idea about their career path which they should proceed. Moreover, according to the results, most of the students are afraid of job interviews due to lack of prior experience and skills which was solved from the developed web and android applications. Furthermore, professional skill development is the most needed criteria suggested by the students and that need is also fulfilled from the Career NextGen application. Most of them prefer to get career guidance through an online platform. Overall, the short survey proved very useful, specifically during the creation of system functions and user requirements. importantly, by analyzing the results of the questionnaire, I could realize that I have given the solutions to the real problems

faced by students and the real requirements needed by them through my project.

4.1.2. Interview

Had discussions with the responsible people through career guidance of some government and private universities such as University of Colombo, Open University of Sri Lanka, University of Sri Jayewardenepura and SLIIT. Contacted some career guidance institutes such as VTA and NAITA. The expectation was to get an understanding about how universities are providing career guidance and development and to identify how career guidance institutes work and what they offer. This technique helped a lot to obtain so many details regarding how career guidance units of universities interact with students in career guidance the programs offered by them to develop the skills of students.

4.2. System Design and Development

4.2.1. Agile framework

For this project, an Agile approach was taken during the development process. Agile is a set of methods and practices followed during software development that is based on values and principles expressed in the Agile Manifesto. The manifesto advocates that when developing software, the focus should be on interaction, working software, customer collaboration and responding to change. Processes, extensive documentation, contract negotiation and sticking to a plan hold less value. The reason this approach was more suited to this project than, for example, the traditional Waterfall model was because it promotes iterative and incremental development. With Waterfall, processes, such as requirements and design, are treated as one-off activities. In Agile, they are seen as continuous which allows for adaptation and changes at any time in the development process. This was important for this project because potential users were going to be massively involved throughout development to ensure the product created was liked and usable. If users were unhappy with the current product, Agile's flexibility allowed for changes to requirements and design. Having processes as

continuous activities also meant that a fully working piece of software should be present at the end of each iteration. This was necessary for this project as there were tight time constraints. It was better to have a working piece of software that did not have all the functionality rather than an incomplete, non-working piece of software that tried to incorporate all functionality

4.2.2. Test Driven Development

Test Driven Development (TDD) is an agile technique, where project requirements are expressed through tests before implementation is commenced was used throughout the project to identify breaking changes made to the code base and test the requirements of the project. Test-driven development is a style of programming that works well with Agile as it relies on a very short development cycle. It is made up of three main phases. The testing phase where a test is developed and executed, the coding phase where the code is developed to pass the test and the refactoring phase where improvements are made to the code while preserving the functionality. The main benefits a test-driven development approach is that it helps the developer establish an understanding of what the code needs to do. While also testing each piece of functionality before starting a new task.

4.3. Implementation

After the requirements gathering stage, high-level system designs were created including initial UI designs, UML diagrammatic explanations which were used to design the underlying data model of the system and to identify the activities within the construction process. In the system implementation, the following tasks are identified:

Identification of software components and the architecture of the software - The components are identified, and the system is designed in a way that all the software components are interrelated. This is mainly called as the software architecture. This software architecture is converted into a

system which is compatible and operatable with the computer.

Interface designing - The user connects with the system through the system interface and do the necessary tasks through that. So, proper interface designing enhances the convenience of using the system. The interface is always designed in an attractive way.

Database designing - In database designing, the necessary data required for the entire system were identified and saved in the system database.

4.4. Control plan

The PRINCE2 two project management methodology (Bentley, 2009) was followed throughout the project timeline from the point of starting the project and to the final demonstration. Thereby, the major milestones were achieved by adhering to the process-based project management framework by controlling each phase of the project properly. Various techniques were utilized such as supervisor reviews, highlight reports, minor documentation at the end of each stage, proper risk management and quality plans evidence through videos and recordings, end-stage reviews with the intention of reaching the desired objectives according to the project timeframe. As well as adopting Agile for the development process, PRINCE2 was adopted for the overall management of the project.

4.4.1. Practices followed

Throughout the development process it was important to use coding practices so that the code was consistent and followed the same structure. Code following the same structure also meant for future developers, the code could be understood quicker. Proper formatting of the code documents Commenting the functions of important codes Each function is tested for the

performance and accuracy after each functionality implementation.

4.4.2. Verification and validation

The verification is used to check whether the application is aligned with the specifications and to certify that the application is bug free. Verification techniques include

Inspection- visual assessment of project outcomes and deliverables to distinguish errors, mistakes, development standards' violations, and supplementary issues

Reviews - Obtaining the feedbacks/comments from project stakeholders such as supervisors, users, clients, or other interested parties to find defects and to assure quality. This included design reviews, document reviews, requirement reviews

Analysis - Utilization of perceived analytic techniques to clarify or ensure the performance of the project components

Test- Verifying the system some predefined inputs to guarantee that the system will deliver expected outputs as determined by the necessities.

The validation is done to check whether the requirements are met, and the validity of the right product is confirmed. The validation techniques include White box testing for Detailed investigation on internal logic and the structure of codes, Black box testing-for Examining the functionalities without caring about its internal workings, Consistency checks and validity checks, Completeness checks.

4.4.3. Tools and technologies

“CareerNextGen” is completely developed using the latest trending technologies in the industry such as PHP, HTML, AJAX, JavaScript, jQuery, Bootstrap and MySQL. Used tools such as Visual Studio Code, phpMyAdmin, WAMPP Server, Stripe payment gateway have led into a flexible developing approach where it provides many

services which could be used while the development is going on. The reasons to choose the above technologies are, it provides the latest security and performance increments without much of a hassle. Many of the technologies are becoming widely used technologies over the industry. These come in handy where the developer gets what they need, with the best solution implementations.

4.4.4. Usability evaluation

Usability refers to the nature of a client's experience while cooperating with items or frameworks, including application Usability is a blend of variables including:

Understandable design: an almost easy comprehension of the architecture and navigation of the system. Simplicity of realizing: how quick a client who has never seen the UI can achieve fundamental assignments

Productivity of utilization: How quick an accomplished client can achieve undertakings

Mistake recurrence and seriousness: how regularly clients make mistakes while utilizing the framework, how genuine the mistakes are, and how clients recuperate from the mistakes.

5. FINDINGS AND RESULTS

Questions asked to selected samples Circulated questionnaire was based on close-ended questions. For further evaluation and assistance to research, certain interviews and one to one discussion are carried out with open-ended questions. In the questionnaire, 15 questions were given to answer regarding to the career guidance and development. Thereby, the responses were taken successfully from various student categories such as undergraduates, graduates, school leavers and from various age groups who are with different employment

statuses. The key findings following the interview and questionnaire stage are as follows:

- Most of the respondents highly believe that the existing career guidance methodologies in Sri Lanka should be further improved.
- The students are in need of proper mechanisms to guide them towards their career goals and thereby assisting for the professional skill development.
- There are very limited number of approaches to obtain career guidance after leaving the schools or after graduating.
- Online platforms can be used effectively to improve people's professional capabilities.
- University-industry collaboration plays a vital role in providing career guidance and thereby it has to be improved further with the technology.

The developed system caters almost all the career guidance plus development requirements as discussed above in this paper.

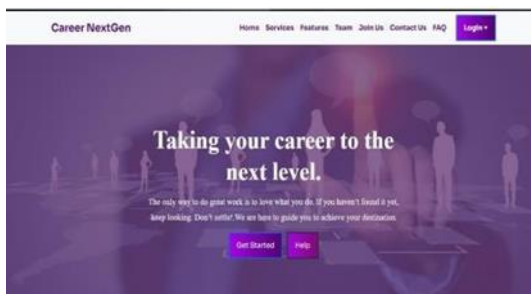


Figure 1: The main page of the developed system.

The Figure 1, given below shows the main page of the web application which gives the users the chance to access their related user accounts and navigate to the allocated functionalities.

The university industry collaboration is established in order to implement career

guidance methodologies for the university student(undergraduates). The university of each registered undergraduate will interact with them to provide numerous facilities. The universities and registered companies interact with each other through this platform and through the inbuilt chatting functionality. The Figure 2 given below shows the university dashboard where university users can perform activities like managing partnership companies and undergraduates, publishing notices and trainings, collaborate with companies through the chat.

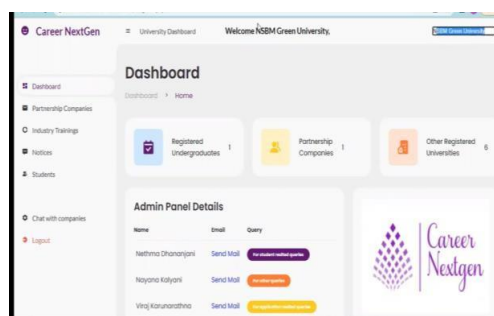


Figure 2: University dashboard

The Figure 3 shows what the users can do as students. The given figure is the dashboard of undergraduates but the other two student categories; school leavers and graduates will be redirected to a different dashboard with different set of functionalities upon login. From here, functional requirements such as job portal, advisor section, career development courses,

forum etc. can be accessed according to the necessity.

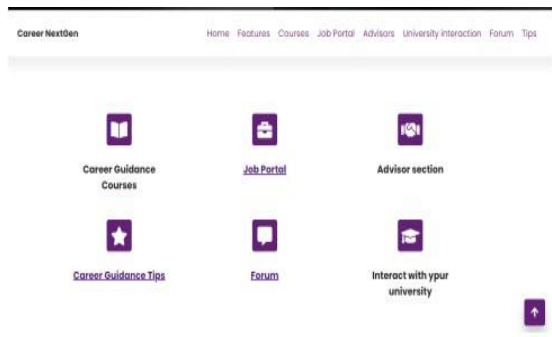


Figure 3: Functionalities available for the undergraduates

One of the main functionalities in the developed system is the advisor section which provides mentorship to students. The students have the ability to send connection requests to the registered career advisors in various job fields in order to receive continuous career guidance. Thereby, if the particular advisor accepts the connection request, the student has to pay a certain fixed amount through the integrated payment gateway before receiving the mentorship. Online after the proper payment, the connected students get the chance of selecting meeting time slots published by the specific advisor and then connect with a meeting. The Figure 4 given below depicts the payment

operation which is done through Stripe payment gateway.

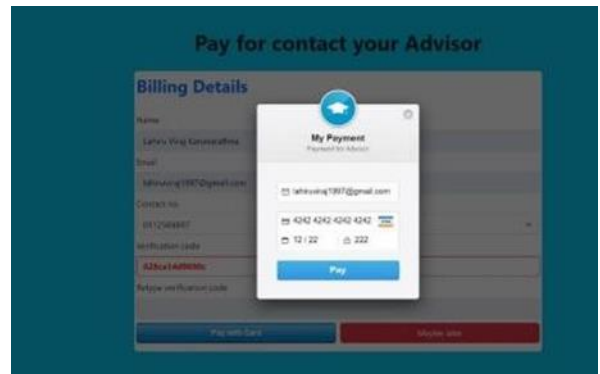


Figure 4: Payment gateway interface of the system

Another major functionality of the application is the job portal where companies can publish job vacancies, the applications received from candidates and download resumes, reject or shortlist received applications, send messages to the candidates through the inbuilt mailbox where the students get the chance of viewing the available job vacancies posted by the companies, filter job search as required, apply for the jobs, viewing the status of applied jobs whether the application is rejected or shortlisted, sending direct messages to the companies and receive replies through mailbox etc. The given Figure 5 displays the dashboard of the job portal which is related to a company.

The above provided are only some of the major functionalities of the implemented application. But there are many more functional requirements such as FAQ section where frequently asked questions can be viewed, career guidance tips section, where uploading/downloading of files related to career guidance are involved, Student Forum in which students get chance to post questions or reply to the posted questions and career guidance courses section where students can enroll into various professional courses and learn on their own etc. All integrated features are also aligned with nonfunctional requirements such as performance, security, usability,

reliability, scalability etc. in order to ensure the effectiveness and the quality of the system.

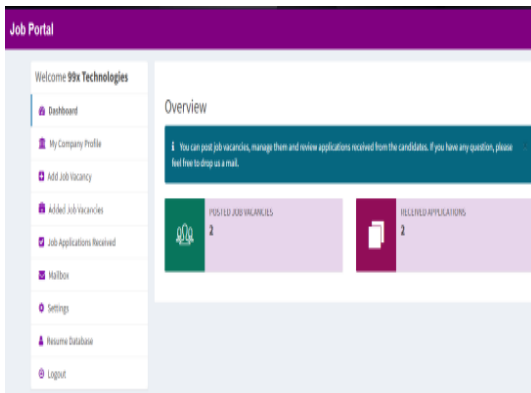


Figure 5: Job portal

6. CONCLUSION

According to the analyses results, it is realized that there must be a technique that facilitates professional skills development, the interaction of students with industry experts, university-industry collaboration, mentorship and guidance and many more provisions through a single platform. With the developed system, the assistance to the students is given through stepwise career guidance and development solutions with the help of emerging technology and in a way that it suits the modern digital era. The problem of not having a mechanism to bridge the industry and the students who look for employment opportunities and also the circumstances where students who are not equipped with proper professional skills struggling a lot with the career were the major motivations behind choosing this project domain. The critical focus of the project is aimed to offer online-based help to its primary client group(students) despite geological restrictions or a few other related issues, for instance, time imperatives etc. The students are helped to a great extent since the excellent career guidance and professional improvement are guaranteed exclusively via this solution. Users and other parties who are involved in the purpose will find very easy to use this system because there are internationally accepted standards. The business

model is pretty straightforward as the Sri Lanka is indeed in need of a better and simplified career development procedure.

This could be improved furthermore in the future by addressing the consumer needs.

7. FURTHER WORK

The project can be extended to facilitate inbuilt video conferring mechanism to connect with the advisors from the web application itself without using Zoom Meetings.

Moreover, as for future work, the researcher is planning to analyze more on the user requirements and provide opportunities for the universities or companies to hold online career guidance and development programs through the platform and also implement several diverse components to expand the better quality of the solution.

REFERENES

- Aditya Biala, Sharmistha Banerjee. (2021). Digital System and Application for Career Guidance for students. *ResearchGate*, 47.
- Authority., N. A. (1981-Present). Retrieved from National Apprentice and Industrial Training Authority.: <http://www.naita.gov.lk/>
- Bentley, C. (2009). *PRINCE2 Revealed*. Career Connect(Sheila Clark, Kath Waykne). (n.d.). Careers Guidance provision in the general education. *British Council research*, 41.
- CareerGuide.com. (2018, 05 05). CareerGuide.
- ColomboPage News Desk, S. L. (2020, 04 14). *Unemployment among females and youth was higher in Sri Lanka in 2019*. Retrieved from ColomboPage: http://www.colombopage.com/archive_20A/Apr14_1586888700CH.php
- Council, N. Y. (1978-2022). Retrieved from National Youth Service Council.: <https://www.nysc.lk/>

- Maree, J. G. (2018). Promoting career development in the early years of people's lives through self- and career construction counselling to promote their career resilience and career adaptability. *ResearchGate*, 424.
- Mustafa Serbes, Mustafa Albay. (2017). Importance of Career Planning and Development in Education. *ResearchGate*.
- Pathfinder. (n.d.). Retrieved from PathFinder Career Consultancy services: <https://web.pathfinderlk.com/>
- Peters, J.-H. (2021). *The importance of vocational training for career development*. Retrieved from EHL Insights: <https://hospitalityinsights.ehl.edu/vocational-training-career-development>
- Policy, N. H. (2012, 11 15). *Career Guidance and Counselling*. Retrieved from National Human Resources and Employment Policy: https://www.nhrep.gov.lk/index.php?option=com_content&view=article&id=102&Itemid=59&lang=
- Team, P. (2014). *Online Career Counselling Guide*. European countries (Bulgaria, Italy, Austria, Greece, Great Britain, Ireland): Prometheus Project- European Commission.
- Vanessa Dodd, Jill Hanson & Tristram Hooley. (2021). Increasing students' career readiness through career guidance: measuring the impact with a validated measure. *British Journal of Guidance & Counselling*, 260-272.
- Verma, S. (2020, 04 06). *Need and Importance of Career Guidance; Top #5 Reasons why Career Guidance is Must for Students*. Retrieved from idreamcareer: <https://idreamcareer.com/blog/importance-of-career-guidance/>
- Vincent Vickey Victor, Jyoti, Dheya careers, Rahul Sharma, Sndra Jones, A Sudarshan. (2016-2022). *How is career development important for a student?* Retrieved from Quora: <https://www.quora.com/How-is-career-development-important-for-a-student>
- VTA. (n.d.). Retrieved from Vocational Training Authority- Sri Lanka: <https://www.vtasl.gov.lk/>

Pre-Co: The Next Generation of E-commerce

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ABSTRACT

In the COVID-19 situation, most companies had to face huge losses, and many companies started to do their business online. Global users of e-commerce applications have increased during the past two years. Then lots of companies wanted a new e-commerce application that could give more facilities than the existing e-commerce applications. The main objective of this project is to create an application that can provide more functionalities to users than existing e-commerce applications. The author has identified certain requirements from a survey. This project is based on users' recommendations and suggestions. system requirements are readily accessible and easy to operate. This e-commerce application will result in a user-friendly, dependable, and efficient application. Customers of the system will be able to predict the price of the given product using a price prediction system. This application contains a voice assistant to guide users through the system. This e-commerce application will provide an efficient platform to connect sellers and buyers.

Sellers will receive a chatbot to interact with their customers. On the other hand, the previously mentioned price prediction system will help all citizens of the country to have a better idea of the variation of the price of the product.

Key Words: *Machine learning, Voice assistant, Price prediction, Chat Bot, E-commerce, Web application.*

1. INTRODUCTION

Electronic commerce involves sharing business information, maintaining business relationships,

and conducting business transactions by means of telecommunication networks' commerce. Users can visit an online marketplace and place an order for goods or services and use their own equipment, and e-commerce is influenced by the internet. Most merchants and customers moved on to e-commerce platforms. E-commerce is conducted to serve a wide variety of uses, including e-mails, internet compilations, shopping trolleys; data transmission (EDI), syncing; web technologies, and wireless devices. This project will definitely help to overcome those who are facing the previously mentioned difficulties with new features. The Pre co-application introduced in the project has more functions than normal e-commerce applications. This application contains a price prediction system, voice assistant, and chatbot.

Price prediction uses algorithms to evaluate a product based on its own characteristics, demand, and trends in the market (CBSL, 2022). Then the operating system sets the price at a level it tries to predict will both attract more customers and promote sales. Price prediction machine learning is among the most effective tools in every company's toolbox. Because electronic price forecasting can allow you to stay in alignment with your industry and, finally, improve the efficiency of your sales process.

A voice assistant also named a smart personal assistant or a linked presenter, is a new type of product introduced to the market by Apple, Google, and Amazon and is known as natural language voice recognition. Chatbots are computer programs that automatically respond to messages. Chatbots can be programmed to respond the same way at all times, to respond differently to messages containing specific keywords, or even to use machine learning to change their responses to that situation.

Automating your procedures as much as possible is one way to stay competitive in modern business. Self-inspection in grocery stores and ordering in-store are examples of this trend.

This program will be very helpful because it won't just assist consumers in making purchases; the voice assistant of the system will also help users navigate the application, and purchasers of this application will have access to the price prediction system.

Although the developer of this program made every effort to reduce the likelihood of data entering errors, it is still possible for errors to occur. As a result, the developer set up error alerts for users to see if they enter erroneous data into the system. To use this service, a user needs no special abilities. The system's facts collectively demonstrate that it will be designed to be user-friendly for all system users. The Pre-co web application can help a large number of buyers and sellers do their transactions. This application will help customers to connect with sellers according to their needs. This process can be done by spending a small time period in the system.

There are various sections in this project; signup and sign in; chatting (a chatbot will respond to a buyer), searching for products, etc. Sellers can get messages and orders from buyers all over the world.

2. LITERATURE REVIEW

2.1. E-Commerce

Users can visit an online marketplace and place an order for goods or services and use their own equipment, and e-commerce is influenced by the internet. The customer's search engine will connect to the server that includes the online store webpage as the order is placed. The purchase supervisor then communicates the information to database systems that preserve stock levels, a merchant system that appears to be able to receive payment information (utilizing apps like Payment Gateway), and a financial institution laptop, before going back to the order manager (Altexsoft, 2019). This is designed to ensure that the firm's equity and customer cash can complete the purchase. The buying manager

will inform the browser after the purchase has been confirmed, and the web application will also display a message informing the consumer that their sequence has indeed been properly processed. In order for the service or product to be successfully sent to the buyer, the purchase boss would then offer up customer orders to the warehouse storage or fulfillment section. A customer may obtain actual or electronic goods at this present time, or connectivity to a provider may be granted. E-commerce is conducted to serve a wide variety of uses, including

e-mails, internet compilations, shopping trolleys; data transmission (EDI), syncing; web technologies, and wireless devices. It would also involve business-to-business actions as well as community engagement, like using email for unprompted ads, widely perceived as junk mail, to clients as well as other future growth, and sending out e-newsletters to subscribers and text message texts to mobile devices. So many 21 businesses presently try to entice personal customers online using methodologies such as digital coupons, online marketing, and targeted advertisements (PricePrediction, 2022). An e-commerce framework is a tool used to manage an e-commerce business. There are e-commerce platform options for customers that vary in size, from start-ups to large enterprises. These e-commerce devices include online markets, including eBay and Amazon, which require full user registration and no IT activation. Another e-commerce platform is SaaS, which can help shoppers "rent" internal development as well as cloud hosting space that does not require infrastructure. Other e-commerce systems can take the form of cloud infrastructure (cloud or premises), open-source projects that require full management and implementation.

2.2. Price Prediction

Price prediction uses algorithms to evaluate a product based on its own characteristics, demand, and trends in the market. Then the operating system sets the price at a level it tries to predict will both attract more customers and promote sales (Rojewska, 2021).

Every company wants to earn a profit. And technology can help. Price prediction machine

learning is among the most effective tools in every company's toolbox. Because electronic price forecasting can allow you to stay in alignment with your industry and, finally, improve the efficiency of your sales process. In some groups, the process is called price predicting or predictive pricing.

Furthermore, some people are extremely skeptical of it (Team, 2022). That is because more experienced teams often feel they have such a firm understanding of their manufacturing prices. Technical analysis looks at historical prices, economic growth rates, and other relevant factors and sets an approximate price. Then, to get a more accurate picture of the market, the process turns to basic analysis (Kumar, 2020).

The move looks at various external and internal factors, including macro factors such as season and micro-influences such as time of day, trying to find out when a customer is most likely to make a purchase. ²⁴ In mathematics, these methods are called regression analysis. Which would be a numerical way of predicting the relationship among variables (one variable and one — or even more — predictor variables). In price forecasting, the cost is the independent factor. And it's impacted by several response variables.

3. SYSTEM DEVELOPMENT PROCESS

3.1. Problem identification and information gathering

Because the programmer intends to create a platform that won't be suited for Sri Lankan users just, the pre- co e-commerce application is based on the thoughts and ideas of 142 citizens who are from six different countries. The author has gathered information from a variety of sources that represent many cultures and viewpoints. While addressing the sellers' commercial needs, this application can be used on a global scale. The system's requirements were obtained by the developer prior to system development using a questionnaire.

3.2. Existing Price Prediction Systems

There are a huge number of e-commerce applications that are operating at the moment. eBay, Amazon, and others are examples. However, it was found to be ineffective in meeting the demands of an expanding business. Consumers should make a plan to arrange their budget on their own. The current e-commerce platform is built in a user-friendly way, but there are things that can be improved.

3.3. Drawbacks in the Existing Systems

A number of issues affected the most recent implementations. If a consumer wants to buy a product, they should reach the shop and find the product. If a customer needs to reach the shop, it will be a waste of time. When it comes to pandemic time periods, it will get worse. In the normal course, merchants should recruit more employees compared to an e-commerce platform. When it comes to the order receiving process and issuing the products, the shopkeeper should maintain a large number of records, and finding a past transaction will be a complicated process. Security of records is a huge challenge for current retail shops.

3.4. Assumptions and Limitations of the project

Statements that are presumed to be true are known as assumptions. During the project, it had to make several assumptions. This program primarily serves as a fish-selling program. The price of the product and the demand for that product has a negative relationship when one takes into account the price prediction systems that have been put in place for consumers. There are various circumstances that are difficult to categorize.

3.5. Security of the application in the project

When considering the security of the application, there are some limitations.

- Two-step verification

Two-step verification is the best security method identified. Two-factor

Authentication If someone knows the username and password of another person, that person will be able to log in as the first person. It's very important to prevent.

- Face identification/recognition

Face recognition is a good security method to validate the user, and many users expect it from systems. This will be for future implementations of the project.

4. FINDINGS

4.1. Price Prediction Algorithm Development

Fishermen and retail sellers will give their fish quantities to the wholesalers. Then wholesale sellers sell those products and take a commission and give money to the fishermen. On a given day, there are lots of transactions that can happen. Considering a random day,

- 1) Small quantities will be sold to customers at varying prices.
- 2) Retail sellers can provide different sizes of fish.
- 3) Quality sizes can be obtained from retail sellers.

These variables will calculate the average of each factor. These are the inputs and calculations that the author has made to predict the price.

After calculating each factor of a day, data will be ready to import as an input to the model.

Price prediction is calculated through a polynomial regression model. Polynomial regression (HAYES, 2022) is a type of linear model named a special case of multiple linear regression which quantifies the relationship as an n th degree polynomial. Even though polynomial regression is robust to outliers, the existence of one or two exceptions can adversely affect achievement.

Fish prices are changing day by day due to several factors. This equation is true if the price of fish doesn't change day by day.

$$y=k \quad (1)$$

(Y-Fish price, K-constant)

If fish prices change due to one reason only, this equation is true.

$$y=mx \quad (2)$$

Y-Fish price, m-Coefficient, x-Factor affects fish price)

In this system Price prediction will be given using multiple linear regression. Multiple linear regression is a technique that can give a prediction after studying multiple independent data sets. This technique can be considered as an extension of simple linear regression. Fish prices can be changed due to the variation of different factors.

$$y=m_1*x_1+m_2*x_2+m_3*x_3+\dots+m_n*x_n - (3)$$

(y-Price (Dependent variable), m-Coefficient, x-Factors affecting the fish price (Independent variables))

Price will be predicted according to this equation but there can be error when prediction is happened,

$$\hat{y}=m_1*x_1+m_2*x_2+m_3*x_3+\dots+m_n*x_n \pm E \quad (4)$$

(\hat{y} -Actual price of a given date, E-Error of the prediction)

4th equation will give the actual fish price of the date. 3rd equation to 4th equation,

$$\hat{y}=y \pm E \quad (4)$$

When E (Error of the prediction) =0,

$$\hat{Y}=y \quad (5)$$

Actual price=Predicted price.

4.2. Price Prediction system

The price of a kilogram of (yellow-finned) tuna will be predicted using this technique. The author spent five days conducting research at the fish market before putting the price prediction technique into action. The goal of the project's real-time data collection and analysis was to pinpoint the variables that influence fish pricing. After then, two months' worth of data were collected and processed to reach the goal. The forecasts made by this price prediction system will be based on user-inputted historical data. With the help of a voice assistant and a machine learning model, this system will forecast prices. The prediction will come from the system after it

has examined the variables influencing fish pricing.

The price prediction system was implemented by Python. Several Python libraries were required by the project to create the system for price prediction.

Table 1: Python libraries used in price prediction system

Python Library	Reason for using the library
Pandas	Pandas' library will help to analyze data. Author has used the pandas library to read the csv file which contains all processed data.
sklearn.linear_model (package)	The sklearn machine learning library was commonly used for statistical modeling. Author has used this package to implement multiple linear regression models.
pyttsx3	This library will convert text to speech. Author has used this library to speak to the user.
matplotlib.pyplot (package)	matplotlib library is mainly used to draw charts. This library has been used to draw charts showing independent

4.3. Voice Assistant

Voice assistant was implemented by python. Author had to use several python libraries to implement voice assistants.

Table 2: Python libraries used the voice assistant

Python library	Reason for using that library
pyttsx3	This library will convert text to speech
speech recognition	This library will be used to recognize the user's voice and to convert the user's voice command to a text.
datetime	This library is mainly used with date and time. Author has used this library to tell the time to the user according to the user's preference.
pywhatkit	Pywhatkit was used to play background music. Author has used this library to redirect to youtube and play the music.
subprocess	A Python subprocess was used to close the system.

4.4. Chatbot

Python was used to construct the chatbot. The project implemented chatbots using a number of Python packages.

Table 3: Python libraries used the chatbot

Python library	Reason for using that library
pytsx3	The author has used this library to greet buyers by voice.
	The author has used this library to reply to buyers' voices.
datetime	The author has used this library to check the time. The Bot will check the time and send the greeting according to the time.

5. CONCLUSIONS AND FUTURE APPLICATIONS

This project's primary goal is to build an e-commerce platform that will provide more features than current e-commerce applications. All country residents are having a very difficult time right now. There are many travel restrictions and lockdowns during this time. Due to this, the majority of firms tended to conduct these transactions online. As a result, more people are using e-commerce platforms. The facilities' expectations may rise along with the number of accounts, which will be increased. Information was acquired by the author from questionnaire surveys that were carried out in six different nations. 95.8% of the responses to the poll indicate that more facilities are desired than are offered by the current e-commerce software. This e-commerce platform contains a price prediction system. The prediction system will give a prediction after considering several factors. This price prediction system, which has been implemented using machine learning, will help users in several ways.

- Consumers will get to know future prices accurately. This will help them to make arrangements.
- This price prediction system can analyze multiple data points and accurately predict the price.
- Pre-co is operated as an e-commerce platform. There are several implementations that can be done in the future. Developers should definitely think of that also.

These are the future implementations that the author has proposed.

Currently, pre-co is operated as a web application. In the future, mobile applications and desktop applications will be released.

The following system contains a price prediction system to predict the price of fish. In the future, it will be implemented to predict the price of other food items.

REFERENCES

- Altexsoft. (2019, February 26). Price Forecasting: Applying Machine Learning Approaches to Electricity, Flights, Hotels, Real Estate, and 1 Stock Pricing. Retrieved from <https://www.altexsoft.com/blog/business/price-forecasting-machine-learning-based-approaches-applied-to-electricity-flights-hotels-real-estate-and-stock-pricing/>
- CBSL. (2022, June 02). Daily Price Report. Retrieved from <https://www.cbsl.gov.lk/en/statistics/economic-indicators/price-report>
- HAYES, A. (2022, June 23). Multiple Linear Regression (MLR). Retrieved from Investopedia: [https://www.investopedia.com/terms/m/mlr.asp#:~:text=Key%20Takeaways-Multiple%20linear%20regression%20\(MLR\)%2C%20also%20known%20simply%20as%20multiple,uses%20just%20one%20explanatory%20variable](https://www.investopedia.com/terms/m/mlr.asp#:~:text=Key%20Takeaways-Multiple%20linear%20regression%20(MLR)%2C%20also%20known%20simply%20as%20multiple,uses%20just%20one%20explanatory%20variable)
- Kumar, A. (2020, March 30). Price Prediction using Machine Learning Regression — a case study. Retrieved from

<https://towardsdatascience.com/mercari-price-suggestion-97ff15840dbd>

PricePrediction. (2022, July 15). Metafish Price Prediction 2022, 2025, 2030 | FISH Price Forecast. Retrieved from <https://priceprediction.net/en/price-prediction/metafish>

Rojewska, K. (2021, September 15). Price Prediction: How Machine Learning Can Help You Grow Your Sales. Retrieved from <https://dlabs.ai/blog/price-prediction-how-machine-learning-can-help-you-grow-your-sales/>

Team, C. (2022, May 5). Multiple Linear Regression. Retrieved from <https://corporatefinanceinstitute.com/resources/knowledge/other/multiple-linear-regression/>

Steganography For Extreme Secure Communication

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ABSTRACT

This reading source includes the learnings of research conducted regarding the credibility of Steganography, on 08 of August 2022, by the Cyber Wing of the Centre for Defence Research & Development, Sri Lanka. Information security is a crucial factor when it comes to the exchange of knowledge using conversations between two parties. Transmitting data between two points securely is a challenge in the present time as the chance of compromising the message content by an interceptor before it ever reaches the destination is considerably high. As per the methodologies of securing the content of the confidential message, there are many, but Cryptography and Steganography have proven the accuracy of the security. There is even a developed concept called “Crystography” which was built using both core ideas of Steganography and Cryptography with rapid key changing algorithms. If taking Steganography for instance; which will be focused on in this analysis report; the concept is mainly using images to hide images, text files, audio, and video files sensitively without changing the image size which is very effective for extreme secure communication that sectors like military, financial and medical industry may find very interesting as when it comes to a higher chain of command, it is all about the confidentiality of data and messages being transmitted to a higher chain of command, it is all about the

confidentiality of data and messages being transmitted.

Keywords: *Steganography, Cryptography, encryption, LSB algorithm, PVD, CNN-based steganography, GAN-based steganography*



Figure 1: Binary hidden in pixels

9. BACKGROUND

Communication through digitized media has been increasingly evident with the development of the Internet and the present time, as everything is turning digital, sending data or private information is rapidly increasing. At the same time, threats of data breaching or leaking are also increasing, while all individual and commercial communication takes place on the Internet, where computerized media is the primary means. It contains huge amounts of information in different fields. Due to that Information hiding methods received attention from research communities due to the rapid use of information in modern technology. The two most common approaches for hiding information and securing

data are steganography and cryptography. Steganography infers covered writing. It is characterized as “the way toward composing a secret message with the end goal that the proximity of the message is just known to the sender and receiver”. It is the workmanship and study of undetectable communication and a push to cover the presence of the embedding data.

Steganography is a prominent issue for research because of this. Steganography is a prominent issue for research because of this. The kind and size of the hidden message are often taken into consideration when choosing the cover medium, and a variety of carrier file formats can be utilized. Digital pictures are now the most common carrier/cover files used to send hidden information, and there are four different varieties of steganography.

- Image Steganography
- Video Steganography
- Audio Steganography
- Text Steganography

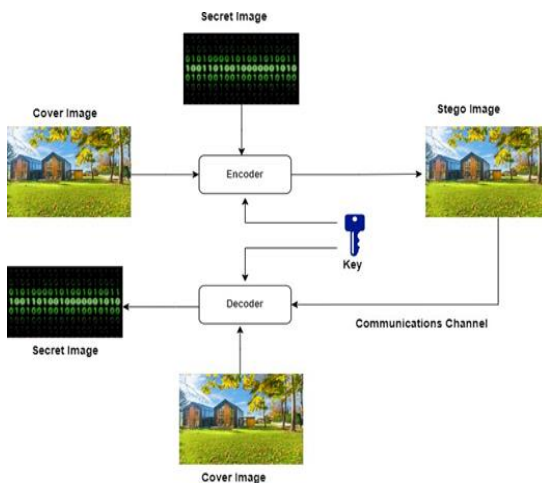


Figure 2: Basic encoding and decoding procedure

1.1 Research Question

1.1.1 What is the current state of Steganography as discovered in previous research work?

It is noted that there are several applications (android mostly) in play with the Steganography data hiding concept. Play store will list some applications most of them which are corrupt experimental level software which leads to the conclusion that this is not popular as other available encrypting concepts.

Recent research work has proven that Steganography has a major impact on image security as it is less popular than Cryptography and it is considered beneficial since the less awareness of the technology, the less attention drawn towards it. In the present world, major sectors like Banking, military, and medical industry are highly involved in encrypting data using this concept. It is also proven effective as even if an intruder intercepts the message, there is no physically possible way to decrypt or uncover the content of the intercepted message. Hiding information is obviously not something new in history. Back in ancient times, Greece attempts to hide a message in trusted media to deliver it across the enemy lands.

1.2 Why Steganography?

As mentioned above, all military, banking, and medical organizations are in need of secure data transmission. Among those, it is extremely important to have high-level security in military confidential information exchange in the name of national security. The banking sector is using online transactions more than ever today with the evolution of technology which leads the activities carried out through the internet is highly vulnerable due to cyber threats on the internet. (Balaji, 2011) The goal is to secure the message even if an intruder intercepts the message and gets hold of it; they will not be able to read and understand or even know what to look for or if something is concealed within the grabbed message.

It can be used for a variety of things, such as digital watermarking, copyright management, television transmission, and audio-video

synchronization. Large multimedia files can be shared, and duplicated courtesy of the almost error-free data transfer provided by broadband internet connections. Everyone has something to hide, yet sensitive communications and information are exchanged over the internet in an insecure fashion. Steganography's objective is to keep the cover medium's general quality high while hiding concealed data inside it (M.Ananthi, n.d.). Unlike traditional steganography, deep learning-based steganography offers a flexible and generalized architecture that does not require expertise during the embedding process. Videos are more expressive and frequently used than photographs, which are the cover used by the majority of steganography algorithms. A multi-scale down-sampling feature extraction structure is made using an encoder, a decoder, and a discriminator network.

2. CATEGORIES OF STEGANOGRAPHY

After carefully evaluating the available frameworks for steganography, it is confirmed that there are three main groups named traditional image steganography, CNN-based image steganography, and GAN-based image steganography (Subramanian, 2021). Traditional frameworks use methods that are not related to machine learning or deep learning algorithms. Almost all traditional methods have relied on LSB (Least Significant Bit) techniques. CNN-based methods are mostly dependent on deep convolutional neural networks for both embedding and extracting the hidden messages while GAN-based methods use some specifics of the GAN variants (Subramanian, 2021).

2.1 Traditional Image Steganography

For conventional image steganography, the Least Significant Bit (LSB) replacement technique is typically utilized. Since the approach only uses some of the image's pixels—not all of them—the photos selected are often of excellent pixel quality. The foundation of LSB techniques is the idea that changing a few pixel values won't result in any noticeable changes to the human sight. The cover picture is then scanned to identify the least significant bits in the noisy region once the

secret information has been converted to binary form. The LSB of the cover picture is then modified by inserting the binary bits from the hidden images. It is important to use caution while using the substitute approach since overcrowding the cover picture might cause obvious modifications that reveal the presence of the hidden information. Several comparable approaches have been presented, using the LSB method as the baseline. For instance, a modest modification to the (HEM)-Huffman encoding method is employed to turn the secret message into binary codes and then encode those binary bits with the secret message. The LSB technique is then used to incorporate the encoded bits in the cover picture. For RGB photos, a different iteration of the LSB approach is employed. The cover image has three channels, each of which is slightly sliced. The hidden message is encoded in the R, G, and B planes in the ratio of 2:2:4. (Subramanian, 2021)

Thereafter, the pixels and the keys are chosen using a pseudo-random number generator. The multiple object tracking (MOT) approach is then used to combine discrete cosine transformation (DCT) and discrete wavelet transformation (DWT) to hide the secret message inside a cover picture and discover the regions of interest. Before being included into the cover picture, the secret data is first encoded and then transformed to binary bits. Pixel Value Differencing is another conventional technique used in picture steganography (PVD). In order to locate the best places to bury the secret bits while still maintaining the uniformity of the cover picture, PVD compares the differences between adjacent pixels. Its combination of LSB on the first two bits and PVD on the following six bits for each 8-bit unit is devised. Other methods include coverless steganography, where the cover picture is produced using secret data rather than being provided. The cover picture is produced by acquiring private information and controlling relationships using the object detection technique. Similar coverless steganography is suggested, where the cover image's and the secret image's Local Binary Patterns (LBP) features are first hashed. The stego picture is produced when the hashes have been matched. The margins of the color cover pictures are obtained similarly, as

opposed to LBP. The margins of the cover photos are then filled with the binary bits of the secret data. CNN-based Image Steganography (Convolution Neural Network)

Image steganography based on CNN models is almost entirely based on encoder and decoder structures. The cover image and the secret image are fed as the inputs to the encoder to generate and output the stego-image and the stego-image is given as the input to the decoder to output the secret image. The basic principle is the same, but the architecture might change according to the variety of methods while changes in the convolutional layer and pooling layer are to be expected. The number of filters used, strides, filter size, activation function used, and loss function vary from method to method. The key point to note here is the size of the cover image and the secret image must be the same, so every pixel of the secret is distributed. (Subramanian, 2021)

2.2 CNN-based Image Steganography (Convolution Neural Network)

Nearly all encoder and decoder structures used in image steganography depend on CNN models. The encoder uses the cover picture and the secret image as inputs to create and output the stego-image, while the decoder uses the stego-image as input to produce the secret image. Although the underlying idea is the same, the architecture may alter depending on the different approaches, while adjustments to the convolutional layer and pooling layer are predicted. Different methods utilize different numbers of filters, strides, filter sizes, activation functions, and loss functions. The size of the cover picture and the secret image must both be the same size in order for every pixel of the secret to be dispersed evenly. (Subramanian, 2021)

Not only image steganography, video steganography also has been done by CNN-based concept. In general, complex 2D layers are used in image steganography and 3D complex layers are used for videos (Mishra, 2019).

2.3 GAN-based Image Steganography (Generative Adversarial Network)

GANs are a deep CNN subtype that was developed by Goodfellow et al IN 2015. A GAN trains a generative model via an adversarial approach for problems involving picture production. In the GAN architecture, the generator and discriminator networks compete with one another to produce the best image. Given the data, the generator model produces an output that closely resembles the input image. The discriminator networks categorize the produced pictures as being either phony or real. The two networks are trained so that the generator model strives to closely resemble the input data with the least amount of noise. The discriminator model is taught to recognize fraudulent photos with accuracy. Since then, several modifications to GAN have been put forth, increasing its potency and suitability for synthetic picture generation applications. (NANDHINI SUBRAMANIAN1, 2017)

GANs are renowned for performing well in the area of picture generation. One such image generating job is picture steganography, which produces one output—the stego image—from two inputs—the cover image and the secret image. The current techniques for image steganography that use a GAN architecture can be divided into five categories: a three-network based GAN model, cycle-GAN-based architectures, sender-receiver architectures using GAN, coverless models where the cover image is generated at random rather than being given as input, and an Alice, Bob, and Eve based model. (NANDHINI SUBRAMANIAN1, 2017)

Additionally, the generator and the discriminator are the two primary parts of a GAN model. A new network called the Steg analyzer is introduced in some of the approaches for picture steganography. These three components' primary purposes are,

- A generator model called G that uses the cover picture and the random message to produce stego images.
- A discriminator model, D, for determining if the picture created by the generator is real or phony.

- A Steg analyzer, S, to determine whether the supplied picture contains any secret, sensitive information.

The three models, G, D, and S are designed to compete with one another in order to generate realistic pictures that are similar to the cover image provided as input. The realistic image and its quality for steganalysis are produced using the errors of D and S and the parameter alpha between [0, 1]. One key distinction from the GAN, in this case, is that G is updated to maximize both the error of D and the error of the linear combination of D and S (NANDHINI SUBRAMANIAN¹, 2017).

3. What are the Compatible Applications of Steganography?

Steganography is not as prominent like Cryptography but is clear that some main industries have involved Steganography in their career. According to recently conducted research work, Sectors, for instance, Medical, Military, and Financial are highly implicating this content hiding concept. A thorough content about how these fields apply Steganography for their work is mentioned below in three subheadings for three main categories.

3.1 Medical Industry

This section will provide the greatest introduction to using steganography in the healthcare sector. Image Steganography is a combination of many techniques. We may leverage this to communicate data securely to users by offering various levels of protection, as per the health industry. These Conference Series 1917 (2021) 012016 IOP Publishing NCAIEV21 Journal of Physics doi:10.1088/1742-6596/1917/1/012016 3 security measures make it difficult for an intrusive party to open or view the file. As a result, resilience is increased because the intruder cannot grasp what is communicated.

Using MATLAB 2021 and a random pixel generator to encrypt the hidden picture, the cover image is turned into a steganography image, which is then validated using credentials such as a user ID, password, and OTP verification using a program called Pega. The major goal of this study is to provide adequate and safe

transmission of the picture while maintaining full encryption. This paper also suggests that in order to validate identification, the sender and recipient should be authenticated more than once.

In the encryption process, the secret picture is encrypted by randomly rearranging the pixels according to a random pixel generator method. Only the sender and receiver are aware of the random key that is used. The Pega Database, which sends emails, was used to extract the user ID and password. The Pega tool sends the OTP to the authorized sender's mobile phone number. The receiver end likewise uses the same two-level authentications. Thus, this method aids in the secure and safe transmission of pictures from sender to receiver.

Figures 1 and 2 show, respectively, the various blocks involved in the proposed system at the transmitter and receiver.

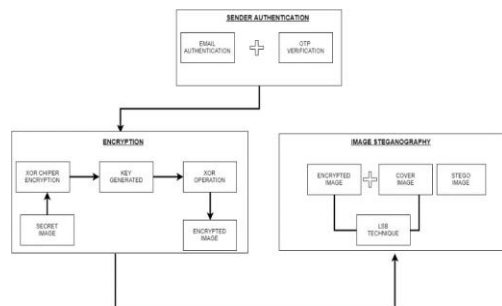


Figure 3: Senders authentication procedure

The authorized user then uses OTP and email authentication on the transmitter side to confirm his identity. Using the Pega tool, email authentication is carried out by sending the authorized user's login information to the sender's email address. Sending the OTP to the sender's mobile number completes the OTP verification process. The sender will be allowed to send the secret picture following successful authentication.

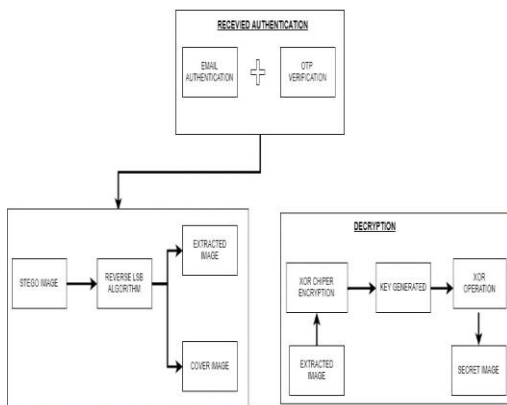


Figure 4: Received Authentication process

Following is a third piece of image to give you a better point of view to get the general idea of the above explained encryption process.

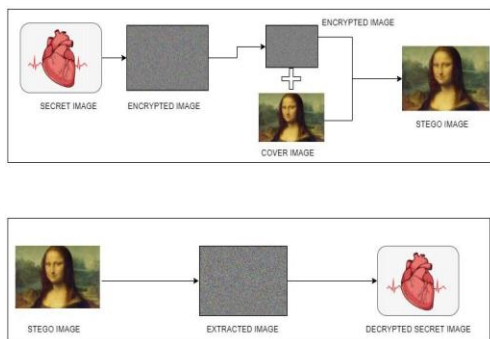


Figure 5: General view of the encryption

3.2 Military Involvement

For the sake of national security, military information interchange must have high degree security. Any data transport involves a substantial amount of information security. Information concealment that concentrates on obscuring the existence of secret communications can provide security. The goal of the data-hiding technique known as steganography is to conceal the presence of communications so that other parties are ignorant of their involvement (M.Ananthi 1, n.d.).

This approach is particularly exceptional in that only authorized employees with access to the key to decrypt the files and retrieve the data hidden in pictures, sounds, or videos may study the original military data. This strategy was more effective than earlier ones in protecting information because it employed military secret data. For instance, the military may use this technique to exchange messages with high-level confidentiality between two remote points, to develop a database that is fully embedded with Steganography where no visible valuable data is available in the database if breached but just a pile of random images that intruder has no idea what they are. And as the military is very good at working with secret codes which have meanings, they can take advantage of it as they can use certain images to specifically identify what category of data is hidden inside the received image for instance.

3.3 Financial Industry (E-Banking)

Steganography is mostly used in the banking industry to guarantee that user information is sent securely across a network while simultaneously being shielded from the prying eyes of hackers. The steganography technique incorporates data into a picture such that there is no visual distinction between the original image and an image containing data.

E-Banking Security is an initiative in the banking industry that strives to give all end customers a safe e-banking system. Before making any purchases, the consumer inputs their card information into our system's Android application. In addition to the card information, the user's position is also determined, including the current date and time and latitude and longitude. The AES technique is then used to encrypt all this data, and the F5 steganography algorithm is then used to embed the encrypted data in a picture. The user uses this picture to complete the relevant transaction, ensuring that user information is safely sent across a network.

The time of image production is verified at the server end after receiving the picture. The user is informed right away that the specific picture cannot be used for the transaction and must generate another image in order to proceed with

the payment if the time gap between the time of the creation of the image and the time of transaction exceeds a period of 5 minutes. Following this initial stage, the provided picture was used to retrieve the encrypted user data. The AES decryption technique is used to decode this data.

Data decryption is followed by the initial job of validating user card information, which entails checking the card number, CVV, expiration date, and name. Following validation, the user transaction's amount is compared to the total of all the user's prior transactions. This is accomplished by calculating the typical expenditure volume for a certain user. A transaction is deemed fraudulent if the amount being spent in it significantly deviates from the amount that is typically spent.

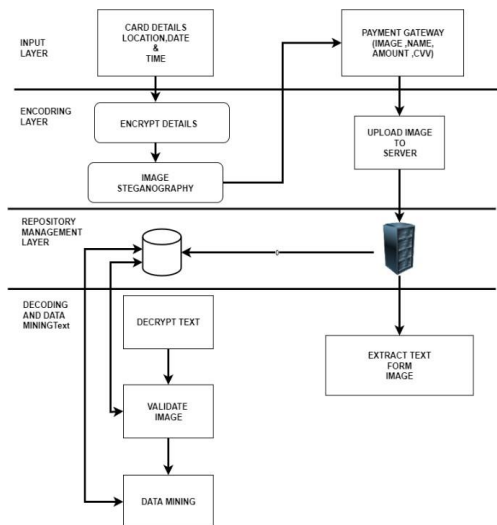


Figure 6: Encrypting process with stego image in E-banking industry

You may comprehend the given table by using the resolution of the carrier picture affects how quickly the F5 method embeds data in an image. The table includes the results of experiments we ran by inserting a block of data into photos of various resolutions. The technique was seen to take a minimum of 2 seconds to process a picture with a resolution of 80x80 pixels, and a maximum of 2 minutes and 27 seconds to process an image with a resolution of 4608x2592 pixels.

As can be seen here, the time required to embed the data in a

picture grows as the resolution of the image rises. Therefore, the system's efficiency is best when the image has a lower resolution and falls as the resolution grows.

Table 1: Resolution of pixels in time ratio of min to sec

RESOLUTION (PIXELS)	TIME (MINUTES: SECONDS)
80x80	00:02
275x183	00:07
461x551	00:30
1280x1280	00:38
2576x1932	01:54
4608x2592	02:27



One may conclude from the above-mentioned photographs that the original image and the image produced after steganography are identical. This indicates that the image produced by our system has minimal to no distortion, or distortion that cannot be seen with the unaided human eye. As a result, the system is successful in constructing an object that can't be questioned by a potential hacker as to whether it contains important data.

4. LIMITATIONS OF STEGANOGRAPHY

Sending encrypted communications on a regular basis can attract the attention of crackers and hackers, which may lead to attempts to decrypt

and reveal the original contents. Steganography is used in the digital era to conceal communications by enclosing a covert message inside another unsuspecting message. Steganography gives security and anonymity and is typically used alongside cryptography (Anderson & Petitcolas, 1998).

There are, however, a few drawbacks to note as well. The fact that there is a lot of overhead to conceal extremely minute bits of information is one of the steganography's drawbacks. The size of the large text places a restriction on how many little messages may be concealed inside it. Text files are not large enough to store more complicated data, such as audio or picture files. And the majority of data concealment techniques profit from the limitations of human perception while also having limitations of their own. Nevertheless, these are independently reversible.

When reviewing the fact, and limitations of this concept, discussion on the encryption algorithms of Steganography is mandatory and major issues with the algorithms of Steganography are as follows.

- Least Significant Bit (LSB) Encoding - Message is hard to recover if the image is subject to attacks such as translation and rotation.
- Low-Frequency Encoding - Significant damage to picture appearance. Message difficult to recover
- Mid Frequency Encoding - Relatively easy to detect, as our project has shown.
- High-Frequency Domain Encoding - Image is distorted. The message is easily lost if a picture is subject to compression such as JPEG.

Even though there are some minor points, still Steganography has proven more effective than Cryptography due to its ability of misleading intruders and the less popularity is another advantageous fact when it comes to the bright side.

5. CRYPTOGRAPHY VS STEGANOGRAPHY

There are some main comparisons when Steganography and Cryptography are taken into account. Unlike steganography, which is less common, cryptography is widely employed. In general, Steganography is about cover writing while cryptography is based on secret writing. These two are two different things entirely. The goal of Steganography is secret communication while cryptography has the aim of data protection. The structure is also varied from each other as the message structure is not altered in Steno and Crypto only altered in the transmission. Steganography is a method used to communicate in a safe and covert manner. Contrarily, using a message in a disguised form, cryptography aims to make the message understandable only by the intended receiver and incomprehensible to others. The key length, which makes the method robust and unbreakable, is used to gauge how secure the secret data is. In steganography, on the other hand, there isn't such a thing.

All that steganography offers are authentication and secrecy. Contrarily, secrecy, integrity, authentication, and non-repudiation are the security concepts offered by cryptography. Some of the algorithms utilized in steganography include model-based, spatial domain, and transform domain embedding. Contrarily, cryptography employs methods such as block, stream, and transpositional ciphers. Steganography may be used on any type of media, including text, audio, video, and images, whereas cryptography is only used with text files which is the main benefit of using Steganography (Anon., n.d.).

6. FUTURE RESEARCH DIRECTIONS

A growing number of people utilize the internet in every aspect of their life as a result of the expansion of internet access and the development of internet-enabled gadgets, frequently disclosing extremely sensitive personal information without being aware of the risks associated with data abuse. We predict that, as the amount of personal data

being shared online increases, concerns about end-user privacy will only get worse in the

future. Additionally, usability concerns are receiving increased attention as a method to create end-user-oriented security mechanisms that users can easily understand and use, without complexity or a steep learning curve, to safeguard their data.

6.1 Focus on Privacy

With the growth of networked systems and the internet in recent years, privacy has emerged as a crucial concern in the development of IT systems. Nowadays, we utilize the internet in every aspect of our life, which calls for a rising amount of personal data to be submitted to the internet. J.P. Morgan's annual study (Dimon, 2021) states that worldwide e-commerce sales have expanded at a rate of 19.4% each year, reaching \$963 billion in sales by 2013. This rise in online buying indicates that people are getting more at ease disclosing their private financial information, including credit card numbers and delivery addresses. Like this, social and professional networking websites that link internet users with shared interests have seen rapid development over the past ten years (2012). Since its launch in May 2003, LinkedIn has grown to 200 million users as of January 2013. As of September 2012, Facebook, which debuted in February 2004, has 1 billion active members. According to these figures, more people feel at ease sharing personal information about themselves online. Additionally, people seem more likely to speak up about perceived privacy invasions when participating in online activities. The addressed message and other content hiding concepts seem to be an answer to this scenario, Steganography can be used for certain to increase security.

6.2 Next Generation Secure Internet

There is no denying that the internet has been a social phenomenon that has transformed and is still changing a variety of social aspects, including how people interact, how businesses function, how crises are handled, and how the military functions. Despite the crucial necessity of the internet, several of its components are vulnerable and continuously under assault from denial-of-service attacks to software vulnerabilities (ELSEVIER, December 2011).

The fact that the internet architecture and its accompanying protocols were largely created for a benign and trustworthy environment, with little to no consideration of security problems, is one of the key causes of these security flaws (ELSEVIER, December 2011).

The internet of today connects millions of people, computers, and businesses in a sophisticated system that covers the whole planet, making it evident that this supposition is no longer true. In light of the concern for new mechanisms for

content delivery over the internet as the next generation internet is set to see huge growth in the amount of content delivered over the internet, newer networking paradigms with content delivery at the center of the architecture are proposed rather than connectivity between hosts, as in the current architecture. Research on challenging networks is largely concerned with various networking scenarios, such as wireless ad hoc networks, where it is impossible to foresee consistent end-to-end connectivity.

6.3 Towards Trust-Worthy Systems

Most systems in use today were constructed utilizing subpar designs, development techniques, and tools from unreliable older systems. As a result, they are frequently unprepared to handle cyberattacks. The problem is made worse by the fact that current gadgets are networks of systems and parts. They must interact intricately with other parts and systems, sometimes leading to unanticipated and sometimes harmful behavior (ELSEVIER, December 2011). In the past, a lot of systems were declared to have a trustworthy computing basis (TBS), which was meant to offer an adequate security foundation to protect the vital components. Error-correcting codes, for instance, were created to work with faulty communications and storage technologies. Despite unsafe communication connections, encryption has been employed to enhance secrecy and integrity. Firewalls have also been deployed to defend internal assets against assaults from the outside. Due to the ongoing development of attacks, the notion of having a

singular solution to a given issue has not proven successful (ELSEVIER, December 2011).

7. CONCLUSION

This study focused on how various businesses might make the most of this data concealing idea while still ensuring the security and integrity of data shared via internet channels. recognizing the weaknesses in current technologies and information technologies. Emerging technologies, such as social media, cloud computing, smartphone technology, and vital infrastructure, have become targets for growing threats that frequently exploit their qualities. The above-mentioned prospective future study areas are thought to be helpful for the advancement of steganography and the expansion of this concept's use. As a result of the exponential growth of cyber assaults, more and more advanced methods of defending against cyber-attacks and deploying countermeasures have also developed in parallel and this is the scenario.

REFERENCES

- 2011, E., December 2011. Research challenges towards the Future Internet, s.l.: ELSEVIER.
- Anderson, R. & Petitcolas, 1998. On the limits of steganography, s.l.: IEEE xplore.
- Anon., n.d. Difference Between Steganography and Cryptography. techdifferences.
- Balaji, R. & N., 2011. SECURE INFORMATION TRANSMISSION USING STEGANOGRAPHY FOR MILITARY APPLICATIONS, Nashik, India: International Conference on Electro/Information Technology.
- Balaji, R. & N. G., 2011. SECURE INFORMATION TRANSMISSION USING STEGANOGRAPHY FOR MILITARY APPLICATIONS, Nashik, India: International Conference on Electro/Information Technology.
- Dimon, J., 2021. Annual Report & Proxy, s.l.: JPMorgan Chase & Co.
- JulianJang-Jaccard, 2012. A survey of emerging threats in cyber security, CSIROICTCentre,Australia: ElsevierInc..
- M.Ananthi 1, R. K. N. S. S. Y., n.d. Secure Sharing Military Information Using Image, Audio and Video With Steganography, Tamilnadu , India: Departmentof Computer Science and Engineering, Cheran College of Engineering.
- M.Ananthi, R. K. N. S. S. Y., n.d. Secure Sharing Military Information Using Image, Audio and Video With Steganography, Tamilnadu, India: Department of Computer Science and Engineering, Cheran College of Engineering.
- Mishra, A. K. S. N. A. & I. S., 2019. Video Steganography Network using Spatio-Temporal features and Micro- Bottleneck, Mandi, India: Indian Institute of Technology.
- NANDHINI SUBRAMANIAN1, O. E. S. A.-M. A. A., 2017. Image Steganography: A Review of the, Doha, Qatar: 1Department of Computer Science and Engineering, Qatar University.
- Subramanian, N. E. O. A.-M. S. & B. A., 2021. Image steganography: A review of the recent advances, Doha,Quatar: 1Department of Computer Science and Engineering, Qatar University,.

A Housing Price Prediction and Forecasting System for Sri Lanka

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ABSTRACT

Nowadays Machine learning can be identified as trending technology. The objective of the project is to forecast and estimate a fair price for a home using a variety of machine learning algorithms, and to select the models with the highest accuracy rating to do so. To determine the best price to purchase a home, both the developer and the client can benefit from house price prediction. House prices are influenced by numerous factors. Location, concept, and physical condition are the three broad categories into which these variables can be divided. Examples of physical conditions that can be perceived by the human senses include the size of the house, the number of bedrooms, the presence of a garden, the size of the land and other structures, and the age of the house. A concept, on the other hand, is a recommendation made by developers to entice potential customers. The goal of this project is to improve communication between the buyer and the seller. After examining several ML models, the Random Forest Regression model was chosen to train the data set. The Housing Price Prediction System was created using the dataset of Sri Lankan housing prices. Future house price projections were made using the ARIMA model. The Buying and Selling Platform has been integrated with the prediction and forecasting feature. This System will assist buyers and sellers in establishing trust with one another. Finally, the system's predicted price and the sold price of the house will be shown close to the advertisement. This will make it easier for **buyers and sellers to**

comprehend how machine learning techniques can be used to predict prices that differ from the actual price.

Keywords- *Price prediction, Random forests, Forecasting, ARIMA Model*

1.INTRODUCTION

The goal of machine learning (ML) is to create self-learning algorithms using datasets so that the machine can predict future behavior based on historical data. With the quick rise in computer storage and processing power over the years, it has demonstrated impressive advancements and attained high significance by being able to create systems that are frequently used in business, education, and other sectors. House has become a basic need of a human, and prices for them vary from place to place depending on the amenities offered, such as parking, neighbourhood, etc. A family's decision to purchase a home is one of the biggest and most significant ones because they invest all their money and gradually pay for it with loans. Machine learning has played a main role in recent years in both the medical field and in everyday speech commands and product recommendations. Instead, it offers superior customer support and a safer automotive system. This evidence indicates that machine learning (ML) is a popular technology across almost all industries, so we are incorporating it into our project. (Lawhale et al., 2022)

In this paper, machine learning has been used to help predict the prices of houses by learning from a sample dataset consisting of attributes that influence this cost. We take the case of one such application in real estate. First, the foundational ideas behind machine learning and its uses are examined. The discussion of feature assessment, learning strategies, and the libraries used for the system's Python implementation follows the discussion of house price prediction. The real estate market is one of the most competitive and price-focused in existence today. With their budgets and after analyzing market tactics, people are looking to purchase a new home. But the primary drawback of the current system is that it determines the price of a house without the necessary foresight into potential future market trends, which leads to an increase in price. But the issue is that manual errors occur at a rate of 25%, which results in financial loss. For those involved in the real estate industry, which is growing rapidly in many nations, such as homeowners, customers, and estate agents, a precise house price prediction is crucial (Alyousfi, 2018). The development of a housing prices prediction model can assist a house seller or a real estate agent to make better-informed decisions based on house price valuation. Only a few works report the use of machine learning (ML) algorithms to predict the values. (Klaus De Aquino Afonso et al., n.d.)

A housing market can be defined as any market for real estate where contracts are negotiated directly between sellers and buyers or through the help of real estate agents. This market attracts consumers and businesses due to the numerous profit opportunities it offers due to the increased demand for housing globally. Numerous factors, such as demography, the economy, and politics, have an impact on these demands. (Klaus De Aquino Afonso et al., n.d.)

To gather the test data set for the prediction system, this paper proposes an automated method to extract House details from online housing sale websites in Sri Lanka. Future house price predictions were made using the ARIMA model. Buying a house is frequently a challenging and drawn-out process. It takes a lot of time for a buyer to sift through all the listing information

available online to find a home that meets his or her needs. An enormous amount of time is frequently wasted looking for a nice house, even before beginning the protracted process of purchasing a property. Final Product is an integrated software that enables buyers and sellers to predict and forecast house prices. Then provides a platform to buying and selling properties.

2.LITERATURE REVIEW

2.1 Background

Prediction systems have been the subject of many research studies that have already used a variety of semantic and web technologies. However, none of them go into detail about buying and selling platforms which includes price prediction. It is crucial to survey to gather information about the situation to integrate the existing housing prediction system technologies with the chosen problem domain (Dimoski & Pettersen, n.d.)

Predicting the housing price direction using machine learning techniques research paper, highlighted a prediction model for predicting potential selling prices for any real estate property is created using the decision tree machine learning algorithm. The two categories of house price prediction are those that emphasize the house's characteristics and those that emphasize the model that is used to predict house prices. A house price prediction model has been created by several researchers. (Erkek et al., 2020)

2.2 Machine Learning Techniques for house price prediction

2.2.1 Ridge regression model.

The Ridge regression model is a regularization model that adds and optimizes an additional variable (tuning parameter) to address the impact of multiple variables in linear regression, commonly referred to as noise in a statistical context. (Zhang, 2021)

2.2.2 XGBoost

Extreme gradient boosting, also known as XGBoost, is the most effective technique for classification or regression problems. It is a gradient boosting algorithm built on a decision tree. (Babu & Chandran, 2019)

2.2.3 Support Vector Machines

While in SVR we try to fit the error within a certain threshold, in simple linear regression we (Erkek et al., 2020) try to minimize the error. It is a regression algorithm and employs the same Support Vector Machines (SVM) regression methodology. (Zulkifley et al., 2020a)

2.2.4 Random Forest

Random Forest is an advanced regression algorithm; it may help to improve prediction accuracy. Random Forest is a kind of ensemble model that combines the prediction of multiple decision trees to create a more accurate final prediction. Random Forest is a verified powerful tool based on previous studies. (Babu & Chandran, 2019)

2.2.5 Multiple Linear Regression

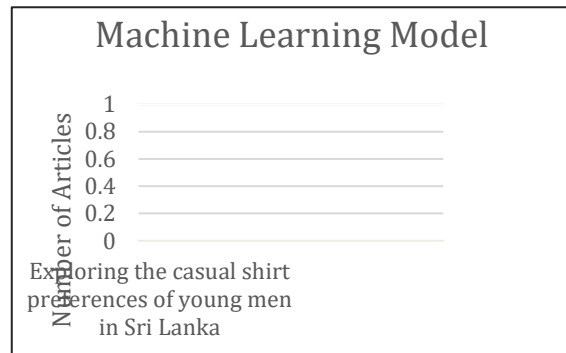
The two variables independent variable (X) and the Dependent variable are accepted by the linear regression algorithm (Y). Sklearn Library was used to import the linear regression model. The dataset of various cities' characteristics and costs is utilized to train the linear regression model. The entities in the dataset will be split into two groups: training (80%) and testing (20%). The X train independent variable entries and Y train Dependent variable entries will be used to train the linear regression model. The 20% test dataset entities will be used to test the trained model. The model will be used for prediction after training and testing. (Zhang, 2021)

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_p X_{ip} + \epsilon$$

27 research papers were analysed to study what machine learning techniques have been used to

predict house prices in previous years. Multiple linear regression and Random Forest regression were identified as the most used ML algorithms in previous research papers.

Figure 10 Machine learning techniques



2.3 Feature Analysis

The factors influencing house prices can be classified into three categories as Location, structural and neighbourhood condition, and Transactional variables (Price, Date, Seller, Property count). Location predictors-local amenities such as railway stations, supermarkets, schools, hospitals, temples, parks, etc. house features-collecting information on the number of bedrooms, number of washrooms, number of perches, number of floors, etc. concerning the price. (Shah et al., 2020)

2.4 Technologies

The Flask framework is used to integrate the trained model with the user interface.

2.5 House Price forecasting

1. ARIMA model

The ARIMA model is commonly used for forecasting purposes such as stock, temperature forecasting, sales predictions, etc. The ARIMA model combines three forecasting techniques: the auto-regressive (AR) model, the integrated differencing model, and the moving average (MA) model. (Kuvalekar et al., n.d.; Monika et al., 2021)

Table 12 Machine Learning techniques used in previous papers

study	Data collection method	Machine Learning Techniques	Best Model
(Tiwari et al., 2020)	Kaggle data set	Linear Regression Random Forest Gradient Boosting	Gradient Boosting
(Alyousfi, 2018)	Kaggle data set	Extreme Gradient Boosting Gradient Boosting Regression Random Forest Regression Light Gradient Boosting Machine Regression Support Vector Regression	Light Gradient Boosting
(Sinha, n.d.)	real estate from Ranchi capital of Jharkhand	Data refining, OLS regression, Classification, Clustering, correlation matrix.	OLS regression
("Abstracts of 1st International Conference on Machine Intelligence and System Sciences," 2022)	-	linear regression using multiple variables and Artificial Neural Network (ANN)	
(Monika et al., 2021)	-	Gradient Boosting, Gradient Boosting Regression, Random Forest Regression, Light Gradient Boosting Machine Regression, and Support Vector Regression.	Random Forest regression
(Xue et al., 2020)	capture the information of Lianjia (a house information publishing website),	random forest algorithm (RF), lightweight gradient lift algorithm (LGBM), and gradient lifting regression tree algorithm (GBDT).	Locational attributes were analysed.
(Quang et al., 2020)	Beiging data set	Random Forest, XGBoost, and LightGBM and two techniques in machine learning including Hybrid Regression and Stacked Generalization Regression	Hybrid regression

Table 13 Structural Attributes

Study	No of bedrooms	No of Bathrooms	Floor Area	Lot Size	Parking slot
(Priya et al., 2021)	✓	✓	✓	✓	✓
(Alyousfi, 2018)	✓	✓	✓	✓	
(Quang et al., 2020)	✓	✓		✓	✓
(Lawhale et al., 2022)	✓	✓	✓	✓	✓
(Liyaqatullah et al., 2021)	✓	✓			✓

Table 14 Locational Attributes

Study	Access to hospitals	Access to schools	Access to the shopping mall	Public Transportation
(Zulkifley et al., 2020b)	✓	✓	✓	✓
(Babu & Chandran, 2019)	✓		✓	✓
(Liyaqatullah et al., 2021)	✓	✓	✓	✓
(Sivasankar et al., 2020)			✓	
(Xue et al., 2020)	✓	✓	✓	✓

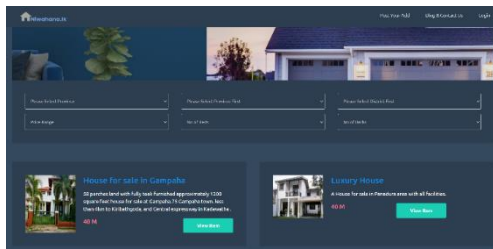
3. METHODOLOGY

3.1 Implementation

3.1.1 User Interface

This is a web-based system. Users of this software include entrepreneurs, investors, and other people looking for real estate. They must. Enter information regarding the property they desire, and then the computer program will provide the precise expected value. Additionally, the user can guess the amount by typing the date. The user of this program must input website information about users' locations, such as many stories, square footage, location, bedrooms budget, etc.

Figure 11-Home Page of the web system



3.1.2 Data set

For the objective of predicting property prices, a dataset was collected using Robotic Process Automation and extracted from lankaproperty.lk utilizing the web scraping technique. The house price index according to the data for the years 2018 to 2022 is included in the dataset used for forecasting.

Figure 3-Data set (Extracted from Lankaproperty.com)

A	B	C	D	E	F	G	H	I	J	K	L	M
headline	house_url	house_price	bedrooms	bathrooms	house_size	house_loc	parking	floors	land_size	year		
1 House for https://wv	18	1	1	2500	Panadura	1	1	8	2018			
2 HOUSE FO https://wv	10	3	3	1250	Panadura	1	1	12	2022			
3 House for https://wv	13	3	1	1400	Panadura	1	1	20	2021			
4 2BHK/ Ho https://wv	8	2	2	1600	Panadura	4	1	10	2021			
5 House for https://wv	11	2	1	1000	Panadura	1	1	10.4	2021			
6 House for https://wv	5	3	1	1200	Panadura	1	1	15	2019			
7 HOUSE FO https://wv	20	4	2	3000	Matara	1	2	15	2018			
8 HOUSE FO https://wv	4	6	3	5700	Matara	1	2	23	2018			
9 House for https://wv	8	5	1	180	Matara	1	2	25.5	2018			
10 HOUSE FO https://wv	1	4	1	7900	Matara	1	1	29	2018			
11 HOUSE FO https://wv	12	3	2	1270	Matara	1	1	1	2018			
12 HOUSE FO https://wv	7	3	1	2040	Matara	1	1	7.5	2018			
13 HOUSE FO https://wv	24	5	2	1700	Matara	2	2	7	2018			
14 A House ii https://wv	19	1	7	600	Kandy	1	2	1.5	2021			
15 A valuable https://wv	21	3	2	600	Kandy	1	1	9	2021			
16 House & P https://wv	90	4	2	2000	Kandy	2	2	60	2021			
17 10 Perch li https://wv	55	5	3	3300	Kandy	1	3	10	2021			
18 17.5 Perch https://wv	10	3	1	1200	Kandy	1	1	17.5	2021			
19 Half built i https://wv	10	2	1	2000	Kandy	1	1	14	2020			
20 On Main R https://wv	22	3	4	3.15	Kandy	1	3	3	2021			
21 Well maini https://wv	110	8	5	3000	Kandy	1	1	46.23	2021			
22 10 perch li https://wv	26	9	4	3300	Kandy	1	3	10	2021			
23 Well maini https://wv	10	3	1	2100	Kandy	1	1	9.8	2021			
24 20 perch li https://wv	11	5	1	1800	Kandy	3	1	20	2021			
25 Valuable li https://wv	40	4	1	2500	Kandy	1	1	440	2021			

iii. Exploratory data analysis

EDA refers to the in-depth examination of data to identify patterns and anomalies. It is crucial to look at all your factors before concluding the data.

Figure 4- Attributes of the dataset

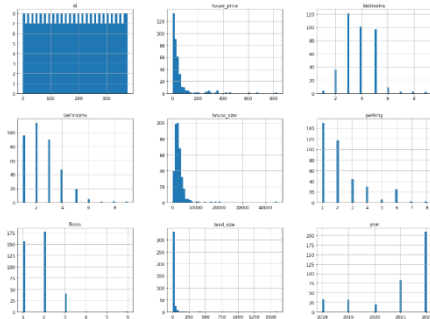
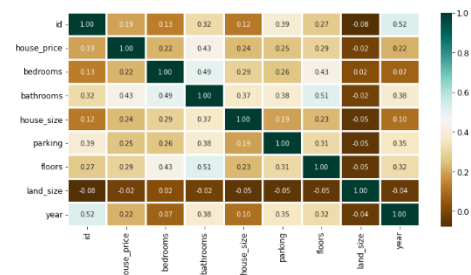


Figure 5-Heatmap



refers to the deep analysis of data to discover different patterns and spot anomalies. Before making inferences from data, it is essential to examine all your variables.

3.2. House Price prediction

Figure 12-User Input Parameters

Figure 13-Predict a Fair Price

These are the parameters used for estimating house prices in this system. In addition to our variables, our unique method considered nearby local amenities such as a train station, grocery, school, hospital, temple, parks, etc. Using Google Maps, we examine the nearby 1 km (0.6 mi) radius - circle of the major town - facilities. And if we locate such amenities in our area, the system raises the price of those houses with one another.

3.2.1 Random Forest Regression

After training four machine learning algorithms Random Forest regression was selected for the training dataset. SVM, Multiple linear regression, Random Forest regression, and decision tree were compared. Finally, after the best-fitted model, Random Forest was selected.

3.3 forecasting Future House Price

One variable is needed to create ARIMA (Autoregressive Integrated Moving Average) [Z]. The residuals, or values representing the discrepancy between reality and expectations, are created by ARIMA models using real values and lagged data. The best technique to get univariate data to collaborate with R when working with this type of data is by establishing a time series object. ARIMA models involve intricate statistical calculations. They are related to p, d, and q values. Typically, it is written like this: ARIMA. The p-value addresses the autoregressive component of the model and typically addresses the sequence in which the linear component of the model integrates with preceding points

In this System, the user-entered date will be the input for the ARIMA model. The output of the ARIMA model is the House Price Index (HPI),

which is then translated to House price using a formula.

Then Flask was used to display forecasted prices on the web.

vi. Backend Connectivity

This web application is connected to the backend using the python flask framework. The Flask-MySQL extension makes it possible to access a MySQL database. our model into pickle and JSON files and create a webpage using HTML, CSS, and JavaScript before building the web application and connecting the model with the web application. With this, the Model is prepared for the web application's display and prediction capabilities.

4.RESULTS AND DISCUSSIONS

4.1 Machine learning techniques

To select the model that best fits our data, particularly the test datasets, we trained several ML models. Starting with the most fundamental one, Linear Regression.

I. Linear Regression

The RMSE, the model's typical prediction error is a big amount. To make the model more accurate, more features should be added or tried for complex ML algorithms. So, we tried complex ML models

After a comparison of other models, like our final model, we selected the Random Forest model in production because the excellent RMSE of Random Forest is low. It's always a good idea to compute the model's prediction interval because it helps us understand how much the error can fluctuate. After adding cross-validation these are the results of linear regression and decision trees these results were displayed. Compared with SVM, Decision tree, Multiple linear regression Random Forest gives the least error rate.

So Random Forest was selected for the train dataset

4.1.1 Random Forest regression

Mean Absolute Percentage Error (MAPE) can be used to calculate the loss.

Evaluating the Random Forest Model

The accuracy of Random Forest regression is 86.9% and MSE can be identified as 18.15.

5.CONCLUSION

By introducing new features or by creating new features, this model can be enhanced and expanded with more features to increase accuracy. This model can be used to forecast home values anywhere in the world by simply changing the features and parameters. In Sri Lanka, there is no program that can be used to calculate the cost of a house before buying it. In the past few years, Sri Lanka's economy has paid a lot of attention to the issue of house price forecasting. Sri Lanka's social and economic statistics could be significantly impacted by a minor error in the housing market. The distinctive characteristics of Sri Lanka that affect predictions of house prices have changed over time. It takes a long time to manually insert those modifications for the prediction, though. These problems cast doubt on the accuracy of the findings. The ideal model to train the data set was determined to be Random Forest Regression. The most effective model for predicting house prices was found to be ARIMA.

REFERENCES

- Abstracts of 1st International Conference on Machine Intelligence and System Sciences. (2022). *Abstracts of 1st International Conference on Machine Intelligence and System Sciences*. AIJR Publisher. <https://doi.org/10.21467/abstracts.120>
- Alyousfi, A. (2018). *House Price Prediction Using Machine Learning Techniques*.
- Babu, A., & Chandran, A. S. (2019). Literature Review on Real Estate Value Prediction Using Machine Learning. *International Journal of Computer Science and Mobile Applications*, 7, 8–15. www.ijcsma.com
- Dimoski, M., & Pettersen, M. (n.d.). *Predicting Housing Prices With Machine Learning NORWEGIAN SCHOOL OF ECONOMICS*.
- Erkek, M., Çayırılı, K., & Hepşen, A. (2020). Predicting House Prices in Turkey by Using Machine Learning Algorithms. In *Journal of Statistical and Econometric Methods* (Vol. 9, Issue 4) (online) Scientific Press International Limited.
- Klaus De Aquino Afonso, B., Carvalho Melo, L., Gomes De Oliveira, W. D., Bruno, S., Sousa, S., & Berton, L. (n.d.). *Housing Prices Prediction with a Deep Learning and Random Forest Ensemble*. <https://www.kaggle.com/c/data-science-challenge-at-eef-2019/>
- Kuvalekar, A., Mahadik, S., Manchewar, S., & Jawale, S. (n.d.). *HOUSE PRICE FORECASTING USING MACHINE LEARNING*. <https://ssrn.com/abstract=3565512>
- Lawhale, P., Ramatkar, Y., Dakhore, S., Gumble, M., Tawlare, A., & Thakare, Y. A. (2022). House Price Prediction using Machine Learning. *International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)*, 2(7). <https://doi.org/10.48175/IJARSCT-4404>
- Liyaqatullah, K. S., Malik, U., & Basheeruddin, Q. M. (2021). This work is licensed under a Creative Commons Attribution 4.0 International License HOUSE PRICE PREDICTION USING MACHINE LEARNING. *International Journal of Advanced Research in Computer and Communication Engineering*, 10. <https://doi.org/10.17148/IJARCC.2021.10468>
- Monika, R., Nithyasree, J., Valarmathi, V., Hemalakshmi, M. G. R., & Prakash, N. B. (2021). House Price Forecasting Using Machine Learning Methods. In *Turkish Journal of Computer and Mathematics Education* (Vol. 12, Issue 11).
- Priya, P., Kumaran M, A., Kumar K, D., & Singha, N. (2021). *Prediction of Property Price and Possibility Prediction Using Machine Learning* (Vol. 25). <http://annalsofscsb.ro3870>
- Quang, T., Minh, N., Hy, D., & Bo, M. (2020). Housing Price Prediction via Improved Machine Learning Techniques. *Procedia Computer Science*, 174, 433–442. <https://doi.org/10.1016/j.procs.2020.06.111>
- Shah, D., Rajput, H., & Chheda, J. (2020). House Price Prediction Using Machine Learning and RPA. *International Research Journal of Engineering and Technology*. www.irjet.net
- Sinha, A. (n.d.). Utilization Of Machine Learning Models in Real Estate House Price Prediction. *Amity Journal of Computational Sciences (AJCS)*, 4. www.amity.edu/ajcs
- Sivasankar, B., Ashok, A. P., & Madhu, G. (2020). House Price Prediction. *International Journal of Computer Sciences and Engineering Open Access Research Paper*, 8(7). <https://doi.org/10.26438/ijcse/v8i7.98102>

- Tiwari, P., Singh Thakur, V., Shankar, S., Shukla, P., & Tech Scholar, M. (2020). Comparison on Advance Regression Techniques on House Price Prediction. *Issue*, 173(01). www.ijsspr.com
- Xue, C., Ju, Y., Li, S., Zhou, Q., & Liu, Q. (2020). Research on accurate house price analysis by using gis technology and transport accessibility: A case study of xi'an, china. *Symmetry*, 12(8), 1–21. <https://doi.org/10.3390/sym12081329>
- Zhang, Q. (2021). Housing Price Prediction Based on Multiple Linear Regression. *Scientific Programming*, 2021. <https://doi.org/10.1155/2021/7678931>
- Zulkifley, N. H., Rahman, S. A., Ubaidullah, N. H., & Ibrahim, I. (2020a). House price prediction using a machine learning model: A survey of literature. *International Journal of Modern Education and Computer Science*, 12(6), 46–54. <https://doi.org/10.5815/ijmecs.2020.06.04>
- Zulkifley, N. H., Rahman, S. A.

Design and Development of Air Quality Monitoring System for Higher Education Institute using MQ-2 and MQ-8 with WSN and IoT

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ABSTRACT

Most schools, universities, and educational institutions are close to significant intersections and the city center. Therefore, it is crucial to understand the air quality levels in these institutions' vicinity. More than 25% of a student's day is spent on educational institutes premises. The most vulnerable population is in the greatest danger due to the poor air quality levels on campuses and in schools. Young children's lungs are especially susceptible to air pollution, according to the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF). While the immune system is still developing, childhood exposure can lead to lung cancer, asthma, and other long-term respiratory health problems. This air monitoring is necessary in and around the school and university facilities as a result. This paper discusses the wireless sensor network (WSN) and internet of things (IoT)-based air quality monitoring system that uses MQ2 and MQ8 sensors. The goal of this system is to monitor the air quality in the institutions. MQ2 and MQ8 sensors were employed in the study to measure the concentration of gases in the air, including LPG, propane, methane, hydrogen, alcohol, smoke, and carbon monoxide. Thingspeak is an IoT cloud platform that houses all acquired data.

Data is shown on the website following analysis. This technique aids in better decision-making and reduces the likelihood that pupils may experience pollution-related health problems.

1. INTRODUCTION.

The natural atmosphere's delicate equilibrium has been upset by excessive industrialization, which has also reduced the quality of the air and seriously harmed people's health. Therefore, it is essential to keep an eye on air quality to safeguard and enhance inhabitants' quality of life. As a result, expensive air quality monitoring devices with limited data granularity are progressively being replaced with more effective and affordable IoT-based solutions (Mokrani, Lounas, Bennai, Salhi, and Djerbi, 2019).

This research looks at air quality in the surrounding environment using MQ2 and MQ8 sensors. IoT is also being used more and more by researchers to track the evolution of high pollution levels and monitor air quality.

Monitoring environmental factors including temperature, sound, vibration, pressure, motion, or pollution, a wireless sensor network (WSN) collectively transmits data to the top position or sink where it may be displayed and evaluated (AlSheikh & Hagem, 2021).

2. LITERATURE REVIEW

Khan, Rahman, Arafat, and Jony (2022) implemented a system combination of a website, an android app, a server, and gas sensors to detect CO₂, CO, LPG, CH₄, and H₂. Additionally, it showed analyzable real-time data for users. A Raspberry pi microcontroller board, MQ2, MQ8, M135, sound sensor, and DHT11 sensors were used to implement the system. Based on system functionalities, sensors (MQ2, MQ8, M135, Sound sensor, DHT11) get analog data values and convert them into digital values using a Raspberry pi microcontroller and send them to the server. A statistical method (mean and standard deviation) was used to analyze the data. Moreover, the analyzed data is shown in the mobile app and website. Additionally, they checked their system accuracy using trusted websites (www.accuweather.com and www.timeanddate.com) to compare the data's temperature and humidity.

Hasan & Putri (2020) decided on the hexacopter drone to measure air pollution using mobility-wireless technology, using gas concentrations such as CO, LPG, H₂, and smoke. Controlling drones (UAVs) and measuring air pollution are the core functionalities of this system. The low-cost MQ2, MQ6, and MQ8 gas sensors and the Arduino UNO with Lora WIFI shield are used for developing the air pollution detection section. Collected sensor data could show the mobile base station, and a drone can also control that ground station. Researchers analyzed the data using a gas concentration formula.

Devi, Meivel, Ranjit Kumar, and Vijayamenaka (2021) claim that IoT systems keep track of the air quality index (AQI) in various places. Moreover, the system monitored five different gas (CO, CO₂, NH₃, LPG, and NO_x) concentrations using an MQ2 sensor. They also employed the MQTT protocol for lightweight message transferring and the DHT11 sensor to measure temperature. Data from sensors is transmitted to Thingspeak's IoT cloud storage. To display the level of pollution at any particular place, the Raspberry Pi microcontroller connects sensors and Thingspeak. This system measures gas concentration ppm value and AQI value

based on the AQI range, analyzing results shown on the website.

In order to identify indoor harmful gasses, AbdulWahhab (2020) created the IoT base equipment for integration with a smartphone application that tracks real-time air pollution. This air quality monitoring system logs data online on humidity, temperature, methane, ethanol, toluene, CO₂, CO, alcohol, LPG, NH₄, benzene, and hexane gases, as well as other environmental variables. Additionally, this designed system connects the sensors and communicates with IoT using an ESP8266 Wi-Fi board and an Arduino UNO microcontroller board. GP2Y1010AU0F sensors using data from an IoT-based cloud platform Thingspeak with date, time, and locations longitude and latitude. MQ-2, MQ-3, MQ-135, MQ-9, DHT11, and GP2Y1010AU0F sensors. Using a mobile app, the ARIMA static model analyzes gathered data and presents findings.

An IoT-enabled air quality monitoring system that analyzes real-time data measuring levels of monoxide gas, smoke, and PM was proposed by Kumar, Kumari, and Gupta (2020). The primary functions of such a system are sensing local area air contamination and producing analytical data supplemented by alerts to the public via a buzzer. Hypertext transfer protocol (HTTP) is used to store and retrieve data online using ThingSpeak, an open cloud platform. The Node MCU serves as a processing unit and receives readings from the MQ9 gas sensor, which is used to detect carbon monoxide, the MQ2 sensor, which is used to detect smoke, and the PMS3003 G3 particle sensor, which is used to detect PM2.5. The sensed data may also be plotted graphically and shown on the OLED monitor with the aid of the ThingSpeak platform.

3. METHOD

To address the research problem, this study is based on discovering the prevailing air quality monitoring system for higher education institutes using MQ2 and MQ8 sensors. Therefore, this section presents the main steps concisely for achieving the timely development of the research.

ESP32 microcontroller is used to develop the system because it has built-in Wi-Fi technology. It helps to connect the Thingspeak IoT platform easily. Many microcontroller boards have no built-in Wi-Fi technology, for the ESP32 has that Wi-Fi facility. Therefore, there is no need to combine it with a Wi-Fi shield. Therefore, MQ2, MQ8, 16x4 LCD screens, buzzers, and LEDs are also connected to the ESP32 board. Figure 1 illustrates the system overview.

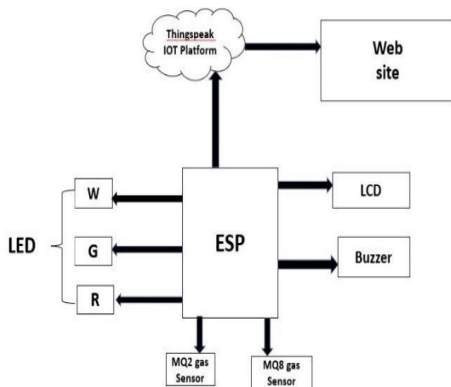


Figure 1. System overview.

Figure 2 shows the pin arrangement on the ESP32 microcontroller board with other peripherals devices.

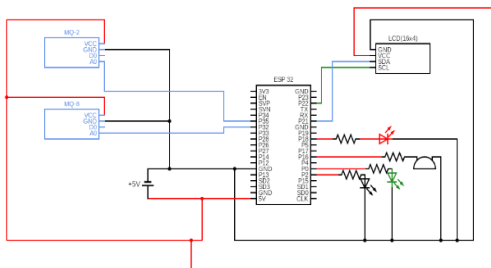


Figure 2. The circuit diagram.

Figure 3 shows how the prototype device is connected to the ESP32 microcontroller board and other components.

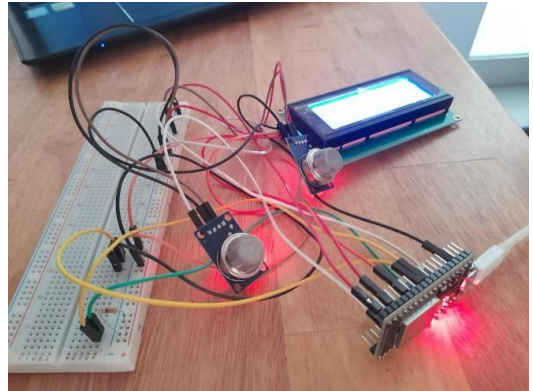


Figure 3. Prototype device

The raw data collected from MQ2 (smoke) and MQ8 (hydrogen) sensors are shown on the LCD screen in real-time. Then, the ESP32 board passed the raw data into the Thingspeak IoT platform using a Wi-Fi connection. The Thingspeak IoT platform showed the collected data in a graph format. Then, the cloud platform passed data into the local server using the read API key in Thingspeak. The local server retrieved and stored the data by using PHP with MySQL. Then, a web application was used to display the collected data. Finally, data from eight days were considered for data analysis using MS Excel.

4. RESULT

Figure 4 illustrates the field charts of MQ2 (smoke) and MQ8 (hydrogen) sensor values for the place where the experiment was conducted in PPM.



Figure 4. Thingspeak MQ2 and MQ8 data.

Table 1 is shown a statistical analysis of smoke and H₂ in the maximum, minimum, mean, median, and standard deviation for each day.

Table 1. statistical analysis of smoke and H₂

Date	08/25		09/02		09/03	
	Smoke	H ₂	Smoke	H ₂	Smoke	H ₂
Min	242	272	16	102	71	229
Max	937	917	4095	917	4095	4095
Mean	540.33	591.82	547.27	591.82	1503.69	1086.93
Median	482	657	455	657	743	866
S.D	126.167	119.089	514.492	119.089	1058.567	523.473

09/04		09/06		09/07		09/08	
Smoke	H ₂	Smoke	H ₂	Smoke	H ₂	Smoke	H ₂
400	835	15	209	445	724	379	755
2810	2023	4095	4095	521	925	527	991
1067.47	1097.8	1259.37	1116.41	493.93	800.90	476.66	793.87
526	979	873	864	496	789	487	779
918.705	254.429	969.666	721.664	12.808	42.643	30.311	40.935

5. DISCUSSION

Based on the above result, the data is categorized wisely according to the day. The statistical method found each date's mean, median, and standard deviation.

Moreover, gas sensors' detectable value range is 100 ppm to 10,000 ppm. According to the research on clean air, the smoke concentration is around 4453.76 ppm, and the hydrogen concentration is 1000 ppm.

Considering the analyzed data, smoke concentration is no higher than the clean air smoke range rate, and on some dates, it exceeds the clean air hydrogen gas limit.

The standard deviation value says how much spread the data is related to the mean; according to the theory, stranded deviation near zero means the data set is balanced and can be used for analysis purposes. On the other hand, if the

standard deviation is high or low, the data is not suitable for getting the overall output decision.

According to the standard deviation analyzed, it can be said that in the Malabe higher education area, the air is free from smoke and hydrogen gas.

6. CONCLUSION

The goal of this system is to monitor the air quality in the institutions. The proposed method uses MQ2 (used for sensing smoke) and MQ8 (used for detecting hydrogen) sensors. All collected information was stored on an IoT cloud platform called Thingspeak and sent to a local server.

This system helps us with better decision-making and minimizes students' risks from pollution-related health issues.

Most schools and universities are close to significant intersections and city centres. Therefore, it is crucial to understand the immediate vicinity of these institutions. In addition, poor air quality at schools and universities is the highest risk because many health problems are spreading.

However, this system uses MQ2 and MQ8 sensors. As a result, this system helps with better decision-making and minimizes students' risks from pollution-related health issues.

REFERENCES

- Mokrani, H., Lounas, R., Bennai, M. T., Salhi, D. E., & Djerbi, R. (2019). Air Quality Monitoring Using IoT: A Survey. *IEEE International Conference on Smart Internet of Things (SmartIoT)*, pp. 127–134. doi: 10.1109/SmartIoT.2019.00028.
- AlSheikh, R., & Hagem, R. (2021) A Survey on Smart Monitoring System of Environment Based on IoT. *AREJ*. vol. 26, no. 1, pp. 147–159. doi: 10.33899/rengj.2021.128944.1072.
- Khan, H. B. H., Rahman, R. U., Arafat, M. Y., & Jony, M. A. N. (2018) *Air pollution monitoring system for smart city*. Thesis, BRAC Univeristy.

- Devi, K.I., Meivel, S., Kumar, K.R., & Vijayamenaka, J. (2021). A survey report of air polluting data through cloud IoT sensors. *Materials Today: Proceedings*. doi: 10.1016/j.matpr.2020.12.621.
- Hasan & Putri, D. (2020). The Effects of Speed and Altitude on Wireless Air Pollution Measurements using Hexacopter Drone. *International Journal of Advanced Computer Science and Applications*. vol. 11. doi: 10.14569/IJACSA.2020.0110931.
- Wahhab, S.A. (2020). Air Quality Monitoring System: Towards IoT based system for Air Pollutant Concentration Prediction. *10th International Conference on Advanced Computer Information Technologies (ACIT)*, Deggendorf, Germany, pp.311–316. doi:10.1109/ACIT49673.2020.9209010.
- Kumar, M. K., & Gupta, H. (2020). Design and Analysis of IoT based Air Quality Monitoring System. *International Conference on Power Electronics & IoT Applications in Renewable Energy and its Control (PARC)*. pp.242-245. doi:10.1109/PARC49193.2020.236600.

IoT-based Air Pollution Monitoring System for Surrounding Environments in Private Education Institute using MQ135 and MQ7 Sensors

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ABSTRACT

In the 21st century, there are various contributing factors to air pollution due to many human activities, such as factory wastes, wildfire, and vehicle emissions. This air pollution produces significant consequences, including health issues. This study suggests that IoT technology with MQ7 and MQ135 sensors could be used to make a low-cost, portable, and easy-to-control device based on ESP32. Accordingly, the device analyzed the carbon monoxide (CO) and carbon dioxide (CO₂) levels in the air for five days at different spots around the private education area in Sri Lanka. The device collected data from different places and sent it to the Thingspeak platform in the cloud. The data was then shown on a web app and later analyzed to make decisions and look at the air quality.

1. INTRODUCTION.

One of the most essential elements for maintaining human life is air. In today's world, air pollution is expanding at an alarming rate due to climate change, negatively affecting everyone. The air around us is polluted, because of toxic emanations from businesses and vehicle emissions, driving an increment in concentrations of hurtful gasses and particles in the environment. Outflows of harmful substances such as industrial gasses and vehicle emissions are unstable for earthbound. Health issues such

as stroke, heart disorder, lung disease, cancer, and respiratory infection may happen due to poor Air quality.

Air pollution in the outdoor environment in private education institutes should be considered an essential factor. Usually, students visit the institute in the morning hours when the air pollution is higher due to vehicle emissions. Since the roads are filled with people's vehicles going to their jobs, schools, and other necessities, it causes higher vehicle emissions. As a result, the air becomes polluted. Usually, private education institutes are located in commercial areas, which contain supermarkets, restaurants, and public parks. Therefore, this air pollution negatively affects students and other parties, such as people who exercise in the morning in public parks and do day-to-day activities around the private institute.

This study focuses on the outdoor and indoor environment around the private education institute, Horizon Campus, located at Malabe in Sri Lanka. First, an ESP32 board and MQ7 and MQ135 sensors were used, and indications including carbon monoxide (CO) and carbon dioxide (CO₂) are recorded. The data is then stored in a cloud platform called Thingspeak. After that, the information can be afterward used to do further studies and choices about the

condition of the air quality utilizing a web application.

2. LITERATURE REVIEW

2.1. IoT-based air pollution Monitoring System.

Automation and modernization are pervasively becoming more common. Additionally, pollution is becoming more visible everywhere. To keep the cutoff points in check, the World Health Organization (WHO) has developed certain regulations. regarding particular gases like O₃, NO₂, and SO₂. It has been discovered that there is a strong correlation between lung diseases and environmental toxins. Monitoring of air pollution can also be used in daily routines to warn oil and gas workers against complacency. It reenacts the three contaminating gases, including CO, CO₂, and SO₂, in the air. This repetition creates awareness among individuals in urban communities (Sajjan & Sharma, 2019).

2.2. IoT-based Air Pollution Monitoring System for Smart Villages.

For people living in underdeveloped nations, air pollution is a major health risk. Mild allergic reactions and throat, eye, and nose irritation are just a few of the negative effects of air pollution. Serious issues like bronchitis, heart illness, lung disease, and worsened asthma might be brought on by it.

Over the internet, the air quality is monitored by an IOT-based air pollution monitoring system. The system will trigger an alarm when there are high levels of harmful gasses in the air. Temperature and humidity are also monitored in the system, as well as humidity and temperature (Jazavac & Tatari, 2021).

2.3. Air Pollution Monitoring System Using IoT.

In any nation, whether it was made or not, air pollution is the most serious problem. Gas emissions frequently cause lung cancer, eye discomfort, and breathing problems in both people and animals. Mild allergic reactions near the throat, eyes, and nose as well as more serious conditions like bronchitis, heart infections, pneumonia, lung, and aggravated asthma are a few more harmful effects of pollution. These issues typically arise when the industry fails to

follow government regulations for gas reduction. Particularly in urban regions of emerging nations, where industrialization and the rise in vehicle traffic cause the production of several gaseous pollutants, health issues have been becoming worse faster.

There must be effective, dependable, and accurate monitoring of the environment and pollution levels near manufacturing facilities. The high pollution rates are checked by monitoring dangerous gases in the vicinity of the industry. It compares them to the norms, and when the quality falls below a predetermined threshold, it alerts people that the situation is unsafe (Walsange & Yerigeri, 2020).

2.4. Designing an IoT-based air quality monitoring system.

Nasution, Muchtar, and Simon (2019) designed a system to recognize the quality of air. Temperature, humidity, and chemicals present in the air can all be measured as part of air quality monitoring.

2.5. Air Quality Monitoring: The Use of Arduino and Android.

In recent years, air pollution has posed a serious hazard. by keeping an eye on the air quality with three sensors. The optical dust sensor GP2Y1010AU0F was used to measure the concentration of dust particles in the air, and MQ9 and MQ135 are two of the gas sensors (Husain, Rini, Haque, and Alam, 2016).

2.6. Air Development of Blynk IoT-Based Air Quality Monitoring System.

As air pollutants are affected by other air pollutants, the challenge of air pollutants is becoming more evident.

These air pollutants are frequently due to human sports, open burning, smoke components, and lots of different gasses that could harm. Furthermore, these air pollutants contribute to worldwide Global warming and should motivate the melting of This polluted air can also motivate acid rain to fall on polluted air areas.

IoT systems with implanted air quality sensors, microcontroller units (MCUs), and electronic software frameworks enable data exchange.

Moreover, the information results can be used by further developing correspondence innovation frameworks to give moment refreshes other than checking the effect of air quality levels specifically (Yunus, 2021).

2.7. An IoT-based Approach To Minimize And Monitor Air Pollution Using ESP32 and Blynk Platform.

Air pollution is one of the worst environmental problems, causing many harmful human health problems, impacting water resources and the climate, and causing ozone damage on Earth. In all major cities, industry and automobiles are the main contributors to air pollution.

The offered IoT-based air quality measurement system can be used in two ways. It works both as a standalone device and as a vehicle-mounted device. To improve air quality, the device proposes using an ESP32 microcontroller and IoT technology to track the atmosphere. The monitoring cycle for many environmental issues is improved by IoT technology adoption. In this study, air quality management challenges are proposed (Asra, Raju, and Varsha, 2020).

2.8. IOT-based Air Quality Monitoring System Using MQ135 and MQ7 with Machine Learning Analysis.

Air pollution is rapidly increasing as a result of factors that can impair human health, such as industries, urbanization, population growth, and automobile use. Industries that produce poisonous gases, car emissions, and an increase in dangerous gases and particulates in the atmosphere are all responsible for pollution.

This research presents an independent, real-time air quality monitoring system. All industries are now making a substantial use of the Internet of Things (IoT), which is essential to our system for tracking air quality. In order to easily monitor the air quality, we have set up our system to display the PPM (Parts per Million) readings on a web page. Anyone may check the pollution level using a computer or a mobile device from anywhere (Sai, Subbareddy, and Luhach, 2019).

2.9. Air Pollution Monitoring System Using Arduino With MQ135 Sensor.

Pollution also becomes more visible everywhere as technology and automation get more extensive. It has been observed that human pleasure increases rapidly in nations that produce or make things mechanically. Air pollution is a problem that no system can screen or monitor. There is a strong correlation between diseases like asthma and Batten's climatic poisons, including lung-related illnesses. Around the world, air pollution is currently a major concern (Kanti, Jagadish, and Soumya, 2020).

Sensors are used by the system of continuous internet checking to screen numerical values and then transfer them to regulate the system's emphasis. This mode of information transfer includes both wired and wireless systems. Although the framework is strong, it has flaws across the board and a wide dynamic range, such as the intricate and expensive system cabling.

3. METHOD

The proposed system was built using the ESP32 Wi-Fi board. The carbon monoxide (CO) levels in the air were measured using an MQ7 sensor, and the carbon dioxide (CO₂) levels were measured using an MQ135 sensor (PPM). The readings were measured at an interval of five seconds. The proposed system's system overview diagram is shown in Figure 1.

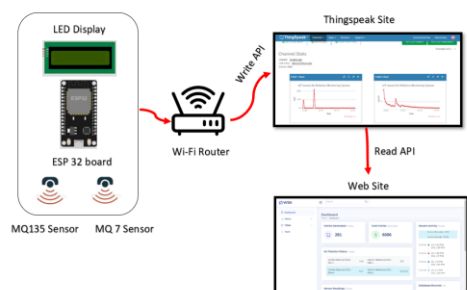


Figure 1: System Overview Diagram

An LCD (20x4) was connected to the ESP32 board to display the readings of the sensors. Three LED bulbs (yellow, green, and red) were associated with the board to indicate the different levels of air quality, called good, average, and poor. All physical components were fixed inside

a small container box, as shown in Figure 2, to carry the device to different locations.

The data was collected for five days, and the collected data was sent to the Thingspeak cloud platform using a write API through the Wi-Fi connection from the board. Afterward, the data was retrieved from the Thingspeak cloud using the read API and stored in a local database. A web application is created to evaluate the gathered data using indicators like maximum, minimum, mean, and median. Following that, separate tables for MQ7 and MQ135 readings for the five days with daily charts were produced using the analyzed results.



Figure 2: Air Pollution Monitoring Device

4. RESULT

The detailed implementation was presented. The experiment was done from five locations over five days. Table 1 shows the dates and locations, and Figure 3 displays the map of each location.

TABLE I. Experimented Locations with Dates

No	Location	Date
01	Chandrika Kumaratunga Mawatha	2022-09-01
02	Millennium Drive	2022-08-31
03	Suhada Mawatha	2022-08-30
04	Horizon Campus Open Area	2022-08-29
05	Horizon Campus Inside	2022-08-25

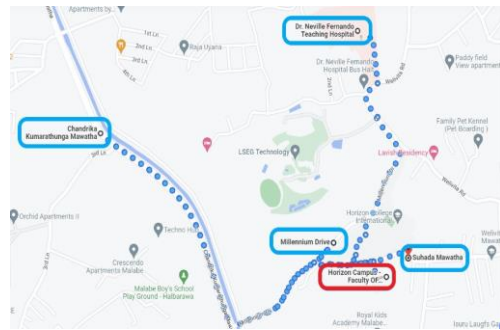


Figure 3: Map of experimented locations

A graphical analysis of the data acquired for CO and CO₂ values with time on the X axis and air quality in PPM on the Y axis is demonstrated in the following set of figures, which are displayed in Figure 4. Additionally, it displayed line charts created using PHP with MySQL as the backend and Bootstrap as the front end, utilizing data gathered from the Thingspeak account in CSV format.

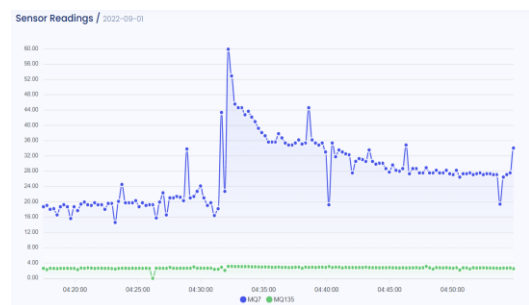


Figure 4: Time vs. Air Quality in PPM at Chandrika Kumaratunga Mw



Figure 5: Time vs. Air Quality in PPM at Millennium Drive



Figure 6: Time vs. Air Quality in PPM at Suhada Mw



Figure 7: Time vs. Air Quality in PPM at Horizon Campus Open Area

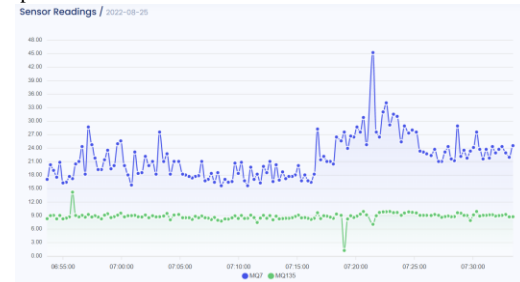


Figure 8: Time vs. Air Quality in PPM at - Horizon Campus Inside

Table 2 presents a statistical analysis of air quality in PPM surrounding areas.

Table 2. Statistical Analysis of Air Quality in PPM

Location	Date	Name	Mean	Median	Min	Max
1	2022-09-01	CO ₂	2.63	2.6	2.1	4.67
		CO	21.51	18.72	0.93	70.08
2	2022-	CO ₂	2.70	2.66	0.41	5.07

	08-31	CO	21.51	20.67	.88	167.28
3	2022-08-30	CO ₂	3.68	3.41	2.59	10.2
		CO	29.85	16.42	7.84	604.31
4	2022-08-29	CO ₂	3.01	2.92	1.97	4.55
		CO	27.61	15.5	2.66	167.72
5	2022-08-25	CO ₂	8.81	8.88	1.25	14.21
		CO	21.71	21.04	15.65	45.25

5. DISCUSSION

According to the result of the research, the air quality of five locations was monitored within five days. The mean and median levels of carbon dioxide (CO₂) and carbon monoxide (CO) were measured. Because many diseases are conveyed by the air, people must be aware of the air quality in their local area. Providing awareness might suggest solid solutions for such a problem. There can be certain levels between the maximum and the lowest. If those levels change, it might cause diseases. Rarely does air pollution cause deaths as well.

Low is defined as 50 PPM when addressing levels of carbon monoxide exposure that vary from low to harmful; mid-level is defined as between 51 PPM and 100 PPM. Furthermore, if no one is exhibiting symptoms, a PPM level greater than 101 is considered high. However, if someone is experiencing symptoms when the range is significant than 101 PPM, that level is dangerous. According to the air quality levels, several symptoms can be experienced. For example, after two to 200 PPM, people may experience a slight headache, fatigue, and dizziness when the carbon monoxide level increases to three hours. When the level is 400 At PPM, someone may experience a frontal headache within one to two hours. Dizziness, nausea, and convulsions may be felt within 45 minutes of an 800 PPM reading. Unconsciousness may be felt within two hours, and death may occur within two to three hours. People may experience headaches, dizziness, and

nausea within 20 minutes of the dangerous 1600 PPM level, which results in death within an hour.

Body metabolism generates carbon dioxide, which is a colorless, odorless, and non-flammable gas. In inhabited interior spaces with efficient air exchange, carbon dioxide levels in the external air typically vary from 400 to 1000 PPM (less than 400 PPM) and 300 to 400 PPM (less than 400 PPM). Poor air has a PPM level greater than 1000. Carbon dioxide concentrations in urban areas can reach 600–900 PPM.

On the first day, August 25th, 2022, the air quality of the campus environment was measured. According to the results of measurements, the carbon dioxide maximum level was 14.21 PPM, and the minimum level was 1.25 PPM. Furthermore, the mean was 8.81, and the median was also 8.88. Given that the values are below 400 PPM, it is possible to infer that carbon dioxide is not affected by air pollution. When moving on to carbon monoxide, the maximum level was 45.25, and the minimum was 15.65. Those ranges are less than 50 PPM and close to the low-level range. The mean carbon monoxide was 21.7, and the median was 21.04. Additionally, the median and mean were below 50 PPM (Low Level). Because of that, we can decide that the carbon monoxide level is appropriate for our campus environment. So, it is suitable for people to behave in this environment according to the health guidelines.

On August 29th, 2022, air quality monitoring was done on campus outside the environment. Due to the second day's results, a 4.55 PPM maximum level was received for carbon dioxide as a 1.97 minimum level of carbon dioxide had been measured. The mean was 3.01, and the median was 2.92. All ranges mentioned are less than 400 PPM. So, it might be concluded outside environment of the campus the prevalence of carbon dioxide ranges and that it differs from campus indoor air quality levels. When discussing carbon monoxide levels, the maximum level was 161.72 PPM, and the minimum was 2.66 PPM. However, the maximum level is higher than 101 PPM. That is not a suitable air quality level, though the mean and median are 2.66 and 27.06. Sometimes, polluted air might be included in this air. It is important to be safe from polluted air. Finally, it might be suggested that if someone experiences

symptoms, they must consider it and leave the environment. Both carbon monoxide and carbon dioxide should be in appropriate levels to conclude that this environment is suitable.

On August 30th, 2022, the Suhada Mawatha area was visited to monitor the air quality of this area. The air quality of the Suhada Mawatha area could be measured at a 10.2 PPM carbon dioxide maximum level, and the minimum level of carbon dioxide was 2.59 PPM. In addition, the mean was 3.68, and the median was 3.41. It might be decided that polluted air is not included with carbon dioxide. However, the maximum level of carbon monoxide has increased to 604.31 PPM. The minimum level was 7.84. The mean and median were 29.85 and 16.42. The maximum level might be changed according to the time. Sometimes, polluted air might be included with carbon monoxide. Finally, informing people who reside in this area might be suggested by distributing notices in relation to air quality awareness.

On August 31st, 2022, the air quality of the Millennium Drive area was measured. The maximum level of carbon dioxide was 5.07 PPM, and the minimum level was 0.41 PPM. In addition, the mean and median were 2.70 and 2.66. Therefore, it might be concluded that polluted air is not included with carbon dioxide. When discussing carbon monoxide levels, the maximum carbon dioxide level was 167.28. This maximum level is not appropriate, even if it is a metropolitan area. It means that polluted air might may include with carbon monoxide.

On September 1st, 2022, monitoring air quality was measured at Chandrika Kumaratunga Mawatha. According to the results, the maximum carbon dioxide level was 4.67 and the minimum was 2.1; the mean and median were 2.63 and 2.67. Those levels were appropriate. Therefore, it might be decided that air pollution is not present with carbon dioxide. In addition, carbon monoxide levels were checked, a 70.08 PPM maximum level was received, and the minimum level was 0.93. The mean and median values were 21.51 and 18.72. When considering the maximum level, it is at the mid-level. That is appropriate to some extent when comparing with other locations' carbon monoxide levels.

6. CONCLUSION

In this paper, a low-cost IOT-based air pollution monitoring system has been designed for private educational institutes, which can get real-time air pollution data.

MQ135 and MQ7 sensors were used to design this device to detect air quality. A number of research studies on tracking air quality have also been examined by reading literature reviews. The ESP32 board has sent data to the cloud system using Wi-Fi. Then, the Thingspeak cloud was used to receive data from the ESP board. After that, the data was analyzed using a web application to make further decisions and analyses about the state of air quality.

Nowadays, a lot of diseases are spread by air pollution. As a result, this research is very important for students who are studying in private education institutes to avoid dangerous diseases. Awareness of good air quality levels causes us to minimize dangerous diseases.

The MQ135 gas sensor is anticipated to be added to the ESP32 board in the future to detect ammonia gas in the environment and provide more information about air pollution. In order to provide more accurate information on air pollution, it is also anticipated that the web application would improve in terms of giving more statistical data.

REFERENCES

- Sajjan, V., & Sharma, P. (2019). Research on an IoT Based Air Pollution Monitoring System, *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, 8(92), 553-557.
- Jazavac, N., & Tatari, (2021). IoT-based air pollution monitoring system for smart villages. Bachelor Thesis, Kristianstad University, Sweden.
- Walsange, M., & Yerigeri, V.V. (2020). A Review: Air Pollution Monitoring System Using IoT. *International Journal of Creative Research Thoughts (IJCRT)*, 8(4), 1959-1963.
- Nasution, T. H., Muchtar, M. A., & Simon, A. (2019). Designing an IoT-based Air Quality Monitoring System. *IOP Conf. Ser.: Mater. Sci. Eng.* 648(1), 012037.
- Husain, A. M., Rini, T. H., Haque, M. I., & Alam, R. (2016). Air Quality Monitoring: The Use of Arduino and Android. *Journal of Modern Science and Technology.* 4(1), 86 – 96.
- Yunus, N. M. (2021). Development of Blynk IoT-Based Air Quality Monitoring System. *Journal of Engineering Technology.* 9, 63–68.
- Asra, N., Raju, J., & Varsha, V. (2020). An IoT-Based Approach to Minimize and Monitor Air Pollution Using ESP32 and the Blynk Platform. *Journal of Xi'an University of Architecture and Technology.* 558-566.
- Sai, K., Subbareddy, S., & Luhach, A. (2019). IOT-based Air Quality Monitoring System Using MQ135 and MQ7 with Machine Learning Analysis. *Scalable Computing: Practice and Experience.* 20(4), 599-606.
- Kanti, A., Jagadish, P., & Soumya, P. (2020). AIR POLLUTION MONITORING SYSTEM USING ARDUINO WITH MQ135 SENSOR. *International Research Journal of Modernization in Engineering Technology and Science.* 2(8), 412-421.

An Over-The-Top Video Streaming Platform Enhanced with Artificial Intelligence

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ABSTRACT

Presently, over-the-top video streaming services have gained a lot of popularity among movie and television show viewers. This is because current over-the-top video streaming services offer hassle-free, easily accessible and affordable subscription-based platforms to consume thousands of entertainment contents with clicks of a few buttons. But due to the vast content pool indexing, discovering, searching and recommending a particular content in a streaming platform is a very onerous task. Most of the time an online video streaming platform user will be spending most of his time “browsing what to watch ” rather than enjoying a piece of content. “Entertainment” should be a hassle-free process because it is a getaway for people to take a break from their work to relax and enjoy. But because browsing an entertainment piece is a hefty task in these current streaming platforms most of the users have begun to abandon or move to other streaming platforms or to traditional methods of movie/television content watching. From a business point of view this will ultimately lead to a huge financial loss in these streaming platforms. With the help of the conversational artificial intelligence which will be built upon the author’s developed streaming platform, a user can get to establish a conversation with the platform to unravel his entertainment needs, in a similar way that he would do conversations with a friend of him about a certain movie or movie

genre that he would like watch. By examining those conversations that the user had with the conversational AI and the user patterns, developed machine learning models will be able to make personalized content recommendations to a particular user. In addition to that using artificial intelligence and machine learning algorithms content sorting, content recommendation and the content discovery will be engineered to the most efficient level.

Keywords — Conversational Artificial Intelligence, Entertainment Web Application, Video Streaming Platform, Web Application

1. INTRODUCTION

Nowadays, over the top (OTT) video streaming services which offer movie or television content directly to the viewers via the internet, have gained a lot of popularity, engagement and viewership. Because unlike traditional video content viewing methods such as going to the cinema, buying DVDs, pre-scheduled television streams, OTT video streaming platforms have hassle-free & affordable subscription payment models, easy accessibility and lack of traditional constraints. Due to the high demand and popularity for streaming content via the internet, most of the creators have begun to create their movie or television contents targeting these streaming platforms. Following this, the huge

collections of contents have established certain issues which cannot be neglected (Moore, 2021).

Due to the vast content pool, indexing contents of a streaming platform in a meaningful manner is onerous. Searching, discovery and recommendation of a particular content which will be suitable for a particular viewer is effortful. Due to the plethora of content in these streaming platforms, a viewer can easily get distracted and overwhelmed with the content that he's been bombarded with. This results in the user's overall engagement with the platform to an unsatisfactory one (Lee, 2021). Most of the time an online video streaming platform user will be spending most of his time "browsing what to watch" rather than enjoying a piece of content (Park, 2021). "Entertainment" should be a hassle-free process because it is a getaway for us to take a break from our work to relax and enjoy. But because browsing an entertainment piece is a hefty task in these streaming platforms most of the users have begun to abandon or move to other streaming platforms or to traditional methods of movie/television content watching. From a business point of view this will ultimately lead to a huge financial loss in these streaming platforms.

To address the issues of distracted engagement and overwhelming nature in the video streaming platforms, I plan to use the technological facilities that artificial intelligence provides to an online video streaming platform which will be made by me. By using artificial intelligence and machine learning algorithms I plan to make the content sorting, content recommendation and the content discovery to the most efficient level. Because unlike conventional technological methods artificial intelligence is strong in the areas of huge data collection, analyzing huge data sets and making predictions and recommendations based on past encounters (Artificial Intelligence (AI) – What it is and why it matters, 2021). With the help of the conversational artificial intelligence which I'm going to build for my streaming platform, a user can get to establish a conversation with the platform to unravel his entertainment needs, in a similar way that he would do conversations with a friend of him about a certain movie or movie

genre that he would like watch. By examining those conversations that the user had with the conversational AI and the user patterns, the machine learning models which I'm planning to build will be able to make personalized content recommendations to a particular user.

This way the platform will be dynamic, and tailor-made to each user. Therefore, a particular user will be able to choose a piece of content that he truly desires to watch in a matter of seconds because the platform will analyze and make user preference models in a real-time fashion. Also, the user will be able to automate certain tasks across the platform, such as billing, changing the subscription plan and searching for content using the conversational AI. These solutions will ensure the overall satisfaction and engagement of users with the platform to a higher level.

2. LITERATURE REVIEW

2.1. LITERATURE OVERVIEW

As previously mentioned in section 1 - introduction, video streaming platforms have become a part of our day-to-day life. Presently video streaming platforms are not just a tool or a technology, it is a lifestyle. Each year many video streaming services from vendors are introduced to the rapidly growing video streaming market. But the author has identified a major issue with those video streaming platforms. That is, with the huge collection of content pools that they offer to their users, the users are distracted and frustrated. From the plethora of contents, the users are unable to choose a particular content that he/she desires. There's so much to watch but what should I watch now? is the question that every video streaming platform user asks. Most of the time the user spends browsing the content pool to select what to watch rather than watching a particular content. Therefore, many users tend to abandon these video streaming platforms because they do not offer as much usability to the user as they desire. To tackle this problem the author introduced and developed the "Orange Video Streaming Platform". This is a video streaming platform with built in conversational

artificial intelligence functionalities. The users can make conversations with the conversational AI as if it's a friend of theirs. The conversational AI or the AI chatbot will recommend good entertainment contents to the user based on his desired parameters. Hence the user will get the feeling that he's getting content recommendations from a fellow friend of his who has a vast knowledge of entertainment pieces. The initial plan of the development of the Orange video streaming platform was to analyze the existing video streaming platforms and identify their functionalities, operations and drawbacks. Then the requirement gathering was done for the projects and improvements were proposed. As the final step, the development of the application was done based upon the data gathered from the requirement analysis phase and design phase. A project plan was made considering the available days to complete the project.

2.2. Analyzing existing streaming media platforms

Researching, designing and developing an over-the-top video streaming platform from the ground up is a complex and immense task. Hence the studying of various real life successful examples in the industry was essential to the initial start of this project. How does the well-established streaming platforms work, what their secret recipe, what technologies do they use and how they handle their risks were taken into deep consideration. Some of the most well established, popular and successful streaming media platforms case studies were analyzed in this phase. Those streaming platforms are:

Netflix - which is the most successful and most popular over the top video streaming platform in the market had a huge story to tell which describes their inner workings. By being the industry expert Netflix uses the best available technologies to create and maintain their streaming platform. Technologies that are essential to the successful completion of this project were picked up by analyzing the technological stack of Netflix. Other than basic functions in an over-the-top video streaming

platform, Netflix uses a massive amount of artificial intelligence driven technologies in their platform. The study of this part was essential to this project because this project also involves the enhancement of artificial intelligence to the streaming platform.

Disney Plus - which is the newest competitor to the so called "Streaming-Wars" is a well-established streaming platform which is backed by a wealthy investor - Disney. In Terms of technological advancements Disney Plus is not second to Netflix. But their work is very different from how Netflix operates. Hence the studying of Disney Plus streaming platform was essential to articulate different methods and strategies to the completion and success of the project.

Spotify - which is the world's most popular music streaming service. Although this project focuses on video streaming, an audio streaming application like Spotify was taken into consideration and analyzed because Spotify has one of the best recommendation algorithms in the business. Whether the utilization of that knowledge could be applied to the video streaming platform was considered in this Spotify analysis.

Amazon Prime Video - which is one of the most stable streaming platforms in the business. Amazon Prime Video is backed by the well-known technological giant - Amazon. The analysis of Amazon Prime Video was taken into consideration because most of the other streaming platforms in the market such as Netflix & Spotify use Amazon Web Services to run their applications. And Amazon Prime Video gets to utilize Amazon Web Services at the highest proportion because Amazon Web Services are their very own proprietary technologies. Many of the Amazon Web Technologies were developed in order to cater to the requirements of the streaming platform - Amazon Prime Video. Hence this project plans to use a considerable amount of Amazon Web Services, it was

essential to study the inner works of Amazon Prime Video.

2.3. Analyzing how artificial intelligence has been embedded to existing streaming media platforms.

Artificial intelligence plays a huge role in this research & project. The use of artificial intelligence in the content recommendation & conversational AI is essential to the composition of this project. Artificial Intelligence related technologies such as natural language processing, machine learning, supervised and unsupervised learning, and deep learning has been utilized to successfully complete this project. Hence the study of utilization of artificial intelligence technologies in the existing streaming media platforms was crucial to the successful completion of this project.

Also, data science methodologies and approaches have been applied to this project in order to analyze user preferences more accurately and recommend more relatable content to the user. Conversational AI takes a huge role in this project by interacting with the user in a human like friendly conversation manner.

2.4. User requirements gathering & analyzing

Identifying accurate requirements in a research & a project is one of the most vital tasks that ensures the success of a project. Also, to ensure that optimal requirements are received the requirement gathering methods are also important. Inability to identify correct requirements or poor requirements will ultimately lead to a project failure one way or another. So, in the analysis phase of this project gathering user requirements and analyzing those requirements were taken into deep consideration. The following user requirement gathering methods were used:

Questionnaire/Survey (Both qualitative & quantitative) : A questionnaire or survey as a method of requirements gathering will allow the researcher to gather information in a short period

of time. Also, stakeholders and users or the respondents of the survey do not have to be physically available. A survey has been done using Google Forms in order to collect user requirements regarding streaming platforms. In the survey questions such as occupation status, whether they are experienced with streaming technologies, how many hours do they spend on streaming platforms, what they like and dislike about streaming platforms, what devices they use to access streaming platforms were presented. By gathering answers for those questions, it was quite easy to get an idea of the streaming media platforms usage in Sri Lanka. Based on the collected information the planning, designing and developing of the application was conducted.

The questionnaire is consisted of 12 questions as follows,

1. Occupation (Closed question – Employed or Student)
2. Do you use online streaming technology to watch Movies/Tv-Shows? (Closed question)
3. If yes, which products do you use to watch Movies/Tv-Shows? Check all that apply. (Closed question)
4. How many hours per day do you spend watching Movies/Tv-Shows on streaming media platforms? (Closed question)
5. Rank these devices according to how often you access streaming media platforms from them. (Closed question)
6. What is the likelihood of you watching Movies/TV-Shows on streaming media platforms joined by at least one other person. (Closed question)
7. In which of the following forms do you like to discuss Movies and TV-Shows? Choose all that apply. (Closed question)
8. Rank the following in order of importance when you are choosing a Movie/Tv-Show with 5 being the most

- important and 1 being the least important. (Closed question)
9. What are the things that you dislike about streaming media platforms? (Open question)
 10. If you could change anything about streaming media platforms, what would it be? (Open question)
 11. Do you have any experience with products/services which are enhanced by Artificial Intelligence? (Closed question)
 12. If yes, please state that product/service? (Open question)

Questionnaire Results

Most of the participants were employed that indicated they have some sort of financial capability to spend money on streaming media platforms.

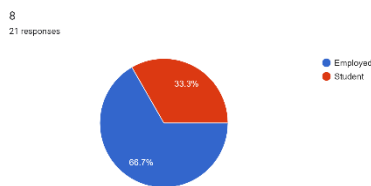


Fig. 01. Occupation Results

Most of the participants use Netflix as their streaming media service provider. Hence

analyzing the Netflix platform prominently was considered as an advantage.

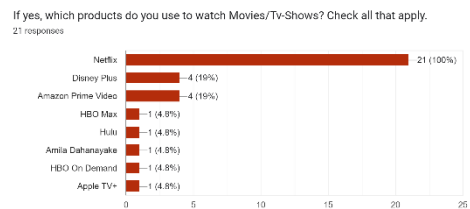


Fig. 02. Streaming Media Platforms ranked by usage

Almost 95% of the participants spend 0-5 hours with a streaming media platform. That indicates that there is a considerable amount of time to market products/services to the users.

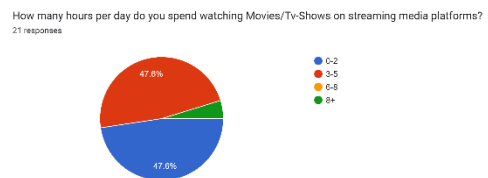


Fig. 03. Streaming Media Platforms usage by time

95% of the participants discuss the movies/tv-shows that they've watched with their friends in-person manner. That indicates that most of the users prefer to discuss movies/tv-shows with their friends. If the proposed system can mimic

the interaction between users and friends that will be highly interactive.

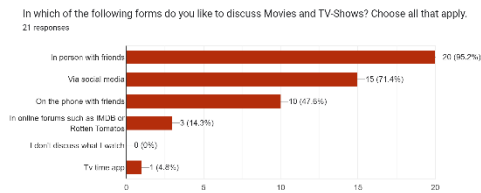


Fig. 04. Movie/tv-shows discussion medias

User observation: Although the direct approach of questionnaire/survey delivers great user feedback, that feedback is based upon the questions asked of them. Hence direct observation is sometimes better suited to get a better understanding of how the user behaves in the related environment. In this case the related environment is the use of streaming media platforms. Information such as streaming media platforms usage behaviors and patterns from several subjects was collected. Those collected user behaviors were:

1. What is the go-to device for streaming platforms?
2. How familiar are they with accessing the platform?
3. How often do they access streaming platforms?
4. What is the frequency?
5. What is the first thing they do on the platform?
6. How do they navigate through the platform?
7. And how the user navigation differs from user to user.
8. What are the complaints that they make about the platform?
9. What are the admirations that they make about the platform?
10. What is streaming media platform literacy across the platform?
11. How many hours do they spend using the platform?
12. Does the whole operation happen on the platform or are other resources needed?
(Ex: When selecting a movie, ratings of

the movie will be obtained from a web browser because many streaming media platforms do not provide movie ratings.)

Analyzing existing documents is a useful method of requirement gathering because it provides a better documented and wider range of information across the globe. Many streaming media platforms have case studies on their technological approaches, marketing approaches and user behaviors and patterns. And those existing documents were taken into consideration. For instance, Netflix Tech Blog was highly referenced in taking notes of the technical approach of a streaming media platform.

3. METHOD OF APPROACH

3.1. OVERVIEW

During the initiation, planning, analyzing, designing, developing and implementing phases of this research and project agile methodology was used as the project management methodology. Using agile methodology, the author was able to manage the project easily by breaking the project into several manageable parts. Therefore, rapid production was achieved, and constant revisions were made into the small components before assembly of the whole product. Due to that the allocated time frame was profoundly managed. The developed application is a web-based application, and it is branded as "Orange Video Streaming Platform". And it has two major components. The first one is the video streaming section and the second one is the conversation interface. The video streaming component was developed using tailwind CSS, ReactJS and NextJS with help of an external API called TMDb. The conversation interface was developed using the natural language processing platform called Google Dialogflow. The development of the whole application was done in an incremental approach. • Application development the development of the web application was done using typescript using the

Visual Studio Code IDE with the help of React libraries and Tailwind CSS as the CSS framework. Server-side rendering was done using Next JS. • API for contents All the media contents available in the application were fetched from an external API called TMDb. • Conversation Interface The conversation interface or the conversational artificial intelligence was developed using the external natural language processing platform called the Google Dialogflow. • Firebase Database To store user data the firestore real-time database of Google Firebase was implemented.

3.2. Working Product

With the final implementation of the project, the completion of the video streaming web interface and the conversational artificial intelligence (AI ChatBot) is reported.

A. Video Streaming Web Interface

Using the video streaming web interface users will be able to browse, select and watch video contents that they like.

Web interface is developed using HTML, CSS, JavaScript, ReactJS and NextJS.

B. Conversational Artificial Intelligence

Using the conversational artificial intelligence users will be able to make meaningful conversations related to entertainment with the chatbot. Chatbot will assist the users with content recommendations and make companionship with the users.

Conversational Artificial Intelligence was developed using Google Dialogflow.

3.3. TESTING

This project was done under the project management methodology of agile methodology. Therefore, after completing each stage of development that part was tested for errors and

bugs. If there were any errors or bugs in that stage the development won't be carried forward until that error gets fixed. This type of testing is referred to as unit testing and it is supported to complete this project in an efficient and a timely manner.

Unit testing is a testing technique that breaks up the project into different individual units and tests them to identify if there's any errors or defects in that unit. Unit testing is mainly concerned with the functional correctness of those individual units. In unit testing, since defects are captured in the early phases the danger of do-over the whole thing is low. And it also allows the developers to better refactor codes and ultimately improves the design. The overall processes of unit testing allow the application development to be agile in the process, hence aiding the agile methodology.

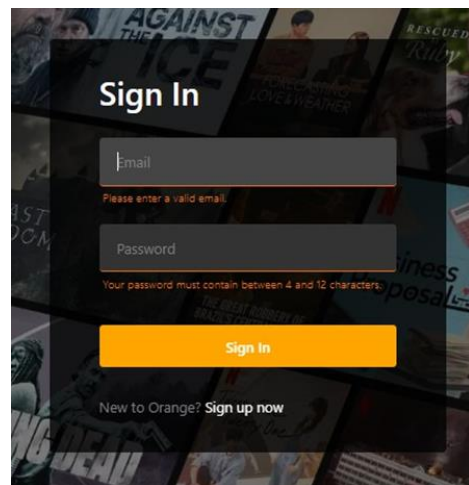


Fig. 05. Testing of the Sign In / Sign Up screen form

If both fields of email and password are not filled and the user clicks the Sign In button, the form will display the error message to enter a valid email and a valid password. The sign-in process won't be continued until the user enters both a valid email and a password.

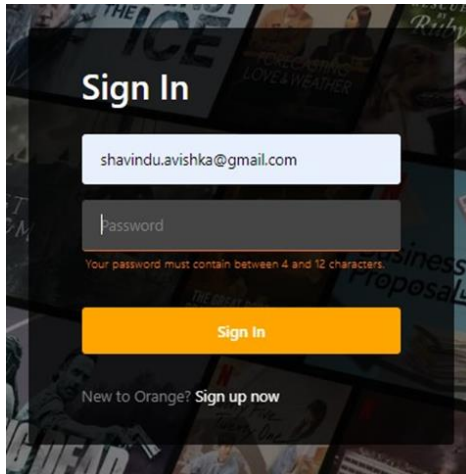


Fig. 06. Testing of the Sign In / Sign Up screen form

If the user has only filled out the email field and has not filled in the password field and tries to click the sign in button, then an error message will be displayed to enter a valid password. Sign in process won't be continued until the user enters both a valid email address and password.

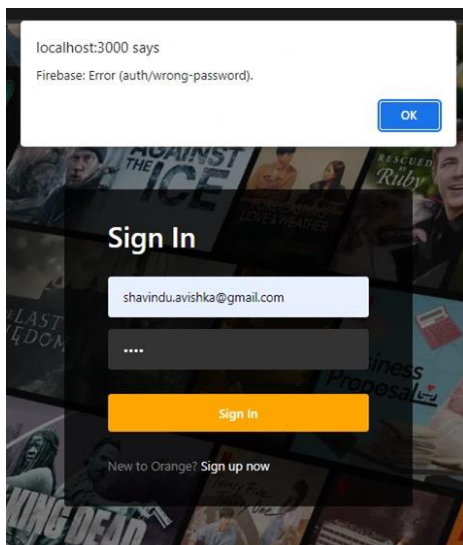


Fig. 07. Testing of the Sign In / Sign Up screen form

If the user tries to enter an invalid password to a particular registered email address, then an error prompt will be displayed to inform that the user has entered a wrong password into the password field.

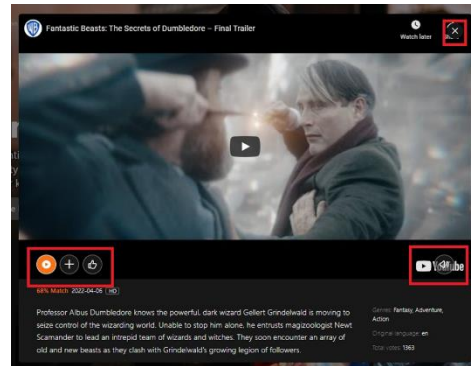


Fig. 08. Testing the video modal

All the buttons in the video player modal work as intended. When the Play button is clicked the video starts to play, and when playing the video, the Play button morphs into the Pause button. When the Pause button is clicked the video gets paused. When the Add button is clicked the content gets added into the My List section. When the Like button is clicked the video gets a like count. When the audio button is clicked the audio gets muted. While the audio is muted the audio buttons morph into Audio On button. When the Audio On button is clicked the audio of the video gets resumed. When the Close button is clicked the video player modal gets closed.

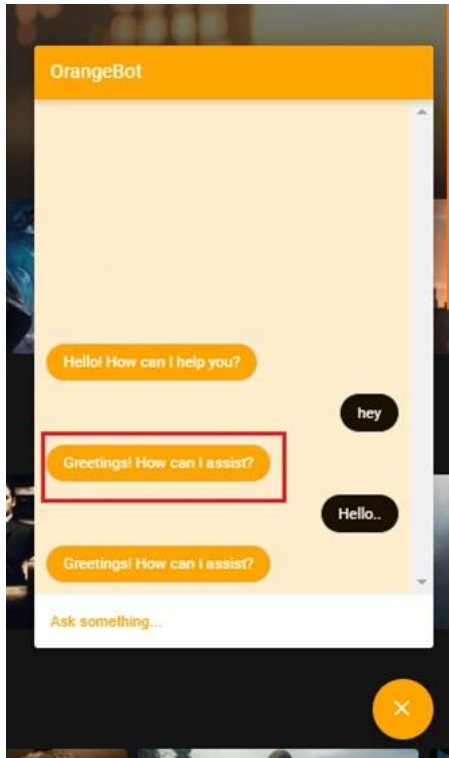


Fig. 09. Testing the Chat Bot

3.2. Challenges

Content API: The author didn't have time or resources to develop a movie database from the ground up because developing the video streaming application with the conversation interface was a huge task. Therefore, the author has used an external third-party movie database which is presented in the form of an API. Searching and selecting a suitable API for the task was a great challenge but with thorough research the author was able to find the most suitable API for the job - TMDb.

Learning new technologies: Technologies and the use of frameworks such as React Js, Next Js was completely new to the author. Hence a massive amount of time had to be invested in learning those technologies before implementing the application. Also, conversational artificial intelligence was a whole new arena for the author and most of the conversational artificial intelligence related technologies and platforms

lacked comprehensive documentation. Choosing an easily comprehensible natural language processing platform with good documentation was indeed a challenge.

4. Business Objectives Achieved

Orange video streaming platform can play a huge role in the rapidly emerging and highly competitive video streaming market. If a particular company wants to endeavor a video streaming platform of their own, they can use Orange video streaming as a boilerplate. Also, unlike other streaming platforms the users of the Orange video streaming platform won't get bored or frustrated with the massive content collection thanks to the AI chatbot-OrangeBot. Therefore, Orange video streaming platform offers more user friendliness to the users compared to the current video streaming platforms in the market. More user friendliness will lead to more business profits on any platform.

Using the proposed system, the following objectives will be accomplished

- Can handle a massive collection of video contents.
- Removes the need for users to navigate a plethora of contents to select an entertainment piece to watch.
- Offers more user friendliness to the users with the help of the conversational artificial intelligence.
- Platform can be used to display advertisements - the banner section can be configured to archive that task.
- More profits can be made because the platform offers more user friendliness compared to other existing video streaming platforms.
- The conversational AI is so natural that the users will feel like they've been talking to a friend - a user can build a unique relationship with the platform. Building an ecosystem.
- ChatBot can be used to recommend promotional materials to the user.
- To enhance the overall user engagement processes

5. Discussion

5.1. Future Directions

During the development of the project the author has gained a great deal of knowledge in the field of web developing, API integration and

conversational artificial intelligence developing. Therefore, the author wishes to extend this knowledge with further research on the subject and develop a more advanced video streaming platform with cloud functionalities. Also, the author wishes to practice more into developing conversational artificial intelligence and integrating it into various business needs. Since this research & project was only considering web applications, the author plans to extend this application into the form of a mobile application in the future.

5.2. Conclusion

By developing the web application Orange, the author has gained two major objectives. The first one being the fully functional video streaming web application and the second one is the conversation interface. The main business need of this application was to implement a way of communication with the application to the user. Therefore, increasing the usability of the application. This need was fulfilled by implementing the conversation interface to the web application. Since this application was tailored to web environments programming languages like HTML, CSS, JavaScript and Typescript were used. And libraries/frameworks such as React Js, Next Js, React Hooks, React Player, Material UI were also used in the making of the application. To implement the conversation, interface the natural language processing and understanding platform Google Dialogflow was used. To store and retrieve user data Google Firebase and Firestore was used as the real-time NoSQL database. Although the completion of this project was done amidst many challenges and barriers a successful project was achieved in the end.

REFERENCES

[1] Moore, K., 2021. How Long Would It Take To Watch All Of Netflix?. [online] What's on Netflix. Available at: <<https://www.whats-on-netflix.com/news/how-long-would-it-take-to-watch-all-of-netflix/>> [Accessed 17 November 2021].

[2] Park, N., 2021. How to solve the problem of “Netflix Syndrome”—a UX case study. [online] Medium. Available at:

<<https://uxdesign.cc/how-to-solve-the-problem-of-netflix-syndrome-6111cb9e7c94>> [Accessed 1 November 2021].

[3] Lee, D., 2021. Why Can't We Find What to Watch on Netflix?. [online] uxplanet.org. Available at: <<https://uxplanet.org/why-cant-we-find-what-to-watch-on-netflix-2fdaccfe3155>> [Accessed 1 November 2021].

[4] Sas.com. 2021. Artificial Intelligence (AI) – What it is and why it matters. [online] Available at:

<[https://www.sas.com/en_us/insights/analytics/what-is-artificial-intelligence.html#:~:text=Artificial%20Intelligence%20enhances%20the%20speed,manually%20intense%20data%20man agement%20tasks.>](https://www.sas.com/en_us/insights/analytics/what-is-artificial-intelligence.html#:~:text=Artificial%20Intelligence%20enhances%20the%20speed,manually%20intense%20data%20management%20tasks.>) [Accessed 1 November 2021].

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Criminal Vehicle Identification using Computer Vision and Deep Learning

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ABSTRACT

As registered vehicles grow, Sri Lanka needs more than just staff to manage and implement legal and safety regulations. The Sri Lankan Police Department or any other responsible party may benefit from this paper's deep learning method for recognizing license plates of vehicles in Sri Lanka to identify criminal vehicles. Since Sri Lanka has no proper automated approach to identifying criminal vehicles on the way, a study is carried out to implement a technological solution for this problem. This developed system provides a resilient and efficient deep learning method using a mix of two Convolutional Neural Network (CNN) architectures. The resulting product provides accurate identification of criminal vehicles under several challenges.

1. INTRODUCTION

In Sri Lanka, the process of identifying criminal vehicles is done by a very traditional manual approach. And this approach has several drawbacks and disadvantages. By the current practice, the vehicles associated with criminal records are identified by the policemen who are on duty. What they follow is to keep the criminal vehicle numbers with them and monitor each vehicle passing by to catch the suspected vehicle. As it seems, there will be so many missing incidents when it comes to human monitoring. Since this approach has difficulties, this project suggests a technological system that can detect vehicle numbers in real-time and identify vehicles with criminal records. (Jayamanne, 2018)

Automatic Number Plate Recognition (ANPR) technology is a critical law enforcement

capability used to detect, deter, and disrupt criminality at a local, regional, and national level, including Organized Crime Groups, people traffickers, serious sexual offenders, and terrorists. ANPR is also used to protect vulnerable people from harm. (Automatic Number Plate Recognition (ANPR) Strategy 2020-2024, 2020)

An automatic crime vehicle detector is an AI solution proposed to be developed using computer vision technologies. This system can detect the nameplates of vehicles and extract the vehicle number. Then the extracted vehicle number is compared against a criminal records database to identify whether it is associated with a criminal record to catch the suspected vehicle. Also, this system can locate stolen or wanted vehicles. Since there is no technological approach to achieve this scenario in Sri Lanka, this project will considerably support identifying criminal vehicles without any human efforts or failures. (Jayasekara et al., 2015)

2. LITERATURE REVIEW

When it comes to computer vision, object detection is a critical activity that is used to recognize instances of visual objects of specific classes (for example, human beings, animals, cars, or buildings) in digital images such as photographs or video frames. To achieve this, object detection aims to construct computational models that answer the question "What things are where?" that is required for computer vision applications. (Boesch, 2021)

Image processing algorithms are often unsupervised in nature, meaning that they do not require past data to be trained. Consequently,

those activities do not necessitate the use of annotated photos, in which humans manually labeled data (for supervised training).

Several limitations apply to this technique, including complex circumstances (without a single-color background), occlusion (partially hidden objects), illumination and shadows, as well as the clutter effect. (Xu et al., 2018)

Deep Learning approaches are typically reliant on supervised training to function. The performance of GPUs is restricted by their calculation power, which is expanding at an alarming rate year after year.

Image classification is the process of estimating the class of a single object in a photograph. **Object localization** is the process of detecting the location of one or more items in an image and creating a bounding box around the extent of those objects. When these two tasks are combined, **object detection** can be used to identify, locate, and classify one or more items in each image. (Laroca et al., 2021)

YOLO object detection is a real-time object detection system that relies on a single neural network to detect objects in real-time. A new feature in the newest release of ImageAI v2.1.0 is the ability to train a custom YOLO model that can recognize any type or number of objects. Conventional neural networks are examples of classifier-based systems in which the system repurposes classification or localization algorithms to do detection and then applies the detection model to an image at a variety of different locations and scales. The portions of the image with "high score" are deemed to be detections in this procedure. Simply put, the regions that most closely resemble the training images are those that are positively identified. (Redmon et al., 2016)

Because it is a single-stage detector, YOLO can complete classification and bounding box regression in a single step, making it significantly faster than most convolutional neural networks. When it comes to object detection, for example, YOLO is 1000 times faster than R-CNN and 100 times faster than Fast R-CNN. (Redmon et al., 2016)

On the MS COCO dataset, YOLOv3 achieves a mean accuracy of 57.9 percent, compared to DSSD513's 53.3 percent and RetinaNet's 61.1 percent for the other two algorithms. When it comes to training, YOLOv3 makes advantage of multi-label categorization with overlapping patterns. So it has the potential to be applied in complex circumstances for object detection. For small-item classification, YOLOv3 can be used because of its multi-class prediction capabilities. However, when it comes to large or medium-sized object classification, YOLOv3 performs significantly worse. More information on YOLOv3 can be found here. (Gnanaprakash et al., 2021)

MobilenetSSD is an object detection model that takes an image as input and computes the bounding box and category of an object within that bounding box. It is possible to achieve fast object detection optimized for mobile devices by utilizing the Single Shot Detector (SSD) object detection model, which makes use of Mobilenet as a backbone. (Puarungroj et al., 2018)

MobileNetV2 is a convolutional neural network architecture that has been designed to perform well on mobile devices such as smartphones and tablets. It is based on an inverted residual structure, in which the residual connections are between the bottleneck layers, rather than between the layers themselves.

Convolutional neural networks, such as inception-ResNet-v2, are trained using images from the ImageNet collection, which contains more than a million images. A 164-layer network can classify photos into 1000 object categories,

which include things like a computer keyboard, a mouse, a pencil, and a variety of animals. Thus, the network has learnt rich feature representations for an extensive variety of images because of its training. The network accepts images with a resolution of 299 by 299 pixels.(Alam et al., 2021)

There has been evidence that the Inception architecture can achieve extremely good performance at a cheap computational cost, and that training Inception networks with residual connections can dramatically expedite the training of Inception networks. Additionally, there is some evidence that residual Inception networks outperform comparably expensive Inception networks that do not include residual connections.

YOLOv5 is a family of object detection architectures and models that have been pretrained on the COCO dataset. It is the result of open-source research conducted by Ultralytics into future vision AI methods. It incorporates best practices and lessons learned from thousands of hours of research and development.

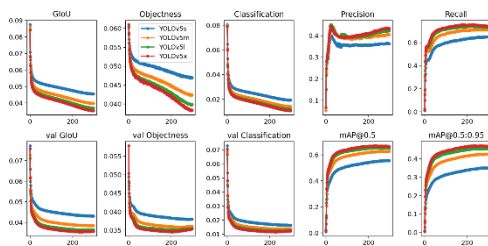


Figure 14: YOLOv5 Results on COCO Dataset¹

Optical character recognition, also called an optical character reader, is the electronic or mechanical conversion of images of typed, handwritten, or printed text into machine-encoded text. This can be done from a scanned document, a photo of a document, a scene-photo, or from subtitle text superimposed on an image. (Long et al., 2021)

Open-source text recognition (OCR) engine Tesseract is accessible under the Apache 2.0 license and is free to use. A programmatic interface (API) can be used to extract written text from photographs, or it can be utilized directly (for programmers). (Vetriselvi et al., 2021) It can support many different languages. Tesseract does not come with a built-in graphical user interface (GUI), although there are various options accessible on the 3rdParty website.

Because of wrappers, Tesseract is compatible with a wide range of programming languages and frameworks, which can be found here.(Profile, 2016) A combination of this feature with an external text detector can be used to recognize text within a big document, or it can be used in conjunction with a single image of a text line to recognize text from a single text line. (Sable, 2022)

Easyocr is a python module developed to optical character recognition based on LSTM architecture. This package works as follows:

- Generation of data is done by MJ-Synth package.
- For detections, the CRAFT model is used.
- Training a tweaked pipeline for text recognition based on the "What is wrong" paper (see above).

Other ways to improve.

Multi-language: as said, OCR contains some NLP elements. So, dealing with different languages has both differences and similarities that we could use to our advantage. Therefore, the CRAFT model (and probably other detection models) is multilingual. The training process is the same, but the recognition models are different for each language (e.g Hebrew and Arabic are rtl and not left to right) (JaidedAI, n.d.)

Image processing techniques research has been done to identify best technique to improve ocr

¹ <https://github.com/wonbeomjang/yolov5-knowledge-distillation>

results. The following methods were on the research. (Shafii et al., 2015)

3. DATA PREPARATION

Since there was no Sri Lankan vehicle numberplate dataset to be found, a new dataset was created during the study. Meanwhile, the numberplate detection model was trained using existing foreign vehicle numberplate datasets found on Kaggle.com.²(Xu et al., 2018)

4. ANALYSIS OF EXPERIMENTS

According to the findings of the research, the following three model architectures have been investigated thus far. (Profile, 2016)The three model architectures chosen for this project were chosen because they are lightweight, have a fast inference time and high accuracy, and are well suited to the project's application and resources, which include computing power.(Azad et al., 2013)

1. `ssd_mobilenet_v2/fpnlite_320x320`
2. `InceptionResnet v2`
3. `YOLO v5`

Since this project is focused on developing an automatic vehicle numberplate recognition system to identify criminal vehicles in real time, the project should be able to run on device-level micro-computers/mobile devices.

The object detection model developed should be compatible with low-performance devices which require minimum computing resources.(Profile, 2016)

5. Analysis of Object Detection Model Results

The model architectures are selected to experiment by transfer learning on a new vehicle

nameplate dataset which contains Sri Lankan vehicle number plates. All the results were evaluated manually one by one.(Lazrus et al., 2011)

Table 15: Experimented Results of Model Architectures

Model Architecture	Accuracy on Sri Lankan Numberplates
<code>ssd_mobilenet_v2/fpnlite_320x320</code> model	80% and below
<code>InceptionResnet V2</code>	50% and below
<code>YOLOv5s</code>	90% and above

Even though the **`ssd_mobilenet_v2/fpnlite_320x320`** model and **`InceptionResnet V2`** models show significant results on the COCO dataset and ImageNet datasets, the models have not shown better results on Sri Lankan vehicle number plates. Comparing all three experimented models, the YOLOv5s has shown accurate detections on almost all the Sri Lankan data except the corrupted or low-quality images.

6. Analysis of Optical Character Recognition module results

Easyocr is faster and smaller than Pytesseract and has more accuracy. This model has various techniques to give better results like having a tighter shape of image parts for object recognition.(Smelyakov et al., 2021)

² <https://www.kaggle.com/datasets/andrewmvd/car-plate-detection>

Table 16: OCR Model Analysis

OCR Model	Accuracy
EasyOCR	95%
Tesseract OCR	71.76%

As per the results of the experiments done on Sri Lankan vehicle nameplates, the EasyOCR model experiments' results have shown better results than the other two OCR modules. (Smith)

Table 17: OCR Modules Error Rate

OCR Model	Error rate on numbers	Error rate on alphabets
Tesseract OCR	5.5%	0.7%
EasyOCR	1.9%	4.3%

When comparing the error rate of recognizing numbers, EasyOCR has the lowest while Tesseract OCR is higher. Vehicle number plates consist of numbers with two or three block letters. (Smelyakov et al., 2021) The EasyOCR model performs better on Sri Lankan Nameplates. But this module also misinterprets some characters in different scenarios. The below table contains the most misinterpret characters. (Yogheedha et al., 2018)

Table 18: Misinterpreted characters by EasyOCR

Actual character	Misinterpret character
D	O
W	H
-	.

But the study has been expanded to improve the EasyOCR model results on Sri Lankan Vehicle number plates by experimenting with various image processing techniques.

7. Analysis of experiments in Image Processing techniques

Image processing techniques research has been done to identify the best technique to improve OCR modules' results. The following methods were on the research. (Shafii et al., 2015)

During the research, every image processing technique has experimented on Sri Lankan vehicle nameplates. The techniques including smoothing, thresholding, binarization, noise removal, erosion, dilation, opening, closing, and convolutional 2D were experimented with by tuning parameters. (Türkyilmaz et al., 2017)

According to the test results, binarization and thresholding techniques failed to enhance the number plates. Smoothing techniques showed some improvements where erosion performed numberplates were clearly read by the EasyOCR. (Wanniarachchi et al., 2007)

8. ANALYSIS OF RESULTS

Going through the results of the above-mentioned experiments on different model architectures and techniques, the prototype was implemented using the YOLOv5s model and EasyOCR to detect and extract the vehicle numbers.

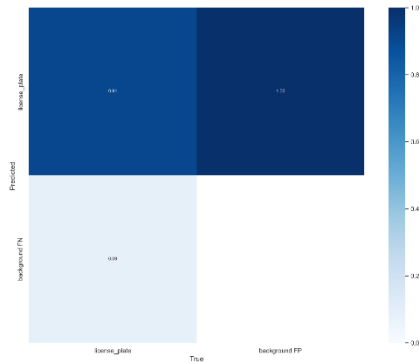


Figure 15: Confusion Matrix

9. TESTING AND CHALLENGES

OCR model output testing was carried out by experimenting with different image processing techniques. Since Sri Lankan vehicle numberplates are in different styles, some of the nameplates failed to read the actual vehicle number by the OCR (Jayasekara et al., 2015). Also, most Sri Lankan vehicle nameplates are with various designs and templates. Due to the variety of structures, EasyOCR module misinterpret several characters. (Smelyakov et al., 2021)

Figure 16: Different Types of Sri Lankan Vehicle Number plates³

10. CONCLUSION AND FUTURE DIRECTIONS

In summary, this study followed by a prototype was based on a real problem in Sri Lanka. Since Sri Lankan police department does not have proper technological approach to identify criminal vehicles on the roads other than the manual method, this project gives a best solution to it. Per the discussion with police officers from different police stations, their feedback was that this kind of solution is worth implementing a needful to police operations on investigating criminal inquiries associated with vehicles.

Apart from giving a solution to this problem, this study represents the technological advancements and applicability. And so on, according to the background research, there are no such solutions implemented in this matter. Only research are presents. Furthermore, this study has presented various image processing techniques that can enhance the results of reading vehicle numbers from the detected Sri Lankan vehicle number plates.

REFERENCES

- Alam, N.-A., Ahsan, M., Based, M. A., & Haider, J. (2021). Intelligent System for Vehicles Number Plate Detection and Recognition Using Convolutional Neural Networks. *Technologies*, 9(1), 9. doi: 10.3390/technologies9010009
- Azad, R., Azad, B., Reza, H., & Brojeeni, S. (2013). Real-time and efficient method for accuracy enhancement of edge based license plate recognition system. *First International Conference on Computer, Information Technology and Digital Media*, 146–155.
- Gnanaprakash, V., Kanthimathi, N., & Saranya, N. (2021). Automatic number plate recognition using deep learning. *IOP Conference Series: Materials Science and Engineering*, 1084(1), 012027. doi:

³ http://www.worldlicenseplates.com/world/AS_SRIL.html

10.1088/1757-899x/1084/1/012027

- Jayasekara, J. M. N. D. B., & Kumara, W. G. C. W. (2015). Text extraction for Sri Lankan number plates. *2015 8th International Conference on Ubi-Media Computing, UMEDIA 2015 - Conference Proceedings*, c, 89–91. doi: 10.1109/UMEDIA.2015.7297434
- Laroca, R., Zanolensi, L. A., Gonçalves, G. R., Todt, E., Schwartz, W. R., & Menotti, D. (2021). An efficient and layout-independent automatic license plate recognition system based on the YOLO detector. *IET Intelligent Transport Systems*, 15(4), 483–503. doi: 10.1049/itr2.12030
- Lazrus, A., & Choubey, S. (2011). A Robust Method of License Plate Recognition using ANN. *International Journal of Computer Science and Information Technologies*, 2(4), 1494–1497.
- Long, S., He, X., & Yao, C. (2021). Scene Text Detection and Recognition: The Deep Learning Era. *International Journal of Computer Vision*, 129(1), 161–184. doi: 10.1007/s11263-020-01369-0
- Profile, S. E. E. (2016). *Comparative Study of Different Techniques for License Plate Recognition. December 2013*.
- Puarungroj, W., & Boonsirisumpun, N. (2018). Thai License Plate Recognition Based on Deep Learning. *Procedia Computer Science*, 135, 214–221. doi: 10.1016/j.procs.2018.08.168
- Redmon, J., Divvala, S., Girshick, R., & Farhadi, A. (2016). You only look once: Unified, real-time object detection. *Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 2016-Decem*, 779–788. doi: 10.1109/CVPR.2016.91
- Shafii, M., & Sid-Ahmed, M. (2015). Skew detection and correction based on an axes-parallel bounding box. *International Journal on Document Analysis and Recognition*, 18(1), 59–71. doi: 10.1007/s10032-014-0230-y
- Smelyakov, K., Chupryna, A., Darahan, D., & Midina, S. (2021). Effectiveness of modern text recognition solutions and tools for common data sources. *CEUR Workshop Proceedings*, 2870, 154–165.
- Türkyilmaz, I., & Kaçan, K. (2017). License plate recognition system using artificial neural networks. *ETRI Journal*, 39(2), 163–172. doi: 10.4218/etrij.17.0115.0766
- Vetrivel, T., Lydia, E. L., Mohanty, S. N., Alabdulkreem, E., Al-Otaibi, S., Al-Rasheed, A., & Mansour, R. F. (2021). Deep learning based license plate number recognition for smart cities. *Computers, Materials and Continua*, 70(1), 2049–2064. doi: 10.32604/cmc.2022.020110
- Wanniarachchi, W. K. I. L., Sonnadara, D. U. J., & Jayananda, M. K. (2007). License plate identification based on image processing techniques. *ICIIS 2007 - 2nd International Conference on Industrial and Information Systems 2007, Conference Proceedings*, 373–377. doi: 10.1109/ICIINFS.2007.4579205
- Xu, Z., Yang, W., Meng, A., Lu, N., Huang, H., Ying, C., & Huang, L. (2018). Towards end-to-end license plate detection and recognition: A large dataset and baseline. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 11217 LNCS, 261–277. doi: 10.1007/978-3-030-01261-8_16
- Yogheedha, K., Nasir, A. S. A., Jaafar, H., & Mamduh, S. M. (2018). Automatic Vehicle License Plate Recognition System Based on Image Processing and Template Matching Approach. *2018 International Conference on Computational Approach in*

ZenDesk – A Smart Platform to Improve the Emotional Fitness of the Workplace Employees

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ABSTRACT

The purpose of this study is to enhance the workplace for everyone by providing mental health and wellbeing assistance to prevent burnout, boost resilience and interpersonal skills, and improve mental wellness to remain ahead of work, life, and love. This study aims to develop and assess a mobile application with an IoT device where the company employers can track and recognize the human emotions using Emotional and Artificial Intelligence. The employees will be able to record the personal statistics such as growth progress by tracking emotions and feelings in a regular pattern. The outcome of this study will be helpful to prevent suicidal thoughts, anxiety, depression, and stressful emotions by providing meditation techniques, mental health seminars, and also by the option to seek professional counselling sessions through employee corporate support.

11. INTRODUCTION

Since the beginning of the year 2020, people from around the world, as well as Sri Lankans, had to face the horrendous surge of the Covid-19 pandemic. The rise of the global health crisis has led the workspaces to remote working. The world slowly transformed into a new era, to a completely virtual environment. Although working from home practice has become more common in many countries due to the benefits, organizations still have reluctance to adopt this form of working because of the drawbacks. It is not a fully acceptable practice for all organizations as some parts of the business are

not suitable to be performed from home. It affected the emotional state of the company employees, resulting in decreased productivity of the employees. (Alaqra et al., 2020)

Recent social media-based survey of global workers demonstrated that reception to Work from Home (WFH) initiatives in the context of COVID-19 was resoundingly positive (73%), with employees expressing joy, anticipation, and trust. Of the 27% with a negative perception of WFH, the most commonly expressed emotions were fear, sadness, anger, and distrust. (Merone et al., 2021)

As in many other nations, Sri Lanka's workplaces started to accept WFH. It affected the social-economical lifestyle of people which led to have minimal social interactions. The risk of burnout and mental illness is on the rise. Employees are experiencing higher levels of stress, anxiety, depression, mental health, and emotional stability. This situation has led to absenteeism, high turnover, job abandonment, and the productivity loss of the employees. Suicide rates have risen far above the national norm, with the tendency of people being isolated. (Cramer et al., 2020; Mehta, 2021; Son et al., 2021)

In the Sustainable Development Goals (SDG), the mental health sector currently stands as a part of the target 3.4. The third SDG goal, "Good Health and Wellness," includes a wide range of sub targets focused at ensuring good health and longevity, as well as promoting wellbeing for at all ages. The target which mentions about mental health is as follows. Target 3.4: By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and

treatment and promote mental health and well-being (United Nations Sustainable Development, 2022; Votruba et al., 2016).

The goal of this study is to improve employee mental health and emotional stability by, a. Reducing the productivity loss, high turnover, absenteeism and presenteeism. b. Increasing engagement, resilience, attention, and retention of skilled staff. c. Increasing positive emotions, life satisfaction, and self-esteem beyond the workplace. d. Providing a creative working environment for a clearer, more focused thinking. e. Supporting staff with existing mental health conditions providing emotional safety. f. Committing heightened performance and improve stress management skills. g. Reducing the impacts of overall mental health issues and illnesses such as anxiety and depression.

12. LITERATURE REVIEW

According to Tyler Adams, Employers in all industries, large and small, are quickly adapting to the changes brought on by COVID-19. Companies have moved to entirely remote or semi-remote work environments, which can be stressful, lonely, or isolating for certain employees. In addition to addressing health and safety concerns, employers are looking for methods to support their employees' mental health to help them deal with this current paradigm. People who work at MHA have had their own concerns about remaining safe, healthy, and connected. As the leaders adhered their concerns, they were asked how MHA could best support them during that tough phase. Based on employee input, leadership responded with more PTO (Paid time off), scheduling flexibility, positive breaks during staff meetings, and self-care products. He also mentions that MHA is not the only organization recognizing the mental health impact of this pandemic. From mental health awareness campaigns to one-on-one counseling to meditation, companies such as Chevron Corporation, Culligan Water, PG&E supports employee mental health during COVID-19. (Taylor Adams, 2020)

Ohio State University with Crystal Ott explains Emotional Intelligence as the ability to

understand and control our own feelings as well as recognize and effectively respond to those of others. Daniel Goleman's paradigm with four domains for these lessons: self-awareness, self-management, social awareness, and relationship management. (Ott, 1998)

According to the Meditation Awareness Training (MAT) for Work-related Wellbeing and Job Performance, Work-related stress (WRS) is responsible for 40% of all work-related sickness, and roughly 20% of British people feel stressed as a result of their job. Between mid-2011 and mid-2012, 10.4 million working days were missed in the United Kingdom owing to WRS, costing the British economy up to £26 billion a year when combined with other work-related mental health disorders. In America, 69% of employees believe that work is a significant cause of stress, and 41% of employees claim that they are regularly stressed out throughout the workday. WRS has substantial negative health and socioeconomic implications, such as psychopathology, somatic illness, work-related injury, mortality, decrease in productivity, absenteeism, presenteeism, high staff turnover, unsafe driving, and employee compensation claims. (Shonin et al., 2014)

In this study, **Workplace Employees** are the default user type that uses the platform to improve mental health and wellness. **Workplace Administrator** is the user who has the privilege to view employee details and manages the workplace employees. Each company can have multiple Administrators.

Facial Coding System makes it possible to detect the Emotions and expressions of the users. This can be coded manually and automatically (Craig et al., 2008; McDuff et al., 2016). For this study, **AFFEDEX SDK** is used to get the analysis of the live video feed of the users. This will generate automated codes to identify the Facial Expressions.

AFFEDEX SDK is a Cross-Platform Real-Time, Multi-Face Expression Recognition Toolkit. It presents a real-time facial expression recognition framework that can automatically interpret

Figure 3. - Classification of facial actions and Modeling of prototypic emotions using Emotion FACS (McDuff et al., 2016)

```

anger: 0.0014020040398463607
contempt: 0.008536139503121376
disgust: 0.1758837252855301
engagement: 69.34396362304688
fear: 0.00020290289830882102
joy: 5.726586818695068
sadness: 0.00003906106576323509
surprise: 4.379740238189697

```

Figure 4. – Predicted emotion data for a frame of live video feed.

Furthermore, by analyzing the Facial Action Units, the expressions of the workplace employees are also detected using the Affdex SDK toolkit. Figure 5 shows the predicted results of expression data of the employee. The detected values can be used to generate expression and emotion reports that can be viewed by the Workplace Administrator, and they can get proper decisions about the workload and style changes.

```

attention: 98.21915435791016
browFurrow: 8.240458488464355
browRaise: 0.007386843208223581
cheekRaise: 99.95652770996094
chinRaise: 0.009117366746068
dimpler: 0.008433795534074306
eyeClosure: 0.15638095140457153
eyeWiden: 0.0000022557487682206556
innerBrowRaise: 0.023832188919186592
jawDrop: 2.040297746658325
lidTighten: 94.55232238769531
lipCornerDepressor: 0.0014081813860684633
lipPress: 0.004820031113922596
lipPucker: 0.3728603422641754
lipStretch: 0.0003817754040937871

```

Figure 5. - Predicted expression data for a frame of live video feed.

As the next stage, A **Meditation Session** was considered. Mindfulness sessions, Meditation, calm music has a high effect on psychological health improvements (Champion et al., 2018; Keng et al., 2011; Morrison Wylde et al., 2017). Employees can listen to mindfulness sessions,

mental wellbeing lessons, and techniques to meditate, along with sessions to calm, relax, focus, breathe, wake up, and sleep well. This includes various techniques such as breath awareness and body scanning. These techniques will help the workplace employees to minimize the stress occurring while working straight for a long time. (Champion et al., 2018)

According to the studies, pets play a huge role in reducing Anxiety and Stress in day-to-day life. Stuffed/ Squishy Toys shows a reasonable impact on Stress reveal (Ghabeli et al., 2014; Kiefer et al., 2017; Love, 2021; Solis-Vargas et al., 2021). With that consideration, this solution includes a personalized squishy pet toy that sits on the workplace employee's table. The main camera was included in the toy, and it's the IoT device that sends the live footage of the employee to the analysis algorithm.

The IoT device contains a camera module that is attached to a Raspberry Pi module. This device will be able to transmit the data stream into the Firebase Realtime database system. Having a separate IoT device to capture the live camera feed will also prevent any inconsistencies which could occur with any interaction with the application. If each user were to use their own mobile phone's camera to track emotions, time and attention put into the device could eventually end up as a nuisance to the user. The IoT device will provide the user with the ability to work effortlessly and prevent any inconvenience caused. It may also improve digital wellbeing, consume lesser battery power, and reduce screentime.

The next feature includes an Event Planner which can be used by the Workplace Administrators to create events for Mindfulness Programs, Meditation Programs, etc. These events are broadcasted among the Workplace Employees. The company employees get the luxury to be informed and get updated about company specific events organized by the company.

Employees can also request professional counselling sessions by contacting selected therapists or call the 24-hour support hotline in

multiple people's expressions at the same time. The toolkit is compatible with major mobile and desktop platforms (Android, iOS, Windows). The algorithm is trained on the world's biggest facial expression dataset and has been optimized to operate on mobile devices with minimal false detections. The toolkit facilitates the generation of novel experiences that respond to users' emotional states based on their facial expressions. It provides real time visualization of the expressions captured by the camera. (McDuff et al., 2016)

This **AFFDEX SDK** Toolkit used **Facial Action Coding System (FACS)** to detect the expressions of the users using a live video feed. These expressions can be detected using **Facial Action Units**. (McDuff et al., 2016)

Facial Action Units are the observable actions of certain muscle movements in the face. This units acts like the building blocks of the Facial Expressions. (McDuff et al., 2016)

Histogram of Oriented Gradient (HOG) is used in computer vision and image processing systems to identify/ detect objects in images. (McDuff et al., 2016; Pang et al., 2011)

AFFDEX SDK's Automated Facial Coding system includes 4 main components which are Face and facial landmark detection, Face texture feature extraction, Facial action classification, and Emotion expression modelling. (McDuff et al., 2016)

13. METHODOLOGY

The purpose of this study is to identify the strategies to improve the emotional well-being of workplace employees in order to reduce the impacts on less social, isolated environments. The required research materials and recent work developments were discussed and gathered with the existing products/projects such as **Smiling Mind**, **Sumitrayo**, and **AffdexMe**. Their business processes and shortcomings were identified by setting up interview meetings and product usage, and by using questionnaires. The data gathered from those materials were useful to design the solution for this study.

The proposed research project consisted of having an **Emotion Tracker**, **Meditation Sessions**, **Event Planner**, and a **24-hour Help Hotline**. The project was implemented as a mobile application which concludes the aforementioned services. The project was named **ZenDesk**, - a peaceful and a calm workplace for company employees.

By using Facial Expression analysis, **Emotion Tracking** was possible by using the **AFFDEX SDK** on the live camera feed. This was used as the analyzing model for the image frames and get a prediction on the employee's emotion. The images gathered from the camera won't be saved and will be erased after the analysis to protect the privacy of the user. The analysis will give the emotions as Anger, Contempt, Disgust, Engagement, Fear, Joy, Sadness, Surprise, and Violence. These analysis data will be saved anonymously, and the Workplace administrator will be able track and view the progress of emotional status. Figures 1, 2, 3, and 4 shows the process of Face detection to Final Emotion Predictions.

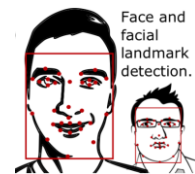


Figure 1. - Detection of face(s) and localization of the key facial landmarks on each face. (McDuff et al., 2016)

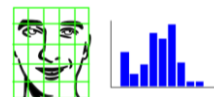
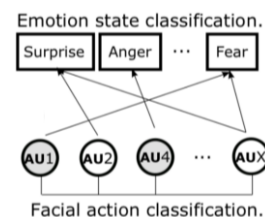


Figure 2. - Extraction of texture features using HOG (McDuff et al., 2016).



collaboration with Sumitrayo through the employee company support.

14. DISCUSSION

The outcome of this research has provided insight into how COVID-19 affects businesses and offers strategies on how to deal with challenges that may arise. The study demonstrates a correlation between the Covid-19 Pandemic and the emotional wellbeing of the company employees.

The proposed system has been developed to a. Track and recognize human emotions using Emotional Intelligence and Artificial Intelligence. b. Record the personal statistics such as growth progress by tracking emotions and feelings in a regular pattern. c. Prevent mental illnesses such as anxiety, depression and prevent suicidal thoughts by providing meditation techniques and mental well-being lessons. d. Provide support through professional counselling sessions, online therapy, and a 24-hour support hotline. e. Inform employees about mindfulness sessions organized by the workplace. f. Provide free service for the company employees under a company subscription. This analysis supports the theory that having an integrated system which delivers the aforementioned services to improve emotional health of the workplace employees has been productive for the end users.

The insurance organizations in Sri Lanka claims to protect and provide life investments. The existing health insurance policies are solely concerned regarding physical health, and yet there is no means to assess and comprehend an employee's emotional wellness. The company's provided health insurance coverage should be adjusted in accordance with the employees' continued physical and mental health well-being resulting in a pleasant experience at the workplace.

The current efforts and actions on Sustainable Development Goals in Sri Lanka could not be concluded due to the lack of resources. It was evident that a modernized system was necessary

to assist Sri Lanka in achieving the aforementioned SDG target.

The methodological choices were constrained by the limitation of freely available resources. To draw a conclusion in the Sri Lankan context, there were insufficient data on the emotional wellbeing of workers, measures taken to prevent suicide, and how workplace conditions changed appropriately to reduce the risk of burnout and decreased productivity.

Further research is needed to establish the authenticity of the facial expression data collected and improve the emotional recognition of the proposed system. Vocal analysis can be applied in addition to image processing to recognize the tone of the voice and determine emotions. The proposed IoT device can be developed further to include a personalized music player, and a daily quote reminder to offer more indulgence and happiness.

15. CONCLUSION

This study is utilized to analyze the concepts and theories associated with tracking and recognizing the human emotions using Emotional and Artificial Intelligence. ZenDesk will provide five major solutions to address the aforementioned issues related to workplace employees. The employees will be able to record the personal statistics such as growth progress by tracking emotions and feelings in a regular pattern. It will also be able to prevent suicidal thoughts, anxiety, depression, and all the other stressful emotions by providing meditation techniques, mental wellbeing lessons, anonymous community forums to talk about how you feel, and request professional counselling sessions, 24-hour online help, through the employee company support. Using Emotional Intelligence in order to improve the workspace for everyone, will also support employees' mental health and keep burnout at bay, grow resilience, relationship skills and increase emotional wellbeing to get ahead of work, life, and love.

16. REFERENCES

- Alaqla, A. S., & Andersson, H. (2020). *The Influence of Working from Home on Employees' Productivity*.
- Champion, L., Economides, M., & Chandler, C. (2018). The efficacy of a brief app-based mindfulness intervention on psychosocial outcomes in healthy adults: A pilot randomised controlled trial. *PLoS ONE*, 13(12). doi: 10.1371/journal.pone.0209482
- Craig, S. D., D'Mello, S., Witherspoon, A., & Graesser, A. (2008). Emote aloud during learning with AutoTutor: Applying the Facial Action Coding System to cognitive - Affective states during learning. *Cognition and Emotion*, 22(5), 777–788. doi: 10.1080/02699930701516759
- Cramer, R. J., Ireland, J. L., Hartley, V., Long, M. M., Ireland, C. A., & Wilkins, T. (2020). Coping, mental health, and subjective well-being among mental health staff working in secure forensic psychiatric settings: Results from a workplace health assessment. *Psychological Services*, 17(2), 160–169. doi: 10.1037/ser0000354
- Ghabeli, F., Moheb, N., & Hosseini Nasab, S. D. (2014). Effect of Toys and Preoperative Visit on Reducing Children's Anxiety and their Parents before Surgery and Satisfaction with the Treatment Process. *Journal of Caring Sciences*, 3(1), 21–28. doi: 10.5681/jcs.2014.003
- Keng, S. L., Smoski, M. J., & Robins, C. J. (2011). Effects of mindfulness on psychological health: A review of empirical studies. In *Clinical Psychology Review* (Vol. 31, Issue 6, pp. 1041–1056). doi: 10.1016/j.cpr.2011.04.006
- Kiefer, M., Neff, U., Schmid, M. M., Spitzer, M., Connemann, B. J., & Schönfeldt-Lecuona, C. (2017). Brain activity to transitional objects in patients with borderline personality disorder. *Scientific Reports*, 7(1). doi: 10.1038/s41598-017-13508-8
- Love, H. A. (2021). Best Friends Come in All Breeds: The Role of Pets in Suicidality. *Anthrozoos*, 34(2), 175–186. doi: 10.1080/08927936.2021.1885144
- McDuff, D., Mahmoud, A., Mavadati, M., Amr, M., Turcot, J., & el Kaliouby, R. (2016). AFFDEX SDK: A cross-platform real-time multi-face expression recognition toolkit. *Conference on Human Factors in Computing Systems - Proceedings, 07-12-May-2016*, 3723–3726. doi: 10.1145/2851581.2890247
- Mehta, P. (2021). Work from home—Work engagement amid COVID-19 lockdown and employee happiness. *Journal of Public Affairs*, 21(4). doi: 10.1002/pa.2709
- Merone, L., & Whitehead, O. (2021). Covid-19 and working within health care systems: The future is flexible. *Asia Pacific Journal of Health Management*, 16(1). doi: 10.24083/apjhm.v16i1.537
- Morrison Wylde, C., Mahrer, N. E., Meyer, R. M. L., & Gold, J. I. (2017). Mindfulness for Novice Pediatric Nurses: Smartphone Application Versus Traditional Intervention. *Journal of Pediatric Nursing*, 36, 205–212. doi: 10.1016/j.pedn.2017.06.008
- Ott, C. (1998). What is Emotional Intelligence? Daniel Goleman's Emotional Intelligence Quadrant Self-Awareness Self-Management. *Ohio 4H*, 2002.
- Pang, Y., Yuan, Y., Li, X., & Pan, J. (2011). Efficient HOG human detection. *Signal Processing*, 91(4), 773–781. doi: 10.1016/j.sigpro.2010.08.010
- Shonin, E., van Gordon, W., Dunn, T. J., Singh, N. N., & Griffiths, M. D. (2014). Meditation Awareness Training (MAT) for Work-related Wellbeing and Job Performance: A Randomised Controlled Trial. *International Journal of Mental Health and Addiction*, 12(6), 806–823. doi: 10.1007/s11469-014-9513-2
- Solis-Vargas, A., Contreras-Alcázar, I., & Sulla-Torres, J. (2021). Development of a Virtual Pet Simulator for Pain and Stress Distraction for Pediatric Patients using Intelligent Techniques. In *IJACSA International Journal of Advanced Computer Science and Applications* (Vol. 12, Issue 2). Retrieved from www.ijacsa.thesai.org
- Son, J., & Lee, S. (2021). Effects of work stress, sleep, and shift work on suicidal ideation among female workers in an electronics company. *American Journal of Industrial Medicine*, 64(6), 519–527. doi: 10.1002/ajim.23243
- Taylor Adams. (2020). *8 Employers Supporting Employee Mental Health during COVID-19*. United Nations Sustainable Development. (2022). *Health - United Nations Sustainable Development*. Retrieved from <https://www.un.org/sustainabledevelopment/health/>

Votruba, N., & Thornicroft, G. (2016). Sustainable development goals and mental health: learnings from the contribution of the FundaMentalSDG global initiative. *Global Mental Health*, 3, e26. doi: 10.1017/gmh.2016.20

The Impact of the Working Hours on the Work-Life Balance of Remote Workers in Sri Lanka during COVID-19

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ABSTRACT

The number of working hours of an employee is linked to his/her health and well-being. Long working hours have been a pressing issue since before the industrial revolution due to their negative impact on health and well-being. During the COVID-19 pandemic, the number of working hours has shown an increasing trend because of remote working. The present study investigated the effect of long working hours on stress and work-life balance in the context of remote working during the COVID-19 pandemic. A Questionnaire-based survey was conducted with 103 employees, from different professions, working from home during the pandemic. The results revealed statistically significant weak negative associations between the number of working hours and work-life balance ($p < 0.01$). Also, the number of working hours showed a significantly weakly positive relationship to the perceived stress ($p < 0.01$). The study also showed that work-life balance has a statistically significant strong negative correlation with perceived stress ($p < 0.01$). As such, the study concluded that there is a negative impact of long working hours on work-life balance and stress and thus on employees' health and well-being. Long working hours for employees can benefit the wellness and success of the organization in the short run. However, in the long run, this could impact

organizational performance due to the loss of employee productivity.

1. INTRODUCTION

Working hours have been studied since before the industrial revolution, owing to their critical role in the health and well-being of an individual. The balance between one's work and personal life, also known as work-life balance, is an important factor to consider due to its impact on one's well-being. Long working hours result in work-life imbalance, fatigue, tiredness, and a lack of free time to relax (Wong, Chang & Ngan, 2019). Further, long working hours are identified as a major contributor to stress (Chung, Seo, Forbes & Birkett, 2020).

Stress and work-life imbalance are linked to loss of job productivity and job dissatisfaction. This, in turn, adversely affects organizational performance. Poor employee health leads to absenteeism bringing down organizational productivity. Also, companies would need to afford medical compensation due to medical leave and accidents due to poor concentration. Therefore, poor health and lack of well-being have an impact on both employee and organizational productivity. Companies lose hundreds of billions of dollars annually due to factors such as lower productivity, poor performance, medical compensation, sick leave, and substitute hiring and training. Poor employee health cost employers nearly \$575 billion in 2019 due to lost productivity and 1.5 billion for absent days (Integrated Benefits Institute, 2020). Thus,

it is especially important for the employees as well as employers to focus on wellbeing.

The COVID-19 global lockdown prompted the widespread adoption of working from home. This immediate shift to working from home has resulted in extended working hours. The long working hours have a negative impact on work-life balance and in a remote working context this could play out differently. Here, remote working takes place at home. Therefore, the lines between work and life are more likely to blur. Working longer hours, shorter breaks, additional workloads, and work requirements to adjust to online/remote working may result in insufficient time for personal life and leisure time. Also, employees may experience a clash of work commitments and personal commitments, affecting the work-life balance, and adding to the stress of the individual. Stress is a health factor that has become a pressing problem during the pandemic. Increased stress issues during the pandemic could be, at least partly, explained in terms of the extended working hours in the remote working context.

Many organizations and employers are adjusting to the new virtual working environment and may continue to work from home even after the pandemic. Also, future threats such as pandemics and global disasters may force organizations to reintroduce remote working. So, it is important to understand how working from home affects the health and well-being of employees. But, at the moment there exists a large knowledge gap on the impact of long remote working hours during the pandemic as it is a contemporary problem and thus it needs scientific investigations.

Therefore, the current study will investigate the effect of the number of working hours on work-life balance and stress among remote workers during the COVID-19 pandemic.

1.1 Remote Working, Long Working Hours, and Work-Life Balance

Remote working, the work arrangement of working away from the traditional office space, is starting to become a trend around the world especially due to the COVID-19 pandemic. Often, remote working is conducted from home during the global lockdown. There are many

benefits of remote working including cost-effectiveness, convenience, and safety during the pandemic. But there are quite a few disadvantages of working from home mainly due to extended working hours and organizational expectations for employees to be available online 24/7. Long working hours occur when employees work well over 48 hours per week (White & Beswick, 2013).

The Harvard Business School conducted a large-scale digital communication analysis that examined 3.1 million emails and meetings from sixteen global cities (DeFilippis, Impink, Singell, Polzer & Sadun, 2020). The study revealed that during the first few weeks of the pandemic, the average day of work increased by 8.2% (48.5 minutes). Higher rates of meetings and emails were observed even after business hours, indicating a blurring of work-life boundaries during remote work. No cities in Sri Lanka were included in this study. Also, there are no studies published on the working hours of Sri Lankan employees during the COVID-19 pandemic. So, the current study sought to focus on remote working hours in Sri Lanka during the pandemic.

Long working hours may negatively affect the sleep, physical health, mental health, and performance rate of an employee. In addition, it has a broader impact on their family, friends, workplace, and community (Bannai & Tamakoshi, 2014; Afonso, Fonseca & Pires, 2017). Only a few studies have linked working hours to family and other non-work priorities on a societal level, particularly in Sri Lanka and other Eastern countries (Kodagoda, 2018).

Eddleston and Mulki (2017) conducted a mixed-method study to examine remote workers' work-life balance even before the pandemic. They discovered work-to-family and family-to-work conflicts when working from home. Furthermore, the results revealed a link with a lack of ability to disengage from office work. Female workers had a harder time disengaging from work, resulting in work-family conflicts. In conclusion, the study found that remote working leads to overwork. A study by Chung *et al.* (2020) surveyed 1160 remote workers in the UK during the COVID-19. The findings revealed a high rate of blurred work and home boundaries,

as well as an increase in household work among parents, particularly in working mothers. Only 15% of mothers had clear work-life boundaries. This was highlighted as a significant disadvantage of remote working.

In Sri Lanka, a qualitative study conducted before the pandemic investigated how long working hours in the health and banking sectors affect working mothers' health and family life (Kodagoda, 2018). Results from semi-structured interviews conducted with forty working mothers revealed negative impacts on motherhood duties, specifically regarding health and safety concerns, insufficient sleep, childcare issues, and the child's cognitive development. Certain younger mothers reported a greater commitment to work than their children, which was an intriguing revelation. Although the study yielded interesting results, the qualitative nature and small sample size pose a limitation on the generalizability of the findings. Nonetheless, the research evidence from the qualitative study was useful in understanding how work culture affects a collectivist country like Sri Lanka, where family life is made a priority.

In contrast to most studies that have found that working hours have a negative impact on work-life balance, an analysis conducted in Germany by Holly and Mohnen (2012) with data from around 20,000 participants from 1999 to 2009 revealed that long working hours have a positive impact on work-life balance and job satisfaction. Similar findings were reported in a meta-analysis by Gajendran and Harrison (2007) using forty-six studies. According to the meta-analysis, higher work satisfaction, productivity, reduced work-family conflicts, and stress reduction were reported, particularly in high-intensity workers who worked remotely. However, all the primary data examined in the analysis were surveys or interviews, with no higher control field experiments. Thus, it could be argued that the causal relationship of the analysis is uncertain. Furthermore, all studies were conducted 10-20 years ago. With today's fast-changing work culture, the findings of these studies may be out of date, especially with the advancement of technology, lifestyle changes, and the COVID-19 pandemic. Because of the disparities in findings

shown in the preceding studies on the effects of remote working and extended working hours on work-life balance, it is critical to conduct additional research in this area. Therefore, the current study focuses on understanding the impact of the number of working hours on work-life balance and stress in employees from a broader range of organizational positions who are working from home during the COVID-19 pandemic.

1.2 Long Working Hours and Stress

Stress can be defined as the physical and psychological responses to stressors. It is a natural reaction that the body can handle in small amounts. However, when stress becomes chronic or intense, this reaction can lead to unfavorable consequences in the body and mind (American Psychological Association, 2018). Stress negatively affects the physical, psychological, and social well-being of individuals, leading to health issues such as cardiovascular disease, hypertension, diabetes, depression, and anxiety (Wong *et al.*, 2019).

One of the key contributors to workplace stress is long working hours. Long working hours have been shown to lead to poor sleep, fatigue, bodily pains, symptoms of physical inactivity, lack of personal time, and relationship issues (Wong *et al.*, 2019). These factors may, in turn, contribute to stress, affecting one's physical, mental, and social well-being. Furthermore, these factors may lead to decreased job satisfaction and productivity.

A study conducted in Taiwan with 369 employees aimed to better understand the health of individuals working overtime in the banking and high-tech industries. The findings revealed a significant relationship between long working hours, stress, and Work-life balance (Hsu *et al.*, 2019). Furthermore, the findings revealed a significant relationship between organizational stress, work satisfaction, and Work-life balance. These findings support the previous statement about the impact of long working hours on factors such as Work-life balance, stress, and job satisfaction. The study's findings also revealed a positive relationship between working hours and job stress.

While there has been a lot of research on the effect of working hours on stress, there is no specific standard number of hours per day that was declared to be associated with stress. Accordingly, studies have revealed working 10 or more hours per day, 40 or more hours per week, or 60 or more hours per week causes stress (Wong *et al.*, 2019).

1.3 Research Objective

By conducting the current study, the researcher aims to fill in some research gaps related to remote working during the COVID-19 pandemic in Sri Lanka. Scientifically valid evidence is crucial for lawmakers, psychologists, human resource policymakers, organizations, and employers to understand the problems, not just for individuals who may continue working from home after the COVID-19 pandemic, but also as a guide for future pandemics and emergencies. Therefore, research objectives were constructed to suit contemporary issues during the pandemic.

The objective of the study is to examine the impact of long working hours on work-life balance and stress in remote workers during the COVID-19 pandemic. Further, it is intended to investigate the effect of age, gender, marital status, number of children, and organizational position on Work-life balance and stress

2. METHOD

This study takes a quantitative approach under the correlational research design and was conducted as a questionnaire-based survey.

Remote workers who were working at home due to the COVID-19 pandemic in the western province of Sri Lanka were sampled based on convenience and purposive sampling methods. The survey was publicly shared through social media. A total of 103 complete responses were considered in the sample.

The number of working hours is the independent variable of the study. Work-life balance and stress level are the two main dependent variables of the study.

Work-life balance was assessed using Hayman's (2005) 15-item inventory. The scale consists of three subscales to measure three elements of

work-life balance. They are work interference with personal life/WIPL (7 items), personal life interference with work/ PLIW (4 items), and work/personal life enhancement/WPLE (4 items). The 10-items Perceived Stress Scale (PSS-10) by Cohen, Kamarck, and Mermelstein (1983) was used to measure stress. The PSS questions inquire about the thoughts and feelings during the last month with general questions suitable for any population. Moreover, a study-specific questionnaire was administered to get the number of working hours per week and demographic details such as age, gender, residence, marital status, number of children, and the current organizational position.

The ethical clearance for the present study was obtained from Cardiff Metropolitan University Research Ethics Committee. The present study does not have any foreseeable risks to the participants. No personally identifiable details were requested during the study to ensure anonymity and confidentiality were maintained throughout the study. Participation was entirely voluntary and informed consent was taken prior to the commencement of the research. A debriefing was done after the completion of the study.

The information sheet, consent form, three questionnaires, and debriefing sheet were included in a Google form and was publicly shared online through social media (Facebook and WhatsApp) targeting the potential participants. Data collected were analyzed using the SPSS software.

2.1 Analysis

As the data did not have a normal distribution, non-parametric tests were used to analyze data.

Spearman's correlational analyses were performed to see the relationship between the number of working hours and stress and to study the relationship between the number of working hours and work-life balance. Mann-Whitney tests were used to compare the work-life balance and stress between males and females and between single and married participants.

3. RESULTS

Out of 103 participants in the study, fifty were male remote workers (48.5%) and fifty-three were female remote workers (51.5%). The study included seventy-four participants from Colombo (71.8%), twenty-three participants from Gampaha (22.3%), and six participants from Kaluthara (5.8%). Seventy-nine participants had no children (76.7%), eight participants had one child (7.8%) and sixteen participants had 2-4 children (15.5%). There were no participants with over four children. Out of 103 participants, sixty-four participants (62.1%) were in the 20-29 age group, twenty-one individuals (20.4%) were in the 30-39 age group, 7 (6.8%) were from the 40-49 age group and eleven participants were in the 50-59 age group (10.7%).

Out of 103 participants, twelve individuals (11.7%) work up to 25 hours per week, sixty-five participants (63.1%) work 25-50 hours per week, twenty-one individuals (20.4%) work up to 51-75 hours per week, three individuals (2.9%) work up to 76-100 hours per week and two participants (1.9%) reported to work over one hundred hours weekly.

Descriptive statistics of the main variables are given in below Table 1.

Table 1. Mean and standard deviation of work interference with personal life, personal life interference with work, work/personal life enhancement, work-life balance, and perceived stress

Variable	Mean
Work Interference with Personal Life	20.47 ± 7.48
Personal Life Interference with Work	14.25 ± 3.76
Work/Personal Life Enhancement	13.40 ± 3.60

Work-Life Balance	48.12 ± 11.91
Perceived Stress	20.167 ± 7.33

Spearman's correlational analysis conducted to study the association between the number of working hours and work-life balance revealed a statistically significant weak negative relationship ($r = -0.36, p < 0.01$). Further, there is a statistically significant weak positive association between the number of working hours and perceived stress ($r = 0.42, p < 0.01$). Spearman's correlation analysis was conducted to see the relationship between Work-Life Balance and stress. Results revealed a statistically significant strong negative association between Work-Life Balance and stress, ($r = -0.620, p < .001$).

All three subcomponents of work-life balance were separately analyzed to see their association of them with the level of stress. Results of the Spearman correlations revealed statistically a significantly strong negative association between Work Interference with Personal Life and stress ($r = -0.616, p < .001$), a statistically significant moderately negative association between Personal-Life Interference with Work and stress, ($r = -0.474, p < .001$) and a statistically significant weak negative association between work/personal life enhancement and stress ($r = -0.327, p < .001$).

Moreover, the Kruskal-Wallis H test conducted across different working hour groups (up to 25 hours, 25-50 hours, 51-75 hours, 76-100 hours, and over 100 hours per week) showed that there was a statistically significant difference in *Work life balance* between the different working hours groups ($H(4) = 11.624, p = 0.02$). Results also revealed a statistically significant difference in Perceived Stress between the different working hours groups ($H(4) = 14.675, p = 0.005$).

The Mann-Whitney test was conducted to compare if there is a difference in work-life balance and stress among males and females and no statistically significant differences were revealed. Also, there was no statistically significant difference observed in the work-life

balance between married and single participants. However, there was a statistically significant difference in the perceived stress ($U = 888.000$, $p = 0.045$) among married and unmarried participants.

4. DISCUSSION

Work-Life Balance and stress are topics with a large body of research. However, there is insufficient empirical evidence of the effect of working hours on these factors, particularly those pertaining to remote workers during the COVID-19 pandemic (Prasad, Vaidya & Mangipudi, 2020).

The present quantitative study consisted of 103 remote workers between the ages of 21-55, residing in Colombo, Gampaha, and Kalutara. According to the results, long working hours have a significant impact on work-life balance and stress.

The Role theory assumes that individuals accumulate numerous roles (work and nonwork) throughout life. It states that role interference and the inability to comply with responsibilities and demands of roles may lead to role conflicts (Kahn, Wolfe, Quinn, Snoek & Rosenthal, 1964). So, when the work roles and commitments of an employee interfere with the family roles such as a wife, mother, daughter, etc., it leads to work-life imbalance. Accordingly, excessive working hours are a resource of personal life, which has been redirected and used towards fulfilling work demands. As a result, work begins to interfere with life, and work becomes a source of stress. This affects the individual's overall stress level. This could explain why Work Interference with Personal Life was higher ($H=18.960$) in the current study and even statistically significant, while Personal Life Interference with Work is lower in contrast ($H=2.093$). Individuals have a stronger identification with work matters because of financial problems, work pressures, and competitiveness during the COVID-19 pandemic times. The study discloses the trends of long working hours significantly impacting work-life balance and work hindering personal life rather than trends of personal life interfering with work. In contrast, Sieber (1974) proposed role accumulation to be beneficial and tends to

surpass stress when fulfilling these roles, leading to a sense of fulfillment and the opportunity to accumulate resources.

In line with other studies conducted during the COVID-19 pandemic on work-life balance and work-and-life blur (Chung *et al.*, 2020), the current study's results also reported a trend of higher interference of work with personal life and a blur of work and life. This may be due to work and personal life occurring at home, thus, making it a greater struggle to disconnect. Further, due to higher workloads and cutoffs during the difficult years of the pandemic for most organizations, employees may feel pressured to work longer. The current study also supports the findings of Hsu *et al.* (2019), who discovered that working hours have a significant impact on work-life balance. However, unlike these studies, which only included employees from the banking and high-tech industries, the current study included a broader range of occupations. Long working hours have an impact on WLB across cultures and industries.

These results contradict the study revelations of Wong and Cheung (2020) in Hong Kong during the pandemic, which revealed a reduction in work stress, more time to rest, and an increase in work-life balance when working from home. The study, however, revealed a higher preference for a mixed mode of working from home and at the office.

Pre-COVID-19 pandemic studies also reported mixed results. While some studies are in line with the results of the present study, which found over-working and a lack of time for personal life and recuperation when working from home (Noonan & Glass, 2012) some other studies revealed positive outcomes of remote working (Golden & Gajendran, 2019; Holly & Mohnen, 2012). Factors such as compensation and social support were found to be linked to positive outcomes. Hence, it can be assumed that there is a mixed pattern of results, suggesting other moderators also play a role in the experience of individuals.

The preset study reveals an association between Work-Life Balance and stress, which has a statistically significant strong negative

correlation. This suggests that a high work-life balance would lead to low levels of stress and vice versa. Therefore, it can be assumed that long working hours could lead to high levels of stress, thus, reducing levels of work-life balance. Research by Weerasinghe and Dilhara (2018) is in line with these findings, which disclosed a negative correlation between work-life balance and stress. Additionally, they showed organizational culture to be a crucial moderator in supporting work-life. These revelations could be used in recommending the implications of appropriate policies and good occupational culture in organizations, particularly given the change in work culture during the pandemic.

Examining the demographic data with the impact on stress, outcomes disclosed no statistical significance for gender. These outcomes add to the existing research which has also revealed stress and factors such as gender do not have a statistically significant impact (Faraji, Karimi, Azizi, Janatolmakan & Khatony, 2019). This may be because of the impact of stress despite gender. In contrast, studies during the pandemic (Chandola, Booker, Kumari & Benzeval, 2019) and other past pandemic outbreaks such as bird flu and SARS (Lewis, 2020) have seen trends of working mothers facing higher stress than the average person. Generally, it is assumed that women have more household responsibilities than men, resulting in a poor work-family balance during the pandemic. But it should also be noted that confounding variables such as supportive partners, social support, and organizational support play a primary role in stress and work-life balance as well.

The outcomes of the study revealed a statistically significant effect of stress across different civil statuses. These shreds of evidence contradict the outcomes of Panisoara and Serban (2013) who did not find statistical significance in the level of stress across different civil statuses. The difference in results could be because of cross-cultural differences. Moreover, the current study, which was conducted during the pandemic when stress levels were high, may have influenced the results, in contrast to the Panisoara and Serban study which was conducted before the pandemic. However, studies conducted during the pandemic

are in line with the current study where relationship status has had an influence on psychological health, revealing individuals single, separated, or divorced to be at a higher risk of stress (Nkire *et al.*, 2021).

4.1 Limitations and Future Directions

While the study has its strengths, it should be noted that it inevitably has limitations. The small sample size, as well as the study being conducted in only three different districts, may raise concerns about the generalizability of the results. In addition, the use of questionnaires may have led to response biases, affecting results.

Although it may be difficult to replicate a similar study of the current research during the COVID-19 pandemic due to the time-sensitivity of the pandemic, future research could look into examining remote working and similar factors which may affect the occupational health of employees. This is especially true given the likelihood that some organizations will continue to use remote working after the pandemic, as well as the possibility of future pandemics and disasters that will change work trends and reintroduce working from home. Furthermore, it would be beneficial to investigate the impact of a hybrid working approach, which involves a mix of office and homework, on occupational health and productivity.

5. CONCLUSION

Remote employees' long working hours negatively impact their work-life balance and lead to increased stress levels. As the study reveals a direct negative effect of long remote working hours on one's personal life and mental health, the government and organizations should consider implementing suitable human resource policies and guidelines to safeguard employees' well-being. Family-friendly work cultures with non-extended or flexible working hours when working remotely could lead to higher satisfaction and productivity of workers. Lastly, including the mental health and well-being services of professionals such as counselors and organizational psychologists in the workplace could impact employee wellbeing and overall efficiency in the organization.

REFERENCES

- Afonso, P., Fonseca, M., & Pires, J. F. (2017). Impact of working hours on sleep and mental health. *Occupational Medicine*, 67(5), 377–382.
- American Psychological Association. (2018). *Stress affects the body*.
- Bannai, A., & Tamakoshi, A. (2014). The association between long working hours and health: A systematic review of epidemiological evidence. *Scandinavian Journal of Work, Environment & Health*, 40(1), 5–18.
- Chandola, T., Booker, C. L., Kumari, M., & Benzeval, M. (2019). Are flexible work arrangements associated with lower levels of chronic stress-related biomarkers? A study of 6025 employees in the UK household longitudinal study. *Sociology*, 53(4), 779–799.
- Chung, H., Seo, H., Forbes, S., & Birkett, H. (2020). *Working from home during the COVID-19 lockdown: Changing preferences and the future of work*. University of Kent.
- Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *J. Health Soc Behav.* 24, 385–396.
- DeFilippis, E., Impink, S., Singell, M., Polzer, J., & Sadun, R. (2020). Collaborating during coronavirus: The impact of COVID-19 on the nature of work. *Harvard Business School Organizational Behavior Unit Working*, 21(6).
- Eddleston, K. A., & Mulki, J. (2017). Toward understanding remote workers' management of work–family boundaries: The complexity of workplace embeddedness. *Group & Organization Management*, 42(3), 346–387.
- Faraji, A., Karimi, M., Azizi, S. M., Janatolmakan, M., & Khatony, A. (2019). Occupational stress and its related demographic factors among Iranian CCU nurses: A cross-sectional study. *BMC research notes*, 12(1), 634.
- Gajendran, R. S., & Harrison, D. A. (2007). The good, the bad, and the unknown about telecommuting: Meta-analysis of psychological mediators and individual consequences. *Journal of Applied Psychology*, 92(6), 1524–1541.
- Golden, T.D., & Gajendran, R.S. (2019). Unpacking the role of a telecommuter's job in their performance: Examining job complexity, problem solving, interdependence, and social support. *Journal of Business and Psychology*, 34(1), 55–69.
- Hayman, J. (2005). Psychometric assessment of an instrument designed to measure work life balance. *Research and Practice in Human Resource Management*, 13(1), 85–91.
- Holly, S., & Mohnen, A. (2012). Impact of working hours on work-life balance. *SSRN Electronic Journal*.
- Hsu, Y., Bai, C., Yang, C., Huang, Y., Lin, T., & Lin, C. (2019). Long hours' effects on work-life balance and satisfaction. *Biomed Research International*, 2019, 1-8.
- Integrated Benefits Institute. (2020). *Poor health costs US employers \$575 billion and 1.5 billion days of lost productivity per integrated benefits institute*.
- Kahn, R. L., Wolfe, D. M., Quinn, R. P., Snoek, J. D., & Rosenthal, R. A. (1964). Organizational stress: Studies in role conflict and ambiguity.
- Kodagoda, T. (2018). Working long hours and its impact on family life: Experiences of women professionals and managers in Sri Lanka. *Indian Journal of Gender Studies*, 25(1), 108–126.
- Lewis, H. (2020). *The coronavirus is a disaster for feminism: pandemics affect men and women differently*. The Atlantic.

- Nkire, N., Nwachukwu, I., Shalaby, R., Hrabok, M., Vuong, W., Gusnowski, A., Surood, S., Greenshaw, A. J., & Agyapong, V. (2021). COVID-19 pandemic: influence of relationship status on stress, anxiety, and depression in Canada. *Irish Journal of Psychological Medicine*, 1–12.
- Noonan, M.C. & Glass, J. (2012), “The hard truth about telecommuting”, *Monthly Labor Review*, 135(6), 38-45.
- Panisoara, G., & Serban, M. (2013). Marital status and work-life balance. *Procedia - Social and Behavioral Sciences*. 78, 21-28.
- Prasad, K., Vaidya, R., & Mangipudi, M. (2020). *Effect of occupational stress and remote working on psychological well-being of employees: An empirical analysis during COVID-19 pandemic concerning information technology industry in Hyderabad*.
- Siebert, S. D. (1974). Toward a theory of role accumulation. *American Sociological Review*, 39(4), 567–578.
- Weerasinghe, T., & Dilhara, M.G.D. (2018). Effect of work stress on work life balance: Moderating role of work-life support organizational culture in Sri Lanka customs department. *Kalyani: Journal of the University of Kelaniya*. 32, 46-69.
- White J., & Beswick J. (2013). *Working long hours*. Health and Safety Laboratory; Sheffield, UK.
- Wong, H. K. A., & Cheung, J. (2020). “Survey findings on working from home under COVID-19.” Lingnan University.
- Wong, K., Chan, A., & Ngan, S. C. (2019). The effect of long working hours and overtime on occupational health: A meta-analysis of evidence from 1998 to 2018. *International Journal of Environmental Research and Public Health*, 16(12), 2102.

Weighted Gene Co-expression Network Analysis to Identify Key Modules and Hub Genes Related to Withanolides Biosynthesis Pathway in *Datura metel*

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ABSTRACT

The gene co-expression analysis and clustering concept were utilized to identify possible genes present in the withanolides biosynthesis pathway. Weighted Gene Co-expression Network Analysis (WGCNA) was carried out to identify putative genes. The identified known genes were used as bait to locate the co-expressed genes among them in identified modules in WGCNA analysis. As cytochrome P450s and glycosyltransferase (UGT) are candidates for withanolide biosynthesis in the literature, the study was focused on identifying CYPs and UGT genes. Finally, the study was able to locate 6 CYP genes and 1 UGT gene as putative candidate genes involved in the withanolides biosynthesis pathway. However, *in silico* characterization should be carried out for further isolation processes.

1. INTRODUCTION

Secondary metabolism facilitates primary metabolism and ensures that all metabolic pathways are assisted with the required regulation and coordination for the long-term persistence of the plant (Crozier *et al.*, 2007; Nikolić *et al.*, 2012). The resulting metabolites are secondary or specialized and are crucial components actively participating in plant defense mechanisms, hormonal regulation, enzyme catalytic functions, signaling coordination, and are even responsible for the plant's structure, vigour, and colour characteristics. Therefore, secondary metabolites

are intermediate and promote growth and development but are not required for survival (Piasecka *et al.*, 2015; Seca & Pinto, 2019).

Plant synthetic biology, transcriptomics, genomics, proteomics, metabolomics, and gene function prediction have all had a significant impact on identifying secondary metabolite biosynthetic pathways in plants (Zhang *et al.*, 2017; Jacobowitz & Weng, 2020; Mutwil, 2020; Nützmann *et al.*, 2016). These methods enabled the elucidation of unknown genes and enzymes in many plants' secondary metabolite biosynthetic pathways and *de novo* biosynthetic pathway prediction in many non-model plants (Tissier, 2012). The production of secondary metabolites is restricted to specialized organs, tissues, and different cell types. Moreover, these are regulated via different environmental parameters such as drought, salt resistance, or regulations via chemical elicitations like salicylic acid and methyl jasmonate (Wang *et al.*, 2016). Therefore, the enzymes and their corresponding mRNAs should only be present in the cells where the specific metabolites are produced innately. These sets of genes co-regulate specific biological functions. This assumption has been exploited to identify biosynthetic genes by employing different gene expressions, gene co-expressions, and metabolite levels in omics technologies, and this is known as gene co-expression, which is based on the guilt by association principle (Gillis & Pavlidis, 2012; Saito *et al.*, 2008; Yonekura-Sakakibara *et al.*, 2008). This assumption was successfully proved

for fatty acid identification in tomato plants (Jeon *et al.*, 2020). Once the known genes and their gene expressions are identified, they can be employed to uncover other unknown genes with a similar expression profile (Serin *et al.*, 2016; Usadel *et al.*, 2009). Several studies have pointed out that genes with similar expression patterns in different organs and developmental stages as well as biotic and abiotic agitations tend to involve similar biological processes (Dugé de Bernonville *et al.*, 2017).

Gene clustering is highly employed in modern RNAseq studies (de Bernonville *et al.* 2020). Genes that form a cluster of genes display relative gene expression across the samples or conditions. In most gene clusters, genes responsible for specialized metabolites like secondary metabolites are located together in the genome. These were found in plants like *Zea mays* (Frey *et al.*, 1997), rice (Yang *et al.*, 2004), tomato (Akthar *et al.*, 2013), and potato (Itkin *et al.*, 2013). Therefore, the Gene Co-Expression Network Analysis (GCNA) method is commonly used in transcriptome-based gene co-expression networks (Higashi & Saito, 2013). It is a genetic approach to analyzing correlated and applicable genes in functional modules and phenotypic traits (Serin *et al.*, 2016). There are numerous tools to analyze gene co-expression analysis. Of those, WGCNA is one of the most common GCNA-based approaches to identifying clustering genes in different metabolic pathways (Langfelder & Horvath, 2008). It is an R software package that uses a correlation of gene expressions for describing and visualizing data point networks related to gene networks (Langfelder & Horvath, 2008; Yao *et al.*, 2019). It is used to find biosynthesis pathways and genes that significantly impact those pathways. Moreover, this method can be employed to predict unknown genes and regulatory factors through the known genes in the networks. The crucial genes are named hub genes. Modules created in this WGCNA method are defined as clusters of highly interconnected genes. The number of genes found in whole genomic expressions is reduced by gene modules (Tai *et al.*, 2018a). Each gene module consists of genes with the same function or similar

biological regulation (Langfelder & Horvath, 2008). When the genes are annotated, like Gene Ontology (GO) enrichment and Kyoto Encyclopedia of Genes and Genomes (KEGG) pathways, that information can be related to modules to identify the hub genes and their modules. That would quickly lead to identifying interconnected and correlated modules. Hub genes enable the exploration of complex gene traits. This process will reduce the amount of data that needs to be processed, thus saving time. This method was extensively used in studies (DiLeo *et al.*, 2011; Jia *et al.*, 2021; B. Yu *et al.*, 2020) and mainly in plants like tomato (DiLeo *et al.*, 2011), soya bean (Gao *et al.*, 2018), strawberry (Hollender *et al.*, 2014) and tea (Tai *et al.*, 2018). Moreover, Zheng *et al.* (2019) identified genes related to the expression pattern of the epidermal wax pathway in maize plants. This method was also utilized to identify hub genes related to abiotic drought stress-induced pathways in papaya plants (Gamboa-Tuz *et al.*, 2018). Finally, this is one of the easiest methods to identify critical genes in interesting biological functions or synthesis pathways.

Withanolides are naturally occurring secondary metabolites that predominantly occur within plants of the *Solanaceae* family, especially the subfamily *Solanoidea* accounting for higher medicinal and economic importance (Chen *et al.*, 2011; Dhar *et al.*, 2015; Glotter, 1991). Withanolides are subdivided into nine withanolides, withaphysalins, physalins, nicandrenones, jaborols, ixocarpalactones, perulactones, acnistins and miscellaneous withasteroids (Misico *et al.*, 2011). Withanolides are synthesized via mevalonate (MVA) and non-mevalonate (MEP/DOXP) pathways in the cytosol and plastids, respectively (Chaurasiya *et al.*, 2012b; Dhar *et al.*, 2015). The Withanolide biosynthesis pathway was elucidated up to 24-methyl-desmosterol via 24-isomerase (EC 5.3.3), which catalyzes the conversion of 24-methylenecholesterol to 24-methyl-desmosterol (Chaurasiya *et al.*, 2012b; Gupta *et al.*, 2013, 2015). No genes were identified after this step. Studies have pointed out that cytochrome P450 mono-oxygenase (CYP450s) and UDP-glycosyltransferases (UGTs) govern the

hydroxylation, oxidation, and glycosylation steps, yielding withanolides (Agarwal *et al.*, 2017; Gupta *et al.*, 2015; Senthil *et al.*, 2015; Tripathi *et al.*, 2016). However, the essential genes related to withanolide biosynthesis in *D. metel* have not yet been identified. Genes related to CYP450s and UGTs in plants are essential to the diversification of withanolides structures. RNA seq and other sequencing techniques provide a better opportunity to identify these possible candidates. Once these genes are identified, their synthesized proteins can be characterized via *in silico* and *in vivo* characterization methods. The objective of this paper is to isolate potential CYP450 and UGTs genes that might be involved in the biosynthesis pathway of withanolides in *D. metel* by using WGCNA analysis methods for the sequenced data.

2. METHODOLOGY

2.1 Transcript Quantification

Transcript-level quantification was performed to estimate gene and isoform expression levels from *D. metel* RNA-Seq data. The RSEM software package was used for this process. Initial sequencing reads and a *de novo* assembled transcriptome of *D. metel* were processed in this RSEM program to quantify the expression from transcriptome data. It aligned the reads against the reference annotated transcriptome and calculated relative abundances using the Bowtie2 aligner program within the RSEM program. The results provided the isoform level and gene level quantified tables called count tables

2.2 WGCNA Analysis

The WGCNA enables the identification of modules of highly correlated genes and hub genes with important effects in the withanolide biosynthesis pathway. Genes that were differentially expressed from the Differently Expressed Gene (DEG) analysis (7888 genes) were normalized, and their gene expression values (FPKM) were used as the input for WGCNA analysis in R software (version 4.0.5). WGCNA network construction and module detection were conducted using a signed topological overlap matrix (TOM). The soft

power value is 18, the minimum module size is 30, and the merge cut height is 0.25. Each module was identified by color. In each module, the most significantly correlated genes with a WGCNA edge weight of 0.1 were visualized using Cytoscape 3.5.1 software. The most highly connected nodes within the module, known as "hub genes", were identified for each module. Functional analysis of the modules was carried out using Gene Ontology Enrichment. Further, the distribution of identified critical genes involved in the withanolides biosynthesis pathway in the modules was screened (Figure 01). Then the CYPs and UGTs co-expressed with known genes were identified as potential genes. KEGG pathway analysis was also performed on the modules.

2.3 Candidate gene selection based on the co-expressed gene expression criteria.

Due to the known localization of the metabolic pathway to leaf tissue, any gene not expressed in the leaf can be discarded. Moreover, the leaves elicited with SA allow us to identify the upregulated genes upon SA induction. The Withanolide biosynthetic pathway responds to SA elicitation (Dasgupta *et al.*, 2014; Sivanandhan *et al.*, 2014), and therefore, genes that are preferentially expressed in response to SA elicitation are preferred candidates. The upregulated genes in the DEG analysis were further selected by co-expression analysis. Co-expression selection was based on gene discovery, utilizing the spatial proximity of genes

on the genome that act as physical clustering of genes in secondary metabolism in plants. These methods are currently employed to identify candidate genes in specialized metabolism in several plant species (Nützmann *et al.*, 2016). Unigenes identified in each co-expression method were clustered together using a Venn diagram using Omics Box (2021). Unigenes co-expressed together or at least present in two co-expression methods were selected as the final possible candidate genes in the withanolide biosynthesis pathway for the *D. metel* transcriptome.

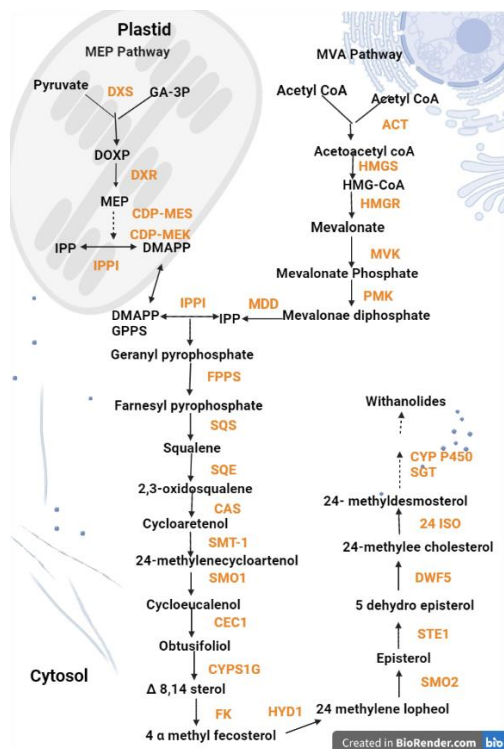


Figure 01: Known genes in Withanoloids Biosynthesis pathway

3.0 RESULTS AND DISCUSSION

There were 6 gene co-expression modules (Figure 02) identified under WGCNA method. The number of genes in the module ranged from 125 (Red) to -3403 (Turquoise). The cluster dendrogram generated (Figure 03) represents how all DE genes are distributed among modules. Each branch of the clustering tree represents a module with a different colour. Each leaf displays a gene. The correlation coefficient of the modules with each other represented the module relationships (Figure 04). Known genes present in the withanolide pathway were assessed, and they were mainly distributed to yellow, blue, and brown modules, respectively. Once the known genes were identified, CYP450s and UGTs were identified that co-expressed with the known genes in each module (Table 01).

Moreover, enriched CYP450 and UDP-GT were also investigated in three interesting modules.

Unigenes that encode for CYP450, and UDP-GTs and their modules are given in Table 01. Their gene expressions were evaluated, and higher gene expressions were selected as candidate genes for withanolide production. KEGG pathway analysis revealed that brown and yellow modules consist of steroid and brassinosteroid, and triterpenoid biosynthesis pathways. Therefore, higher attention was given to examining those modules.

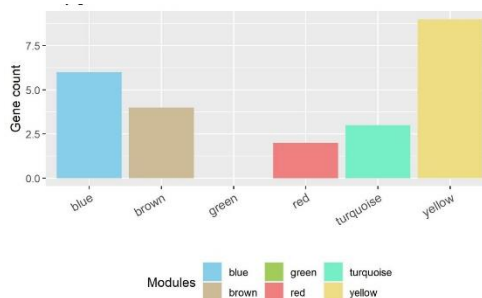


Figure 02: WGCNA modules identified for DEGs in *D. metel* transcriptome. The yellow module consisted of more DEGs while the red module for a smaller number of DEGs. No genes were observed in green module.

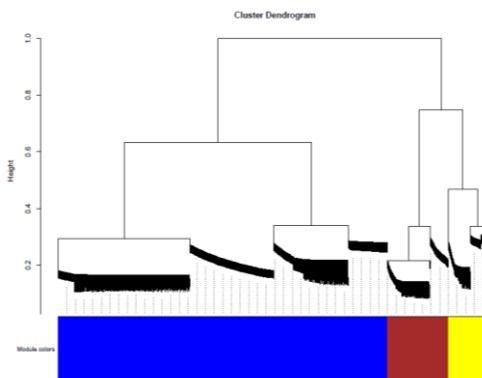


Figure 03: Known genes for withanolide biosynthesis pathway present in modules blue, brown, and yellow modules.

Table 01: Identified genes for further studies

Unigene	Gene Class	Symbol for CYP
TRINITY_DM8039_c0_g3_i1	Cytochrome P450	CYP83B1
TRINITY_DM483_c0_g1_i5	Cytochrome P450	CYP450 monooxygenase
TRINITY_DM7998_c0_g1_i1	Cytochrome P450	CYP87A2
TRINITY_DM472_c1_g1_i4	Cytochrome P450	CYP88A3
TRINITY_DM2774_c0_g1_i11	Cytochrome P450	CYP72A5
TRINITY_DM399_c0_g2_i2	Cytochrome P450	CYP97
TRINITY_DM4536_c0_g2_i2	Glycosyltransferase	UGT

4.0 CONCLUSION

Genes named DM483, DM472, DM2774, DM8039, DM7998, DM399, and DM4536 were identified as potential candidate genes for the withanolides biosynthesis pathway in *D. metel* leaf and flower tissues. The isolated genes were further characterized via *in silico* methods, phylogenetic trees, and multiple sequence alignment methods. This study shows the significance of using WGCNA analysis on identifying key modules and hub genes in Withanolides biosynthesis pathway in medicinal plants. However further *in silico* and *in vitro* characterizations are needed to carry on to confirm the genes functions and phenotypic expression in withanolides production in *D. metel* plants.

REFERENCES

Akhtar, T. A., Matsuba, Y., Schauvinhold, I., Yu, G., Lees, H. A., Klein, S. E., & Pichersky, E. (2013). The tomato cis-prenyltransferase gene family. *The Plant Journal*, 73(4), 640-652.

Chaurasiya, N. D., Sangwan, N. S., Sabir, F., Misra, L., & Sangwan, R. S. (2012). Withanolide biosynthesis recruits both mevalonate and DOXP pathways of isoprenogenesis in Ashwagandha *Withania somnifera* L.(Dunal). *Plant cell reports*, 31(10), 1889-1897.

Courtney A. Hollender, Chunying Kang, Omar Darwish, Aviva Geretz, Benjamin F. Matthews, Janet Slovin, Nadim Alkharouf, Zhongchi Liu, Floral Transcriptomes in Woodland Strawberry Uncover Developing Receptacle and Anther Gene Networks, *Plant Physiology*, Volume 165, Issue 3, July 2014, Pages 1062–1075, <https://doi.org/10.1104/pp.114.237529>

Crozier, A., Jaganath, I.B. and Clifford, M.N. (2007) Phenols, polyphenols and tannins: *Plant Secondary Metabolites: Occurrence, Structure and Role in the Human Diet*. Blackwell Publishing, pp. 1-24. ISBN 1405125098

De Bernonville, T. D., Papon, N., Clastre, M., O'Connor, S. E., & Courdavault, V. (2020).

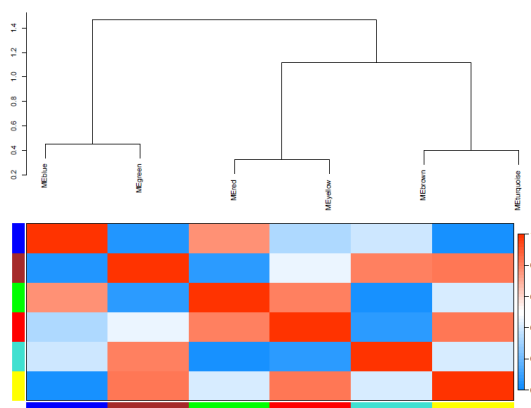


Figure 04: Correlation coefficient of modules with each other. Correlation 1 represents the higher module relationship while 0 represents the lower module relationship with each other.

Unigenes identified in WGCNA Unigenes co-expressed together or at least present in two co-expression methods were selected as the final possible candidate genes in the withanolide biosynthesis pathway for the *D. metel* transcriptome (Table 01).

- Identifying missing biosynthesis enzymes of plant natural products. *Trends in Pharmacological Sciences*, 41(3), 142-146.
- Dhar, N., Razdan, S., Rana, S., Bhat, W. W., Vishwakarma, R., & Lattoo, S. K. (2015). A decade of molecular understanding of withanolide biosynthesis and in vitro studies in *Withania somnifera*(L.) dunal: Prospects and perspectives for pathway engineering. *Frontiers in Plant Science*, 6(NOVEMBER), 1–20. <https://doi.org/10.3389/FPLS.2015.01031/BIBTEX>
- DiLeo, M. V., Strahan, G. D., den Bakker, M., & Hoekenga, O. A. (2011). Weighted correlation network analysis (WGCNA) applied to the tomato fruit metabolome. *PloS one*, 6(10), e26683.
- Dugé de Bernonville, T., Carqueijeiro, I., Lanoue, A., Lafontaine, F., Sánchez Bel, P., Liesecke, F., ... & Courdavault, V. (2017). Folivory elicits a strong defense reaction in *Catharanthus roseus*: metabolomic and transcriptomic analyses reveal distinct local and systemic responses. *Scientific Reports*, 7(1), 1-14.
- Frey M, Chomet P, Glawischnig E, Stettner C, Grün S, Winklmaier A, Eisenreich W, Bacher A, Meeley RB, Briggs SP, Simcox K, Gierl A. Analysis of a chemical plant defense mechanism in grasses. *Science*. 1997 Aug 1;277(5326):696-9. doi: 10.1126/science.277.5326.696. PMID: 9235894.
- Gamboa-Tuz, S. D., Pereira-Santana, A., Zamora-Briseño, J. A., Castano, E., Espadas-Gil, F., Ayala-Sumano, J. T., ... & Rodríguez-Zapata, L. C. (2018). Transcriptomics and co-expression networks reveal tissue-specific responses and regulatory hubs under mild and severe drought in papaya (*Carica papaya* L.). *Scientific reports*, 8(1), 1-16.
- Gillis J, Pavlidis P (2012) "Guilt by Association" Is the Exception Rather Than the Rule in Gene Networks. *PLOS Computational Biology* 8(3): e1002444. <https://doi.org/10.1371/journal.pcbi.1002444>
- Glotter, E. (1991). Withanolides and related ergostane-type steroids. *Natural product reports*, 8(4), 415-440.
- Gupta, P., Goel, R., Agarwal, A. V., Asif, M. H., Sangwan, N. S., Sangwan, R. S., & Trivedi, P. K. (2015). Comparative transcriptome analysis of different chemotypes elucidates withanolide biosynthesis pathway from medicinal plant *Withania somnifera*. *Scientific reports*, 5(1), 1-13.
- Gupta, P., Goel, R., Pathak, S., Srivastava, A., Singh, S. P., Sangwan, R. S., ... & Trivedi, P. K. (2013). De novo assembly, functional annotation and comparative analysis of *Withania somnifera* leaf and root transcriptomes to identify putative genes involved in the withanolides biosynthesis. *PLoS One*, 8(5), e62714.
- Higashi, Y., & Saito, K. (2013). Network analysis for gene discovery in plant-specialized metabolism. *Plant, cell & environment*, 36(9), 1597-1606.
- Huihui Gao, Yan Wang, Wei Li, Yongzhe Gu, Yongcai Lai, Yingdong Bi, Chaoying He, Transcriptomic comparison reveals genetic variation potentially underlying seed developmental evolution of soybeans, *Journal of Experimental Botany*, Volume 69, Issue 21, 12 October 2018, Pages 5089–5104, <https://doi.org/10.1093/jxb/ery291>
- Itkin, M., Heinig, U., Tzfadia, O., Bhide, A. J., Shinde, B., Cardenas, P. D., ... & Aharoni, A. (2013). Biosynthesis of antinutritional alkaloids in solanaceous crops is mediated by clustered genes. *Science*, 341(6142), 175-179.
- Jacobowitz, J. R., & Weng, J. K. (2020). Exploring uncharted territories of plant specialized metabolism in the postgenomic era. *Annual review of plant biology*, 71(1).
- Jia, D., Chen, C., Chen, C., Chen, F., Zhang, N., Yan, Z., & Lv, X. (2021). Breast cancer case identification based on deep learning and bioinformatics analysis. *Frontiers in Genetics*, 12, 628136.
- Ju Eun Jeon, Jung-Gun Kim, Curt R. Fischer, Niraj Mehta, Cosima Dufour-Schroif, Kimberly Wemmer, Mary Beth Mudgett, Elizabeth Sattely, A Pathogen-Responsive Gene Cluster for Highly Modified Fatty Acids in Tomato, *Cell*, 180, 1, 2020, 176-

- 187.e19,00928674,<https://doi.org/10.1016/j.cell.2019.11.037>
- Kazuki Saito, Masami Y. Hirai, Keiko Yonekura-Sakakibara, Decoding genes with coexpression networks and metabolomics – ‘majority report by precogs’, *Trends in Plant Science*, Volume 13, Issue 1, 2008, 36-43, ISSN 1360-1385, <https://doi.org/10.1016/j.tplants.2007.10.006>.
- Keiko Yonekura-Sakakibara, Takayuki Tohge, Fumio Matsuda, Ryo Nakabayashi, Hiromitsu Takayama, Rie Niida, Akiko Watanabe-Takahashi, Eri Inoue, Kazuki Saito, Comprehensive Flavonol Profiling and Transcriptome Coexpression Analysis Leading to Decoding Gene–Metabolite Correlations in *Arabidopsis*, *The Plant Cell*, Volume 20, Issue 8, August 2008, Pages 2160–2176, <https://doi.org/10.1105/tpc.108.058040>
- Langfelder, P., & Horvath, S. (2008). WGCNA: an R package for weighted correlation network analysis. *BMC bioinformatics*, 9(1), 1-13.
- Li, X., Zhang, L., Ahammed, G. J., Li, Z. X., Wei, J. P., Shen, C., ... & Han, W. Y. (2017). Stimulation in primary and secondary metabolism by elevated carbon dioxide alters green tea quality in *Camellia sinensis* L. *Scientific reports*, 7(1), 1-12.
- Misico, R. I., Nicotra, V. E., Oberti, J. C., Barboza, G., Gil, R. R., & Burton, G. (2011). Withanolides and related steroids. *Progress in the Chemistry of Organic Natural Products Vol. 94*, 127-229.
- Mutwil, M. (2020). Computational approaches to unravel the pathways and evolution of specialized metabolism. *Current Opinion in Plant Biology*, 55, 38–46. <https://doi.org/10.1016/J.PBI.2020.01.007>
- Nikolić, D., Gödecke, T., Chen, S. N., White, J., Lankin, D. C., Pauli, G. F., & van Breemen, R. B. (2012). Mass spectrometric dereplication of nitrogen-containing constituents of black cohosh (*Cimicifuga racemosa* L.). *Fitoterapia*, 83(3), 441-460.
- Nützmann, H.-W., Huang, A. and Osbourn, A. (2016), Plant metabolic clusters – from genetics to genomics. *New Phytol*, 211: 771-789. <https://doi.org/10.1111/nph.13981>
- Piasecka, A., Jedrzejczak-Rey, N., & Bednarek, P. (2015). Secondary metabolites in plant innate immunity: conserved function of divergent chemicals. *New Phytologist*, 206(3), 948-964.
- Seca, A. M., & Pinto, D. C. (2019). Biological potential and medical use of secondary metabolites. *Medicines*, 6(2), 66.
- Senthil, K., Thirugnanasambantham, P., Oh, T. J., Kim, S. H., & Choi, H. K. (2015). Free radical scavenging activity and comparative metabolic profiling of in vitro cultured and field grown *Withania somnifera* roots. *PLoS One*, 10(4), e0123360.
- Serin, E. A., Nijveen, H., Hilhorst, H. W., & Ligterink, W. (2016). Learning from co-expression networks: possibilities and challenges. *Frontiers in plant science*, 7, 444.
- Tai, Y., Liu, C., Yu, S., Yang, H., Sun, J., Guo, C., ... & Wan, X. (2018). Gene co-expression network analysis reveals coordinated regulation of three characteristic secondary biosynthetic pathways in tea plant (*Camellia sinensis*). *Bmc Genomics*, 19(1), 1-13.
- Tissier, A. (2012). Glandular trichomes: what comes after expressed sequence tags? *The Plant Journal : For Cell and Molecular Biology*, 70(1), 51–68. <https://doi.org/10.1111/J.1365-313X.2012.04913.X>
- Tripathi, S., Jadaun, J. S., Chandra, M., & Sangwan, N. S. (2016). Medicinal plant transcriptomes: the new gateways for accelerated understanding of plant secondary metabolism. *Plant Genetic Resources*, 14(4), 256-269.
- Usadel, B., Obayashi, T., Mutwil, M., Giorgi, F. M., Bassel, G. W., Tanimoto, M., ... & Provart, N. J. (2009). Co-expression tools for plant biology: opportunities for hypothesis generation and caveats. *Plant, cell & environment*, 32(12), 1633-1651.
- Wang, X., Pan, Y. J., Chang, B. W., Hu, Y. B., Guo, X. R., & Tang, Z. H. (2016). Ethylene-Induced Vinblastine Accumulation Is Related to Activated Expression of Downstream TIA

Pathway Genes in *Catharanthus roseus*. *BioMed Research International*, 2016.
<https://doi.org/10.1155/2016/3708187>

Yang, Y., Qi, M., & Mei, C. (2004). Endogenous salicylic acid protects rice plants from oxidative damage caused by aging as well as biotic and abiotic stress. *The Plant Journal*, 40(6), 909-919.

Zhang, H., Samadi, A. K., Cohen, M. S., & Timmermann, B. N. (2012), Antiproliferative withanolides from the solanaceae: A structure-activity study. *Pure and Applied Chemistry*, 84(6), 1353–1367.

Zheng, J., He, C., Qin, Y., Lin, G., Park, W. D., Sun, M., ... & Liu, S. (2019). Co-expression analysis aids in the identification of genes in the cuticular wax pathway in maize. *The Plant Journal*, 97(3), 530-542.

The Effect of Gut Microbiome Composition on Human Mental Health

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ABSTRACT

Human gut microbiota is a complex microbial community where the host and each member have established a strong relationship with each other. The effects of gut microbiota on the immune system, brain development, and especially for mental disorders like depression and anxiety have attracted attention in recent years. Since clinical observations and animal trials have revealed much evidence of an active link between the gut and the brain, the interactions of gut microbiota with the surrounding environment have become a new and significant area of study in medical, biochemical, and many fields. However, there is very little knowledge about the nature of these interactions and how they caused changes in human physiology, development, immunity, and nutrition. By getting an exact idea of how gut microbiota affects depression and anxiety, more efficient treatments with lesser side effects can develop for patients with the above mental illnesses. Therefore, this field needs more research using animal and human patients. This review summarizes the connection between the alteration of gut microbiota composition and mental health to give a clear idea of how gut microbiota is involved in depression and anxiety disorders, including behavioral and neurochemical changes.

1. HUMAN MICROBIOTA

The mammalian body is a complex and thriving ecosystem populated by a huge and complex group of microbes. The microorganisms that live inside and on human bodies are referred to as microbiota, and the genetic material of those microbes is called the microbiome. The human

microbiota is composed of bacteria, archaea, and eukarya, and they are important in nutrition regulation, metabolism, development, and function of the immune system (Allen et al., 2012). Microbial diversity depends on host genetics, age, gender, body mass index (BMI), diet, environment, geography, diseases, and early microbial exposure. From the human microbiome project (HMP) microbiome of a healthy individual has been characterized. In a healthy human host, the majority of microbiota inhabits the distal gut of the gastrointestinal (GI) tract. *Streptococcus* dominated in the oral cavity, *Lactobacillus* spp. dominating the vaginal sites, *Staphylococcus*, and *Corynebacterium* are dominant in the skin, and *Bacteroides* are dominant in the gut (The Human Microbiome Project Consortium). The selective pressure from the host cells and microbial competitors toward gut microbiota leads to the homeostasis of the microbial ecosystem, where some microbes are in high abundance, and some are in low abundance (Evrensel & Emin, 2015). However, some factors like diet and antibiotic use (Bailey et al., 2010), exposure to prolonged restraint (Bailey et al., 2010), and social disruption (SDR) (Riesenfeld et al., 2004) can cause alterations in the community structures of gut microbiota.

2. DEPRESSION

Depression is a multi-factorial recurring and debilitating disease condition that is caused by biological, social, and psychological factors (Kleiman et al., 2015). It had affected nearly 300 million people worldwide and is associated with nearly 800,000 suicide deaths annually (Davidsen & Fosgerau, 2014). According to Cui et al. (2015), psychiatry has debated about the diagnosis of depression for decades. Since existing knowledge of depression is incomplete;

there are no adequate treatments (Qin et al., 2010). So, new insights into depressive disorder are needed urgently including innovative therapeutic interventions because available treatment options are far from being mechanism-based (Dinan & Cryan, 2013; Jiang et al., 2015).

2.1. Anxiety

Anxiety is an emotional state, and it includes feelings of apprehension, tension, nervousness, and mainly worry accompanied by physiological arousal. It is something felt, and intense anxiety was prevalent in most psychiatric disorders. Generally, anxiety is a mix of disorders such as phobia, panic disorder, obsessive-compulsive disorder, social anxiety disorder, illness anxiety disorder, post-traumatic stress disorder, and separation anxiety disorder (Spielberger, 2009). Some differences exist between anxiety and depressive disorders and within anxiety disorders. However, it is difficult to divide these differences, and they are not consistent with subdivisions of fear disorders vs. anxious misery disorders. Still, there is much more data to collect through further research to identify unique features of anxiety and depressive disorders (Neumann & Landgraf, 2012)

3. GUT-BRAIN AXIS

The interactions between the gut and brain are highly complex, and the denomination of the Gut-Brain Axis (GBA) is used to describe them (Cryan & O'mahony, 2011). There is tremendous importance in a complex communication system of gut-brain crosstalk. Not only the proper maintenance of GI homeostasis, but gut-brain communication also has many influences on motivation and higher cognitive functions. GBA is regulated at neural, hormonal, and immunological levels (Neufeld et al., 2011). Foster and Neufeld (2013) mentioned that monitoring and integrating gut functions and linking cognitive and emotional centers of the brain with peripheral intestinal mechanisms as the roles of GBA. The GBA provides bidirectional communication (from microbiota to the brain and from the brain to microbiota),

which is in a homeostatic route. The dysfunction of this route can have severe pathophysiological consequences. Specific alterations in the stress response and overall behavior factors are associated with the modulation of the brain-gut axis (Severance et al., 2013). According to Neufeld et al. (2011), the alterations in brain-gut interactions are associated with gut inflammation, obesity, chronic abdominal pain syndromes, eating disorders, and many other disorders, including irritable bowel syndrome (IBS) and inflammatory bowel disorder (IBD) which are found as related to depression and anxiety disorders.

4. ROLE OF GUT MICROBIOTA IN DEPRESSION AND ANXIETY

Recent findings prove that the microbiota-gut-brain axis is involved in psychiatric disorders such as depression and anxiety disorders (Bastiaanssen et al., 2020; Cruz-Pereira et al., 2020). Many tests have been conducted in this case using mainly animal models there is some research with human patients. There is a growing body of literature that supports and characterizes the possible role of gut microbiome imbalance in depression and anxiety. In the process of studying the role of the intestinal microbiota on depression and anxiety, it was found that microbiota can alter the functions of the hypothalamic-pituitary-adrenal (HPA) axis and directly influences stress circuits (Naseribafrouei, 2014; Carabotti, 2015). Antibiotic use, GI infection studies, probiotic treatments, fecal microbiota transplantation, and germ-free mice studies have been used to study the effect and influence of the gut microbiota on mental health situations (Qin et al., 2010).

4.1. Germ-Free Housing

Germ-Free (GF) animals are animals free from any microbes, including bacteria, viruses, fungi, parasites, and protozoa and they are widely used to study microbiome-GBA. GF mice are used to investigate the impacts of probiotics on microbiome-GBA and to investigate the effect of the complete absence of intestinal microbiota on

behavior (Kennedy et al., 2012). According to the independent tests, the level of plasma corticosterone (CORT) and anxiety-like behavior has increased in GF mice when compared to specific pathogen-free (SPF) mice (Bennet, Eriksson, & Nord, 2002). Since it has previously been found that anxiety-like behaviors are not related to CORT levels (Rhee, Pothoulakis, & Mayer, 2009) these observed results should be because of the alterations of the microbiota. It was able to normalize some aspects of behavior by reconstitution of gut microbiota in GF mice in early life (Neufeld, Kang, Bienenstock, & Foster, 2011). However, data from the studies done using these animals are useful only as research tools in neurogastroenterology, and they cannot be used as translational to human disease studies because GF mice do not represent any of the real situations in the human population.

4.2. Antibiotic treatment

The oldest drugs used in managing GI tract diseases are antibiotics. Antibiotic therapy is currently used in the treatment of disorders such as IBS, and there the composition of gut microbiota is modified to manage disease conditions (Cui et al., 2015). The frequent use of broad-spectrum antibiotics, especially for infectious diseases, has become one of the main reasons to reduce the biodiversity of the gut microbiota and delay the colonization by some probiotic strains such as *Lactobacilli* (Cani et al., 2008). In another experiment, male adult mice who were exposed to a mixture of Neomycin and Bacitracin antibiotics (both in 5 mg/ml) together with Pimaricin antifungal agent, for seven days had shown reduced anxiety-like and altered behavior when tested with the step-down and the light/dark box tests. The use of antibiotics on GF mice did not show any behavioral changes, and it was confirmed that behavioral alterations of previous mice resulted from changes in gut microbiota because of the antibiotics (O'mahony et al., 2014). It has been observed that antibiotic therapy caused the reduction of luminal lipopolysaccharide concentration and led to an increase in hypothalamic proinflammatory cytokines expression and attenuated HPA axis

stress response. However, these observations vary with the strains of mice as the microbiota composition changed with the strains of mice (Cui et al., 2015).

4.3. Probiotics

Probiotics are live microorganisms that can be administered as dietary supplements or as food products, like yogurt. Several probiotic bacteria such as *Bifidobacterium* sp. (*Actinobacteria*) and *Lactobacillus* sp. (*Firmicutes*) had tested for health benefits and used in the treatment of the GI symptoms of disorders such as IBS [Arumugam et al., 2011; Kennedy et al., 2012]. There is much clinical evidence of probiotics used for depression and anxiety symptoms, but there is little published work that is concerned about the effects of probiotics on depression and anxiety symptoms in humans. In a group clinical trial, a mixture of probiotics containing *Lactobacillus helveticus* R0052 and *Bifidobacterium longum* R0175 or placebo had given to healthy human subjects for 30 days, and then anxiety, depression, and stress were evaluated using a questionnaire. Reducing anxiety and depression symptoms were observed as the results (Logana & Katzman, 2005). A recent study which was done with a combination of *L. helveticus* and *B. longum* probiotics and with the use of both human subjects and rats has found that probiotics reduced anxiety. Another research found an overall positive effect of probiotics on depressive symptoms in clinically depressed patients when used as a supplement to antidepressant treatment compared to antidepressant treatment alone (Nikolova, Zaidi, Young, Cleare, & Stone, 2019). Not only in reducing anxiety and depression but probiotics are also involved in decreasing serum cortisol in patients and causing beneficial psychological effects. Some probiotics have the potential to lower inflammatory cytokines, decrease oxidative stress, and improve nutritional status, and those will lead to an increased level of neurotransmitters, which are involved in the regulation of depression and anxiety (Cryan, Page, & Lucki, 2001). Another study was conducted using *Lactobacillus plantarum* PS12

probiotic, and it was found that probiotics caused an increase in levels of serotonin and dopamine in the striatum and had antidepressant-like effects in mice (Greenberg, Xu, Lu, & Hempstead, 2009). According to Chen et al. (2018), probiotic agents like *Bifidobacterium infantis* can initiate antidepressant-like behavior by having antidepressant properties in the forced swim test. It is a well-established model used in evaluating the activity of pharmacological antidepressants and it caused the increase of plasma tryptophan and suppression in stimulation-induced increases in peripheral pro-inflammatory cytokines (both above had implicated in depression). So, certain probiotic strains can modulate various aspects of the microbiome-GBA and make changes in anxiety and depressive behaviors.

4.4. Infection and Gut Inflammation Increase Anxiety-Like Behavior

Many studies have been done using animal models to show that if pathogenic bacteria are present in the GI tract in the absence of systemic immune response, it can lead to an increase in anxiety-like behavior. These studies show the collective impact of infection and stress on the central nervous system (CNS) and point to the fact that commensal gut microbiota is necessary for both spatial and working memory. There are no human-related studies on this topic, but studies done by observing the behavior of animals following infections most times very well represented the human condition in specific instances (Kennedy et al., 2012). In a study, it has been found that mice with *Trichuris muris* (closely related to the human parasite *T. trichiura*) caused GI inflammation and related to increased anxiety-like behavior and hippocampal brain-derived neurotrophic factor (BDNF) alterations. When infected mice were treated with the probiotic *Bifidobacterium longum*, anxiety-like behavior was normalized. In GI inflammatory disease - Colitis, animals treated with dextran sodium sulfate (DSS) show GI inflammation and increased anxiety-like behavior. When *B. longum* probiotic-treated mice use for the same experiment, a reduction of

anxiety-like behavior was observed [75]. There are several studies done with the use of *Citrobacter rodentium*, an infectious agent, to investigate GBA function. This pathogen only makes infections in some strains of mice and caused to increase in anxiety-like behavior (O'mahony et al., 2014). Sub pathogenic infection of enteric *Campylobacter jejuni*, led to the activation of brain regions involved in the processing of GI sensory information in mice and caused increased anxiety-like behavior. There are two more studies done with *C. rodentium* and *C. jejuni*, which showed increased anxiety-like behavior after eight hours of infection, but there was no difference in intestinal inflammation or plasma cytokine levels when compared with control mice (Powley et al., 2008)

4.5. Fecal Microbiota Transplantation

The injection of filtrate stools from a healthy donor to a patient as a cure to heal from a specific disease is known as fecal microbiota transplantation (FMT). It was found that FMT caused improved sexual function in patients with Crohn's disease, and this finding caused a stronger connection between gut microbiota and depression/mood (Griffiths, Calear, Banfield, & Tam, 2009). According to two studies conducted with patients with IBS or other functional gastrointestinal disorders, it was found that fecal microbiota transplantation alleviates depression and anxiety (Huang et al., 2019).

4.6. Diet and Gut Microbiota

According to Schreiner et al. (2019), IBS Patients who are on a vegetarian diet (VD) or gluten-free diet (GFD) have significantly higher depression, anxiety, and symptom levels. Also, this study found that there is a significant difference in gut microbiota composition in IBD patients following a VD or GFD than that of omnivores.

5. FUTURE DIRECTIONS

At present, the role of the microbiome in metabolic and immunologic aspects is well established, and the pathways that indigenous microbes used to modulate neurological function

in health and disease are only now becoming appreciated. The rapid and sustained growth of research needs on the GBA and intestinal microbiome connection can be used to discover new potential therapeutics for numerous stress-related diseases like depression and anxiety, where some causes of those remain challenging to interpret and understand, treatment options are limited and ineffective, and have severe side effects. More broad and highly statistical powered research is needed to increase power to detect the role of imbalance of gut microbiota in mental disorders. Identification of microbial taxa that modulate the GBA axis will be advanced in efforts to explore the nature of the microbial-derived signals and host pathways that influence specific neurophysiological and behavioral alterations during the depression and anxiety conditions. Not only depression and anxiety but understanding the signals that drive neurotransmitter production by intestinal bacteria can provide a foundation for therapies in diseases that are currently treated by pharmacological alteration of neurotransmitter levels such as Parkinson's disease. Many studies today are on animals, and more human-related studies are needed with ideal study conditions such as a large sample of more severely ill, unmedicated patients diagnosed with depression, and assessed for severity by trained clinical researchers using validated instruments. The process of studying the relationship between intestinal microbiota with depression and anxiety-like behaviors is multi-disciplinary, and the service of microbiologists, psychiatrists, neuroscientists, immunologists, and bioinformaticians needs to understand the whole process.

6. CONCLUSION

There is a significant increase in the process of studying and recognizing the connection of microbial GBA with mental illnesses like depression and anxiety. Several findings show that microbiota imbalances in the gut caused alterations in the bidirectional communication of GBA and behavioral changes related to depression and anxiety. Also, much evidence is

there to show the microbial mechanisms linked with generating and preventing those mental disorders. Because of limited human studies, it is not clear which gut microbial taxa are involved in the above diseases. With the development of science shortly, new technologies and tools will allow scientists to understand how imbalances of gut microbiota caused depression and anxiety-like disorders and to develop new drugs, therapies, and treatments to cure those illnesses

REFERENCES

- Allen, R. G., Lafuse, W. P., Galley, J. D., Ali, M. M., Ahmer, B. M., & Bailey, M. T. (2012). The intestinal microbiota are necessary for stressor-induced enhancement of splenic macrophage microbicidal activity. *Brain, behavior, and immunity*, 26(3), 371-382.
- Arumugam, M., Raes, J., Pelletier, E., Paslier, D.L., Yamada, T., Mende, D.R., ... & Bork, P. (2011). Enterotypes of the human gut microbiome. *Nature*, 473(7346), 174-180.
- Bailey, M. T., Dowd, S. E., Galley, J. D., Hufnagle, A. R., Allen, R. G., & Lyte, M. (2011). Exposure to a social stressor alters the structure of the intestinal microbiota: implications for stressor-induced immunomodulation. *Brain, behavior, and immunity*, 25(3), 397-407.
- Bailey, M. T., Dowd, S. E., Parry, N. M., Galley, J. D., Schauer, D. B., & Lyte, M. (2010). Stressor exposure disrupts commensal microbial populations in the intestines and leads to increased colonization by *Citrobacter rodentium*. *Infection and immunity*, 78(4), 1509-1519.
- Bennet, R., Eriksson, M., & Nord, C. E. (2002). The fecal microflora of 1-3-month-old infants during treatment with eight oral antibiotics. *Infection*, 30(3), 158-160.
- Cani, P. D., Bibiloni, R., Knauf, C., Waget, A., Neyrinck, A. M., Delzenne, N. M., & Burcelin, R. (2008). Changes in gut microbiota control metabolic endotoxemia-induced inflammation in high-fat diet-induced obesity and diabetes in mice. *Diabetes*, 57(6), 1470-1481.

- Carabotti, M., Scirocco, A., Maselli, M.A., & Severi, C. (2015). The gut-brain axis: interactions between enteric microbiota, central and enteric nervous systems. *Annals of Gastroenterology*, 28, 203-209.
- Chen, Z., Li, J., Gui, S., Zhou, C., Chen, J., Yang, C., ... & Xie, P. (2018). Comparative metaproteomics analysis shows altered fecal microbiota signatures in patients with major depressive disorder. *Neuroreport*, 29(5), 417-425.
- Cryan, J. F., & O'Mahony, S. M. (2011). The microbiome-gut-brain axis: from bowel to behavior. *Neurogastroenterology & Motility*, 23(3), 187-192.
- Cryan, J. F., Page, M. E., & Lucki, I. (2005). Differential behavioral effects of the antidepressants reboxetine, fluoxetine, and moclobemide in a modified forced swim test following chronic treatment. *Psychopharmacology*, 182(3), 335-344.
- Cui, B., Feng, Q., Wang, H., Wang, M., Peng, Z., Li, P., ... & Zhang, F. (2015). Fecal microbiota transplantation through mid-gut for refractory Crohn's disease: Safety, feasibility, and efficacy trial results. *Journal of gastroenterology and hepatology*, 30(1), 51-58.
- Davidson, A. S., & Fosgerau, C. F. (2014). What is depression? Psychiatrists' and GPs' experiences of diagnosis and the diagnostic process. *International journal of qualitative studies on health and well-being*, 9(1), 24866.
- Dinan, T. G., & Cryan, J. F. (2013). Melancholic microbes: a link between gut microbiota and depression? *Neurogastroenterology & Motility*, 25(9), 713-719.
- Evrensel, A., & Ceylan, M. E. (2015). The gut-brain axis: the missing link in depression. *Clinical Psychopharmacology and Neuroscience*, 13(3), 239.
- Foster, J. A., & Neufeld, K. A. M. (2013). Gut-brain axis: how the microbiome influences anxiety and depression. *Trends in neurosciences*, 36(5), 305-312.
- Greenberg, M. E., Xu, B., Lu, B., & Hempstead, B. L. (2009). New insights in the biology of BDNF synthesis and release: implications in CNS function. *Journal of Neuroscience*, 29(41), 12764-12767.
- Griffiths, K. M., Cascar, A. L., Banfield, M. A., & Tam, A. (2009). Systematic review on Internet Support Groups (ISGs) and depression (2): What is known about depression ISGs?. *Journal of medical Internet research*, 11(3), e1303.
- Huang, H. L., Chen, H. T., Luo, Q. L., Xu, H. M., He, J., Li, Y. Q., ... & Zhou, Y. J. (2019). Relief of irritable bowel syndrome by fecal microbiota transplantation is associated with changes in diversity and composition of the gut microbiota. *Journal of Digestive Diseases*, 20(8), 401-408.
- Jiang, H., Ling, Z., Zhang, Y., Mao, H., Ma, Z., Yin, Y., ... & Ruan, B. (2015). Altered fecal microbiota composition in patients with major depressive disorder. *Brain, behavior, and immunity*, 48, 186-194.
- Kennedy, P. J., Clarke, G., Quigley, E. M., Groeger, J. A., Dinan, T. G., & Cryan, J. F. (2012). Gut memories: towards a cognitive neurobiology of irritable bowel syndrome. *Neuroscience & Biobehavioral Reviews*, 36(1), 310-340.
- Kleiman, S. C., Watson, H. J., Bulik-Sullivan, E. C., Huh, E. Y., Tarantino, L. M., Bulik, C. M., & Carroll, I. M. (2015). The intestinal microbiota in acute anorexia nervosa and during renourishment: relationship to depression, anxiety, and eating disorder psychopathology. *Psychosomatic medicine*, 77(9), 969.
- Logan, A. C., & Katzman, M. (2005). Major depressive disorder: probiotics may be an adjuvant therapy. *Medical hypotheses*, 64(3), 533-538.
- Naseribafrouei, A., Hestad, K., Avershina, E., Sekelja, M., Linløkken, A., Wilson R., & Rudi, K. (2014). Correlation between the human fecal microbiota and depression. *Journal of Neurogastroenterology and Motility*, 26, 1155-1162.
- Neufeld, K. A. M., Kang, N., Bienenstock, J., & Foster, J. A. (2011). Effects of intestinal microbiota on anxiety-like

- behavior. *Communicative & integrative biology*, 4(4), 492-494.
- Neufeld, K. M., Kang, N., Bienenstock, J., & Foster, J. A. (2011). Reduced anxiety-like behavior and central neurochemical change in germ-free mice. *Neurogastroenterology & Motility*, 23(3), 255-e119.
- Neumann, I.D., & Landgraf, R. (2012). Balance of brain oxytocin and vasopressin: implications for anxiety, depression, and social behaviors. *Trends in Neurosciences*, 35(11), 649-659.
- O'mahony, S. M., Felice, V. D., Nally, K., Savignac, H. M., Claesson, M. J., Scully, P., ... & Cryan, J. F. (2014). Disturbance of the gut microbiota in early-life selectively affects visceral pain in adulthood without impacting cognitive or anxiety-related behaviors in male rats. *Neuroscience*, 277, 885-901.
- Powley, T. L., Wang, X. Y., Fox, E. A., Phillips, R. J., Liu, L. W. C., & Huizinga, J. D. (2008). Ultrastructural evidence for communication between intramuscular vagal mechanoreceptors and interstitial cells of Cajal in the rat fundus. *Neurogastroenterology & Motility*, 20(1), 69-79.
- Qin, J., Li, R., Raes, J., Arumugam, M., Burgdorf, K. S., Manichanh, C., ... & Wang, J. (2010). A human gut microbial gene catalogue established by metagenomic sequencing. *nature*, 464(7285), 59-65.
- Rhee, S. H., Pothoulakis, C., & Mayer, E. A. (2009). Principles and clinical implications of the brain-gut-enteric microbiota axis. *Nature reviews Gastroenterology & hepatology*, 6(5), 306-314.
- Riesenfeld, C. S., Schloss, P. D., & Handelsman, J. (2004). Metagenomics: genomic analysis of microbial communities. *Annual review of genetics*, 38(1), 525-552.
- Schreiner, P., Yilmaz, B., Rossel, J. B., Franc, Y., Misselwitz, B., Scharl, M., ... & Swiss IBD Cohort Study Group. (2019). Vegetarian or gluten-free diets in patients with inflammatory bowel disease are associated with lower psychological well-being and a different gut microbiota, but no beneficial effects on the course of the disease. *United European gastroenterology journal*, 7(6), 767-781.
- Severance, E. G., Gressitt, K. L., Stallings, C. R., Origoni, A. E., Khushalani, S., Leweke, F. M., ... & Yolken, R. H. (2013). Discordant patterns of bacterial translocation markers and implications for innate immune imbalances in schizophrenia. *Schizophrenia research*, 148(1-3), 130-137.
- Spielberger, C. D. (2009). State-Trait Anxiety Inventory. In I.B. Weiner & W.E. Craighead (Eds.), *The Corsini Encyclopedia of Psychology*. John Wiley & Sons.
- The Human Microbiome Project Consortium. (2012). Structure, function and diversity of the healthy human microbiome. *NATURE*, 486, 207-214.

Key Problems of Straw Fuel Ethanol

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ABSTRACT

Straw is an agricultural residue that is plenty in quantity and can be a raw material for bioethanol production. Bioconversion of straw to fuel ethanol is becoming a viable avenue to alleviate the energy crisis around the world without jeopardizing food sources for the human race. This work introduces related research and reviews on bioethanol production using straws. The crucial problems of bioconversion were analyzed, which include the pretreatment method of straw material, enzymatic hydrolysis of straw by cellulose, screening, construction of strain, and choosing the fermentation process. To optimize the entire process and enhance productivity, it is important to treat the above-mentioned issues as interrelated. Based on the understanding, the suggestion is that, while the cellulosic ethanol technology is in the development phase, converting fermentable sugar in straw directly to fuel ethanol can be considered a feasible way.

Keywords - straw, fuel ethanol, retreatment, cellulose, fermentation

1. INTRODUCTION

The energy crisis and environmental pollution problems rapidly heat the biofuel ethanol industry. The first generation of biofuel ethanol uses grain as raw material, which will affect food security and feed safety in the long run. In recent years, this production method has been widely questioned. Ethanol production technology has become an inevitable trend of economic and social development.

Crop straw is an important agricultural by-

product and an important cellulose raw material.

It is not only abundant in reserves but also low in cost. It is generally considered one of the most promising biomass energy sources. Sri Lanka has a wide range of straw resources, with an annual straw output of more than 2 million tons. These are used as feed for herbivores and as raw materials for paper, construction, and handicraft industries, but most of them have not been effectively developed and utilized. If the straw can be used reasonably and effectively, it can meet the raw material supply problem in the production of fuel ethanol for several years, and there is no problem of competing with others.

At present, all countries in the world have attached great importance to the use of fermentation to produce fuel ethanol. The Energy Independence and Security Act of 2007, passed in December 2007, requires the United States to produce at least 36 billion gallons of renewable fuel annually by 2022, including cellulosic biomass produced from agricultural waste, straw, wood chips, and grass. Fuel accounts for 16 billion gallons. The American Alternative Energy Technology Center (AETC) announced on February 26, 2008, that it had achieved a breakthrough in cellulosic ethanol, completing the initial design of a plant to esterify lignin into gasoline. The advantage of the know-how of this biodiesel plant is the availability of raw materials such as forestry waste, grass, wood chips, and grain husks. Gen Biotechnology from Canada has the world's largest cellulosic ethanol production line. The company achieved large-scale ethanol production from cellulosic raw materials in 2004, with an annual output of 1 million gallons (3.78 million L), and its raw materials are mainly from wheat, Corn stalks, wind grass, etc. The Japanese government actively promotes the development of cellulosic ethanol technology and has formulated a series of incentive measures. At present, Japan has

established a relatively complete research system

related to cellulose fuel acetone, and has combined the strengths of alcohol associations, companies, and universities to give full play to their respective advantages.

Research on the production of fuel ethanol from straw as raw material has been carried out for more than 20 years worldwide. At present, certain achievements have been made at the pilot level, but there are still cost problems and the industrial production scale has not yet been reached. In October 2007, Henan Tianguan group's annual output of 3000t cellulosic ethanol project was officially put into operation. The Chinese Academy of Engineering built a production line in Shandong for an annual output of 3000t straw fuel ethanol and its comprehensive utilization industrialization demonstration project.

1.1 Key Issues of Straw Cellulosic Ethanol

Most of the straw has a compact structure, and the cellulose in it is highly crystalline and insoluble. It is tightly surrounded by lignin and hemicellulose, which makes the contact area with catalysts or enzymes small and hydrolysis difficult. To use a drill pipe for microbial fermentation to produce ethanol, the complex structure in the dead stalk must be destroyed first so that cellulose, hemicellulose, and lignin are separated, cellulose and hemicellulose are released, and the symbiotic organisms are formed under the action of enzymes. Available six-carbon and five-carbon sugars, which are then processed by microorganisms fermentation produce fuel ethanol. The pretreatment of straw, cellulose hydrolysis, and fermentation process are the key processes involved in the production of fuel ethanol from straw cellulose fermentation.

2. METHOD

2.1 Pretreatment Method of Straw

Good pretreatment can destroy the physical and chemical barriers of straw cell walls so that

cellulose and hemicellulose can fully contact the substrate. There are physical, chemical, physical-chemical, and biological methods. Here are some commonly used preprocessing methods. Dilute Acid Method

Dilute acid has a good hydrolysis effect on straw cellulose, compared with concentrated acid, it can not only improve the reaction rate but also significantly improve the cellulose hydrolysis rate. It is usually carried out under high temperatures and high-pressure conditions. However, when the straw is pretreated with dilute acid hydrolysis, while the hemicellulose is hydrolyzed into mononuclear, some by-products that may affect the subsequent fermentation will also be produced in the hydrolyze. Substances such as acetic acid, formic acid, vanillin, onion and hydroxymethyl aldehyde were detected, and the study showed that various substances affected the growth and metabolism of *Saccharomyces cerevisiae* to varying degrees. The operating cost of the dilute acid pretreatment method is higher than that of steam explosion and other methods, and a large amount of alkali needs to be consumed to neutralize the dilute acid before the subsequent hydrolysis and fermentation, which has a more significant impact on the environment.

2.1.1 Alkali Treatment Method

The mechanism of action of alkaline hydrolysis by carbon treatment is to saponify the points where cellulose and other substances such as lignin in hemicellulose are connected to each other and remove lignin so that the porosity and permeability of the material will continue to increase. It is true that NaOH, KOH, Ca(OH)₂, and ammonia are used more. The hydrolysis method has an obvious effect on crop straws with low lignin content. Pretreated corn stalks with lime, adding

0.075g Ca(OH)₂, and 5g water per gram of biomass, and heating them at 120 °C for 4h. After treatment, the enzymatic hydrolysis capacity of corn Stover was significantly improved compared with that before pretreatment.

Treating straw by adding peroxide under alkaline conditions usually improves a better treatment effect. Used the alkaline peroxidation method for the separation of hemicellulose from wheat straw. The soluble hemicellulose yield was 18.9%

to 26.6% at a temperature of 50 °C and a pH of 12.5, and 2% H₂O for 16h, a higher hemicellulose yield can be obtained. The hydrolysis products of the alkaline peroxidation method are different from those of the traditional alkaline treatment method. The wheat straw was extracted with a 10% concentration of KOH and then bleached. "Extracting wheat straw under salty conditions resulted in higher content of arabinose and glucose in the hemicellulose components. Similar to the dilute acid treatment method, the cost of reagents used in the broken treatment method is relatively high, and the impact on the environment is also relatively large.

2.1.2 Steam Explosion Method

The steam explosion method uses high temperature and high-pressure steam through diffusion, penetrates and does not wet the cell wall of the wood fibre, and then rapidly decompresses the raw material, causing the burst of cellulose crystals and fibre bundles so that the lignin and cellulose are separated. Pretreatment time and temperature are the main factors affecting steam explosion.

Pretreated wheat straw was exploded by steam explosion method, the pretreatment temperature was 190 °C and 210 °C, and the residence time was 2 min, 4 min and 8 min, respectively, and studied the effect of different pretreatment conditions on the yield of wheat straw, Hemicellulose fraction, cellulose recovery, and enzymatic hydrolysis yield of cellulose. The results showed that under the pretreatment conditions of 190°C and residence time of 2 min, the yield of steam-exploded wheat straw and the recovery of cellulose was the highest, reaching 81.2% and 58.4%, respectively. Under the treatment conditions, the degree of fibre separation of the steam-exploded wheat straw was the best, and the enzymatic hydrolysis rate of cellulose was the

highest, reaching 73.2%. However, the steam explosion method consumes less energy and has less impact on the environment. These inhibitory substances should be removed by washing before the process, and the loss of sugar will inevitably be caused during the washing process.

Wet Oxidation Method

The wet oxidation method was proposed in the 1980s, and under the conditions, water and oxygen participate in the reaction together, and the treated material can enhance the sensitivity to enzymatic hydrolysis. Investigated the process conditions for the separation of hemicellulose, cellulose and lignin from wheat straw using a wet oxidation process under alkaline conditions. At higher temperatures and longer reaction times, 69% of the pure cellulose fraction was efficiently converted to glucose. At 185°C, the hemicellulose produced was approximately three times that at 150°C. Applied the alkaline wet oxidation to the pretreatment of wheat straw, resulting in hemicellulose-rich hydrolyzes and a cellulose-rich solid fraction. When fermented with the high-temperature anaerobic bacteria, the wet oxidative treated wheat straw hydrolyzes did not inhibit bacterial growth and ethanol production.

2.1.3 Biological Pretreatment Method

The biological pretreatment method uses fungal microorganisms to treat lignin and hemicellulose. The most commonly used microorganisms are brown, white and soft rot fungi. Brown rot fungi mainly degrade cellulose, while white rot fungi mainly degrade lignin and cellulose. The advantages of biological treatment are low energy consumption and environmental friendliness, but slow degradation has disadvantages.

2.1.4 Combined Treatment Method

Due to the shortcomings of various pretreatment methods, many people are now committed to combining two or more pretreatment methods to obtain better treatment effects. One of the tests used the combined pretreatment process of

ultrasonic and alkali to treat corn stalks. The results showed that ultrasonic wave was beneficial to strengthening straw NM treatment, and the reducing sugar yield was significantly higher than that of alkali pretreatment alone. Considering the experimental effect, when 0.5% NaOH is used, the ultrasonic power is 480W, and the treatment time is 30 min, a better treatment effect can be achieved.

Attempt to treat the cork raw material treated by steam explosion method with alkali extraction method, hoping to remove the lignin in the pretreatment liquid, so as to improve the efficiency of enzymatic hydrolysis in the later stage. They used NaOH, ammonia water and lime to extract the lignin in the cork after steam explosion treatment respectively. However, the sensitivity of the treated raw materials to enzymes decreased with the increase in the lignin removal rate. The ethanol yield of the NaOH- treated raw materials was not significantly different from that of the non-alkali-treated materials, while the ethanol yields of the ammonia and lime-treated materials were higher.

2.2 Cellulose Hydrolysis

The pretreated straw material needs to undergo further scarification and hydrolysis to become monosaccharides that microorganisms can utilize. Commonly used hydrolysis methods include acid hydrolysis and enzymatic hydrolysis. Acid hydrolysis process conditions are harsh and corrosive to equipment, while enzymatic hydrolysis conditions are mild, which is the direction of future development. Celluloses used in cellulosic ethanol fermentation include endoglycanase (ED), cellobiohydrolase (CBH), and B-glucosidase (GL). At present, cellulose accounts for 30%-60% of the production cost of cellulosic ethanol. Therefore, to realize the large-scale production of straw cellulosic fuel ethanol, the production cost of the enzyme must be reduced first. Researchers from all over the world have conducted a lot of research, mainly on breeding high-yielding strains and optimizing the fermentation process, thereby increasing cellulose

production and activity. Among them, gene recombinant and location mutation are considered the most efficient way.

2.3 Bacteria and Technology

2.3.1 Bacteria

To use straw hydrolyze as a substrate for fermentation to produce ethanol, it is necessary to select ridges or construct microorganisms that can metabolize five-carbon and six-carbon sugars at the same time, and at the same time, microorganisms are required to have a certain resistance to inhibitors. Many researchers at home and abroad have devoted themselves to the construction of microbial strains that can metabolize pentose and hexanol simultaneously and have explored the fermentation process of recombinant strains. Among them, the most studied strains are *Saccharomyces cerevisiae* and *Bacillus mobilis*.

Generally, *Saccharomyces cerevisiae* can only metabolize hexoses such as glucose. If the genes encoding the key enzymes xylose reductase (XR) and xylitol dehydrogenase (XDH) in the metabolic pathway of xylose are transferred into *Saccharomyces cerevisiae* through genetic engineering operations. The intracellular expression can make *Saccharomyces cerevisiae* share the ability to metabolize both glucose and xylose at the same time. However, due to the shortcomings of excessive secretion of xylitol and low ethanol yield of recombinant strains, it has not been applied in industry. Researcher's believed that the secretion of xylitol was caused by the imbalance of reducing power caused by the different coenzyme factors of XR and XDH in stem cells, so they used protein engineering methods to construct an efficient biomass ethanol conversion system. And through the introduction.

However, the secretion of xylitol was reduced, and the strains constructed by it had a maximum ethanol yield of 5.94 g/L in the mixed fermentation with glucose and xylose concentrations of 15 g/L and 5 g/L, respectively, to reduce the secretion of

xylitol. Controlled the metabolic process by optimizing the ratio of XR/XDH in the xylitol.

The IOGEN Company in Canada, in cooperation with the University of Toronto, has studied the C6/C5 co-fermentation behaviour of a recombinant *Bacillus mobilis*". The substrates used are mainly agricultural wastes such as corn cob and wheat straw. The recombinant *Bacillus mobilis* AX101 was treated with D - Xylose and L-arabinose as central carbon sources and can ferment these pentose sugars to produce ethanol. Since the arabinose gene of *E. coli* is inserted into the gene segment of D-lactate dehydrogenase of the host chromosome, AX101, acetic acid production was very low. In this work, a mixture containing glucose 6% (w/z), water sugar 3% and arabinose 0.35% were used to simulate biomass hydrolysate, additionally, 3g/L corn steep liquor and Inorganic nitrogen (0.8 g/L NH₄ Cl or 1.2 g/L (NH₄)HPO₄) were supplemented as nitrogen source. In the absence of acetic acid and pH 5.0, the maximum ethanol production capacity of continuous fermentation was 3.54 g/(L.h), and the sugar alcohol conversion rate was maintained above 85%.

2.3.2 Fermentation Process

Various fermentation processes used in the fermentation of starchy raw materials have also been widely studied in the fermentation process with hydrolyzate as the substrate, such as immobilized fermentation, SSF (simultaneous saccharification fermentation process), and so on. Used glucose and xylose in the hydrolyzate of corn stover as substrates to compare the immobilized cell fermentation and free cell fermentation of recombinant *Saccharomyces cerevisiae* ZU-10. The fermentation was performed at 30 °C and pH 5.5 for 80 g/L: xylose, the fermentation period of free cells was 96 h, and the ethanol yield was 0.37. After the cells were immobilized, the fermentation period was shortened to 60 h, and the ethanol yield was increased to 0.4. Compared with free cells, the tolerance of immobilized cells to acetic acid was significantly enhanced, and the effect of acetic acid on xylose fermentation was small when the

mass concentration was lower than 1.2 g/L. Using immobilized recombinant yeast to ferment the glucose and xylose in the corn stover hydrolyzate, 65.0 g/L glucose and 27.0 g/L ethanol were completely utilized within 36 h to generate 36.9 g/L ethanol. The ethanol yield of glucose and xylose is 0.40.

In the system using recombinant *Saccharomyces cerevisiae* for xylose and glucose fermentation, since the utilization rate of glucose is about 200 times that of xylose, glucose inhibits the absorption of xylose by bacteria, so to obtain higher ethanol production, it is necessary to control the Concentration of glucose. Hope to control glucose concentration in the fermentation system by adopting the SSF (simultaneous saccharification and fermentation) process. Experiments show that in the SSF process, for the hydrolyzate with the insoluble matter (WIS) concentration of 9%, the feed-feed fermentation mode of ethanol is used. SSF process, for the hydrolyzate with the insoluble matter (WIS) concentration of 9%, the feed-feed fermentation mode of ethanol is used. The ethanol yield reached 71% of the theoretical conversion rate, while the batch fermentation process was only 59%; when the WIS concentration was 7%, the ethanol yield of the fed-feed fermentation mode was close to 80% of the theoretical conversion rate. In addition, this study showed that the optimal fermentation temperature of the SSF process was 34°C when glucose and xylose were fermented together.

3. Relationship between key issues

There is a complex relationship among the three key issues faced by straw-based fuel ethanol. The hydrolysis effect of cellulose has an important relationship with the pretreatment method used in the raw materials. Different cellulases have different adaptability to the pretreatment method, which has also become an aspect that needs to be considered when selecting a pretreatment method. The purpose of pretreatment is to destroy the dense structure of straw, but attention should be paid to controlling the degree of energy input. If the energy input is too much, it will cause excessive

degradation, produce a large number of inhibitory substances, and affect the effect of later fermentation. At the same time, when choosing the fermentation process, the difference in the composition of the feed liquid produced by different pretreatment methods and enzymatic hydrolysis conditions should also be considered. Therefore, pretreatment, enzymatic hydrolysis, and fermentation should be regarded as an interrelated whole in the research, and strive to achieve overall process optimization and yield improvement.

4. CONCLUSION

In today's society, where the energy crisis is becoming more and more serious, and the production of fuel ethanol from food crops may endanger food security, the production of fuel ethanol using cellulose raw materials such as straw is considered to be the most promising fuel for ethanol. It is one of the production methods, which is conducive to the sustainable development of our country's economy and has extremely far-reaching social, economic, and environmental benefits. However, due to the limitations of the pretreatment effect and cost, as well as the selection and breeding of excellent fermentation strains, it is difficult for the producers of fuel ethanol to directly use the cellulose components of straw to reach the industrialized level. As a transition period from grain fuel ethanol to cellulosic fuel ethanol, it is feasible to use the fermentable essence in the stalk with high sugar content, such as sweet sorghum to produce fuel ethanol, and it is worthy of in-depth research and promotion.

REFERENCES

- Ralph P-Overend. Biomass, bio-energy, and biotechnology: a futuristic perspective [M]. New York and London. : Bio-mass Energy Development, Plenum Press, 1985; 116.
- Bian Bingxin, Zhao Youcai, Treatment and Comprehensive Utilization of Agricultural Solid Waste [M]. Beijing: Chemical Industry Press, 2005.
- Chen Yunzuo, Chen Fang, Wang Chunming, Bulletin of Dynamic Monitoring of Scientific Research - Advanced Industrial Biotechnology Special Issue [Sichuan: National Science Library of Chinese Academy of Sciences, 2008, 387.
- Kaar WR, Holtzaple MT. Using lime pretreatment to facilitate the enzymic hydrolysis of corn stover [J]. Biomass and Bioenergy, 2000, 18 (3) :189-199.
- Fang JM, San R C, Salisbury D, et al. Comparative study of hemicelluloses from wheat straw by alkali and hydrogen peroxide extractions [J]. Polym Degrad Stab, 1999, 66:
- Schell D, Nguyen Q. Tucker M, et al. Pretreatment of softwood by acid-catalyzed steam explosion followed by alkali extraction [J]. Applied Biochemistry and Biotechnology, 1998, 70-72(1):17-24.
- Kataeval, Li X L, Chen H Z, et al. Cloning and sequence analysis of new cellulase gene encoding CelK, a major cellulosome component of *Clostridium thermoceUum*, evidence for gene duplication and recombination [J].Journal of Bacteriology, 1999, 181(17);5288-5295.
- Li X L, Calza R E. Fractionation of cellulases from the ruminal fungus *Neocallimastixfrontalis* EB188[J]. Applied and Environmental Microbiology, 1991, 57(11): 3331

- Laopaiboon L. Thanonken P. Jaisi P, et al.
Ethanol production from sweet sorghum juice in batch and fed-batch fermentations by *Saccharomyces cerevisiae* [J]. World Journal of Microbiology and Biotechnology, 2007, 23(10):1497-1501.
- Kuyper M, Torkena MJ, Diderich JA, et al.
Evolutionary engineering of mixed-sugar utilization by a xylose-fermenting *Saccharomyces cerevisiae* strain [J]. FEMS Yeast Research, 5(10) 925-934.



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Remodeling the Cancer Angiogenesis by Nanoparticles: A novel approach to Cancer Treatment

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ABSTRACT

Cancer is one of the most life-threatening as well as deadly diseases with uncontrolled, uncoordinated cell division. Neoplasm is a mass of tumor cells that are not invasive but after it becomes malignant form, it is exceedingly difficult to eradicate. Cancer causation is mainly due to several factors such as genetic, occupational, way of life, chemical carcinogens, different artificial food additives, toxins, chronic infections of many pathogens, and other environmental factors. Notwithstanding, there is a massive range of cancer therapies, due to the many obstacles and resistance of the tumor cells it could not be able to get an efficient outcome. In past decades most of those therapies were focused on tumor cells alone. However, many documentations undoubtedly have shown that the tumor microenvironment has a greater influence on this complex localized disease. The tumor microenvironment consists of an enormous range of cells and non-cellular components. As a profitable nature, numerous studies have experimentally shown the efficiency of nanotechnology-based cancer therapies. The remodeling of the cancer microenvironment by nanoparticles (NP) is one efficacious strategy for the treatment of cancer. Most of them have shown enormous outcomes in-vivo and some of them are under preclinical trials. This review mainly focuses on a novel treatment that is associated with NP by targeting the remodeling angiogenesis of the tumor. Angiogenesis is the process of the emergence of new blood vessels from early blood vessels and it plays a major role in the pathologic and physiologic processes of cancer development. Therefore, the main

objective of this review is the identification of strategies for cancer treatment mainly focusing on angiogenesis of the tumor microenvironment.

1. WHAT IS CANCER?

Cancer is the most dangerous life-threatening disease, which causes millions of deaths per year. Most cancers are masses of cells, which are known as solid tumors with uncontrolled, uncoordinated cell division, unlike normal cells (Rahany, 1991). Nevertheless, blood cancers like leukemia are not solid tumors. Malignant and benign tumors are two types of tumors. Benign tumors are not invasive and by removing those masses of cells they can get a complete cure. However, malignant tumors are invasive and spread all over the body, and it is cancer (Kauffman, 1971).

1.1 CANCER MICROENVIRONMENT

According to the National Cancer Institute (NCI), Tumor Microenvironment (TME) means the normal cells, molecules, and blood vessels, which are surrounding the tumor cells and affect tumorigenesis. T lymphocytes, B-lymphocytes, tumor-associated macrophages, neutrophils, fibroblasts, Natural Killer cells (NK cells), Natural Killer T cells (NKT cells), myeloid-derived suppressor cells, dendritic cells, adipocytes, and pericytes are some of the cells that are common in TME (Balkwill et al, 2012). Collagen, proteoglycans, laminin, and fibronectin are some non-cellular components that give both biochemical and structural support for tumor progression and those are considered

as extracellular matrix (ECM) of the tumor (Walker et al, 2018) (Figure 1).

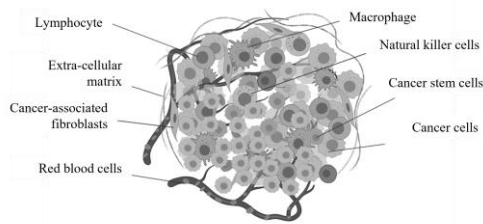


Figure 1. Components of the tumor microenvironment (Hassan and Seno, 2020).

The survival and growth of tumors require the blood and lymphatic vascular system with Oxygen and other sustenance as well as the removal of Carbon Dioxide. Angiogenesis is the process of the formation of new blood vessels from the existing ones, and they promote tumor growth and malignancy. (Bock et al, 2011).

2. ANGIOGENESIS

Angiogenesis is a remarkable series of actions of the establishment of new blood vessels from the previous vasculature and this key feature is very common in tissue repairing, development, reassembling of interior layers of the uterus after the menstrual cycle of females and in one of the deadliest diseases, Cancer (Otrock et al, 2007).

A tumor cell gradually develops up to a diameter of 2–3 mm by nourishments provided by existing blood vessels. For survival and proliferation, oxygen and nutrients are the main factors required by cancer cells. (Weis and Cheresh, 2011). Therefore, the vasculature system must have accessibility to tumor cells to provide the required components. According to many studies, tumor cell samples from patients with initial stages of cancer are less vascularized than those from patients with malignant tumors (Lugano et al, 2020). The angiogenic switch is always active during the process of tumorigenesis (Hanahan, and Folkman, 1996). In the report by Lugano et al. (2020), the Angiogenic switch is the crucial point of initiation of vascularization of tumor cells.

2.1 TUMOR VASCULATURE & PROANGIOGENIC AND ANTIANGIOGENIC FACTORS

The blood circulation system of cancer is comprised of both cellular and non-cellular components such as arteries, aorta, veins, and capillaries with the overall function of the vascular system by supplying nutrients and removing wastes from tumor cells. Tumor vessels are mal-shaped, irregular, leaky, and tortuous in nature.

Tumor angiogenesis is initiated by an anagenesis switch which is upregulated by the balance between two key factors, proangiogenic and antiangiogenic factors (Bergers and Benjamin, 2003). The formation of new vasculature results from the action of proangiogenic factors overpowering the antiangiogenic factors. Among the proangiogenic factors, Vascular endothelial growth factor (VEGF), epidermal growth factor (EGF), interleukin 8 (IL-8), basic fibroblast-like growth factor (bFGF), and transforming growth factor β (TGF- β) are playing a vital role in tumor angiogenesis and those are fundamental targets of cancer treatments (Ferrara and Kerbel, 2005). Thrombospondin-1 and Endostatin/angiostatin, like antiangiogenic molecules, upregulate angiogenesis by maintaining the balance of two key molecules (Tonini et al, 2003).

REMODELING THE CANCER ANGIOGENESIS BY NANOPARTICLES

The vascular system of cancer is one of the key points responsible for its progression. Due to this profound impact, the remodeling of cancer angiogenesis became a modern target of cancer treatment. Due to the limitations and side effects of other conventional methods, nanotechnology-based methods have become prominent at an alarming rate nowadays. The remodeling of the cancer angiogenesis can be done by using different approaches by remodeling the vasculature (by disrupting the vessels or normalization) using NP (Chen et al, 2018) (Figure 2).

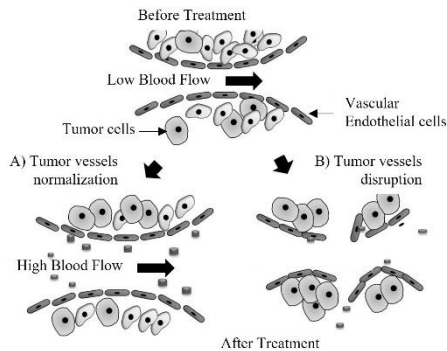


Figure 2. Schematic illustration of remodeling of Tumor vessel using Nanoparticles. A; Tumor Vessel Normalization; B; Tumor Vessel Disruption. In the tumor vessel normalization, it increases the blood flow within the tumor. Leaky, heterogeneous blood vessels also can be removed by disrupting those.

Due to the abnormal tumor vessels providing sufficient nutrients for the development of tumors, disrupting those can lead to necrosis and apoptosis (Ojha et al, 2017). In addition, there are many advantages to targeting the tumor vasculature than the other cells in cancer. Among them, have a greater effect on tumor development, no risk of further resistance due to the stability of the extracellular matrix (Jahanban-Esfahlan et al, 2007). As an example, a type of NP that is a near-infrared laser-activated nano bomb has been used for tumor vascular disruption (Gao et al, 2017). In this strategy, the vinyl azide is used as a bubble generator that produces nitrogen (N_2) and amide and after the Red-to-near-infrared irradiation, it would lead to the burst of N_2 bubbles due to the temperature increases. Therefore, finally, it would be led to vascular disruption and necrosis (Gao et al, 2017).

In addition to that, PEGylated gold NP has been modified by using both tumor neo-vasculature-targeting ligand (RGD) and the AF647 imaging dye for disruption of the vasculature (Kunjachan et al, 2015). This approach was done by targeting the $\alpha_v\beta_3$ integrin receptors followed by irradiation and according to the results of this study, clearly showed that the tumor vasculature disruption by changing the morphology compared to the intact vessels in the control tumor sample. Tumor-associated platelets

(TAPs) are also an important parameter to maintain the tumor vasculature. Thereby disruption of these TAPs by NP is another highly effective treatment for cancer (Chen et al, 2018).

Furthermore, tumor vasculature can be inhibited or normalized by targeting the various types of agents. A major target for tumor vasculature is inhibitors of the Angiogenic growth factors. One of the most important Angiogenic growth factors in cancers is vascular endothelial growth factor (VEGF), which is encoded by the VEGF gene (Paradowska-Gorycka et al, 2016). The expression of VEGF is extremely high in most tumors, and it is induced by the hypoxia-inducible factor-1 (HIF-1) at the transcriptional level (Shi, and Fang, 2004). In addition to that oncogenes like *ras* are also responsible for the upregulation of the VEGF (Rak et al, 1995). Therefore, basic fibroblast growth factor (bFGF), and transforming growth factor- β (TGF β) are the main targets of cancer therapies as much as VEGF. Moreover, many methods that disrupt the function of these factors are used with the combination of nanotechnology (Jahanban-Esfahlan et al 2007). As an example, one of the studies (Lai, et al 2016), has suggested a method to use bovine serum albumin-capped graphene oxide (BSA-GO) NPs to inhibit the function of VEGF-A through the high-affinity ultra-strong binding. This study also experimentally proven that BSA-GO has a greater influence on the inhibition of the chick chorioallantoic membranes (CAM) and rabbit corneal neovascularization.

Nanocarriers of emodin-loaded magnesium silicate hollow can also have the ability to prevent angiogenesis by targeting VEGF (Ren et al, 2014). Emodin has disrupted angiogenesis by inhibiting VEGF-A by blocking the phosphorylation of VEGF-A receptor 2 (KDR/Flk-1) (Kwak et al, 2006). According to the mRNA expression in the previous study, they clearly have proven the effectiveness of the use of emodin with nanocarriers in both transcriptional and translational levels than the user of the emodin alone. Triamcinolone is an agent that blocks the IL-6 or VEGF-dependent vascularization by blocking the expression of

signal transduction activator 3 (Ebrahim et al, 2006).

Small interfering RNA (siRNA) is the type of double-stranded RNA commonly used for gene silencing (Dana et al, 2016). The mechanism of siRNA involves multiple steps. Here, the first RNA molecules are cleaved into the siRNA by the enzyme called Dicer. Then they form a complex called RNA-induced silencing complex (RISC) and finally silence the targeted mRNA (Dana et al, 2017). Due to the many limitations in siRNA transport, siRNA conjugated with NPS is commonly used to treat cancer. According to the study done by He et al (2009), lymphomagenesis and progression of colorectal cancer could be inhibited by the use of VEGF-C siRNA transported throughout the calcium carbonate NPs. Here NPs with siRNA could effectively silence the VEGF-C factor. PEG conjugated with the siRNA also has the ability to silence the gene encoding for VEGF (Kim et al, 2006).

Also, a type of another growth factor, bFGF is a target of different types of NPS, and Long et al (2011), have suggested a method by using poly (ϵ -caprolactone)-poly (ethylene glycol)-poly(ϵ -caprolactone) NPs which encapsulated with bFGF and those have been efficiently suppressed the angiogenesis *in vivo*. The dual system of doxorubicin/ methotrexate (DOX-MTX) with cationic mesoporous silica NPS is used to inhibit the action of growth factors. Some of the NPs are targeted, receptors of the pro-Angiogenic factors like tyrosine receptor kinase receptors, sorafenib, imatinib, TGF- β inhibitor, FGFR1/ErK/AKT activation, and VEGFR2 (Flk-1) (Jahanban-Esfahlan et al 2007).

Other common types of therapies that are combined with nanotechnology to inhibit angiogenesis can be categorized into three types targeting the signaling pathways, tumor endothelial markers, or using vascular disrupting agents. The phosphatidylinositol 3-kinase (PI3K/ AKT/mammalian target of rapamycin (mTOR) signaling pathway (PI3K/AKT/mTOR) is one of the major pathways in most common types of human cancers which leads to both HIF-

1 dependent and independent secretion of VEGF (Karar and Maity, 2011). One study done by Harfouche et al (2009), has proven that PI3K inhibitor-loaded NPs can inhibit tumor vascularization by targeting the PI3K pathway. By using the inhibition of mTOR by using NPs angiogenesis can be inhibited and polyamidoamine dendrimers, albumin-bound NPs, Nano-SiO₂, Amine-functionalized polystyrene NPs (PS-NH₂), functionalized single-walled carbon nanotubes (f-SWCNTs), magnetic NPs, zinc oxide NPs, SF16 peptide modified hydrogels are many NPs that can be used to inhibit or remodel the PI3K/AKT/mTOR pathway (Serej et al, 2018).

The main tumor suppressor gene TP53 is encoded for the protein p53 and is mutated in most types of human cancers. The p53 also promotes the VEGF expression, leading to angiogenesis. As p53 is a major target for cancer therapy, Sharma et al (2011), have synthesized an NP-based gene vector and it has led to the reduction of tumor growth.

Tumor vessel normalization is another strategy to treat cancer and it will lead to regular blood flow, oxygen transportation and facilitate the drug delivery to the correct place (Chen et al, 2018). Li et al (2016), has been suggested a novel method by using the recombinant human endostatin (Endostar/rhES) associated with gold NPs to mediate the targeted drug delivery to normalize the tumor vessels. In this study use of these NPs to treat mice with H22 tumors has proven vessel normalization. So far tumor vessels can be disrupted by either normalization or disruption of them.

3. CONCLUSION

Most of the therapies that have been used in the past centuries, mainly focus on tumor cells. But most of the evidence has been experimentally shown that tumor angiogenesis has an immeasurable influence on tumor growth, progression, and metastasis. For that reason, many scientists have tried to develop a variety of treatment methods by normalization or disruption of tumor vessels by NPs and most of

these methods are under pre-clinical trials and they have shown tremendous outcomes *in-vivo*. Therefore, finally, it can clearly be said that remodeling angiogenesis by using nanoparticles is a very efficient method for the treatment of cancer.

REFERENCES

- Balkwill, F.R., Capasso, M., & Hagemann, T. (2012). Tumor microenvironment at a glance. *Journal of cell science*. vol. 125, pp. 5591-5596.
- Bergers, G. & Benjamin, L.E. (2003) Tumorigenesis and the angiogenic switch. *Nature Reviews Cancer*. vol. 3, pp. 401–410.
- Bock, K.D., Cauwenberghs, S., & Carmeliet, P. (2011). Vessel abnormalization: another hallmark of cancer? Molecular mechanisms and therapeutic implications. *Current Opinion in Genetics & Development*. vol. 21, pp. 73-79.
- Chen, Q., Liu, G., Liu, S., Su, H., Wang, Y., Li, J. & Luo, C. (2018). Remodeling the tumor microenvironment with Emerging Nano therapeutics. *Trends in Pharmacological Sciences*. vol. 39, pp. 59-74.
- Dana, H., Chalbatani, G.M., Mahmoodzadeh, H., Karimloo, R., Rezaiean, O., Moradzadeh, A., Mehmandoost, N., Moazzen, F., Mazraeh, A., Marmari, V., Ebrahimi, M.A., Rashno, M., Abadi, S.J., & Gharagouzlo, E. (2017). Molecular Mechanisms and Biological Functions of siRNA. *International Journal of Biomedical Science* vol. 13, pp. 48 - 57.
- Ebrahim, Q., Minamoto, A., Hoppe, G., Anand-Apte, B., & Sears, J.E. (2006). Triamcinolone Acetonide Inhibits IL-6– and VEGF-Induced Angiogenesis Downstream of the IL-6 and VEGF Receptor. *Investigative Ophthalmology & Visual Science*. vol. 47, pp. 4395-4941.
- Ferrara, N., Kerbel, R.S. (2005). Angiogenesis as a therapeutic target. *Nature*. vol. 438, pp. 967–974.
- Gao, W., Li, S., Liu, Z., Sun, Y., Cao, W., Tong, L., Cui, G. & Tang, B. (2017). Targeting and destroying tumor vasculature with a near-infrared laser-activated “nanobomb” for efficient tumor ablation. *Biomaterials*. Vol. 139, pp. 1-11.
- Hanahan, D., & Folkman, J. (1996). Patterns and Emerging Mechanisms of the Angiogenic Switch during Tumorigenesis. *Cell*. Vol. 86, pp. 353-364.
- Harfouche, R., Basu, S., Soni, S., Hentschel, D.M., Mashelkar, R.A., & Sengupta, S. (2009). Nanoparticle-mediated targeting of phosphatidylinositol-3-kinase signaling inhibits angiogenesis. *Angiogenesis*. Vol. 12, pp. 325-338.
- Hassan, G., & Seno, M. (2020). Blood and Cancer: Cancer Stem Cells as origin of Hematopoietic cells in solid Tumor Microenvironment. *Cells*. vol. 9, pp. 1293.
- He, X.W., Liu, T., Xiao, Y., Feng, Y.C., Cheng, D.J., Tingting, G., Zhang, L., Zhang, Y., Chen, Y., Tingting, G., & Zhang, L. (2009). Vascular Endothelial Growth Factor-C siRNA Delivered via Calcium Carbonate Nanoparticle Effectively Inhibits Lymphangiogenesis and Growth of Colorectal Cancer In Vivo. *Cancer Biotherapy and Radiopharmaceuticals*. Vol. 24, pp. 249-259.
- Jahanban-Esfahlan, R., Seidi, K., Banimohamad-Shotorbani, B., Jahanban-Esfahlan, A., & Yousefi, B. (2007). Combination of nanotechnology with vascular targeting agents for effective cancer therapy. *Journal of Cellular Physiology*. Vol. 233, pp. 2982-2992
- Karar, J., & Maity, A. (2011). PI3K/AKT/mTOR pathway in angiogenesis. *Frontiers in Molecular Neuroscience*. vol. 4, pp. 1-8.
- Kauffman, S. (1971). Differentiation of malignant to benign cells. *Journal of Theoretical Biology*. 1971; vol. 31, pp. 429-451.
- Kim, S.H., Jeong, J.H., Lee, S.H., Kim, S.W., & Park, T.G. (2006). PEG conjugated VEGF siRNA for anti-angiogenic gene therapy. *Journal of Controlled Release*. Vol. 116. pp.123–129.
- Kunjachan, S., Detappe, A., Kumar, R., Ireland, T., Cameron, L., Biancur, D.E., Motto-Ros, V., Sancey, L., Sridhar, S., Makrigiorgos, G.M., Berbeco, R.I. (2015). Nanoparticle Mediated Tumor Vascular Disruption: A

- Novel Strategy in Radiation Therapy. *Nano letters*. vol. 15, pp. 7488-7496.
- Kwak, H.J., Park, M.J., Park, C.M., Moon, S.I., Yoo, D.H., Lee, H.C., Shin, W.S., Park, I.C., Rhee, C.H., & Hong, S.I. (2006). Emodin inhibits vascular endothelial growth factor-A-induced angiogenesis by blocking receptor-2 (KDR/Flk-1) phosphorylation. *International Journal of Cancer*. vol. 118, pp. 2711-2720.
- Lai, P.X., Chen, C.W., Wei, S.C., Lin, T.Y., Jian, H.J., Lai, I.P., Mao, J.Y., Hsu, P.H., Lin, H.J., Tzou, W.S., Chen, S.Y., Harroun, S.G., Lai, J.Y., & Huang, C.C. (2016). Ultrasrong trapping of VEGF by graphene oxide: Anti-angiogenesis applications. *Biomaterials*. vol. 109, pp. 12-22.
- Li, W., Zhao, X., Du, B., Li, X., Liu, S., Yang, X. Y., Ding, H., Yang, W., Pan, F., Wu, X., Qin, L., & Pan, Y. (2016). Gold Nanoparticle-Mediated Targeted Delivery of Recombinant Human Endostatin Normalizes Tumour Vasculature and Improves Cancer Therapy. *Scientific reports*. Vol. 6, pp. 30619.
- Lugano, R., Ramachandran, M., & Dimberg. (2020). Tumor angiogenesis: causes, consequences, challenges and opportunities. *Cellular and Molecular Life Sciences*. vol.77, pp. 1745- 1770.
- Ojha, T., Pathak, V., Shi, Y., Hennink, W.E., Moonen, C.T.W., Storm, G., Kiessling, F., & Lammers, T. (2017). Pharmacological and Physical Vessel Modulation Strategies to Improve EPR-mediated Drug Targeting to Tumors. *Advanced Drug Delivery Reviews*. Vol. 119, pp. 44-60.
- Otrock, Z.K., Mahfouz, R.A.R., Makarem, J.A., & Shamseddine, A.I. (2007). Understanding the biology of angiogenesis: Review of the most important molecular mechanisms. *Blood Cells. Molecules, and Diseases*. vol. 39, pp. 212-220.
- Paradowska-Gorycka, A., Pawlik, A., Romanowska-Prochnicka, K., Haladyj, E., Malinowski, D., Stypinska, B., Manczak, M., & Olesinska, M. (2016). Relationship between VEGF gene Polymorphisms and Serum VEGF Protein Levels in patients with Rheumatoid Arthritis. *PloS One*. Vol. 11, pp. 1-17.
- Rahany, E.H. (1991). Molecular Genetics in Cancer. *Western Journal of Emergency Medicine*. vol. 155, pp. 544-546.
- Rak, J., Mitsushashi, Y., Bayko, L., Filmus, J., Shirawasa, S., Sasazuki, T., & Kerbel, R. (1995). Mutant ras Oncogenes Upregulate VEGF/VPF Expression: Implications for Induction and Inhibition of Tumor Angiogenesis. *Cancer Research*. Vol. 55, pp. 4575-4580.
- Ren, H., Zhu, C., Zhaohui, L., Wei, Y., & Song, E. (2014). Article Emodin-Loaded Magnesium Silicate Hollow Nanocarriers for Anti-Angiogenesis Treatment through Inhibiting VEGF. *International Journal of Molecular Sciences*. vol. 15, pp. 16936-16948.
- Serej, F.A., Pourhassan-Moghaddam, M., Kalan, M.E., Mehdipour, A., & Serej, Z.A. (2018). Targeting the PI3K/Akt/mTOR Signaling Pathway: Applications of Nanotechnology. *Crescent Journal of Medical and Biological Sciences*. vol. 5, pp. 7-13.
- Sharma, B., Ma, W., Adjei, I.M., Panyam, J., Dimitrijevic, S., & Labhasetwa, V. (2011). Nanoparticle-mediated p53 gene therapy for tumor inhibition. *Drug Delivery and Translational Research*. Vol. 1, pp. 43-52.
- Shi, Y.H., & Fang, W.G. (2004). Hypoxia-inducible factor-1 in tumor angiogenesis. *World Journal of Gastroenterology*. vol. 10, pp. 1082-1087.
- Tonini, T., Rossi, F., & Claudio, P.P. (2003). Molecular basis of angiogenesis and cancer. *Oncogene*. Vol. 22, pp. 6549–6556.
- Walker, C., Mojares, E., & del Río Hernández, A. (2018). Role of extracellular matrix in development and cancer progression. *International Journal of Molecular Sciences*. vol. 19, pp. 3028.
- Weis, S.M., & Cheresh, D.A. (2011). Tumor angiogenesis: molecular pathways and therapeutic targets. *Nature Medicine*. vol.17, pp. 1359-1370.

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Glutathione Encapsulated Liposomes for Efficient Delivery in Pharmaceutical and Cosmeceutical Products

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ABSTRACT

The present study focuses on a simple yet effective approach to synthesizing glutathione (GSH) encapsulated liposomes and further discusses its potential applications of it. The modified ethanol injection method and the reverse-phased evaporation method were performed to find a suitable method of synthesis. Characterization techniques such as High-Performance Liquid Chromatography (HPLC) and the Particle Size Analyzer (PSA) were utilized for the verification of glutathione encapsulation and to identify the average particle size and the Polydispersity Index (PDI), as these factors play a main role in the efficacy of different applications. The results obtained report the encapsulation of glutathione and a particle size of 86.14 nm and PDI of 0.132 suggesting the formation of small unilamellar vesicles (SUVs) containing glutathione.

Keywords: *Liposomes, Glutathione, Small Unilamellar Vesicles, Drug-delivery, Liquid chromatography*

1. INTRODUCTION

Glutathione is a small, water-soluble, low molecular weight thiol-tripeptide that is vital for maintaining intracellular redox equilibrium. It is biosynthesized from cysteine, glycine, and glutamate in the human body. Glutathione exists in two states which are disulfide oxidized form (GSSG), and thiol reduced form (GSH). The dominant form is the thiol reduced form.¹ The ratio between GSH and GSSG is involved in maintaining intracellular redox equilibrium. This ratio is higher than 100 in healthy cells, while a ratio of mean cells in-between 1-10 indicates the exposure of cells to oxidant stress. Also, glutathione can be identified as a thiol buffer that maintains sulfhydryl groups of many proteins in its reduced form. Two reduced glutathione make the oxidized form of glutathione when bound together by a sulfur atom during oxidative stress.² GSH plays an important role in several processes, including antioxidant defense, detoxification of xenobiotics and/or their byproducts, control of cell cycle and apoptosis, cysteine storage, redox potential maintenance, immune system modulation, and fibrogenesis.

Extensive research in various specialties has proved that the dysregulation of GSH production causes the development of many pathological conditions. These include drug-resistant tumor

cells, alcoholic liver disease, cholestatic liver injury, diabetes mellitus, cardiovascular diseases, chronic age-related diseases, Parkinson's, peripheral obstructive arterial disease, cystic fibrosis, emphysema, preterm infants' autism, contrast-induced nephropathy, chronic otitis media, and pulmonary and liver fibrosis.^{1, 3} Therefore, reduced glutathione has been utilized in medical conditions as a supplement. However, there is limited information available on the role of glutathione supplementation in these disorders. Most of the studies have been done for cancers, autism, and cystic fibrosis.⁴ The discovery of its anti-melanogenic qualities has resulted in its commercialization as a skin-lightening agent in addition to its exceptional antioxidant properties. In some ethnic populations, it is frequently used as a skin-lightening agent and a supplement.

The two main forms of glutathione delivery are parenteral (intravenous and intramuscular) and oral formulations (pills, solutions, sublingual tablets, syrups, and sprays). Intranasal and intrabronchial administration methods have also been utilized. The three main methods of delivery for skin whitening are intravenous injections, oral (capsules and sublingual/buccal pills), and topical (creams, face washes).⁵

When considering the oral form of GSH, Due to the tripeptide's status as a substrate for gastrointestinal tract proteases (peptidases) and the lack of a specialized glutathione carrier at the level of the cell membrane, oral glutathione has a low level of systemic bioavailability.⁶ However, under Section 201(s) of the Federal Food, Drug, and Cosmetic Act of the United States Food and Drug Administration (US-FDA) oral dietary supplements containing glutathione are generally recognized as safe (GRAS). There are no restrictions on its oral forms in Japan, the Philippines, or the United States. Oral formulations are marketed as over-the-counter pharmaceuticals in India and other Asian countries.⁷

Although topical treatments have been utilized to transport GSH over the skin, their usage is restricted due to their inability to penetrate the stratum corneum (SC, the skin's outermost barrier).⁸ However, to increase the effectiveness

of topical and oral application in pharmaceutical and cosmeceutical formulations, an appropriate carrier is required to increase drug deposition.

Liposomes are small, spherical artificial vesicles that can be made from cholesterol and nontoxic, natural phospholipids. Liposomal properties considerably differ due to lipid composition, surface charge, size, and the manufacturing process. They are generally spherical vesicles with particle sizes ranging from 30 nm to several micrometers and are made up of aqueous units surrounded by one or more lipid bilayers, with the polar head groups orientated in the direction of the inner and outer aqueous phases. However, polar lipids can self-assemble into a variety of colloidal particles in addition to the conventional bilayer forms, which depend on the molecule shape, temperature, and environmental preparation conditions.

The hydrophobic and hydrophilic properties of liposomes, in addition to their biocompatibility, make them an ideal drug delivery platform. Apart from that, liposomes show outstanding properties for drug delivery such as non-toxicity, flexibility, biodegradability, and non-immunogenic for systemic and non-systemic administration. Also, it can increase efficacy, drug therapeutic index, and stability via encapsulation. Additionally, liposomes can include both hydrophilic and hydrophobic materials in the aqueous compartment and bilayers, respectively, while being simple to synthesize on a large scale.⁹

The limitations of current GSH delivery techniques can be addressed by the liposome encapsulation of GSH. Liposomes provide targeted and sustained release while shielding the encapsulated compound from deterioration. According to existing literature, liposomes are effective colloidal carriers for administering medications to the skin and are secure and effective due to the striking similarity between their components and skin lipids.¹⁰ Therefore glutathione encapsulated liposome can be utilized for topical administration in cosmeceutical products successfully.

When considering oral administration, glutathione encapsulated liposomes can be delivered through the gastrointestinal tract

without digesting glutathione. Liposomal glutathione is a compound that has been water-encapsulated inside of a fat ball with the purpose of "tricking" the digestive system into perceiving it is a fat cell and as a result won't be hydrolyzed, allowing it to reach the bloodstream.⁵

In 1990, Malle et al. have demonstrated the utilization of liposomes for achieving targeted delivery of glutathione.¹¹ This study has proved the administration of liposomal encapsulated glutathione in the lungs, while, Veerawat et al. have proved the effective penetration of liposomal encapsulated *Artocarpus lakoocha* (AL) heartwood extract (antioxidant) to the skin better than the non-encapsulated extract. These results demonstrate that liposomes are an excellent means of improving the skin's permeation of AL heartwood extract effectively for skin lightening.¹² Similarly, this study focuses on the synthesis of glutathione encapsulated liposomes for efficient delivery of glutathione and discusses the potential use of the synthesized liposomes in pharmaceutical and cosmeceutical products.

2. MATERIALS AND METHODS

2.1. Materials

L-Glutathione (GSH, 98%), cholesterol ($C_{27}H_{46}O$, 99%), and egg lecithin ($C_{42}H_{80}NO_8P$, 97%) were purchased from Xian Lyphar Biotech, Xian Imaherb Biotech, and Xi'an Yingmai Co., Ltd, respectively. Sodium hydroxide (NaOH, 98%), sodium chloride (NaCl, 99%), potassium chloride (KCl, 99%), disodium phosphate (Na_2HPO_4 , 98%), monopotassium phosphate (KH_2PO_4 , $\geq 99.9\%$), ethanol (C_2H_5OH) and chloroform ($CHCl_3$) were purchased from Sigma Chemical Company (Sigma-Aldrich Inc., St. Louis, MO). The organic solvents used were of analytical grade.

Methods

Trials were carried out with the reverse-phase evaporation method and the ethanol injection method before selecting the ideal method of synthesis. Finally, the method used to synthesize glutathione encapsulated liposomes was the

modified ethanol injection method. All sample preparation and analysis were performed at 25 ± 5 °C. The method utilized transcends other methods due to its simplicity, eco-friendly and convenient nature. The glutathione loading technique used here is the passive loading technique where GSH is encapsulated during the formation of the liposome.⁹ The passive loading technique is based on the dissolution of dried thin films of lipids in aqueous solutions containing the target drug.¹³ In the alcohol injection method the lipid solution is directly injected into a well sonicated aqueous phase which results in the formation of small unilamellar vesicles (SUVs).

2.1.1. Preparation of the Phosphate Buffered Saline (PBS) Solution

A PBS solution of 1 L with a pH of 7.4 was prepared using NaCl (8.00 g), KCl (0.20 g), Na_2HPO_4 (1.44 g), KH_2PO_4 (0.24 g), and Mili-Q water. This solution was then sonicated for 10 minutes.

2.1.2. Preparation of Glutathione Encapsulated Liposomes

An aqueous phase containing 0.4 M glutathione solution was prepared in phosphate buffered saline solution (10.00 mL, pH 7.4) and sonicated (Sonorex Super RK 102 H, Ultrasonic bath with heater) for 5 minutes (aqueous phase). Egg lecithin (0.10 g), and cholesterol (0.04 g) were dissolved in ethanol (10.00 mL) and filtered to obtain a clear solution (organic phase). The organic phase was injected perpendicularly into the aqueous phase using a glass syringe with a flow rate of 0.6 mL/min while being stirred at 200 rpm. The solution immediately turned milky as a result of liposome formation. The suspension was further stirred for 15 minutes in an open-air system to evaporate the remaining ethanol.

3. CHARACTERIZATION OF GLUTATHIONE ENCAPSULATED LIPOSOMES

The conformation of encapsulated glutathione and their structural properties can be studied

using characterization instruments such as the High-Performance Liquid Chromatography and the Particle Size Analyzer.

3.1. High-Performance Liquid Chromatography (HPLC) Studies

This analysis was conducted using the Alliance HPLC - e2695 Separations Module by Waters. The column used was the Waters Spherisorb ODS2 HPLC C18 column of 5.0 μm (4.6 x 250 mm), with a flow rate of 1.0 mL/min and the HPLC measurements were taken at a wavelength of 210 nm.

3.1.1. Preparation of the Mobile Phase for HPLC Studies

The mobile phase used was 0.1% (v/v) Trifluoroacetic acid (TFA). This solution was then sonicated for 30 min before use.

3.1.2. Preparation of Standard Solution for HPLC Studies

The standard stock solution was prepared by dissolving GSH (216.4 mg) in a 100 mL volumetric flask using Mili-Q water. This solution was further diluted 10 times and sonicated for 10 min before analysis. Finally, the solution was filtered using a syringe filter of 0.45 μm .

3.1.3. Preparation of the Test Solution for HPLC Studies

The test solution was prepared by filtering about 10 mL of sample solution using a syringe filter of 0.45 μm to obtain a clear solution.

3.2. Particle Size Analyzer (PSA)

The measurement of the mean particle size and polydispersity index (PDI) was analyzed using the Zetasizer Nano ZS, Malvern Instruments, UK. The test solution was placed in a polystyrene cuvette and a total of three runs were performed to obtain the average particle size and polydispersity index.

RESULTS AND DISCUSSION

High-Performance Liquid Chromatography (HPLC)

High-performance liquid chromatography was performed for the confirmation of glutathione encapsulation. This test was carried out for the test solution and a standard glutathione solution was prepared as mentioned above. The comparison of the test results obtained for both solutions can verify the encapsulation of glutathione, as the results from the test solution should correlate to the results of the standard glutathione solution

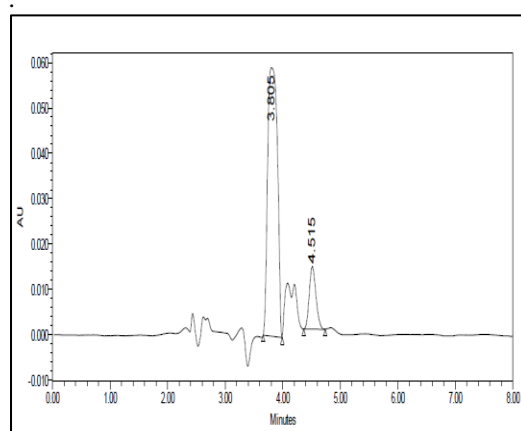


Fig 1.1: HPLC – direct injection spectra obtained for 10 ppm standard glutathione solution

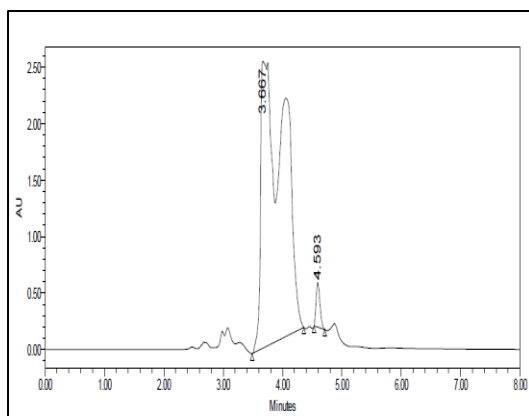


Fig 1.2: HPLC – direct injection spectra obtained for glutathione encapsulated in liposomes

The 10-ppm standard glutathione solution showed a peak at 3.8 min while the glutathione from the test solution eluted at 3.7 min, as depicted in fig 1.1 and fig 1.2 respectively. Literature suggests that GSH elutes at 3.5 mins and variations in elution time can occur due to different types of solvents and columns used in the analysis.^{14,15} The peak splitting could suggest the presence of isomers and this is observed because the test solution is further diluted than the 10 ppm standard glutathione solution. According to literature, the isomers present for GSH are as follows: 21 (LD-GSH), 9 (DL-GSH), 3 (LD-GSH), and 6 (DD-GSH),¹⁶ and hence one of them could be responsible for the peak splitting.

A quick supplementary method to configure the cause of the peak split is by conducting an HPLC analysis for the corresponding wavelength of the apprehensive compound responsible for the specific peak split and if an intense peak is obtained for the maximum wavelength of the suspected compound, the identity of the compound responsible for the peak can be confirmed. For further verification of glutathione present in the test solution, a confirmation HPLC analysis could be performed. For the confirmation analysis, initially, 6 injections of the standard solution of glutathione should be injected, followed by 2 blank injections and finally 6 injections of the test solution. The relative standard deviation (RSD) should be calculated at the specific retention time from the

data obtained. Once the data has been analyzed and if an RSD of less than 2% is obtained, this confirms that the peak eluted is glutathione, hence confirming the successful encapsulation of glutathione.

3.3. Particle Size Analyzer (PSA)

Dynamic light scattering (DLS) measures the Brownian motion of particles and correlates this to the size of the particles. The reversed-phased evaporation method presented a mean particle size of 151.5 nm and a PDI of 0.269 (fig 2.1), which in comparison to the data obtained from the ethanol injection method (fig 2.2) is relatively high. As the smaller particle size allows efficient delivery, the injection method was selected over the evaporation method for GSH encapsulated liposome synthesis. The method utilized to synthesize glutathione encapsulated liposomes is the ethanol injection method. This conclusion was made after the comparison of PSA data obtained from both methods.

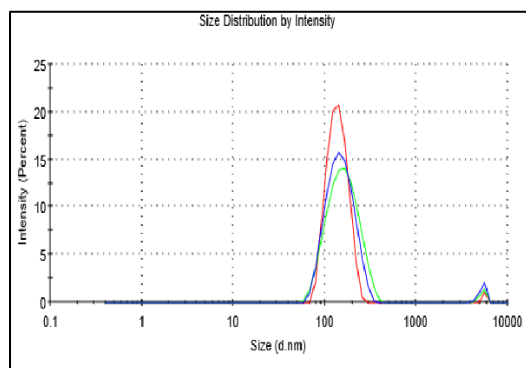


Fig 2.1: Size distribution by intensity obtained for the GSH encapsulated liposome solution synthesized using the reversed-phased evaporation method

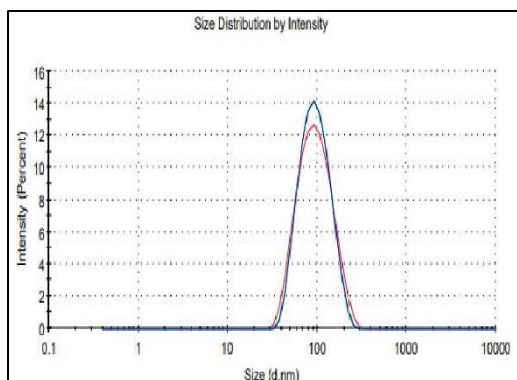


Fig 2.2: Size distribution by intensity obtained for the GSH encapsulated liposome solution synthesized using the ethanol injection method.

The mean particle size obtained via the ethanol injection method was measured to be 86.14 nm and the PDI was 0.132 (fig 2.2). A PDI below 0.2 indicates a rather sharp size distribution of vesicles.¹⁷ As reported in the literature, the results obtained suggest that the glutathione encapsulated liposomes formed are small unilamellar vesicles (SUVs) as they fit in the size range of 20 – 100 nm.¹⁸

The particle size distribution and PDI of liposomes used as vesicles are highly important physical characteristics to be considered when creating pharmaceutical-grade and cosmeceutical products. This is because these attributes affect the bulk properties, product performance, processability, stability, and appearance of the end product. The determination of the average diameter and size distribution of lipid-based carrier systems are fundamental quality control assays for such products.¹⁹ Particle size is a very critical attribute for lipid-based vesicles as it directly correlates to the stability, encapsulation efficiency, drug release profile, bio-distribution, and cellular uptake.²⁰

The liposomal encapsulation of glutathione can be further studied for applications in the pharmaceutical and cosmeceutical industries as it should ideally embody similar properties to other liposome encapsulated antioxidants, as glutathione is an antioxidant. In the pharmaceutical industry, liposomal encapsulation of drugs is a widely studied area

due to its capability to reduce the acute toxicity of the drug while maintaining efficacy and its capability for effective drug delivery owing to drug targeting and protection against enzyme degradation. Certain sizes of vesicles typically less than 400 nm, can rapidly enter tumor sites from blood but are kept in the bloodstream by the endothelial wall in healthy tissue vasculature.²¹ The leaky vasculature of tumors allows the accumulation of high molecular weight therapeutics in the tumors and this is known as the enhanced permeability and retention (EPR) effect, which eventually enables circulating vesicles smaller than around 150 nm to extravasate from circulation through the tumor vasculature and increase the concentration of the chemotherapeutic agents within the tumor.^{22,23,24} Following other literature vesicle sizes below 200 nm for passive targeting tumor tissues via EPR are mentioned.^{25,26} Only vesicles of a certain size (≤ 150 nm) can enter or exit fenestrated capillaries in the tumor microenvironment or liver endothelium.^{20,27} Liposomes can be used to protect the entrapped drug against enzymatic degradation whilst in circulation, using the basis that the lipids used in their formulations are not susceptible to enzymatic degradation and thus the entrapped drug is protected while the lipid vesicles are in circulation in the extracellular fluid.²¹ The entrapped drug is released either by diffusion through the microsphere shell, dissolution of the shell or degradation of the shell by liposomal enzymes.²⁸

Glutathione possesses an important role in cancer treatments, as statistics show that GSH can reverse or prevent cancers. It has been stated that GSH can aid in the removal of carcinogens and detoxify the system while being beneficial in dealing with cancer.⁵ This paired with the other literature stated above, makes the GSH encapsulated liposomes synthesized here a strong contender for applications in the field of pharmaceuticals.

The application of liposomes onto the skin surface (topical drug delivery) has been proven to be effective in drug delivery into the skin.²¹ Liposomes replenish the skin as lipids are hydrated and reduce the dryness of the skin

which is the primary cause of aging.²⁹ There are many cosmeceutical benefits in the use of active ingredient encapsulated liposomes such as improved stability of the active ingredient, enhancement of skin penetration, and the enhancement of the activity of the active ingredient. Due to the similarity of structure between bilayer lipid and natural membranes, liposomes have been attracting attention for their potential applications for skin treatments and cosmeceuticals.³⁰ Because lipid vesicles can alter cell membrane fluidity and fuse with cells, they easily deliver active ingredients to the target site.³¹ According to experts, liposomes have great potential as active vectors in antioxidant carriers, due to the possibility to enhance encapsulating performance by improving antioxidant solubility and stability and, thus too, delivering incorporated antioxidants to specific target sites and providing sustained antioxidant release.³²

The delivery of active ingredients such as glutathione used in cosmeceutical products occurs through two major routes such as the transappendageal and transepidermal pathways.³³ The vesicles in the size range of 10 – 210 nm may preferentially penetrate through the transfollicular route.^{34,35} Generally vesicles with a diameter of 600 nm and above are incapable of delivering encapsulated material into deeper layers of the skin and therefore inclined to stay in or on the stratum corneum forming a lipid layer on the skin after drying. But vesicles with a diameter of 300 nm or below can deliver the encapsulated material into deeper skin layers.^{36,37,38} This suggests that the GSH encapsulated liposomes synthesized by this method will most likely adhere to the transappendageal pathway as the size obtained for the vesicle is in-between the range of 10-200 nm and can penetrate deeper layers of the skin.

For the accumulation of encapsulated vesicles at a target site, formulations should be of homogenous populations with vesicles of a certain size. The parameter used to define the size range of the vesicles is called the polydispersity index (PDI). This describes the degree of non-uniformity of the particle size distribution. In drug delivery applications using lipid-based carriers, a PDI of 0.3 and below is considered to

be acceptable and indicates a homogenous population of phospholipid vesicles.^{39,40,41} The PDI obtained for the GSH encapsulated liposome was 0.132 and hence indicates a well homogenous population of vesicles.

Backed by literature the GSH encapsulated liposomes synthesized by a simple technique show huge potential for future applications in pharmaceutical and cosmeceutical products. Just by the combination of an important antioxidant such as GSH and the culmination of the advantages liposomes possess as a carrier vesicle with regards to its hydrophobic and hydrophilic nature, a supreme product can be manufactured for advanced application.

4. Conclusion

The present study demonstrates a simple method that produces glutathione encapsulated small unilamellar vesicles (SUVs) under mild conditions that can be utilized for various cosmeceutical and pharmacological end uses. The synthesized vesicles containing the active ingredient show potential for future use of liposome-based drug delivery schemes. The ability to produce SUVs rapidly and efficiently opens up new avenues of research to explore.

References

- Lu, S. C., Glutathione synthesis. *Biochimica et biophysica acta* **2013**, 1830 (5), 3143-53.
- Pizzorno, J., Glutathione! Integrative Medicine: A Clinician's Journal 2014, 13 (1), 8.
- Pizzorno, J. E.; Katzinger, J. J., Clinical Implications of Persistent Organic Pollutants-Epigenetic Mechanisms. *Journal of Restorative Medicine* 2013, 2 (1), 4-13.
- Locigno, R.; Castronovo, V., Reduced glutathione system: role in cancer development, prevention and treatment. *International journal of oncology* 2001, 19 (2), 221-236.
- Sonthalia, S.; Daulatabad, D.; Sarkar, R., Glutathione as a skin whitening agent: Facts, myths, evidence and controversies.

- Indian J Dermatol Venereol Leprol 2016, 82 (3), 262-72.
- Allen, J.; Bradley, R. D., Effects of oral glutathione supplementation on systemic oxidative stress biomarkers in human volunteers. *Journal of alternative and complementary medicine* 2011, 17 (9), 827-33.
- Mahmood, M., The Effectiveness of Glutathione on Skin Lightening: A Review. *International Journal of Medical Sciences* 2022, 5 (2), 5-16.
- Lee, Y.; Kumar, S.; Kim, S. H.; Seong, K.-Y.; Lee, H.; Kim, C.; Jung, Y.-S.; Yang, S. Y., Odorless glutathione microneedle patches for skin whitening. *Pharmaceutics* 2020, 12 (2), 100.
- Akbarzadeh, A.; Rezaei-Sadabady, R.; Davaran, S.; Joo, S. W.; Zarghami, N.; Hanifehpour, Y.; Samiei, M.; Kouhi, M.; Nejati-Koshki, K., Liposome: classification, preparation, and applications. *Nanoscale research letters* 2013, 8 (1), 1-9.
- Aparajita, V.; Ravikumar, P., Liposomes as carriers in skin ageing. *Int J Curr Pharm Res* 2014, 6 (3), 1-7.
- Jurima-Romet, M.; Barber, R. F.; Demeester, J.; Shek, P. N., Distribution studies of liposome-encapsulated glutathione administered to the lung. *International Journal of Pharmaceutics* 1990, 63 (3), 227-235.
- Teeranachaideekul, V.; Nithitanakool, S.; Junhunkit, T.; Ponpanich, L.; Nopporn, N.; Detamornrat, U.; Chulasiri, M., Liposomes: A novel carrier system for Artocarpus lakoocha extract to improve skin whitening. *Journal of Asian Association of Schools of Pharmacy* 2013, 2, 243-253.
- Sur, S.; Fries, A. C.; Kinzler, K. W.; Zhou, S.; Vogelstein, B., Remote loading of preencapsulated drugs into stealth liposomes. *Proceedings of the National Academy of Sciences* 2014, 111 (6), 2283-2288.
- Tsiasioti, A.; Zacharis, C. K.; Zotou, A.-S.; Tzanavaras, P. D., Study of the oxidative forced degradation of glutathione in its nutraceutical formulations using zone fluidics and green liquid chromatography. *Separations* 2020, 7 (1), 16.
- Yap, L.-P.; Sancheti, H.; Ybanez, M. D.; Garcia, J.; Cadenas, E.; Han, D., Determination of GSH, GSSG, and GSNO using HPLC with electrochemical detection. *Methods in enzymology* 2010, 473, 137-147.
- Oikawa, T.; Yamauchi, T.; Kumagai, H.; SODA, K., Stereoisomers of glutathione: preparation and enzymatic reactivities. *Journal of nutritional science and vitaminology* 1999, 45 (2), 223-229.
- Charcosset, C.; Juban, A.; Valour, J.-P.; Urbaniak, S.; Fessi, H., Preparation of liposomes at large scale using the ethanol injection method: Effect of scale-up and injection devices. *Chemical engineering research and design* 2015, 94, 508-515.
- Has, C.; Sunthar, P., A comprehensive review on recent preparation techniques of liposomes. *Journal of liposome research* 2020, 30 (4), 336-365.
- Danaei, M.; Dehghankhold, M.; Ataei, S.; Hasanzadeh Davarani, F.; Javanmard, R.; Dokhani, A.; Khorasani, S.; Mozafari, M., Impact of Particle Size and Polydispersity Index on the Clinical Applications of Lipidic Nanocarrier Systems. *Pharmaceutics* 2018, 10 (2), 57.
- Bahari, L. A. S.; Hamishehkar, H., The impact of variables on particle size of solid lipid nanoparticles and nanostructured lipid carriers; a comparative literature review. *Advanced pharmaceutical bulletin* 2016, 6 (2), 143.
- Dua, J.; Rana, A.; Bhandari, A., Liposome: methods of preparation and applications. *Int J Pharm Stud Res* 2012, 3 (2), 14-20.
- Mozafari, M.; Pardakhty, A.; Azarmi, S.; Jazayeri, J.; Nokhodchi, A.; Omri, A., Role of nanocarrier systems in cancer nanotherapy. *Journal of liposome research* 2009, 19 (4), 310-321.
- Aw-Yong, P. Y.; Gan, P. H.; Sasmita, A. O.; Mak, S. T.; Ling, A., Nanoparticles as carriers of phytochemicals: Recent applications against lung cancer. *Int. J. Res. Biomed. Biotechnol* 2018, 7, 1-11.

- Greish, K.; Fang, J.; Inutsuka, T.; Nagamitsu, A.; Maeda, H., Macromolecular therapeutics. *Clinical pharmacokinetics* 2003, 42 (13), 1089-1105.
- Maeda, H., Toward a full understanding of the EPR effect in primary and metastatic tumors as well as issues related to its heterogeneity. *Advanced drug delivery reviews* 2015, 91, 3-6.
- Caracciolo, G., Clinically approved liposomal nanomedicines: lessons learned from the biomolecular corona. *Nanoscale* 2018, 10 (9), 4167-4172.
- Blasi, P.; Giovagnoli, S.; Schoubben, A.; Ricci, M.; Rossi, C., Solid lipid nanoparticles for targeted brain drug delivery. *Advanced drug delivery reviews* 2007, 59 (6), 454-477.
- Uhumwangho, M.; Okor, R., Current trends in the production and biomedical applications of liposomes: a review. 2005.
- Pradhan, B.; Kumar, N.; Saha, S.; Roy, A., Liposome: Method of preparation, advantages, evaluation and its application. *Journal of Applied Pharmaceutical Research* 2015, 3 (3), 01-08.
- Betz, G.; Aeppli, A.; Menshutina, N.; Leuenberger, H., In vivo comparison of various liposome formulations for cosmetic application. *International journal of pharmaceutics* 2005, 296 (1-2), 44-54.
- Gregoriadis, G., Liposomes and anti-ageing creams: the facts beneath the face. *Biochemist* Feb/Mar 1994.
- Laouini, A.; Jaafar-Maalej, C.; Limayem-Blouza, I.; Sfar, S.; Charcosset, C.; Fessi, H., Preparation, characterization and applications of liposomes: state of the art. *Journal of colloid Science and Biotechnology* 2012, 1 (2), 147-168.
- Scheuplein, R. J., Mechanism of percutaneous adsorption: I. Routes of penetration and the influence of solubility. *Journal of investigative Dermatology* 1965, 45 (5), 334-346.
- Geusens, B.; Strobbe, T.; Bracke, S.; Dynoodt, P.; Sanders, N.; Van Gele, M.; Lambert, J., Lipid-mediated gene delivery to the skin. *European Journal of Pharmaceutical Sciences* 2011, 43 (4), 199-211.
- Zeb, A.; Qureshi, O. S.; Kim, H.-S.; Cha, J.-H.; Kim, H.-S.; Kim, J.-K., Improved skin permeation of methotrexate via nanosized ultradeformable liposomes. *International journal of nanomedicine* 2016, 11, 3813.
- Verma, D. D.; Verma, S.; Blume, G.; Fahr, A., Particle size of liposomes influences dermal delivery of substances into skin. *International journal of pharmaceutics* 2003, 258 (1-2), 141-151.
- Verma, D.; Verma, S.; Blume, G.; Fahr, A., Liposomes increase skin penetration of entrapped and non-entrapped hydrophilic substances into human skin: a skin penetration and confocal laser scanning microscopy study. *European Journal of Pharmaceutics and Biopharmaceutics* 2003, 55 (3), 271-277.
- Hua, S., Lipid-based nano-delivery systems for skin delivery of drugs and bioactives. *Frontiers Media SA*: 2015; Vol. 6, p 219.
- Badran, M., Formulation and in vitro evaluation of fluenamic acid loaded deformable liposomes for improved skin delivery. *Digest Journal of Nanomaterials & Biostructures (DJNB)* 2014, 9 (1).
- Chen, M.; Liu, X.; Fahr, A., Skin penetration and deposition of carboxyfluorescein and temoporfin from different lipid vesicular systems: In vitro study with finite and infinite dosage application. *International journal of pharmaceutics* **2011**, 408 (1-2), 223-234.
- Putri, D. C. A.; Dwiastuti, R.; Marchaban, A. K. N., Optimization of mixing temperature and sonication duration in liposome preparation optimasi suhu pencampuran dan durasi sinikasi dalam pembuatan liposom. *Jurnal Farmasi Sains dan Komunitas* **2017**, 14 (2), 79-85.

Use of the Internet of Things to improve the quality of patient care in nursing

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ABSTRACT

The Internet of things (IoT) refers to the connectivity of devices via the internet. Here, things indicate objects with an IP address that can transmit data. Applications of IoT can be used to enhance the quality of patient care in nursing. Since the nurses directly interact with patients, quality patient care can be provided if IoT is integrated into nursing care. Mainly, IoT can be integrated at the interface between a nurse and a patient where quick communication is needed. For example, patient monitoring technologies or patient monitoring systems can be given. In Sri Lanka, the Sri Lanka Institute of Nanotechnology (SLINTEC) has developed a sensor device, collaborating with Hirdramani Groups (Sri Lanka) and CirQ technologies to monitor a person's breathing patterns. In this work, we have used the system mentioned above to observe people in real time and developed a process to integrate the system into nursing practices where asthma-related patients can be monitored.

Keywords: *IoT, Nursing care, Sensors, Asthma patients*

1. INTRODUCTION

The Internet of things refers to the connectivity of devices via the internet. Here, things indicate objects with an IP address that can transmit data. Surveillance cameras are one of the best examples. Here, you can log into your CCTV

camera remotely and have a live monitoring system. However, the entire operation of IoT is not that simple. It has specific steps that execute different activities. The first step of the process is data acquisition. Here, sensing elements in IoT devices collect data. The images/videos are taken or received if the device is a camera. The second step is data transmission. The data is transmitted for processing over cellular or satellite networks, Wi-Fi, Bluetooth, wide-area networks (WAN), or low-power wide-area networks (LPWAN). Transmitted data is then processed. This is crucial to transform data into usable information, which may be sorted, categorized, or calculated. The last stage of the process is visualizing the information via a user interface (Javaid & Khan, 2021).

Here, human engagement with a computer or device is made possible by the user interface (UI). A computer or smartphone's user interface (UI) may comprise a screen, pages, icons, buttons, voice commands, software, and apps. This entire process can be adapted to nursing care activities easily. Since the nurses directly interact with patients, quality patient care can be provided if IoT is integrated into nursing care. Mainly, IoT can be integrated at the interface between a nurse and a patient where quick communication is needed. For example, patient monitoring technologies or patient monitoring systems can be given. Such a system collects, interpret, and communicate a patient's physiological data to nurses. These systems help to access real-time health data. This can be used to utilize the existing workforce effectively. For

example, multiple patients can be monitored via single user interfaces that reduce labour. Additionally, a voice commanding app can be integrated into the system to convey instructions to the patient that will help manage chronic patients residing at home. For example, the number of adults diagnosed with dementia can be monitored simultaneously. So, these patients can be informed via a commanding voice system to wear the blood pressure monitoring system, take the insulin shot, or take the daily medicine dose, ultimately enhancing geriatric nursing care. Apart from that, alerting heart patients to arrhythmia and delivering medications through an infusion pump can be mentioned under the successful utilization of such systems. In addition to the advantages already described, the remote monitoring capabilities of IoT could cut hospital readmissions, eliminate recurrent ER visits, and notify nurses when patients fall or fail to get out of bed (Bhatt & Bhatt, 2017; Laplante & Laplante, 2016).

Wearable devices can also be used to increase the quality of nursing care. Micro-sensors are implanted in various items, including watches, clothes, belts, masks, and spectacles, allowing for the long-term monitoring of chronic patients (Ilén, 2015). Nurses may look at a patient's surroundings, vital signs, or physical conditions. In addition, artificial intelligence can develop models to identify health risks using long-term data collection via wearable devices. In Sri Lanka, the Sri Lanka Institute of Nanotechnology (SLINTEC) has developed a sensor device, collaborating with Hirdramani Groups (Sri Lanka) and CirQ technologies to monitor a person's breathing patterns. Usually, different types of breathing patterns are associated with patients. Especially, for asthma-related patients, short breaths are associated. This is due to the trapped air inside the lungs (Armstrong & Vogiatzis, 2019). In this work, we have used the aforementioned system to observe people in real time and developed a process to integrate the system into nursing practices where asthma-related patients can be treated.

2. MATERIALS AND METHODS

2.1 Preparation of the sensor to use in masks

The sensor device was designed to allow it to be attached or detached from a textile substrate of a mask as described in figure 1. A relative humidity (RH) measuring element was included in the sensor device to get respiratory data. A data processing module was included in the sensor device contains that is operatively connected with a communication module attached to the said sensing element and configured to the said PCB substrate. Breathing pattern data to detect respiratory parameters and mask features were calculated using the data processing module.

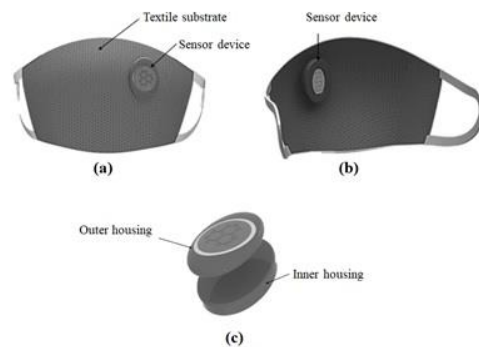


Figure 1. (a) an exterior view of the smart respiratory mask (b) an interior view of the smart mask (c) a perspective view of the detachable sensor device

2.2. Use of the masks to observe the breathing patterns

Prepared masks were then used to observe the breathing patterns of selected individuals. Instructions were given to the users before using it. Here, two aspects were considered. Firstly, the attachment of the sensor device below the nose where two muscles levator labii superioris (Figure 2.a.1) and zygomaticus minor (Figure 2.a.2) are connected to the muscle orbicularis oris (Figure 2.a.3). This alignment is needed to capture exhale air without disturbing the facial movements.

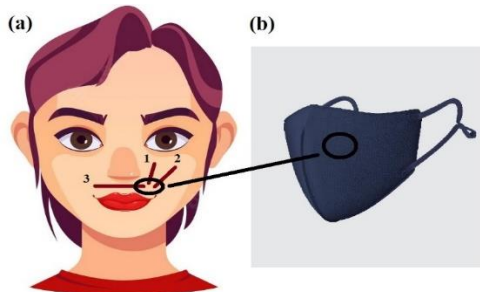


Figure 2. (a) Face anatomy with the sensor position (b) an exterior view of the smart respiratory mask with the sensor position.

2.3. Integration of the system to observe the breathing patterns of asthma patients

Here, as the first step of the process, a properly fixed mask with the sensor is fitted into an asthma patient's face as explained in section 2.2. Data was then continuously collected. After that, the breathing patterns were investigated.



Figure 3. Process chart of the sensor fitted mask implementation to identify health risks in asthma-related patients

3. RESULT AND DISCUSSION

3.1. Use of the masks to observe the breathing patterns

Figure 4(a) illustrates the study of human respiratory patterns including normal, short, and long breaths. The black colour curve is the sensor response, and the blue colour curve is the first derivative of the sensor response. When the user is at rest and breathing normally, a periodic breathing cycle with roughly the same gaps between signal minima is expressed. A single breathing cycle for a normal breath is depicted in Figure 4(b) with a breath time of 3.35 seconds, which equates to an average respiratory rate of about 18 breaths per minute. Short breaths are visible because their cycle times are significantly shorter than those of regular breaths.

A single breathing cycle for quick breaths is depicted in Figure 4(c), with a breath time of 0.79 seconds, or a respiratory rate of around 75 breaths per minute. The mask microclimate becomes whiter as a result of the fast breathing, which causes the baseline resistance to shift toward low resistance values signifying humidity accumulation. In comparison to long and normal breathing, the duration between intake and exhalation is noticeably shorter in this scenario, which causes a larger humidity build-up inside the mask. Figure 4(d) illustrates a single breathing cycle for a long breath. A long breath has a breath period of 6.28 seconds and a breathing rate of about 9 breaths per minute.

The cycle time of a long breath is longer than that of normal breathing. Long exhales and inhales cause the baseline resistance to change toward higher resistance values, which indicates that humidity is being removed quickly as a result of the prolonged drying cycles.

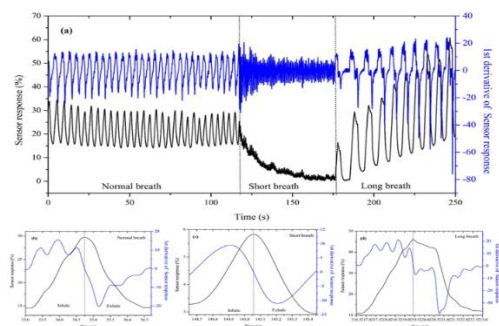


Figure 4. (a) different birthing patterns of normal, short and long breaths and 1st derivative curve (b) single cycle of normal breath (c) single cycle of short breath (d) single cycle of long breath.

As seen in the images, the three signals' amplitude responses are noticeably different, with normal, short, and long breath responses having amplitudes of 15%, 3%, and 30%, respectively. A lengthy breath has a greater amplitude response than a regular breath because its cycle time is longer. Every switch between the normal to short and short to long modes is smooth. This characteristic could be used to pinpoint transitional points and changes in breathing rhythm. The first derivative of the signal, which is analogous to a high-pass filter and is depicted in figure 4(a), reduces the effect of baseline variation for a variety of reasons, resulting in a smoother and sharper signal. This approach helps further analyses the breath signals to determine the mask characteristics and breathing parameters most of the time.

3.2. Integration of the system to observe the breathing patterns of asthma patients

As explained in the literature shorter-breathing patterns were observed for asthma-related patients. This approach can be used to provide geriatric nursing care more effectively by monitoring the breathing patterns of adult asthma patients. Further to that, nurse-assisted drug administered mechanisms can be integrated into the system as a futuristic approach. Based on the breathing patterns of patients, an asthma attack will be predicted, and the patient will be asked to receive the drugs immediately (Figure 5).

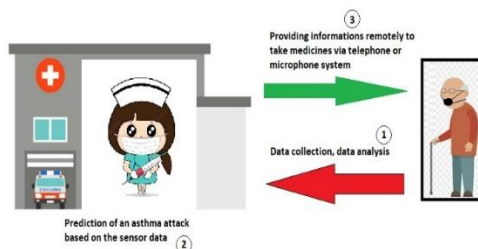


Figure 5. Monitoring and nursing care during an asthma attack.

4. CONCLUSION

Applications of IoT can be used to enhance the quality of patient care in nursing. Since the nurses directly interact with patients, quality patient care can be provided if IoT is integrated into nursing care. SLINTEC has developed a sensor device, collaborating with Hirdaramani Groups and CirQ technologies to monitor a person's breathing patterns. The aforementioned system was integrated into geriatric nursing care where adult asthma patients can be monitored remotely and where the quality of nursing is enhanced.

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REFERENCES

- Armstrong, M., & Vogiatzis, I. (2019). Personalized exercise training in chronic lung diseases. *Respirology*, 24(9), 854-862.
- Bhatt, Y., & Bhatt, C. (2017). Internet of things in healthcare Internet of things and big data technologies for next generation HealthCare (pp. 13-33): Springer.
- Ilén, E. (2015). Decontamination of wearable textile electrodes for medical and health care applications.
- Javaid, M., & Khan, I. H. (2021). Internet of Things (IoT) enabled healthcare helps to take the challenges of COVID-19 Pandemic. *Journal of Oral Biology and Craniofacial Research*, 11(2), 209-214.
- Laplante, P. A., & Laplante, N. (2016). The internet of things in healthcare: Potential applications and challenges. *It Professional*, 18(3), 2-4.

A Review on the Possible Opportunities for the Use of Unmanned Aerial Vehicles in Sri Lankan Tourism and Hospitality Industry

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ABSTRACT

The development of Sri Lankan economy is heavily dependent on the revenue from tourism and hospitality industry. However, there is very limited research on applications of robotics and other advanced technology in the field. As today's competition in the hospitality industry depends on innovative technologies, this paper has explored the opportunities to deploy Unmanned Aerial Vehicles (UAVs), commonly known as "Drones" in various sectors of tourism and hospitality industry of Sri Lanka through a comprehensive literature review. Several opportunities have been identified and presented in this study and the strengths and weaknesses of the application of drones are also discussed.

1. INTRODUCTION

In the future, technologies related to the concept of Tourism 4.0, such as cloud computing, mobile internet, robotics, Artificial Intelligence (AI), autonomous vehicles and even 3D printing, are expected to have a considerable impact on the global tourism workforce (Yeoman & Mars, 2012). Yet, arrival of unmanned aerial vehicles, more commonly known as "Drones" to tourism and hospitality delayed due to the requirement of sophisticated and tailor-made service to fulfil the needs of the customers. They have brought many changes to the industry through package delivery, room service, and as destination marketing tools, thereby enhancing the tourist experience. Currently, research in the incorporation of drones for tourism and hospitality is rather limited and mainly conceptual / experimental. Nevertheless, tourism

practice is evolving rapidly in this direction, creating a gap in research relevance for the coming years (EI Center, 2017).

To the extent of our understanding, the only existing literature focusing drones in Tourism is Hay (2016), who explored the issues of the usage of drones by industry managers and student-tourist owners of drones and a report by Department of Innovation, Tourism Industry Development, and the Commonwealth Games (DITID) in Queensland (Drones Project, 2019) to determine how drones enhance tourists experience and contribute to the increase of tourist visits and expenditures.

Today's competition in the hospitality industry depends on innovative technologies. According to the study by Madushani (2019) and her team's knowledge up to date, there have been no recorded studies in this area relevant to Sri Lanka. Thus, there is an empirical gap in the impact of technological means on the operational efficiency of the hospitality sector.

This paper reviews the application of drones in Tourism and Hospitality in Sri Lankan context. This review will be useful to identify the likelihood of a drone to be successful in the tourism industry. The strengths and weaknesses inherent to drones and their usage in tourism and hospitality are also identified.

2. LITERATURE REVIEW

2.1. Tourism industry in Sri Lanka

Sri Lankan tourism sector flourished over the past few decades with unequalled growth in the tourism after ending the decade-old civil war. Sri Lanka, in 2019, was recognized as the Number 1 travel destination in the world by Lonely Planet (Ranasinghe et al., 2021). The rapid growth of the service sector, which was particularly prominent in the capital, was of great support to the booming tourism industry. According to (Madushani (2019), current and past governments of Sri Lanka have focused on the tourism industry to create economic growth through the implementation and formulation of Tourism Strategic Plans (2011-2016 and 2017-2020). However, since recently, the tourism industry was extensively affected with numerous disasters such as covid-19 outbreak, terrorist attacks as well as due to the recent economic crisis.

The success of Sri Lanka's international tourism industry can be attributed to natural resources, good geographical location, convenient transportation, and marketing strategies adopted to promote the country to the international market. Tourism is a means for Sri Lanka to gain foreign exchange, increase international reserves, stimulate production, and maximize the use of resources in other related sectors, thereby enhancing country's economic status. The hill tribes and their remote communities in the central and north-central, such as the ancient Buddhist heritage sites, are a special attraction. Yet, the country has not significantly invested to recognize the importance of automation and robotics and to promote the growth of the industry. Adoption of novel and advanced technology will lead to the booming tourism market in Sri Lanka.

2.2. Current Drone market in Sri Lanka

Even though the direct application of drones for tourism and hospitality is significantly limited in Sri Lanka, there is an increasing trend of using drones for commercial and industrial sectors by both public and private organizations. Discussed below are some such applications.

Currently, the most common commercial application of drones in Sri Lanka is for photography and videography. Content which has been uploaded to various social media platforms have caused many international tourists to identify the country as a potential destination. In the past, only filmmakers or photographers who had enough wealth to rent helicopters or planes could afford these aerial shots. But, today, most people have access to affordable drones and high-resolution cameras needed for aerial photography. However, drone photography still has limitations, such as the lack of lens options to achieve different effects, limited continuous flight time, and limits placed on the maximum height a drone can fly (Jayasinghe, 2022).

MMBL-Pathfinder Group, a leading investor in Sri Lanka's private civil aviation sector, has announced in May 2022 through its partner Pathfinder Capital (Pvt) Ltd. that it will enter the commercial drone operations sector in Sri Lanka (Nadeera & Walpola, 2022). The services offered by Aerobotics include perimeter security, HSSE monitoring, 2D / 3D mapping, emergency response, asset inspection, survey, and analysis and many more. Drones developed by Aerobotics will cover a vast variety of commercial applications, including public safety, construction, real estate, utilities, ports and airports, and industrial facilities.

Sumathi Information Technologies (SiT), which is a subsidiary of Sumathi Holdings, has successfully launched aerial agricultural spraying across the island and was the first organization in Sri Lanka to test and operate drones for construction, irrigation, and military establishments with a special focus on agriculture (Weerasooriya, 2021).

There has been a growing tendency of using drones in Sri Lanka for journalism and destination marketing. At the time of writing this review, eleven (11) TV channels and eighty-three (83) newspapers in Sri Lanka including many other media organizations and journalists have begun to use drones to provide aerial footage for news and other documentaries (Patabandige, 2019).

The National Youth Service Council (NYSC) launched a project to support the country's agriculture sector in partnership with SRQ Robotics to deploy a drone to drop seeds on five acres of farmland in Eraminiaya, Hambantota (Wipulasena, 2020). The objective is to provide more efficient and cost-effective distribution of seeds, allowing the opportunity to move on to value-added products later.

A discussion was initiated in 2019 with the Sri Lanka Ministry of Health, Ministry of Defense, Civil Aviation Authority, and the President's office along with other stakeholders of government, to study the possibility of implementing Zipline, an India-based drone delivery service to supply on-demand and emergency deliveries of blood products, vaccines, and life-saving medications to Sri Lankan citizens by the year 2020 (Adaderana Biz English, 2019).

2.3. Possible Applications of Drones for Sri Lankan Tourism

The largest segment of Sri Lankan tourism includes religious/heritage festivals, which attract millions of domestic visitors to major religious sites every year. Examples include the Kandy Esala Festival, the Kataragama Festival, the Madu Festival, and the Anuradhapura Jasmine Flower Festival (Indika, 2021). For Sri Lankan tourism industry to grow further, it is important for the country to increase its competitive advantage by modernizing basic accommodations, modernizing transportation facilities which is vital for product marketing and promoting excursion which is the most attractive transport in the tourism industry (Elliot, 1983). The authors have identified several opportunities in different aspects of tourism for implementing drones for the upliftment of tourism in Sri Lanka. The following subsections review these opportunities with their strengths and weaknesses.

2.3.1. Destination Marketing

The attractiveness of a destination has a huge impact on determining a person's preferred destination, his intention to revisit, and the amount of money spent and the duration of stay.

The more tourists who believe that the destination will meet their needs, the more attractive the destination, and therefore the greater the possibility of choosing it as the final destination (Vatanasakdakul, 2006). In addition to that, factors such as the value of resources, such as educational value and abundance, also promote destination attractiveness (Parnwell, 1998). Marketing and promotion using modern technologies such as social media is important to make customers aware of the services, services, and offerings of the hotel (Madushani et al., 2019).

Drones can be programmed to shoot high-speed chase shots, follow objects through busy streets, mountain roads or other environments where it may be difficult to use other methods, where 5 to 10 cameras and the entire shooting team were previously required. Now it takes less than 30 minutes to set up the time to capture, and only 3 crew members can pull it down (United Rotorcraft, 2020). As drones fly closer to the surface of the earth, they can overcome limitations associated with satellite imagery, such as cloud pollution, and thus can provide accurate data. (Ivanov et al., 2019).

2.3.2. Delivery handling for Hotels and Restaurants

Food and beverage industry also play a vital role in the tourism sector. Restaurants usually employ 5 to 15 employees to wait on their customers. From the hotel to the beach, food and drinks must be continuously provided to satisfy their customers. A major factor that affects the experience outcome is the restaurant's ambiance and service. A positive dining experience influences higher income and attract more customers. Therefore, restaurants are adopting various techniques to enhance their service and promote tasty food.

Drone delivery refers to the delivery of packages by an unmanned aerial aircraft. The regular drone has the ability to travel more than 25 kilometers and they are able to deliver long-distance packages and parcels. Since drone delivery makes the delivery experience itself a special event, drones are the perfect complement to events, so the delivery of champagne, wine or

birthday cake also arouses a great interest in customers (iCrowd Newswire, 2020).

In Sri Lanka, companies such as Grasshopper and Kapruka have taken steps in developing a network to facilitate the P2P (point-to-point) delivery of small items such as documents along the coastline of Sri Lanka (Jayasinghe, 2022). This could be further expanded to deliver essential amonites, food and beverages in tourism and hospitality sectors as well. This facility can become a viable cost-effective means for restaurants to increase delivery capacity and reduce reliance on third-party apps without significantly increasing overhead. The drones can be launched from a launch site selected to be close to restaurants or a mall which will be convenient to quickly obtain items and then deliver them directly to the customer (iCrowd Newswire, 2020).

2.3.3. Drones for wildlife and marine observations:

Aerial footage acquired from drones has been used by several countries to observe wildlife or aquatic life. A group of Australian researchers have observed a massive bunch of green sea turtles nesting on Raine Island, a small vegetated coral cay near the Great Barrier Reef which is in the Coral Sea just off the coast of Queensland (Vandinther, 2020). The researchers have found that drone technology helps to track and record endangered creatures more accurately rather than having to paint the shells of the animals with non-toxic white paint, and then use small boats in the water to manually count them.

2.3.4. Passenger Transport

For Sri Lankan tourism industry to grow further, it is important for the country to increase its competitive advantage by modernizing transportation facilities which is vital for product marketing and promoting excursion which is the most attractive transport in the tourism industry. Chinese drone manufacturer EHang is working with hotel developer LN Holdings to build the world's first passenger drone hotel. They will provide transportation services to and from the

hotel as well as scenic tours (Rautray et al., 2020).

2.3.5. Drones for virtual tourism

Virtual tourism is a new trend that reduces limitations and restrictions in travel by recreating an actual travel destination as 3D visualization using augmented reality, mixed reality, and Virtual Reality (VR) (Skondras et al., 2018). In order to create Virtual reality scenes, drones can be used to fly around at the target venues and acquire Omnidirectional video which can be enjoyed by a tourist sitting at home or walking in a treadmill. This facility is most suitable for senior, handicapped, or disabled tourists to revisit their favorite memories. Research by Huang & Tsai (2003) has identified that travel motivation can be classified into rest and relaxation, escape, value for money, health, social interaction learning, exploration, nostalgia, and the opportunity to visit historical sites. As Sri Lanka is a home to its many ancient sites and traditions, this would provide both local and foreign senior citizens to enjoy their virtual visit staying safely at home.

2.3.6. Drones for events and entertainment

The island has become popular as a wedding destination and was serviced by several hotels highly concentrated on the southern coastline. This subset of event tourism can be considered as a potential area for further development (Indika, 2021). The first Drone Light Show in Sri Lanka took place in 2022 for the celebration of Daraz's global rebranding (AdaDerana, 2022). The show illuminated the Colombo night sky using 150 drones and the event was enjoyed by over 10000 people. Such shows are becoming popular around the world and such events can be organized for wedding proposals or as a surprise event for loved ones which could become a new attraction.

Drone racing is a sport where drone pilots strive to build extreme drones to fly around a set course as fast as possible. Almost all drone races today are done using FPV (First Person View) systems. The drone pilot monitors visual displays showing

live streaming video from the camera which is mounted on the drone. The pilot then uses a handheld remote controller to send the thrust and body rate commands in order to control the drone's six-degree-of-freedom (DoF) movement in a 3D space (De Wagter et al., 2021). Introducing drone racing in Sri Lanka in different parts of the country would provide interesting challenge for enthusiastic adventure – lovers.

3. DISCUSSION

From the above review, it is clear that, there is a variety of possible opportunities to use UAVs or drones in Sri Lankan tourism and hospitality sector. This section will explore the feasibility of using drones for the aforementioned applications. The strengths and weaknesses which will emerge with the implementation of drones are discussed in separate sections below.

3.1. Strengths

Drones can provide a novel experience to the travelers through various activities as discussed. Drones can be quickly installed and easily transported due to their light weight. A minimal crew is required for both installation and maintenance. This facility would help to resolve issues such as labor shortages, non -contact service provisions (in case of pandemic situations) and delivery of essentials such as medicine or food quickly. Using drones will also help the restaurant or hotels to avoid dependence on third-party service applications which would save both time and money. In addition to these, there is also the advantage of limited competition.

Drones support a wide variety of tasks. Recent drones are equipped with high resolution video cameras for both image acquisition and surveillance. According to (Mishra et al., 2020) and (Del-Real & Díaz-Fernández, 2021), they can navigate to risky or remote areas and can be also used in tourist rescue missions. These drones can be programmed to operate at any time of the

day, both manually and autonomously without rest.

3.2. Weaknesses

A major hurdle for the application of drones is the legal permission from Aviation authorities. Currently, the Civil Aviation Authority (CAA) of Sri Lanka has restricted the maximum height of travel to 100 m and the drone cannot be flown beyond the area of sight of the pilot. This law has inhibited the applications of drones to reach their true potential (Jayasinghe, 2022). At the same time, the only payload allowed on a drone is the camera mounted on it which would require amendments to the existing laws for drones to be used for deliveries. As with the current technology, a major technical limitation of a drone is the maximum payload it can carry, which is about 2-4 kg. There are ongoing researches to optimize the payload capacity and delivery times as well as to increase the battery life (Laksham, 2019).

Some countries have restricted access of drones to their heritage sites (Myanmar Times, 2016) as drones could be harmful to some aspects of religious observances. There is also the threat from terrorists and cyber-attacks. The drones can be easily programmed to use the location to gain access to the local network and install malware that gives remote users access/privileges (Jacob, 2021). Sri Lanka had suffered from several terrorist attacks throughout the history and many security actions have been taken to safeguard the valuable treasures and heritage sites in the island.

4. CONCLUSION

With the growing technology and improvements to become more user friendly, drones have successfully become ubiquitous in many service industries throughout the world. Yet, studies on application of drones into the travel and hospitality is limited in both foreign and local context. Discovering the opportunities for integrating drones into the industry is very significant for economic growth of Sri Lanka. This study has comprehensively studied the possible opportunities for implementing drones to various sectors in tourism and hospitality

management with regard to the Sri Lankan context. A discussion on strengths and weaknesses in using drones for tourism was also conducted to identify the potential success and failure of the applications. This study would help both the academia and the industry specialists to make a favourable impact on the economic growth of the country.

REFERENCES

- Adaderana Biz English, Sri Lanka Business News. (2019). *Drone delivery in healthcare industry*. [Online] Available at: <http://bizenglish.adaderana.lk/drone-delivery-in-healthcare-industry/> [Accessed 15 July 2022].
- AdaDerana. (2022). 'Daraz drone show' illuminates Colombo Sky'. [Online] Available at: <http://bizenglish.adaderana.lk/daraz-drone-show-illuminates-colombo-sky/> [Accessed 10 July 2022]
- .De Wagter, C., Paredes-Vallés, F., Sheth, N., & de Croon, G. (2021). Learning fast in autonomous drone racing. *Nature Machine Intelligence*, 3(10), 923-923.
- Del-Real, C., & Díaz-Fernández, A. M. (2021). Lifeguards in the sky: Examining the public acceptance of beach-rescue drones. *Technology in Society*, 64, 101502.
- Drones Project. (2019). The Department of Innovation, Tourism Industry Development, and the Commonwealth Games (DITID). Queensland.
- Elliot, J. (1983). Politics, power, and tourism in Thailand. *Annals of Tourism Research*, 10(3), 377-393.
- EI Center (2017). Insight: Three megatrends to change the face of the Thai tourism industry.
- Hay, B. (2016). Drone tourism: a study of the current and potential use of drones in hospitality and tourism. *CAUTHE*, 49-68.
- Huang, L., & Tsai, H. T. (2003). The study of senior traveler behavior in Taiwan. *Tourism management*, 24(5), 561-574.
- iCrowd Newswire. (2020). Drone delivery market is booming worldwide with CAGR of 44.70%. *Wall Street Call*. [Online] Available at: <https://reportedtimes.com/drone-delivery-market-is-booming-worldwide-with-cagr-of-44-70-amazon-com-fedex-united-parcel-service/> [Accessed September 13, 2022].
- Indika, M. K. (2021). Event Tourism in Sri Lanka: An Overview.
- Ivanov, S., Gretzel, U., Berezina, K., Sigala, M., & Webster, C. (2019). Progress on robotics in hospitality and tourism: a review of the literature. *Journal of Hospitality and Tourism Technology*.
- Jacob, S. (2021). The threat from drones and how you can prepare - *HS Today*. [Online] Available at: <https://www.hstoday.us/featured/the-threat-from-drones-and-how-you-can-prepare/> [Accessed September 2, 2022].
- Jayasinghe, P., (2022). Drone Applications in Sri Lanka. [online] Insideaccess.lk. [Online] Available at: <https://www.insideaccess.lk/detail/view/127/industry-insights/drone-applications-in-sri-lanka> [Accessed 15 July 2022].
- Laksham, K. B. (2019). Unmanned aerial vehicle (drones) in public health: A SWOT analysis. *Journal of family medicine and primary care*, 8(2), 342.
- Madhushani, D. M. P., Danthanarayana, C. P., & Fazana, S. F. (2019). Impact of Technological Amenities on the Operational Performance of Hotels: A Case Study Based on Galle District. *University of Vocational Technology*.
- Mishra, B., Garg, D., Narang, P., & Mishra, V. (2020). Drone-surveillance for search and rescue in natural disaster. *Computer Communications*, 156, 1-10.
- Myanmar Times. (2016). Shwedagon Pagoda a no-drone zone. [Online] Available at: <https://www.bangkokpost.com/travel/1101432/shwedagon-pagoda-a-no-drone-zone> [Accessed July 26, 2022]
- Nadeera, D. & Walpola, T., (2022). MMBL-Pathfinder Group to introduce commercial drone operations. *The Island*. [Online] Available at: <https://island.lk/mmb-pathfinder-group-to-introduce-commercial-drone-operations/> [Accessed August 13, 2022].

- Patabandige, G. M. J. (2019). Conceptual paper on drone usage in journalism: a study in Sri Lanka.
- Parnwell, M. J. (1998). Tourism, Globalisation and Critical security in Myanmar and Thailand. *Singapore Journal of Tropical Geography*, 19(2), 212-231
- Ranasinghe, J. P. R. C., Sammani, U. G. O., & Perera, K. J. T. (2021). Impact of the COVID-19 pandemic on tourism operations and resilience: stakeholders' perspective in Sri Lanka. *Worldwide Hospitality and Tourism Themes*, 13(3), 369-382.
- Rautray, P., Mathew, D. J., & Eisenbart, B. (2020). Users' Survey For Development of Passenger Drones. In *Proceedings of the Design Society: DESIGN Conference* (Vol. 1, pp. 1637-1646). Cambridge University Press.
- Skondras, E., Siountri, K., Michalas, A., & Vergados, D. D. (2018). A route selection scheme for supporting virtual tours in sites with cultural interest using drones. In *2018 9th International Conference on Information, Intelligence, Systems and Applications (IISA)* (pp. 1-6). IEEE.
- United Rotorcraft. (2020). How Drones Are Changing the Entertainment Industry, [Online]Available at: <https://www.unitedrotorcraft.com/newsroom/how-drones-are-changing-the-entertainment-industry/> (Accessed: 14 July 2022).
- Vandinther, J. (2020). Drone video shows 64,000 sea turtles nesting on Australian Island. [Online]Available at: <https://www.ctvnews.ca/mobile/sci-tech/drone-video-shows-64-000-sea-turtles-nesting-on-australian-island-1.4979772> [Accessed July 26, 2022]
- Vatanasakdakul, S. (2006). Reshaping e-commerce in Thailand: An exploratory study of Internet technology for inter-firm communication adoption in the Thai tourism industry from a cultural fit perspective. *ACIS 2006 Proceedings*, 108.
- Weerasooriya, S., (2021). Industrial drones to uplift agriculture in Sri Lanka. *The Island*. Available at: <https://island.lk/industrial-drones-to-uplift-agriculture-in-sri-lanka/> [Accessed September 13, 2022].
- Wipulasena, A., (2020). Drone seeding – first time in Sri Lanka. *Sunday Observer*. <https://www.sundayobserver.lk/2020/07/19/news-features/drone-seeding-%E2%80%93-first-time-sri-lanka> [Accessed September 13, 2022].
- Yeoman, I., & Mars, M. (2012). Robots, men and sex tourism. *Futures*, 44(4), 365-371.

Digital Twin in Construction Waste Minimization: A Bibliometric Analysis

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ABSTRACT

The construction industry is renowned for its highly dynamic and sophisticated nature. Correspondingly, this industry has evolved by implementing new technologies. The digital twin technology is a vastly utilized concept in manufacturing, maintenance and operations industries. On the contrary, implementing this technology in the construction industry is still developing. Construction waste has been scorching the industry for a long time and has now snowballed into a drastic issue facing the contemporary world. Therefore, many researchers are working to find sustainable solutions to manage waste emissions from construction activities. Correspondingly, it is evident that digital twin technology has the potential to minimize the construction waste component in a significant manner.

The applicability of digital twins in construction waste management requires a systematic and holistic analysis of the research trends. Therefore, this paper aims to provide an in-depth analysis of the literature on digital twin technology in construction waste management. The bibliometric study supports analyzing research trends and notable topics based on historical data. It also evaluates the performance of journals, research fields, and institutions' contributions and collaborations on the topics. Hence, bibliometric analysis was adapted to achieve the research aim. This study retrieved peer-reviewed articles in the Scopus database within the respective research theme published from 2000 to 2022 for the bibliometric analysis. Accordingly, 3301 articles were retrieved from the database using the combination of keywords

"digital AND twin AND construction AND waste". Correspondingly, 961 publications met the selection criteria after manually eliminating the records unrelenting to the topic. Network Analysis Interface for Literature Studies (NAIIS) facilitated the articles' filtration and selection. And then, the bibliometric analysis uses the VOS viewer to evaluate the citation, co-citation, bibliometric coupling, co-word analysis, and keywords. The findings highlight that in recent years application of digital twins is being widely researched. However, the suitability of digital twin technology for construction waste management is yet to be broadly researched. This research provides insights into the research streams and trends on applying digital twins in construction waste management to academia and industry practitioners.

1. INTRODUCTION

Offori (2012) expresses construction as a complex, vast and a geographically spread-out industry. Accordingly, the people's living standards and the patterns have improved with the development of construction industry (Mohammed, et al., 2022). Similarly, the thriving progression of construction activities has accomplished herculean tasks when transforming the world's major cities into engineering miracles (Ozkana & Ozkanb, 2012). However, findings of Georgiadou & Hacking (2010) highlight this vast urbanization has posed novel concerns in the contemporary world. Climate change, environmental degradation, energy shortage, alteration of landscapes, heat island effect, resource depletion and excessive waste generation are among these striking issues (Georgiadou, et al., 2012). Accordingly, the rapid development of construction activities has influenced excessive waste generation (Lu, et al., 2018). Furthermore, the construction industry

consumes a substantial quantity of materials which eventually become waste during various stages of the construction life cycle (Yan & Shen, 2010). Predominantly the construction waste comprises of building debris, rubble, earth, concrete, steel, timber, mixed site clearance materials and construction trash, such as asbestos produced during the demolition of existing structures (Kabir & Khan, 2020).

Luangcharoenrat, et al. (2019) pointed out approximately 16% to 60% of landfill is generated by construction waste. Moreover, Hao, et al. (2019) exemplify that the overwhelming volume of construction waste has escalated into a global crisis. Accordingly, leading countries including Malaysia, China, the USA, and the UK are experiencing the adverse environmental effects of this catastrophe (Liu, et al., 2021). A study done by Monahan & Powell (2011) point out that miscommunication during the designing stage, poor coordination among construction team, reworks, design changes, and ineffective material utilization as the main reason for construction waste generation. The findings of Salihi (2016) suggest that construction waste can be significantly reduced during the proper decisions during the planning and design stage. It is also evident that implementing an effective waste minimisation plan is a sustainable solution for the construction waste issue. Therefore, the findings of Mohammed, et al (2022) emphasise the requirement of a well-defined waste reduction strategy and technology to mitigate the detrimental effects on environmental, social, and economic factors. However, Mohammed, et al. (2020) suggest that modern simulation applications are more suitable to minimize waste than conventional methods. This is because these technologies can intelligently analyze and smoothly plan the construction procedure from the initial stages (Mohammed, et al., 2020). Similarly, the findings of Ziyue & Lizhen, (2020) identified digital twin as a promising concept that can be used to mitigate construction waste issue.

Furthermore, a bibliometric analysis of the literature regarding this field is developing. Durieux & Gevenois (2010) defines bibliometric analysis as a compilation of mathematical and statistical data from journals, books, articles and

other publications. Moed (2009) also denoted bibliometric analysis as a subfield of quantitative research that analyses scientific and scholarly research. The author further highlighted quantity, quality, and structural indicators as the main types of bibliometric analysis (Moed, 2009). Literature analysis of emerging technology is hard to develop because of the scarcity of historical data (Daim et.al,2006). Therefore, Daim et.al (2006) suggested bibliometric analysis as an efficient tool to find historical data available on emerging technologies in different articles. A bibliometric analysis's main objective is to analyze a specific topic's future research directions by conducting an in-depth data analysis and a content analysis (Ampesea, et al., 2022).

This paper's main research questions are: How many articles are published annually in the SCOPUS data base on the digital twin in construction waste management subject area during 2000-2022? and What are the authorship and collaboration patterns of the articles published on the digital twin in construction waste management. Furthermore, the questions include what are the future research directions of the digital twin in the construction waste management field? A bibliometric analysis provides a comprehensive understanding of the literature's quantitative, qualitative, and structural aspects (Minhas & Potda, 2020). The evaluation can support investigating the total number of articles published per year, annual growth, doubling time, and top contributing countries (Chandwani, Agrawal, & Nagar, 2015). It also explores the most occurring keywords, well-known researchers, most cited articles, average citations, and international collaborations (Monghasemi, et.al.,2015). The key objectives of this analysis are to (1) conduct a quantitative analysis of the literature on the digital twin in construction, (2) conduct a qualitative analysis of the literature (e.g., keyword analysis, degree distributions, etc.), (3) perform a structural/network analysis of the literature (e.g., citation analysis and complex network analysis). The rest of the analysis is organized as follows: the literature overview in section 1.3 provides a complete picture of research progress up to the year 2022. Section

1.4, the methodology, explains the comprehensive data collection and research process used in this study. Section 1.5's research results and discussion demonstrate the key findings, analysis outcomes, and future steps. The study finally presents the conclusion in section 1.6, describing the usefulness and benefits of the study.

2. LITERATURE OVERVIEW

In recent years, research on implementing new technologies for construction waste management has been a hot topic among scholars. Chi et. al (2020) defines construction waste as surplus and abandoned materials resulting from building activities, including construction, renovation, and demolition. Construction waste has snowballed into a drastic issue in the contemporary world, especially because it accounts for 35% of the total global solid waste output (Liu, Yi, & Wang, 2020). As presented by Lu et. al (2018) the construction activities in developed countries contribute 20~30% of solid waste in landfills. Construction waste could emanate throughout the construction life cycle, as presented by Wahab & Lawal (2011) the most significant stages are planning, estimating, design, operational, procurement, and material handling. In the same vein, Osmani, Glass, & Price (2008) signified the close relationship between construction waste and decisions made at the initial stages of the construction process. The study further exemplifies that approximately one-third of construction waste could be resulted from poor design decisions (Osmani, Glass, & Price, 2008). In the findings of Lu & Xue (2020), waste produced during the operational stage is determined by errors during the design stage. Lu et al. (2020) points out that construction waste depends on the location, building types, and the clients of a building project.

Sasitharan, Ismail, & Asmi (2008) identified frequent design changes, improper material storage, the effect of weather, poor planning, ordering errors, workers' mistakes, and leftover materials on-site as the most significant factors of waste generation. Likewise, Kaliannan et al. (2018) pointed out constant design changes, improper material storage, improper material

handling, and weather effects and, errors when ordering from suppliers as the five leading causes of construction waste generation. Gebremariam et al. (2020) highlighted five generic factors which lead to construction waste production. Among the factors are activity-specific factors, labor and equipment-related factors, material and storage-related factors, site condition and weather-related factors, and company policies. Tam, Shen, & Tam (2007) introduced the damage occurring during transportation, storage of excessive amounts of materials, and lack of precision in measuring elements as the primary reasons for waste during construction. Researchers have argued that long transportation times, inappropriate handling of materials, and unexpected change of order requests could increase construction waste by 33% (Zoghi & Kim, 2020). However, the findings of Daoud et al. (2020) illustrated that the ineffective application of the materials procurement process is the main reason for construction waste generation.

On the contrary, the findings of Liu, Yi, & Wang (2020) and Chi et al. (2020) identified transportation of construction materials, storage of construction materials, and on-site construction as the primary source of construction waste. Nagapan et al. (2012) pointed out poor site management, lack of experience, inadequate planning, errors in design, and mistakes during construction as the leading causes of construction waste generation. However, all the factors mentioned above will impact construction waste generation to a varying extent since construction projects differ from one another in terms of the design of the project, construction technologies used, site and surroundings.

Lu & Xue (2020) point out that the exponential growth of construction-associated waste has given rise to construction waste management. For that purpose, construction waste minimization can be defined as a process that prevents, illuminate or reduce waste during different stages of the project life cycle (Osmani, 2013). Ajayi & Oyedele (2018) highlight that by implementing construction waste minimization schemes in the design and construction stages,

waste generation could be reduced by 40.63%. Though construction projects ignore such approaches, Liu, Yi, & Wang (2020) highlight that implementing a scheme to reduce waste at the source is essential. Moreover, Ajayi & Oyedele (2017) emphasize limiting the waste production threshold in the project contract, adequate material transportation, strictly adhering to the construction process, and reducing design changes as the key factors in achieving waste reduction. Present on or two sentences of the connection between the factors and technologies here before the next paragraph.

Information technologies are increasingly adopted worldwide to promote the efficiency of construction waste management (Chen, Li, & Wong, 2002). The findings of Li et al. (2020) presented the applicability of contemporary technologies to minimize construction waste. Building information modelling (BIM), Geographic Information System (GIS), big data, Radio Frequency Identification (RFID), image recognition technology, image analysis, Global Positioning System (GPS), and barcode technology are widely used contemporary construction waste management technologies (Li, et al., 2020). Akinade et. al (2018) point out that BIM's parametric modelling, visualization, and simulation capabilities offer an opportunity to improve the efficiency of construction waste management. Zoghi & Kim (2020) highlighted that BIM-based design could reduce construction waste by 15% by minimizing rework by allowing for design review and clash detection. The findings of Won, Cheng, & Lee (2016) emphasized that zero waste goals in construction projects could be achieved by reducing errors, rework, and awkward clashes by implementing BIM. Guerra, Leite, & Faust (2020) illuminated that BIM technology can be used to visualize waste generation as the construction activities are performed. Therefore, the construction waste minimization can be planned effectively using BIM technology.

Furthermore, the findings of Seror & Portnov (2018) introduced Geographic Information System as a technology that can be used to address the construction waste issue. Moreover, Madi & Srour (2019) highlighted that GIS could

be used to locate suitable recycling plants to minimize construction waste's environmental and economic impact. Lu et al. (2015) adopted Big Data to benchmark the performance of construction waste management. On the other hand, Lu et. al (2016) highlighted that the Big Data technology can be implemented to gather information regarding construction waste for managing waste-related issues. Similarly, Lu, Huang, & Li (2011), explained that Radio Frequency Identification technology can be utilized to record on-time and real-time information about waste disposal time, waste type, the waste volume of vehicle, and location. The findings of Yu, et al (2019) exemplified that the demolition waste in construction projects can be predicted utilizing image recognition technology. Di Maria et al. (2016) suggested using Image Analysis technology for assessing the recycling aggregate distribution size of construction waste. Moreover, Li et. al (2020) argued that the Global Positioning system (GPS) has the potential to monitor construction waste transportation. Li et al. (2003) suggested that bar integration of the code technology to the construction site could help minimize construction waste. However, Ajayi & Oyedele (2017) suggest that modern construction waste management tools are insufficient to reduce unnecessary waste output.

According to Chen & Huang (2020), the digital twin is a virtual replica of a physical asset such as processes, people, places, systems, and equipment. The authors state that this technology can be used for data modelling in intelligent cities and equipment detection. Gerber, Nguyen, & Gaetani (2019) highlight that digital twin have three main elements: a physical artefact, a digital counterpart, and the connection that binds the physical and virtual components. The study further exemplifies that the digital twins use advanced sensing, the internet of things, high-speed networking, and advanced analytics to connect the virtual and the physical modules (Gerber, Nguyen, & Gaetani, 2019). The research findings of Rafael et. al (2020) point out that, unlike a BIM model, a digital twin model can be updated as the physical twin changes. The research further suggests that this distinctive feature enables comprehensively and coherently

planning and controlling the construction design and production (Rafael, Ioannis, Ergo, Haiyan, & Mark, 2020).

Wang et. al (2019) define construction waste minimization as reducing or avoiding waste in the whole process of construction implementation by taking all feasible technical means and management measures. The digital twin application can be effectively used to manage construction waste since this technology enables to make effective production planning decisions and carry out construction procedures in a more detailed manner based on reliable “what-if” scenario assessments (Ogunbiyi, Goulding, & Oladapo, 2014). The findings of Chen & Huang (2020) explain that a digital twin is a real-time digital simulation that can be updated with the changes of the physical copy. Therefore, it is evident that the waste generation of the physical model can be speculated through the virtual simulation. The findings of De-Graft, et. al (2021) exemplify a lack of research that has been carried out to solve the construction-related issues utilizing the digital twin technology. However, the study further suggests that in the manufacturing industry, this technology is implemented for predictive maintenance, fault detection, and state monitoring during the production stage (De-Graft, Perera, Robert O, & Maria, 2021). Hence, these functions of the digital twin technology could be integrated to address the waste issue in the construction industry.

3. METHODOLOGY

Bibliometric analysis can be defined as an up-to-date study of a certain research area and the future direction of the subject area can be gained from this analysis (Abramo & D’Angelo, 2011). Moreover, Hicks & Melkers (2022) introduced bibliometric analysis as a vital method in determining the output of scholars on the subject area. Some academics find bibliometric analysis as a valuable method of obtaining comprehensive insights of a certain topic while some research questions the validity of this research type (Norris & Oppenheim, 2010). Similarly, Costas, van Leeuwen, & Bordons (2010) highlighted that, technological activities can be effectively

monitored using bibliometric analysis. Overall, this method provides a vast canvas of knowledge from the micro level (institutes, researchers, and campuses) to the macro level (countries and continents) (Mryglod, Kenna, Holovatch, & Berche, 2013). This technique can provide more information about the relationship between different research directions among various universities (Chandwani, Agrawal, & Nagar, 2015). Accordingly, the bibliometric analysis method was integrated to achieve the aim. However, this study is limited to descriptive analysis and Thematic analysis.

3.1. Data Source and Collection

The bibliometric analysis will be conducted using the articles specialized in the area of implementation of digital twin in construction industry. The journal articles were accessed using the Scopus database. Scopus is one of the leading multidisciplinary and peer-reviewed literature databases (Durán-Sánchez, Del Río-Rama, Álvarez-García, & García-Vélez, 2019). Studies suggest that the coverage of Scopus is almost 60% higher than the Web of Science database (Zhao & Strotmann, 2015). The Scopus database is also more comprehensive compared to Web-of-Science database since the Web of Science is limited to ISI indexed journals (Youssra, Saikouk, Gunasekaran, & Badraoui, 2021). Finally, Scopus provides extensive information related to each publication including detailed author and institution profiles (Youssra, Saikouk, Gunasekaran, & Badraoui, 2021). Therefore, the data gathered from this database is highly accurate and comprehensive. Considering all the above-mentioned facts Scopus database was selected to gather data for this study. A systematic approach was adopted when searching for journal articles by using the key words "digital AND twin AND construction AND waste". Data retrieved from Scopus database could contain inconsistencies due to multiple representations of authors’ names, affiliations, and related data in the original records. Therefore, substantial amount of manual cleaning of data was carried out to ensure the credibility and the integrity of results.

3.2. Descriptive Analysis

Descriptive analysis can be carried out to present the publishing trends, authorship patterns, citation structures, influences, impacts, activity, authors and their affiliations (Donthu, Reinartz, Kumar, & Pattnaik, 2021). This study has carried out the descriptive analysis by accessing the total articles (TA), number of authors who contributed to the articles (NAC), number of sole- and co-authored articles (SA and CA, respectively), collaboration index (CI), cumulative number of affiliated authors (CNAA), and growth in authorship (GA).

For data analysing purposes parameters such as number of cited articles (NCA), proportion of cited articles (PCA), total citations (TC), average citations per article (C/A), and average citations per cited article (C/CA) were calculated. Annexure 1 shows the definition and calculation method of each of these parameters. Data gathered from the Scopus data base during 2000-2022 period was considered for the descriptive analysis. This period was divided to five equal and consecutive 5-year sub periods (2000-2004; 2005-2009; 2010-2014; 2015-2019; 2020-2022) to show more significant trends in analysis. Accordingly, the gathered data was analysed using the MS-Excel software.

3.3. Thematic Analysis

Co-occurrence analysis is used to study the co-occurrence of key words based on how many times those key words are used together in publications. Based on the key words identified in this analysis a cluster analysis is ultimately conducted to identify the research themes. VOS viewer software was used when generating the co-occurrence network. When generating the network diagram, the minimum number of keyword occurrences were set to 5. The results indicated 41 of 1507 keywords met the threshold. For each of the 41 keywords, the total strength of the co-occurrence links with other keywords was calculated. The keywords with the greatest total link strength were selected. Based on the co-occurrence network diagram clusters was identified and analysed based on the keyword's occurrences and the total link strength.

4. RESULT AND DISCUSSION

The following sections present the analysis of data gathered from the Scopus data base during 2000-2022 period. This period was divided to five equal and consecutive 5-year sub periods (2000-2004; 2005-2009; 2010-2014; 2015-2019; 2020-2022) to show more significant trends in analysis.

4.1. Descriptive Analysis

Table 1 provides information on the number of articles published during each period, total authors, articles per author, authors per arrivals and co-authored articles.

A total number of 606 articles were retrieved from the Scopus data base during 2000-2022 period on the digital twin in construction waste management subject area. The number of radicals has increased in each period. However, no article has been published on this subject area until 2015. This indicates that the digital twin technology is a novel concept to the construction waste management. On the contrary the articles per author value have slightly dropped during 2020-2022 period while the authors per article value have showed an upward trend. Co-authored articles value has also shown a significant increase during 2020-2022 period compared to 2015-2019 period. The total publication output can be illustrated from Figure 2.

Authorship data: general view					
Period	2000 - 2004	2005- 2009	2010- 2014	2015- 2019	2020- 2022
Number of articles	0	0	0	57	549
Total Authors	0	0	0	212	2302
Articles per author	0	0	0	0.27	0.24
Authors per article	0	0	0	3.72	4.19
Co-authored articles	0	0	0	209	2269

Table 19 Authorship data: general view

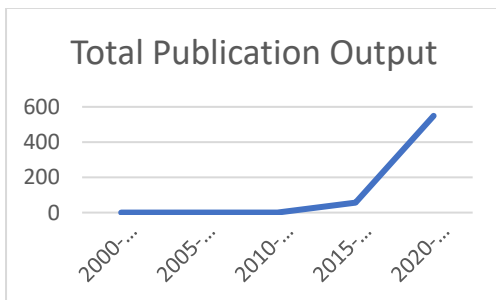


Figure 17 Total publication output

Collaboration Index is one of the early measures of degree of collaboration derived by Lawani (1986).

$$\sum = fi / N$$

fi = Number of authors

N = Number of publications in the year

It is a measure of mean number of authors. Although it is easily computable, it is not easily interpretable as a degree, for it has no upper limit; moreover, it gives a non-zero weight to single-authored papers, which involve no collaboration.

According to table 2, the collaboration index has increased from 3.72 to 4.91 during 2020-2022 period. The table also shows the sole authored articles, co-authored articles and cumulative number of affiliate authors.

Table 20 Authorship pattern

The sole authored articles are drastically less than the co-authored articles. Both co-authored and

Authorship pattern					
Period	2000 - 2004	2005 - 2009	2010 - 2014	2015 - 2019	2020 - 2022
Number of articles	0	0	0	57	549
Single	0	0	0	3	33
Two	0	0	0	11	73
Three	0	0	0	16	117
Four	0	0	0	15	112
Five	0	0	0	4	87
Six	0	0	0	3	67
Seven	0	0	0	2	36
Eight	0	0	0	2	6
Nine	0	0	0	0	4
Ten	0	0	0	0	3
> Ten	0	0	0	1	11
Sole-authored articles	0	0	0	3	33
Co-authored articles	0	0	0	54	516
Cumulative number of affiliated authors	0	0	0	209	2269
Total Authors	0	0	0	212	2302
Collaboration index				3.72	4.19

sole authored articles gave notably increased during 2020-2022 period. Figure 3 illustrates the annual trend of co-authored articles and total articles.

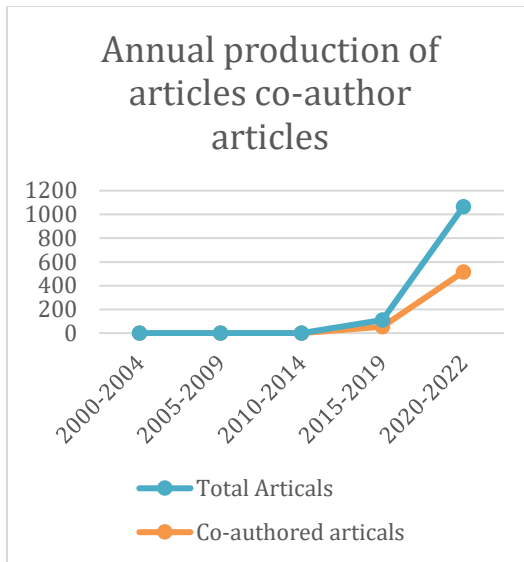


Figure 18 Annual production of articles and co-authored articles

Table 3 presents the number of citations, number of cited articles, proportion of cite articles, citations per publication and citations per cited articles.

Table 3 Citation frequency

Accordingly, the number of citations recorded has almost doubled during 2020-2022 period compared to 2015-2019 period. Similarly, the number of cited articles has also shown an upward trend over the years. However, the proportion of cited articles have dropped during 2020-2022 period. Similarly, the citations per publications and citations per cited articles values have shown a steep downward trend. Figure 4 shows the trends of citations per publication value and the citations per cited articles value during the time period.

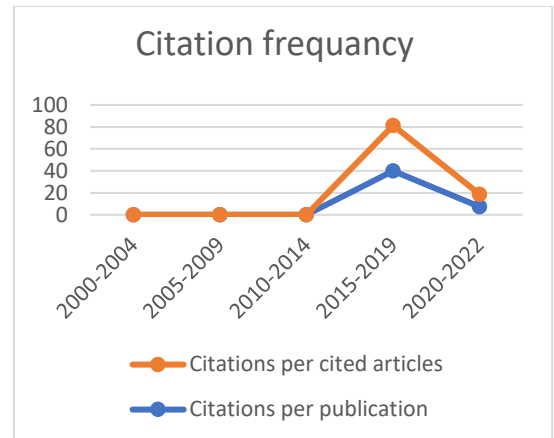


Figure 19 Citation frequency

4.2. Thematic Analysis

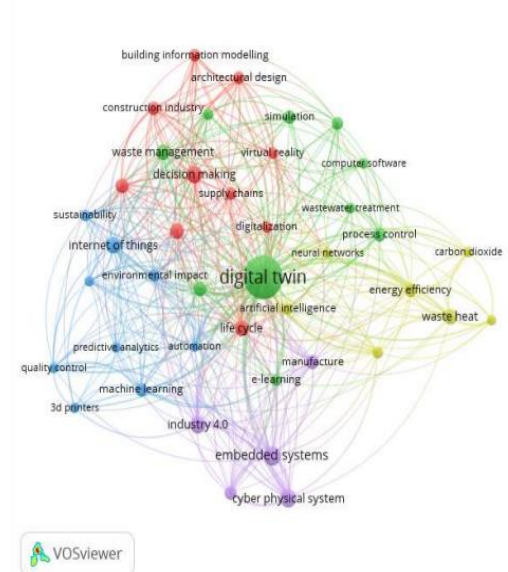
Table 4 reviews the quantitative dimensions of the revealed keywords, which consist of occurrences and total link strength. The co-occurrence network of keywords generated from the final number of keywords is illustrated in Figure 6. The larger the number of abstracts and titles that have the same two terms in common, the closer these terms to appear in the map. The tool divided the keywords into five clusters, as illustrated in Table 5.

Key word	Occurrences	Total link strength
digital twin	74	219
embedded system	16	64
cyber physical system	14	53
life cycle	10	49
internet of things	11	48
industry 4.0	13	46
sustainable development	9	45
circular economy	9	41
decision making	12	41
construction industry	8	40
manufacture	9	40
waste management	10	39
environmental impact	7	38
architectural design	7	37

Table 4 Key word occurrences

Citation Frequency					
Period	2000-2004	2005-2009	2010-2014	2015-2019	2020-2022
Number of articles	0	0	0	57	549
Number of citations recorded	0	0	0	2276	4004
Number of cited articles	0	0	0	55	347
proportion of cited articles	0	0	0	96.49	63.21
Citations per publication	0	0	0	39.93	7.29
Citations per cited articles	0	0	0	41.38	11.54

Figure 20 co-occurrence network



A cluster represents a set of closely related nodes, and each node is assigned precisely to one group. The clusters, as shown in Figure 6 and Table 5, helped to break down the literature into separate groups that emphasise a particular aspect. Table 5 shows that the maximum number of keywords per cluster was 10, while the minimum was 4. The keywords that are listed in the same group appear to show close similarities regarding the research topics. The significant gap between groups, as shown in Figure 6, is because of the lack of connections between some topics or due to the lack of relationship between them. A qualitative analysis was considered. However, it cannot.

4.3. Discussion on Future Implications

The bibliometric analysis conducted in this article helped us to understand the adaption of the digital twin technology to the construction industry over the past decade. The results also indicate the ongoing growth of research on this area since 2014. However, the literature findings and the bibliometric findings suggest that there is lack of research published in the implication of the digital twin technology in construction waste management.

It is evident that construction waste management has become a hot topic in the contemporary world. The literature highlighted poor site management, lack of experience, inadequate planning, errors in design, and mistakes during construction as the leading causes of construction waste generation. The findings further suggested that the digital twin application can be effectively used to manage construction waste since this technology enables to make effective production planning decisions. A digital twin is a real-time digital simulation that can be updated with the changes of the physical copy. Therefore, it is evident that the waste generation of the physical model can be speculated through the virtual simulation. Despite of the potential of becoming an effective waste minimization technology implementation of the digital twin technology to the construction industry is still at the infant stage. However, in the manufacturing industry this technology is implemented for predictive maintenance, fault detection, and state monitoring during the production stage. Accordingly, the findings of the bibliometric analysis suggest that the implementation of digital twin application in construction waste minimization is a promising area of future research.

5. CONCLUSION

This paper adopted a science mapping approach to evaluate how digital twin technology can contribute to minimize construction waste. A two-stage method was used to search, filter, and review publications to aid in the strategic thinking about how digital twin is implemented in construction industry. A total of 660 publications, including articles, proceedings papers, and reviews published since 2022 were selected as the literature sample from the SCOPUS database. An analysis of co-occurrence terms, and co-citation was provided, and a critical review was performed. From the literature, adopting new technologies such as digital twin can minimize the construction waste issue. However, it has been concluded that application of digital twin technology in the construction industry is still at the infant stage. Furthermore, the analysis was based on the dataset retrieved from SCOPUS and only

included literature in English. In addition to the quantitative analysis, a qualitative study was considered, which cannot cover all the literature collected because of the large volume. Samples of the collected papers were reviewed to give insight into the current research. Thus, this study may not reflect the entire digital twin literature within those topics.

REFERENCES

- Abramo, G., & D'Angelo, C. (2011). Evaluating research: From informed peer review to bibliometrics. *Scientometrics*, 87, 499–514.
- Ajayi, S. O., & Oyedele, L. O. (2017). Policy imperatives for diverting construction waste from landfill. *Experts' recommendations for UK policy expansion. J. Clean. Prod.*, 147, 57-65. doi:doi.org/10.1016/j.jclepro.2017.01.075.
- Ajayi, S., & Oyedele, L. O. (2018). Critical design factors for minimising waste in construction projects: A structural equation modelling approach. *Resour. Conserv. Recycl.*, 137, 302-313. doi:doi.org/10.1016/j.resconrec.2018.06.005.
- Akinade, O. O., Oyedele, L. O., Ajayi, S. O., Bilal, M., Alaka, H. A., Owolabi, H. A., & Arawomo, O. O. (2018). Designing out construction waste using BIM technology: Stakeholders' expectations for industry deployment. *Journal of Cleaner Production*, 180, 375–385. doi:doi:10.1016/j.jclepro.2018.01.022
- Alhojailan, & Ibrahim, M. (2012). Thematic Analysis: A Critical Review of its Process and Evaluation. *West East Journal of Social Sciences*, 1(1).
- Ampesea, L. C., Sganzerlaa W, G., Zieroa, H. D., Mudhoob, A., Martinsc, G., & Forster-Carneiro, T. (2022). Research progress, trends, and updates on anaerobic digestion technology: A bibliometric analysis. *Journal of Cleaner Production*, 331.

- doi:doi.org/10.1016/j.jclepro.2021.130004
- Chandwani, V., Agrawal, V., & Nagar, R. (2015). Modeling slump of ready mix concrete using genetic algorithms assisted training of Artificial Neural Networks. *Expert Syst. Appl.*, 42, 885–893.
- Chandwani, V., Agrawal, V., & Nagar, R. (2015). Modeling slump of ready mix concrete using genetic algorithms assisted training of Artificial Neural Networks. *Expert Syst. Appl.*, 42, 885–893.
- Chen, Z., & Huang, L. (2020). Digital Twin in Circular Economy: Remanufacturing in Construction. IOP Conference Series: *Earth and Environmental Science*, 57(2), 588.
- Chen, Z., Li, H., & Wong, C. (2002). An application of bar-code system for reducing construction wastes. *Autom. Constr.*, 11(5), 521–533.
- Chi, B., Lu, W., Ye, M., Bao, Z., & Zhang, X. (2020). Construction waste minimization in green building: A comparative analysis of LEED-NC 2009 certified projects in the US and China. *Journal of Cleaner Production*. doi:doi:10.1016/j.jclepro.2020.120749
- Costas, R., van Leeuwen, T. N., & Bordons, M. (2010). A bibliometric classificatory approach for the study and assessment of research performance at the individual level: The effects of age on productivity and impact. *J. Am. Soc. Inf. Sci. Technol.*, 61, 1564–1581.
- Daim, T., Rueda, G., Martin, H., & Gerdri, P. (2006). Forecasting emerging technologies: Use of bibliometrics and patent analysis. *Technol. Forecast. Soc. Chang.*, 73, 981–1012.
- Daoud, A. O., Othman, A. A., Robinson, H., & Bayyati, A. (2020). An investigation into solid waste problem in the Egyptian construction industry: A mini-review. *Waste Management & Research*. doi:doi:10.1177/0734242X2
- De-Graft, J. O., Perera, S., Robert O, K., & Maria, R. (2021). Digital twin application in the construction industry: A literature review. *Journal of Building Engineering*. doi:doi:10.1016/j.jobe.2021.102726
- Di Maria, F., Bianconi, F., Micale, C., Baglioni, S., & Marionni, M. (2016). Quality assessment for recycling aggregates from construction and demolition waste: An image-based approach for particle size estimation. *Waste Manage.*, 48, 344–352.
- Donthu, N., Reinartz, W., Kumar, S., & Pattnaik, D. (2021). A retrospective review of the first 35 years of the International Journal of Research in Marketing. *International Journal of Research in Marketing*, 38, 232–269.
- Durán-Sánchez, A., Del Río-Rama, M. d., Álvarez-García, J., & García-Vélez, D. F. (2019). Mapping of scientific coverage on education for entrepreneurship in higher education. *Journal of Enterprising Communities: People and Places in the Global Economy*, 13(1/2), 84–104.
- Durieux, V., & Gevenois, P. (2010). Bibliometric Indicators: Quality Measurements of Scientific Publication. *Radiology*, 255, 342–351.
- Gebremariam, A. T., Di Maio, F., Vahidi, A., & Rem, P. (2020). Innovative technologies for recycling End-of-Life concrete waste in the built environment. *Resources. Conservation and Recycling*, 163, 104–911. doi:doi:10.1016/j.resconrec.2020.104
- Georgiadou, M. C., & Hacking, T. (2010). Future-proofed design for sustainable communities. In *Sustainability in energy and buildings. Results of the 2nd international conference on sustainability in energy and buildings SEB'10* (pp. 6-7). London: Springer Verlag.
- Georgiadou, M., Hacking, T., & Guthrie, P. (2012). A conceptual framework for future-proofing the energy performance. *Energy Policy*, 47, 145–155. doi:doi:10.1016/j.enpol.2012.04.039

- Gerber, D., Nguyen, B., & Gaetani. (2019). *Digital twin—towards a meaningful framework*. Arup Research. doi: <https://research.arup.com/>.
- Guerra, B. ., Leite, F., & Faust, K. M. (2020). 4D-BIM to enhance construction waste reuse and recycle planning: Case studies on concrete and drywall waste streams. *Waste Management, 116*, 79–90. doi:doi:10.1016/j.wasman.2020.07.035
- Hao, J., Yuan, H., Liu, J., Chin, C., & Lu, W. (2019). A model for assessing the economic performance of construction waste reduction. *J. Clean. Prod, 232*, 427–440. doi:<https://doi.org/10.1016/j.jclepro.2019.05.348>
- Hicks, D., & Melkers, J. (2022, 07 4). *Bibliometrics as a Tool for Research Evaluation*. 2012. Available online:. Retrieved from https://works.bepress.com/diana_hicks/31/
- Kabir, Z., & Khan, I. (2020). Environmental impact assessment of waste to energy projects in developing countries: General guidelines in the context of Bangladesh. *Assessments, 37*, 100-619.
- Kaliannan, S., Nagapan, S., Abdullah, A. H., Sohu, S., & Jhatial, A. (2018). Determining Root Cause of Construction Waste Generation: A Global Context. *Civil Engineering Journal-Tehran, 4*, 2539-2547.
- Li, C. Z., Zhao, Y., Xiao, B., Yu, B., Tam, V. W., Chen, Z., & Ya, Y. (2020). Research trend of the application of information technologies in construction and demolition waste management. *Journal of Cleaner Production, 263*, 121-458. doi:doi:10.1016/j.jclepro.2020.121458
- Lia, N., Han, R., & Lu, X. (2018). Bibliometric analysis of research trends on solid waste reuse and recycling during 1992–2016. *Resources, Conservation & Recycling, 1(130)*, 109-117.
- Lia, N., Han, R., & Lu, X. (2018). Bibliometric analysis of research trends on solid waste reuse and recycling during 1992–2016. *Resources, Conservation & Recycling, 1(130)*, 109-117.
- Liu, J., Yi, Y., & Wang, X. (2020). Exploring factors influencing construction waste reduction: A structural equation modeling approach. *Journal of Cleaner Production*. doi:doi:10.1016/j.jclepro.2020.123185
- Lu, W., & Xue, F. (2020). Estimating construction waste generation in residential buildings: A fuzzy set theory approach in the Brazilian Amazon. *Journal of Cleaner Production, 265*, 121-179. doi:doi:10.1016/j.jclepro.2020.121779
- Lu, W., Chen, X., Ho, D., & Wang, H. (2016). Analysis of the construction waste management performance in Hong Kong: the public and private sectors compared using big data. *J. Clean. Prod, 112*, 521-531.
- Lu, W., Chen, X., Peng, Y., & Liu, X. (2018). The effects of green building on construction waste minimization: Triangulating 'big data' with 'Thick data'. *Waste Management, 79*, 142-152. doi:doi:10.1016/j.wasman.2018.07.030
- Lu, W., Chen, X., Peng, Y., & Shen, L. (2015). Benchmarking construction waste management performance using big data. *Resour. Conserv. Recycl, 105*, 49-58.
- Lu, W., Huang, G., & Li, H. (2011). Scenarios for applying RFID technology in construction project management. *Autom. Constr, 20*, 101-106.
- Madi, N., & Srour, I. (2019). Managing emergency construction and demolition waste in Syria using GIS. *Resour. Conserv. Recycl, 141*, 163-175.
- Minhas, M., & Potda, V. (2020). Decision Support Systems in Construction: A Bibliometric Analysis. *Buildings, 108(10)*. doi:doi:10.3390/buildings10060108
- Moed, H. (2009). New developments in the use of citation analysis in research evaluation. *Arch. Immunol. Ther Exp., 57*, 13.

- Mohammed, M., Shafiq, N., Abdulrahman, A., Al-Mekhlafi, A., Zawaw, N. ., Mohamed, A. M., . . . Al-Nini, A. (2020). Beneficial Effects of 3D BIM for Pre-Emptying Waste during the Planning and Design Stage of Building and Waste Reduction Strategies. *Sustainability*, 14, 3410. doi:<https://doi.org/10.3390/su14063410>
- Mohammed, M., Shafiq, N., Al-Mekhlafi, A., Rashed, E. ., Khalil, M., Zawawi, A., . . . Sadis, A. (2022). The Mediating Role of Policy-Related Factors in the Relationship between Practice of Waste Generation and Sustainable Construction Waste Minimisation: PLS-SEM. *Sustainability*, 14(2), 656. doi:<https://doi.org/10.3390/su14020656>
- Monahan, J., & Powell, J. (2011). An embodied carbon and energy analysis of modern methods of construction in housing: A case study using a lifecycle assessment framework. *Energy Build*, 43, 179–188.
- Mryglod, O., Kenna, R., Holovatch, Y., & Berche, B. (2013). Comparison of a citation-based indicator and peer review for absolute and specific measures of research-group excellence. *Scientometrics*, 97, 767–777.
- Nagapan, S., Rahman I, A., Asmi, A., Memon A, H., & Zin R, M. (2012). Identifying Causes of Construction Waste “Case of Central Region of Peninsula Malaysia. *International Journal of Integrated Engineering*, 4(2), 27-56.
- Norris, M., & Oppenheim, C. (2010). The h-index: A broad review of a new bibliometric indicator. *J. Doc.*, 66, 681–705.
- Ofori, G. (2012). Developing the Construction Industry in Ghana: the case for a central agency. *National University of Singapore Omega*, 25, 415-435. Retrieved from <http://ghanatrade.com.gh/file/Developing%20the%20Construction%20Industry%20in%20Ghana%20BUILDING.pdf>
- Ogunbiyi, O., Goulding, J., & Oladapo, A. (2014). An empirical study of the impact of lean construction techniques on sustainable construction in the UK. *Construction Innovation*, 14(1), 88–107. doi:<https://doi.org/10.1108/CI-08-2012-0045>
- Osmani, M. (2013). Design waste mapping: a project life cycle approach, *Proceedings of the ICE. Waste and Resource Management*, 166(3), 114-127.
- Osmani, M., Glass, J., & Price, A. D. (2008). Architects’ perspectives on construction waste reduction by design. *Waste Management*, 28, 1147–1158.
- Ozkana, F., & Ozkanb, O. G. (2012). Causal relationship between construction investment policy and economic growth in Turkey. *Technological Forecasting & Social Change*, 362-370.
- Pattnaik, D., Kumar, S., & Vashishtha, A. (2020). *Research on trade credit – a systematic review and bibliometric analysis. Qualitative Research in Financial Markets*. doi:[doi:doi.org/10.1108/QRFM-09-2019-0103](https://doi.org/10.1108/QRFM-09-2019-0103). ahead-of-print(ahead-of-print).
- Rafael, S., I. B., Ergo, P., Haiyan, S. X., & Mark, G. (2020). Construction with digital twin information systems. *Data-Centric Engineering*, 14, 2-23. doi:[doi:doi:10.1017/dce.2020.16](https://doi.org/10.1017/dce.2020.16)
- Salihi, I. U. (2016). Application of structural building information modeling (S-BIM) for sustainable buildings design and waste reduction: A review. *Int. J. Appl. Eng. Res*, 11, 523–1532.
- Sasitharan, N., Ismail, A. ., & Asmi, A. (2008). *A Review of Construction Waste Cause Factors*. UTHM: Faculty of Civil and Environmental Engineering.
- Seror, N., & Portnov, B. A. (2018). Identifying areas under potential risk of illegal construction and demolition waste dumping using GIS tools. *Waste Manage*, 75, 22-29.
- Tam, V., Shen, L., & Tam, C. M. (2007). Assessing the levels of material wastage affected by sub-contracting relationships and projects types with their correlations. *Build Environment*, 42, 1471–1477.

- Wahab, A., & Lawal, A. (2011). An evaluation of waste control measures in construction industry in Nigeria. *African Journal of Environmental Science and Technology*, 5(3), 246-254.
- Wang, J., Yu, B., Tam, V., Li, J., & Xu, X. (2019). Critical factors affecting willingness of design units towards construction waste minimization: An empirical study in Shenzhen, China. *Journal of Cleaner Production*, 526-535.
- Won, J., Cheng, J. C., & Lee, G. (2016). Quantification of construction waste prevented by BIM-based design validation Case studies in South Korea. *Waste Management*, 49, 170-180.
- Wu, H., Zuo, J., Zillante, G., Wang, J., & Yuan, H. (2019). Construction and demolition waste research: a bibliometric analysis. *Architectural Science Review*. doi:DOI: 10.1080/00038628.2018.1564646
- Yan, H., & Shen, Q. (2010). Greenhouse gas emissions in building construction: A case study of One Peking in Hong Kong. *Building and Environment*, 45, 949-955.
- Yousra, R., Saikouk, T., Gunasekaran, A., & Badraoui, I. (2021). Artificial intelligence applications in supply chain: A descriptive bibliometric analysis and future research directions. *Expert Systems With Applications*, 173. doi:doi.org/10.1016/j.eswa.2021.114702
- Yu, B., Wang, J., Li, J., Zhang, J., Lai, Y., & Xu, X. (2019). Prediction of large-scale demolition waste generation during urban renewal: A hybrid trilogy method. *Waste Manage*, 89, 1-9.
- Zhao, D., & Strotmann, A. (2015). *Analysis and visualization of citation networks: Synthesis lectures on information concepts*.
- Ziyue, C., & Lizhen, H. (2020). Digital Twin in Circular Economy: Remanufacturing in Construction. *IOP Conference Series: Earth and Environmental Science*, 588, 106-110.
- Zoghi, M., & Kim, S. (2020). Dynamic Modeling for Life Cycle Cost Analysis of BIM-Based Construction Waste Management. *Sustainability*, 12(6), 2483-. doi:doi:10.3390/su12062483

Use of Montmorillonite Clay Mixtures as Engineered Soils for Plant Survival in Low Water Conditions

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ABSTRACT

Water is essential for the survival of all types of plants. Due to harsh conditions, plants in arid and semi-arid regions will suffer from water shortage or drought at some point in their life. These could be fatal in most situations, or sometimes it dramatically slows down the growth rate of those plants. Soil composites, which contain clay, could be a better option for plant survival in low water conditions. Montmorillonite (MMT) is a widely used layered clay material due to its water retaining ability (Calero & Rodrigo, 2018). Hence, this research was designed to evaluate the best composition ratio of MMT: Soil for plant survivability. Treatments included different ratios of the measured amount of MMT and dried soil; T1; 1000:0, T2; 900:100, T3; 800:200, T4; 700:300, T5; 600:400, T6; 500:500, T7; 0:1000. Chili plants were chosen as the test plant for the experiment and 80 ml of deionized water was added to each treatment. Plants were monitored weekly. However, stress symptoms were observed both in the soil-only pot and MMT-only pot. Gradually other treatments showed stress symptoms. Optimum survival was observed in T3; 800:200.

1 .INTRODUCTION

Several plants; that suffer from low water conditions are easily found in almost all the arid and semi-arid areas of the world (Zia, Nawaz,

Siddique, Hakim, & Imran, 2020). To minimize the dramatic effects of this stress and complete their life cycle under low water conditions, plants in those regions have evolved various adaptive responses (Anjum et al., 2011). Even though, after a certain extent of water level, plants show stress conditions, which may affect the cell cycle, cell expansion, and root-to-shoot signaling (Skirycz & Inze, 2010). Ultimately plants reduce their growth to save and redistribute resources that can become limited under extreme stress conditions. To overcome the above issues, various soil composites could be used (Calero & Rodrigo, 2018). Further, this type of composite could be used for the plants in sloppy areas to gain good water retaining ability to soil and gives good plant stability.

Natural clays are used in different applications such as fertilizers and engineered soil compositions. (Gunaratne, Kottegoda, Adassooriya, & Munaweera, 2016). Those types of materials consist of layered silicates or clay minerals along with little metal oxides and organic matter (Ebrahimi, Pellenq, & Whittle, 2012). With regard to the alternating sheets of SiO₂ and AlO₆ units that make up their constituents, these natural clays have been divided into three classes. They are classified as 1:1 (kaolinite), 2:1 (montmorillonite and vermiculite), and 2:2 (chlorite) with regard to various ratios (Rafiee & Shahzadi, 2018). Due to its strong swelling capability in polar regions and high aspect ratio, MMT is frequently used in material applications out from the above diverse types of clays (Of & Society, 1952).

MMT consists of two tetrahedral silicate sheets, and each comprises unshared oxygen atoms

around a central octahedral hydroxide sheet, which has two planes of unshared. This arrangement made MMT a layered natural clay.

The lamellae are constructed using oxygen atoms and extra hydroxyl groups (OH). Each lamella has a net negative charge that is balanced by positive exchangeable interlayer cations as a result of isomorphous replacements of metal ions inside the clay sheets (Ebrahimi, Pellenq and Whittle, 2012). This system's retention of water molecules results in a significant rise in the basal layer gap. This swelling process significantly impacts the structural and mechanical characteristics of the clay.

Therefore the objective of this paper is to study plant survivability in fewer water conditions using MMT and evaluate the best composition ratio of MMT: Soil for plant survivability.

2. MATERIALS AND METHODS

MMT was purchased from Southern Clay (USA). All chemicals and reagents used for this study were purchased from Sigma Aldrich Company, USA. Chemicals were in analytical grade and used without purification. Data analysis was carried out using the Origin statistical package (version 8.0)

2.1. PXRD Characterization of engineered soil compositions

Powder X-ray diffraction patterns (PXRD) were taken using a Bruker D8 Focus X-ray powder diffractometer, powder X-ray diffraction patterns (PXRD) of soil, MMT, and soil mixture of pot no. 3 were recorded over a 2θ range of $2-80^\circ$ with a step size of 0.02° and a step time of 1 s using Cu K α radiation ($\lambda = 0.154$ nm).

2.2. Plant Experiment

The experiment was conducted on red-yellow podzolic soil in a controlled environment. A Series of a mixture of MMT and dried soil was prepared as in Table 1. Seven nearly identical chili plants were chosen as the test plant. Each plant was planted in a plastic pot, and 80 ml of deionized water was added. The experiment

continued for three weeks, and the setup was monitored online. Images of the set were taken weekly.

Table 1. Different compositions of Soil and MMT in pots

Pot No.	Soil (g)	MMT (g)
1	1000	0
2	900	100
3	800	200
4	700	300
5	600	400
6	500	500
7	0	1000

3. RESULT AND DISCUSSION

3.1. Structure and Morphology

The PXRD data of soil and MMT are shown in Figures 1 and 3. (Benmansour, Slimane, & Benosman, 2018).

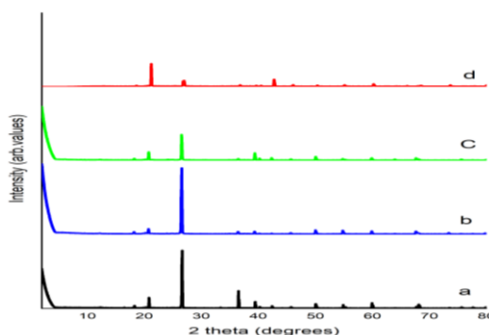


Figure 1. PXRD pattern of (a) initial soil (b) 8% water added soil (c) 16 % water added soil and (d) dried soil at 40 °C

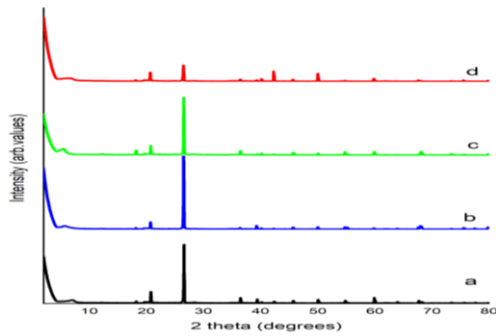


Figure. 2. PXRD pattern of (a) Initial MMT (b) 8% water added MMT (c) 16 % water added MMT and (d) dried MMT at 40 oC for 24 Hrs

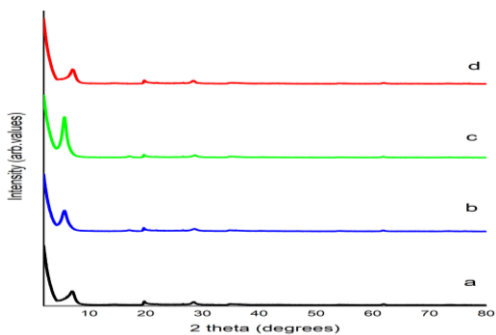


Figure. 3. PXRD pattern of soil 800 + MMT 200 mixture (a) Initial (b) 8% water added (c) 16 % water added and (d) dried mixture at 40 oC for 24 Hrs

XRD allows us to measure the distance between silicate plates and visualize the intercalation behavior of various molecules (Quilaqueo, Echeverría, Ihl, Bifani, & Mauri, 2012). According to the results, soil only sample did not show any characteristic peak shifts with the addition of water (Figure 1).

However, MMT only sample that showed an evident change in the basal/characteristic diffraction peak at $2\theta = 7.0$. This is due to the intercalation of the water molecules between the clay interlayers, which eventually increases interlayer spacing that shifts the diffraction peaks towards lower angle values (Madusanka, Sandaruwan, Kottegoda, & Sirisena, 2017). The basal peak shifted to $2\theta = 5.7$ with the addition of 0.8 ml of water, and it further shifted to $2\theta = 5.6$ with the addition of another 0.8 ml of water,

which suggests that interlayer spacing increased with respect to the amount of water added.

Even in soil water mixture, diffraction peaks related to MMT showed a shift towards lower angle values. Hence, soil: MMT mixture could hold a higher amount of water concerning soil only pot. The reversible nature of the composite layered structure was also observed for pure MMT and MMT engineered soil after heating the samples to 40 °C. The basal peak of MMT was shifted to high theta values resembling low interlayer spacings showing the loss of water molecules from the layered structure resulting in the initial layered structure.

3.2. Plant Studies

Plant studies also help to prove the (PXRD) results. Plant in the soil-only pot shows stress symptoms first, and their leaves start to fall off initially. This is due to the low water retention ability of the native soil system. The same observation was seen in the MMT-only pot. This is mainly due to poor soil features. Usually, clay soil is defined as soil with a high concentration of clay particles. Water logging is caused by its sluggish water drainage and fast hardening. It inhibits root uptake, preventing plants from obtaining vital nutrients for survival. As a result, plant growth is not possible. The optimum survival was shown in the pot with a composition of MMT: Soil; 200 g: 800 g.

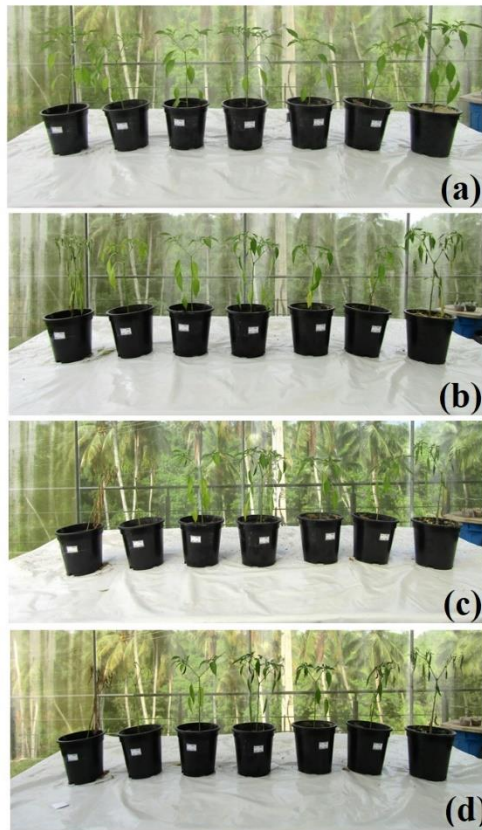


Figure. 4. Pictures of different treatments (a) first day, (b) after 1 week, (c) after 2 weeks, and (d) after 3 weeks

4. CONCLUSION

In conclusion, MMT: Soil; 200 g: 800 g is the most suitable soil mixture for plant growth in extreme temperature conditions and sloppy areas where a low water retention is expected.

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REFERENCES

- Anjum, S. A., Xie, X., Wang, L., Saleem, M. F., Man, C., & Lei, W. (2011). Morphological , physiological and biochemical responses of plants to drought stress, 6(9), 2026–2032. <https://doi.org/10.5897/AJAR10.027>
- Benmansour, K., Slimane, S. K., & Benosman, A. (2018). Adsorptive removal of Acidol Red 2BE-NW from aqueous solutions using chitosan / montmorillonite beads Adsorptive removal of Acidol Red 2BE-NW from aqueous solutions using chitosan / montmorillonite beads, (March). <https://doi.org/10.1080/19443994.2015.1110721>
- Calero, S., & Rodrigo, M. A. (2018). Persistence of submerged macrophytes in a drying world: Unravelling the timing and the environmental drivers to produce drought - resistant propagules, (July 2017), 1–16. <https://doi.org/10.1002/aqc.2879>
- Ebrahimi, D., Pellenq, R. J., & Whittle, A. J. (2012). Nanoscale Elastic Properties of Montmorillonite upon Water Adsorption.
- Gunaratne, G., Kottegoda, N., Adassooriya, N. M., & Munaweera, I. (2016). Two new plant nutrient nanocomposites based on urea coated hydroxyapatite : Efficacy and plant uptake Two new plant nutrient nanocomposites based on urea coated hydroxyapatite : Efficacy and plant uptake, (April).
- Madusanka, N., Sandaruwan, C., Kottegoda, N., & Sirisena, D. (2017). Applied Clay Science Urea – hydroxyapatite-montmorillonite nanohybrid composites as slow release nitrogen compositions. Applied Clay Science, 150(May), 303–308. <https://doi.org/10.1016/j.clay.2017.09.039>
- Of, J. O. U. R. N. A. L., & Society, A. M. E. R. I. C. A. N. C. (1952). J O U R N A L OF THE, 74(9).
- Quilaqueo, M., Echeverría, I., Ihl, M., Bifani, V., & Mauri, A. N. (2012). Carboxymethylcellulose – montmorillonite nanocomposite films activated with murta (Ugni molinae Turcz) leaves extract Carboxymethylcellulose – montmorillonite nanocomposite films activated with murta (Ugni molinae Turcz) leaves extract, (January). <https://doi.org/10.1016/j.carbpol.2011.09.040>

- Rafiee, R., & Shahzadi, R. (2018). Mechanical Properties of Nanoclay and Nanoclay Reinforced Polymers: A Review. <https://doi.org/10.1002/pc.24725>
- Skirycz, A., & Inze, D. (2010). More from less : plant growth under limited water, 197–203. <https://doi.org/10.1016/j.copbio.2010.03.002>
- Zia, R., Nawaz, M. S., Siddique, M. J., Hakim, S., & Imran, A. (2020). I P of. Microbiological Research, 126626. <https://doi.org/10.1016/j.micres.2020.126626>

The Usage of Infrastructural Volumes as Sustainable Democratic Public Platforms

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ABSTRACT

Our current era is defined by the sociopolitical movement known as democracy. Its inclusiveness has confirmed equity in society and improved the idea of "publicness" in numerous built and unbuilt forms. How architecture expresses democracy in the built public space is an intriguing topic to investigate since it serves as a reflection of the way of life that people of a particular era admired. The analytical assumption of research, which is based on the concept that public architecture/space should be a "democratic" setup that is open and accessible to people from all walks of life, has been explored in the process of doing so. The fundamental research question for the study has been established by the aforementioned hypothesis: How can a democratic (barrier-free) use of public architecture and space be determined? What are the public architectural design methods, concepts, and approaches to establish the democracy to empower democratic public activities?

Both a requirement and a quality of better public architecture is democracy in a public setting. However, a significant amount of public architecture created for people's benefit is sometimes absent from what we generally refer to as public buildings. The usage of infrastructural volumes to create democratic public platforms as a solution to the above problem is questioned through this research.

The three illustrative cases and the extortion case data collection methodology begin with literature reviews on each country's historical, sociocultural, and political backgrounds. Following the exploration, the data will be sorted

into graphs and charts for future use. The author will next use an analytical framework he established utilizing earlier work on the subject to analyze these facts. Then, using a critical analysis of all three situations, final conclusions and remarks are differentiated. At first, a theoretical framework was constructed, and context was examined, as well as international instances. The case study, which focuses on the Pettah neighborhood in Colombo, was examined using data acquired from interviews, reports, newspapers, magazines, and a variety of other sources. The nature of the study made it wide and cross-disciplinary. As a result, the scope of the investigation was carefully narrowed without compromising it. The study was carried out in a narrative manner with the aim of portraying it in comprehensive form because the research investigated social-physical processes.

Key words: *Democracy, Public place, public architecture, Infrastructural Volume, Spatial governance*

10. INTRODUCTION

As Jan Gehl has claimed public space is preferably the "living room" of the city and is the place where people gather, interact, and indulge with each other as well as with the city. (Gehl, 2011)

The study was on the usage of infrastructural volumes as public spaces to perform as community empowerment platforms. Architecture able to shape societies, change personal perspectives, and establish the socio-cultural values with providing opportunities to improve the lifestyle of the people.

In the present-day majority of the society focus on the economic development and due to that

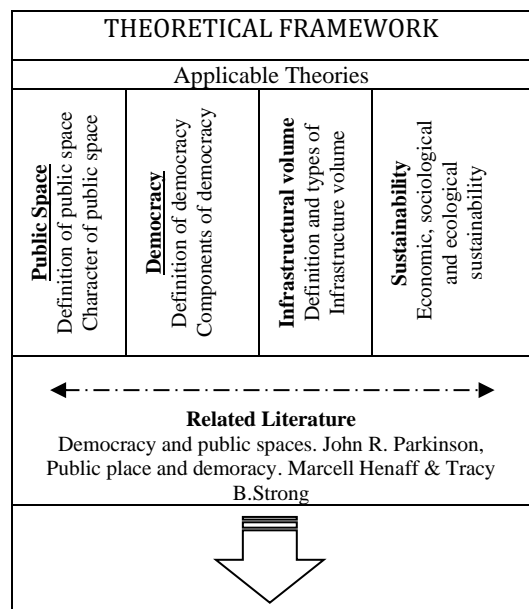
reason, development has been valued in a commercial aspect rather than focusing on humanitarian values. Due to the high land value created by the area's historical significance, view, access to beaches, infrastructure advantages, and other factors, service providers in a highly commercial zone often choose to offer high-end services that are easily out of the financial reach of the area's typical users. The façade will lose its visual appeal to a passerby, who regularly walks towards the above zone, but is unable to interact with 90% of the cafes, hotels, and restaurants he passes on the route. As a result, gentrification can be identified within different social groups and therefore, some communities are marginalized due to the lack of economic capacity. Therefore, initiation of community empowerment platforms can be considered as a social requirement and these platforms need to be public spaces, which are open to everyone. Gentrification can be identified to be the main reason of democratic failure in most of the South Asian Public spaces. Although these new public leisure areas aim to give the city a facelift, the socio-economic comfort levels attained by the new strategy are unquestionably dubious. Hence, the introduction of feasible spaces for public activities without is a requirement to minimize the above-mentioned social issues.

Usage of infrastructural volumes for the above requirement can be considered as a more sustainable solution in aspect to economic, sociological, ecological, and cultural factors. True democracy of a public place can be identified on how people will be received as well as how bold people will be to use a space and that need to be achieved through developing sense of belongingness and cultural engagement. (Liebenberg, Wall, Wood, Hut-MacLeod, 2019). Thus, infrastructural volumes are easy to convey the sense of belonging since these spaces are familiar and accessible for everyone in the society.

The research resembled interpretive research, where the evidence is often derived from artifacts and archival sources. This was due to the fact that these studies tend to concentrate on a sociological situation of the community. The focus of imperative research is on social-physical

events in intricate systems with a goal to comprehensively describe and understand such phenomena. (Groat & Wang, 2002).

Usage of infrastructural volumes for public spaces in the global context are discussed under the third heading with international examples as the initiation for discussion and above examples are taken from different socio-economic and cultural backgrounds to represent the democratic ideologies in different contexts. The theoretical framework found through the literature analysis will serve as the foundation for the case study assessment. The data is displayed in analytical graphs along with illustrations, sketches, and photos. The discussion regarding the analysis of the data gathered will be divided into two parts. A synopsis of each case study in respect to the theoretical framework will be the first stage. The second step will compare the interpretations and analyses of various case studies in order to develop a comprehensive argument regarding the implications of "democracy" in the design of public spaces built in infrastructural volume. Three international cases are taken to validate the theoretical framework and based on the evaluation of above cases, the proposal of using infrastructural volumes as democratic public platforms in Pettah, Colombo was examined through explorative framework.



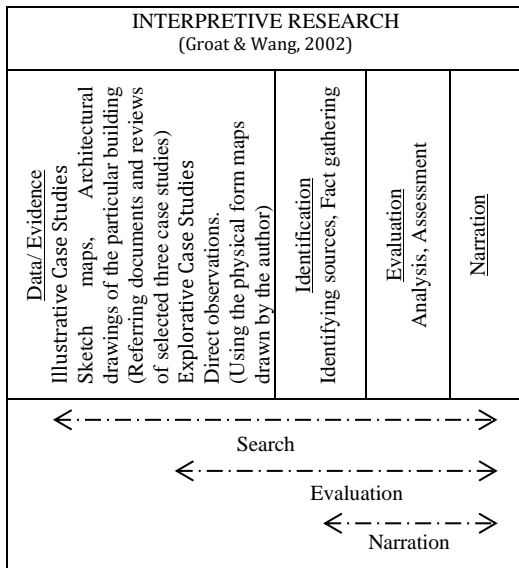


Chart 1: Theoretical framework to execute the interpretative research

11. THEORETICAL FRAMEWORK

11.1. Public Space

“Great public spaces are the living room of the city - the place where people come together to enjoy the city and each other. Public spaces make high quality life in the city possible - they form the stage and backdrop to the drama of life. Public spaces range from grand central plazas and squares, to small, local neighbourhood parks” - (Gehl, 2011)

The term, “Public Space” can be defined in numerous ways but basically, public space is a place which is commonly open and accessible to people. Public spaces provide many prospects for people to gather and to work with the community and thus public spaces are considered as an important asset to cities. According to the renowned urban-planning scholar Jan Gehl, great public spaces are considered as living rooms of the cities, where people come together to enjoy the city and to be with each other. Public space makes a pleasurable and lively environment for people within the community and improve the quality of their lifestyle while establishing social relationships.

Extent of the public spaces can fluctuate from grand central plazas and squares to small local neighborhood parks. Nevertheless, all these spaces achieve the above conditions visible in public spaces. If public places have been productively designed and used, the characteristic that exist between different clusters of people in the society could disappear, ultimately resulting in the promotion of social integrity and making everyone a part of a common societal framework. This character of entertaining the public with equality can be identified as democracy and thus, democracy is a method of making collective decisions, notably concerning three attributes: (1) how to distribute scarce resources, (2) the power relations, and (3) interests that structure distribution. More specifically, it concerns with normative issues of who should get what, and how to structure society (Low & Smith, 2006). In the above definition, resources represent money, time and other physical goods and services, while information and information technology are also sometimes considered as resources.

11.2. Democracy

Democracy calls for people to be treated equally, despite their evident inequalities in other respects (Dahl, 1989: 89). One of the reasons why democracy is valued is because it is a set of decision-making procedures that reflect the ‘wishes’ (May, 1978: 1), ‘felt interests’ (Saward, 1998: 51), or ‘settled preferences’ (Goodin, 2003: 1) of citizens (Saward) or most of the persons affected (May and Goodin) by that decision making process. Primarily, democracy is a collective decision-making mechanism which facilitates people to decide what to do and resolve disagreements.

Fundamentally, a public space which is fair to everyone, a place that treats all in an equitable manner is called a ‘democratic public space’. In such a democratic space, people must be allowed to express their lives and behavior, despite the consequences of their socio economic or political status, origin or ethnicity, or the social position. Creating opportunities for people to enjoy their life without any discriminations support

increasing the quality of life, strengthening mentality, and making a united community.

However, democracy in South Asian context refers to individuals exercising control over how they wish to utilize and interact with a public space. As a result, it is not a place where the public is forced to behave in a certain way. It also does not have physical, social, or political obstacles that prevent individuals from entering or using it. A "democratic public space," by contrast, creates a variety of attributes, circumstances, and chances to draw people from all backgrounds and enable them to unwind, mingle, or even customize, but just be themselves as per their individual, democratic wish. The following analytical framework used to evaluate democracy of public spaces based on the literature review to narrow down the physical and social factors of the democratic public space.

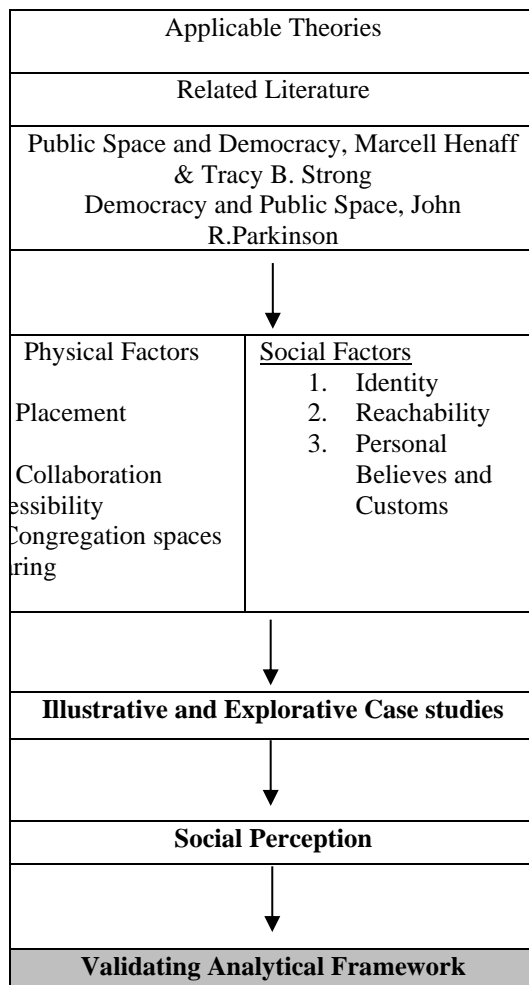


Chart 2: analytical framework to execute the interpretative research

11.3. Infrastructural Volumes

Term "Infrastructure" refers to the social, physical, and economic systems that strengthen society and development of the infrastructure is significant for the efficient operation of a modern, industrialized country. Primarily, two categories can be identified in infrastructure as hard and soft. Physical components which support daily life, such as roads, bridges, highway systems as well as the properties that make above components operational such as buses, trains and mass transit are considered as the hard infrastructure. Human capital—social and economic components such as financial institutions, health-care services, and telecommunications are referred as the soft infrastructure. (Torrisi, G., 2009)

Typology of an infrastructure business entity can be identified in different project forms such as pure public type, public/private mixture type, private type. (Nakamura, Nagasawa, Hiraishi, Hasegawa, Ram, Kim, Xu, 2019). Projects which rely on tax revenue are considered as the pure public type and hard infrastructural components such as mainly roads, railways, bridges, riverbanks, canals considered as the pure public type. This type of infrastructure is operated and treated as public property while the national and local government provide tangible goods for public use. The management of the above-mentioned public property is strictly stipulated by public property management laws and therefore, aforesaid infrastructural components are legally belonging to the government of the country.

Specifically, roads, railways, bridges, and riverbanks can be categorized under transportation infrastructure, and these are the mostly used infrastructure by the public. Even though roads are managed under public property management law, the road law governs disciplinary factors of the automobile highways, general national roads, prefectural roads, and municipal roads. Rivers, canals are also

improvement that add artificiality to natural public goods for the purposes of water use, transportation, flood control, environmental conservation and governed under the river law. The space above and below of the aforesaid infrastructure entity can be identified as the infrastructural volume and that also belongs to the same statutory body. Therefore, infrastructural volume also remains as public property which cannot be used by a separate commercial purpose.



Figure 1 : Infrastructural volume
(Source – Author)

Since the pure public type of infrastructure allows the public to occupy and entertain the outcomes, sense of belongingness to the public is significantly above average even the property legally belongs to the local government.

11.4. **Infrastructural Volumes as Democratic Public Spaces**

As a holistic and deliberative view of democratic societies, people of the democratic society expect various actions and strategies to experience the establishment of democracy. A successful public space is one of the most effective features in a healthy democratic society as a deliberative system where people get equal opportunities and allowed to express their lives without circumstances. Unfortunately, availability of spaces to generate public spaces in the urban area becoming to a lesser extent due to the highly commercial development agendas. As a result of that gentrification can be vastly observed in the society and requirement of introducing of feasible spaces to establish democratic public spaces becomes a conspicuous issue in a democratic society. While creating democratic public space, crucial responsibility of the architects to confirm the existence of such place

without getting threatened from the highly economical approaches. Therefore, utilizing pure public properties to achieve the above objective would be successful but availability of the vacant lands is extremely less due to the higher value of the lands and the congested setup in the urban areas.

As a result of major commercial developments, amount of the vacant lands in the urban context decreasing and launching of the innovative policy options for assembling and making these plots available to responsible users need to be done by the authorities. A range of aggressive and entrepreneurial policies need to be established through the governance to improve the systems development. (Pagano, Bowman, 2000)

Usage of transport infrastructural volumes to create public spaces can be considered as an innovative solution to the shortage of vacant lands in the urban context due to the commercialization. Since the transport infrastructure categorized as pure public properties, threat of being commercialized is not applied to this type due to the property belonging to the government. Furthermore, transport infrastructure is familiar to everyone in the society without social, cultural and economic barrier, gentrification does not generate through these public platforms.

12. **SUSTAINABILITY OF USING INFRASTRUCTURAL VOLUMES AS DEMOCRATIC PUBLIC SPACES**

Sustainability can be an important aspect in the current architectural practice where the resources are running out fast. But apart from ecological sustenance socio-economic substance of a public building is an important aspect to look at considerations taken in this sense will help the building to survive high commercial waves and be able to continuously serve public to keep good mental and social health.

In order to economical sustain, it is quite impossible for public building to sustain independently in a harsh economy. Specially if a building provides socially beneficial services rather than earning any money, it can be hard to

sustain a building without it being an additional cost to the government tempting government to reduce facilities or close it down all together with time. Alternatives of space acquiring are doubtful as filling marshy lands, filling water bodies, using reservation lands and high-rises impact human existence ecologically and sociologically. Therefore, utilizing a lost space through infilling an infill would minimize such impacts.

Creating a space for people can be challenging in a divided society. More powerful party has the ability to swallow up the space for their own needs. Sustenance of social aspect is expected through the mission of the project itself. Mitigating gentrification being the purpose of the project, the sustenance is expected to be delivered in action. On the other hand, in failure of its social sustenance, the research could continue as per why it failed in our context.

13. INFRASTRUCTURAL VOLUMES AS DEMOCRATIC PUBLIC SPACES IN GLOBAL CONTEXT

Three case studies High line in New York, Ponte Vecchio in Italy, Elevated Park in Chapultepec, Mexico are taken as the illustrative case studies to validate the above theoretical frame work.

The High Line, a 1.5-mile-long public park constructed on an abandoned elevated train running from Manhattan's Meatpacking District to the Hudson Rail Yards, was created in conjunction with Piet Oudolf and James Corner Field Operations. The new park celebrates its



legacy by drawing inspiration from the melancholy, untamed beauty of this postindustrial ruin, where nature has reclaimed a once-important component of urban infrastructure. In a series of site-specific urban micro-climates along the railway line, which include sunny, shady, rainy, dry, and sheltered locations, it translates the biodiversity that proliferated after it fell into ruin. During this

project, it was noted how urban infrastructure volumes had been utilized to give the general public a breathing space inside a congested constructed environment. It has been noticed that a common area can function as a well-liked democratic public place without much enforcement, therefore strategies have been implemented into the project.

The Ponte Vecchio, often known as the "Old Bridge," is a historic closed-spandrel segmental arch bridge made of stone that spans the Arno River in Florence, Italy. The businesses were originally occupied by butchers; currently, jewelers, art dealers, and souvenir vendors occupy the space. The Ponte Santa Trinita and the Ponte alle Grazie are the two nearby bridges to the Ponte Vecchio. After receiving permission from the Bargello, it has always welcomed retailers and merchants who displayed their goods on tables outside of their establishments (a sort of a lord mayor, a magistrate and a police authority). The seventeenth century saw the addition of the back shops (retrobotteghe), which may be seen from upriver.

The exponential urban growth of Mexico City over the past few decades has created issues with mobility, unorganized urban growth, and pollution. This has had an impact on the physical connectedness of its roadways and axes as well as its public perception. However, it has also given significant chances for architectural and urban interventions. Urban planning project, developed by FRENTE arquitectura and RVDV arquitectura urbanismo, recently to the above context is an idea for revitalizing public space in one of the city's most promising neighborhoods in an effort to foster community.

Figure 2 : from Left to right - High line in New York, Ponte Vecchio in Italy, Elevated Park in Chapultepec, Mexico

(Source:<https://graylineflorence.com>,
<https://en.wikipedia.org>, <https://archdaily.com>)

	High line, NY	Ponte Vecchio	Elevated Park
Physical Factors			
1. Location (Contextual Placement ,Visibility, Contextual Collaboration)	✓	✓	✓
2. Physical Accessibility	✓	✓	✓
3. Diversity in Congregation spaces	✓	✓	✓
4. Resource Sharing	✓	✓	✓
5. Connectivity	✓	✓	✓
Social Factors			
1. Identity	✓	✓	✓
2. Reachability	✓	✓	✓
3. Personal Believes and Customs	✓	✓	✓

Chart 3: Comparison of illustrative case studies

14. USAGE OF INFRASTRUCTURAL VOLUMES IN PETTAH AS DEMOCRATIC PUBLIC SPACES

Pettah is clearly a socio-cultural landmark of Colombo. It has evolved through years keeping and generating its own characteristics. The vibrancy of the market has made it a place into a tourist attraction as well. Conserving its characteristics in the process of development needs close attention.

Developments coming from private and government agendas keep building and saturating the built environment in such a rapid manner, Pettah faces the threat of losing its inherent vibrant quality in order to adjust to the high rate of gentrification happening all around it. Some proposals include replacing pettah with modern buildings that would match the high economic context around it.

Many up-and-coming projects prove to have a considerable effect on the existing context as

well as how the area will be shaped socially and economically. These effects intensify the need of the project to manage the radically different two ends of architectural and socio- economical character to sustain in a coherent manner through rapid development.



Figure 3: from Left to right – Pettah railway station foyer, public movement character of Pettah, Pettah Market

(Source: <https://nofixedaddress.in>,
<https://www.steuartholidays.com>,
<https://www.covermore.com.au>)

Due to the aforesaid socio- economic issues in the selected context, which is from third world country, usage of infrastructural volumes as public spaces can be considered as a sustainable approach and through this concept, establishment of democracy within the aforementioned public space would be considerable as it achieves the above examined physical and social factors. Furthermore, due to the tropical climate of the country, this approach provides a comfortable atmosphere to the public which works as a social magnet.

14.1. Explorative case study selection

Key reasons to select Pettah area of Colombo as the case study are,

1. Pettah is one of the extremely congested area due to the placement of services, while Colombo being the commercial capital area of the country.
2. Pettah consists of a multi-cultural setting and occupied by people from various socio-economic backgrounds to fulfill their requirement.
3. Due to current socio-economic situation of the country, Sri Lanka requires sustainable solutions to maintain the sociological values of the public.

14.2. Methods of Validation

The validation was built on the following three elements:

1. The theoretical framework and related literature.
2. Case studies from international context are covered in heading 4. (Infrastructural Volumes as Democratic public spaces in the Global context).
3. Evidence, such as sworn statements, journal and newspaper articles, blog posts, videos, photographs, research papers, etc.

Since the analytical framework being validated through the illustrative case studies, establishment of the aforesaid physical and social factors will enhance the democratic features of the explorative case study, which is Pettah, Colombo. Even though, physical factors such as location, public movement, accessibility, connectivity fulfilled in the context of Pettah is indomitable to achieve social factors due to the current socio-cultural perspective. However, it's proved with the illustrative case studies that socially sensitive architectural approach establish the democracy in the designed public space to empower community.

15. CONCLUSION

Within Sri Lanka's discursive and cultural environment, "democratic public space" is a crucial and effective, yet understudied issue. A nation's development depends in part on how many opportunities its citizens are given to exercise their political and democratic rights, and "barrier-free" access to and use of public space is undoubtedly a right that every citizen of a contemporary democracy should be able to exercise without any restrictions. Therefore, it is essential to assess the conceptual depth, spatial qualities, and implementation approaches of such an idea, both at the academic and practical levels.

The three case studies examined here to assess the idea of infrastructure volume as democratic public space are all related to urban planning initiatives that, typologically, depict the country's democratization. Contrary to the society's-imposed belief system, a democratic nation's public space must be developed and it should

entertain the people, being adaptable to their requirements and attainable to their desires and aspirations.

The study concludes by making three important observations. First, the idea that a particular application of design principles might engender a sense of democracy in a public setting. Second, the belief that creating an accessible public space must be a core goal of design used in a democratic administration structure. Thirdly, the implementation of using infrastructural volume as public spaces provides a democratic platform for community empowerment while providing sustainable solution.

The overwhelming presence of democratic public spaces in the international examples demonstrates how equitable, contemporary lifestyles are represented through architecture in advanced democratic societies. Through international instances, the progressive ideology of democracy with justice and equality is realistically implied, which serves as a source of inspiration for future undertakings in the field. In general, the study offers some guidance on how to effectively employ infrastructure volume as a democratic public space that demonstrates values upheld, morality upheld, and principles upheld by the larger socio-political players. In order to do this, the study highlight the necessity of closely examining and understanding how specific architectural forms represent the governance of associated cultures.

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REFERENCES

- Amin, A. (2008). Collective culture and urban public space. *City*, 12(1), 5–24.
- Appel.H, Anand.N, Gupta.A (2018), *The Promise of Infrastructure* (Durham NC: Duke University Press

- Beqaj, B. (2016). Public Space, public interest and Challenges of Urban Transformation. IFAC-PapersOnLine, 49(29), 320–324.
- Gallagher, W. (1993). The Power of the Place. Poseidon Press New York.
- Gehl.J (2011) Life between buildings using public space Island Press
- Henaff, M., & Strong, T. B. (n.d.). PUBLIC SPACE AND DEMOCRACY. 3
- Herzog P.S (2019) Visual research methods 3-13
- Jochen.M (2022) Urban and Infrastructural Rhythms and the Politics of Temporal Alignment Journal of Urban Technology 70-73
- Liebenberg.L, Wall.D, Wood.M ,Hut-MacLeod.D ,(2019) Spaces & Places: Understanding Sense of Belonging and Cultural Engagement Among Indigenous Youth International Journal of Qualitative Methods 3-6
- Pagano M.A & Bowman A (2000) Vacant Land in Cities: An Urban Resource. Center on Urban & Metropolitan Policy 7-9
- Parkinson.J (2006) Holistic democracy and physical public space British Journal of Political Science Conference 1-7
- Parkinson, J. (2012). Democracy and public space: the physical sites of democratic performance. Oxford: Oxford University Press
- Sudjic, Dejan, and Helen Jones. 2001. Architecture and democracy. London: Lawrence King/Glasgow City Council.
- Torrise, Gianpiero (2009) Public infrastructure: definition, classification and measurement issues Munich Personal RePEc Archive 20-21

Factors Affecting the Shopping Experience in Supermarkets for Senior Citizens of Sri Lanka

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ABSTRACT

Sri Lanka is at risk of an aging population and the birth rate is at a decrease and the number of elder people is increasing day by day. It is no doubt that under this critical condition, it is important and mandatory to consider more about age-friendly spaces for facilitating enough comfort and contentment to them. It is universally accepted that most elderly people manifest their preference for shopping in supermarkets, and leisure activities they regularly do or particularly enjoy. As a result of this situation supermarket industry has a huge chance to increase and expand their market. But Sri Lankan supermarket industry have not yet capitalized on the opportunity created by the growing aging population by catering to their needs inconvenience. On the other hand, aging includes common changes including vision, hearing (audibility), accessibility, which is to be considered in the interior design of a common age-friendly spaces to facilitate the health, well-being of elderly people and assures accessible, safe, secure, supportive, fair, and inclusive built forms. Internationally most of the researchers state in their articles that design factors can affect seniors within supermarkets. However, in Sri Lanka, researches related to this topic have not been conducted. The purpose of this research is to identify the reasons which are valid to the Sri Lankan supermarket industry. The author decided to do this study to examine the most effective factors for designing age-friendly supermarket interiors in Sri Lanka to improve self-independence and wellness of elderly people. Data collection for this research was done by using qualitative data methods. Searching online professional journals, newspaper articles, and books, and photographic surveys were used to collect required data.

Sathosa supermarkets within Gampaha district are selected to do the case studies to find out the most effective specific factors for designing an age-friendly supermarket interiors in Sri Lanka. So it is conclusive that seniors need well-arranged supermarket layout, proper arrangements of equipment, comfortable lighting system and most suitable floorings in Sri Lankan supermarkets to make them satisfied by improving age friendliness within the built environment.

16. INTRODUCTION

Sri Lanka is one country in the world that has a rapidly aging population. As a result of this pathetic condition, the birth rate in Sri Lanka is at a decrease, and there are fewer young people. The Daily Mirror in 2008 also stated that Sri Lanka's people aged 60 years and above are projected to increase from the current 11% to 18% in 2025 and 27.6% in 2050. It is distinctly clear that Sri Lanka will have more elders than younger people. This ongoing demographic shift creates opportunities and challenges for marketers, retailers, designers, and researchers. Especially this situation will create a bigger market for the supermarket industry and other elder people supportive services.

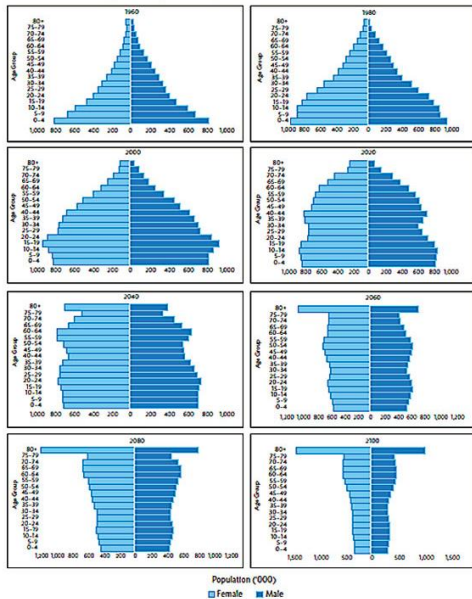


Figure 21. Population pyramid of Sri Lanka from 1960-2100 (Asian Development Bank, 2019)

Some international articles such as UK Time Use Survey (2000) showed that 59% of those aged 65 and over reported liking shopping compared with an average of 47% of people younger than 65. Hence it is clear that older people do enjoy shopping as much as younger people.

Even if senior citizens love grocery shopping, they are less mobile and have many physical and psychological issues. Common physical changes among elders include vision, hearing/ audibility, mobility, and psychological changes commonly include fear of falling which is to be considered in the Interior design of a common age-friendly space. These age-friendly Interiors facilitate the health, well-being of elderly people and assure accessible, safe, secure, supportive, fair, and inclusive built forms.

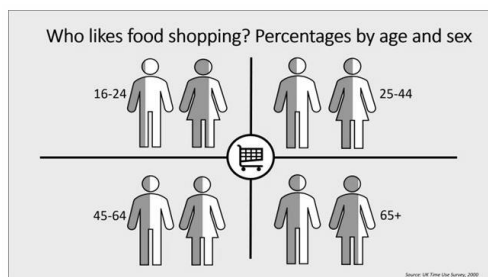


Figure 22. Senior citizen preference for food shopping (Age UK, 2000)

Even if senior citizens love grocery shopping, they are less mobile and have many physical and psychological issues. Common physical changes among elders include vision, hearing/ audibility, mobility, and psychological changes commonly include fear of falling which is to be considered in the Interior design of a common age-friendly space. These age-friendly Interiors facilitate the health, well-being of elderly people and assure accessible, safe, secure, supportive, fair, and inclusive built forms.

Some international researchers have stated that most of the elders are facing a range of difficulties within built environments and these difficulties commonly happen with narrow aisles, poor shelf positioning, shelves that are too high or low, lack of adequate rest and toilet facilities, deep trolleys, and freezers, poor lighting levels, that make it difficult to go shopping (Dagmar Lesakor, 2016). To identify that these reasons are valid to the Sri Lankan supermarket industry as well, the author decided to create main research questions to identify the most important design factors influencing the shopping experience in Sri Lankan supermarkets for seniors.

Since some international researchers have stated that a good supermarket layout which includes a proper rack labeling system, proper signage, location indicators, and containers with linear arrangements, appropriate seating, and toilets will make confidence among the elderly to go shopping (Gelinferry, 2009), the author decided to create a sub question to evaluate the importance of the supermarket layout and its environment for the shopping experience of aged people in Sri Lanka as well.

Robert Donovan in 2005 and also Abraham George in 2007 have stated that most of the older people are shorter than younger people because of the generation difference in average heights. Being shorter will make difficulties when reaching products on higher shelves and,

stretching or reaching for accessories can cause pain in the body parts, especially joints pains for the aged, and discourage them from their daily activities. To identify that these reasons are also valid into Sri Lanka a sub-question is created to find out the effect of equipment placement for the shopping experience of aged people in Sri Lanka.

Moreover, some international researchers have stated, when people are getting older the retina which converts light into neural signals and sends those signals to the brain for recognition becomes less sensitive and elderly people require bright lights for the reading purpose. Richard W. Besdine (2019) stated that 50 + needs 3 times more light to read than the 20s. So, the author decided to create another sub question to find out the effect of Interior lighting for the shopping experience of aged people in Sri Lanka.

Julie Leobach, associate professor in the department of psychiatry, University of California stated that fear of falling avoids some physical activities and decreased capacity to perform daily living activities such as shopping in supermarkets and this happens mainly with the slippery surfaces and the slopes within the supermarket environment. As a result of this statement, the author created another sub question to identify the impact of the floorings in supermarkets on elderly people in Sri Lanka. However, to carry out well-developed research the author created the objectives

- To find out the specified supermarket designing standards for 50-70 years old senior people in Sri Lanka.
- To find out the physical and psychological needs of 50-70 older people which create an impact on shopping experience in supermarkets.
- To find out the most effective specific design factors in Sri Lankan supermarkets for 50-70 years old senior people.

2. RESEARCH METHODOLOGY

This research discusses both primary and secondary research methods. Since the research paper needs to study and observe the behaviour of older people to getting a wider understanding

of the design factors affecting older people within the supermarket-built environment, a case study has been done under qualitative research methods. This case study will be done within Sathosa supermarkets in Sri Lanka. Among all the supermarkets in Sri Lanka, "Lanka Sathosa" has more old customers than other supermarkets. Sathosa is the largest scale business network with over 400 outlets in Sri Lanka. Most of the Sathosa branches are in rural areas and it is also a reason for having many old consumers. Moreover, Sathosa supermarkets give lots of offers and discounts for retired government people, people who are working in the government sector, and for those of state pension age. Specially a large proportion of rural elderly in Sri Lanka do most of their grocery shopping in Sathosa supermarkets. Because of these reasons the author did a present case study within Sathosa supermarkets in Sri Lanka.

2. RESEARCH DESIGN

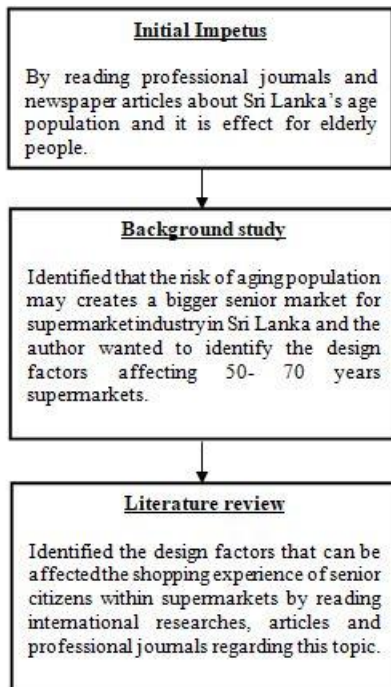


Figure 23. Diagram of research design

The literature review describes the dependent and independent variables to find the most effective design factors affecting the shopping experience of elderly people within supermarkets in Sri Lanka and they are mentioned below.

Design factors affecting the shopping experience of senior citizens in Sri Lanka	
Independent variables	Dependent variables
1. Supermarket environment and layout : (Product arrangements, level differences, ramps and entrances)	1. The comfort and satisfaction of elderly people within supermarket interior

2. Equipment sizes and placements : (Shelf height, counters and checkouts, trolleys and baskets, aisle placements)	
3. Flooring: (Flooring surfaces)	
4. Lightings (Lighting levels, glare, reflection, contrast sensitivity)	

Table 21. Independent and dependent.

4. LITERATURE REVIEW

According to the introduction it is distinctly clear that most of the European countries have specified age-friendly supermarkets. They have specified supermarket design standards to welcome every consumer regardless of age, disability, or other factors. Even though countries like Japan which is in Eastern Asia has some age-friendly supermarkets, in Southern Asian countries like India, Bangladesh there are not any. But they have specified supermarket standards that should be used within every supermarket to welcome all the consumers.

4.1. Standards already specified for supermarkets

As per the introduction, most of the European countries and some Asian countries have

specified supermarkets' standards for welcoming every consumer.

4.1.1. Supermarket environment and layout

1. Product arrangements

A good layout can attract customers to more through the store and buy more products than planned generally, which leads to an increase in customer satisfaction (Baker et al., 2017). Besides for customer satisfaction, design elements are used to project a favorable store environment (Macheilt and Eroglu, 2006). Supermarket store environment should be placed which includes a proper rack labeling system with level indicators and location indicators, containers with the linear arrangement, allocation of space to products, flexible and changeable arrangements, appropriate toilets and seating arrangements for making people confident to go shopping at all (Gelnferry, 2009).

2. Level differences

A store's environment is based on an arrangement of entrances, exits, and aisles that is physically and psychologically welcoming (Masao Ohta, 2013). The interior has been designed to create a "U" shape path to allow the customers to view as many products as possible (Gelnferry, 2009). The meaning of the "U" shape path is the entrance, and the exit should be on the same side. Jaina Rodriguez, creative director of the integrated design-retail design studio has shown that planning for a single store floor design will optimize the customer experience.

3. Ramps and entrances

- All the supermarkets should have a disabled access with a good gradient or always open entrances with the width of more than 815

mm (Gertrude R. Mafatlane, Lily C. Fidzani, Kesitegile S.M. Gobotswang, 2015).

- All doors to be easily opened and wide enough with good handles that are comfortable for wheelchair users as well (Gaelle Walker, 2015).

4.1.2. Equipment sizes and placements

1. Shelf placement

- Plan shelves to enhance the maximum movement and product visibility and shelves need to be organized well to display your customers to the most item and this is why section positioning is essential (Gelnferry, 2009). The world of science in Visual Merchandising and Shelf placement has divided the vertical shelves into four zones and they are stretch level, eye level, touch level, and stoop level.
 - A. Stretch level is above 1.8 m and this level takes physical effort on the shopper to look up the top of the shelves. The only light product should be placed here to prevent possible injuries.
 - B. Eye-level is 1.2m-1.5m and the best level for adults. In this level, sellers are placed products that they are usually selling.
 - C. The touch level is 0.9m-1.2m and the best level for kids. Most of the time sellers place sweets at this level.
 - D. The stoop level is below 0.9m. Normally consumers do not like to bend down to get products on the shelves. Especially elders and disabled people do not like this level and not it does not suit them.

Heavier products are placed here for safety reasons.

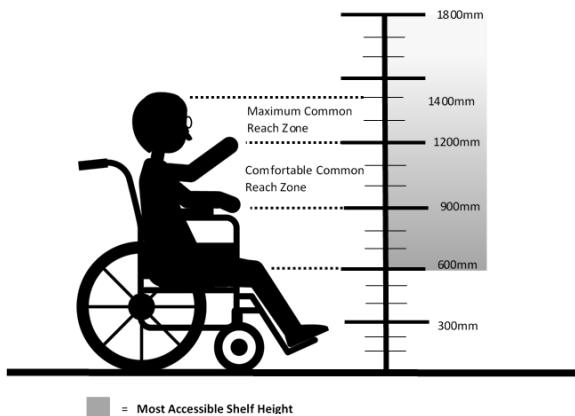


Figure 24. Specified levels for vertical shelves

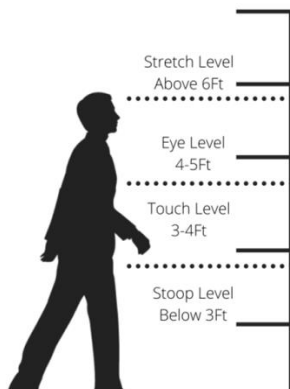


Figure 25. Comfortable shelf levels for wheel chair users

- There should be enough space between aisles for wheelchairs. Aisles width should be more than 850mm for a wheelchair and allow for easy moments (Gertrude R. Mafatlane, Lily C. Fidzani, Kesitegile S.M. Gobotswang, 2015). Ernst Neufert architect's data book stated that the width of the aisles should be 2200-2500 mm. Gertrude R. Mafatlane, Lily C. Fidzani, Kesitegile S.M. Gobotswang in 2015 also stated the same statement.

2. Counters and checkouts

Ernst Neufert architect's data book stated that checkpoints laid out to suit the frontage of the unit with a countertop for purchases, cash register, wrapping spaces with bags, space for parking trolleys, and baskets. The standard dimensions for the counter and checkouts are mentioned below.

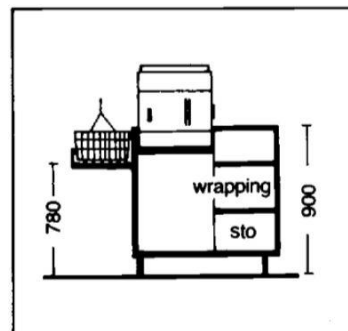


Figure 26. Standard sizes for cash desks (Ernst Neufert Architect's data book) Section view

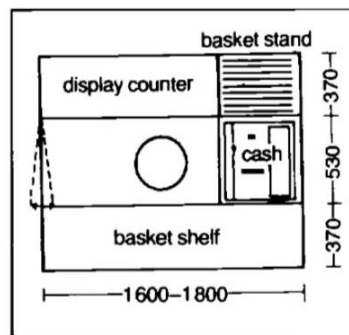


Figure 27. Standard sizes for cash desks (Ernst Neufert Architect's data book) Plan view

3. Trolleys and baskets

Every supermarket should have a proper and special place for parking trolleys and baskets. Normally this space is designed at the entrance. In Ernst Neufert architect's data book stated that,

- Each 100m area for 50-100 baskets and 10 trolleys.
- Each 200m area for 50-200 baskets and 30 trolleys.

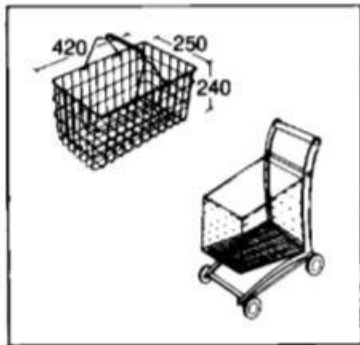


Figure 28. Standard sizes of shopping baskets (Ernst Neufert Architect's data book)

4.1.3. Floorings

All the supermarkets should use suitable non-slippery floorings such as ceramic tiles or vinyl tiles. These non-slippery floorings enable wheelchair users to wheel around the supermarket and the floor area at the entrance should be covered with a rubber mat to reduce accidents (Gertrude R. Mafatlane, Lily C. Fidzani, Kesitegile S.M. Gobotswang, 2015).

4.1.4. Lightings

1. Reflection

There was an interesting article published by Eco Technology in 2018 regarding this topic. They stated that reflection and glare have both useful and harmful effects when using lighting in supermarkets. As they mentioned, these glares and reflection will attract eyes to merchandise when used properly and will irritate and annoy customers when used incorrectly.

2. Lighting level

Vertical lights are important in supermarkets for illuminating goods on shelves. Generally, 750 lux is recommended for supermarkets (Emre Yilmaz, Aydinlatma Portali, Asya Traffic Inc.2017). Recommended lux must increase two times for age over 65 (saving light bulbs, 2014). The article published by eco-technology also stated that the recommended level for the general lighting in supermarkets is 30-50 foot-candles, and for the task lighting it is 50-200 foot-candles, and for the accent lighting 150-1500 foot-candles.

3. Contrast sensitivity

There was a blog published by Maureen A.Duffy about contrast and color. In that blog, the author stated that contrast sensitivity refers to the ability to detect differences between light and dark areas. It is better to use bright yellow or white paint highlights to increase the contrast of doors, ramps, or steps in the supermarket. Increasing the contrast between an object and its background will generally make the object clear.

4.2. Supermarket standards specified within the Asian region

The government of India, the ministry of urban development has designed some harmonized guidelines and space standards for barrier-free built environments. They have introduced these guidelines for all built environments including supermarkets. The standards are related to the supermarket layout, equipment sizes and layout, lighting, and flooring.

The standards gathered are summarized below.

4.2.1. Supermarket environment and layout

1. Interior circulation

Built environments should have wider passages for all the customers and Crutcher person needs a minimum width of 920mm with no obstructions up to 300mm height for comfortable gait. People who are using wheelchairs need a minimum

width of 900mm and for circular motions, they require 1500-2000 mm in diameter.

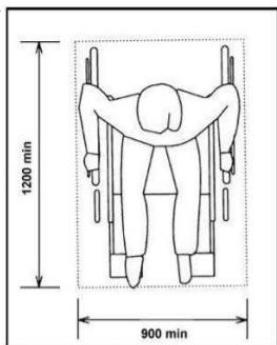


Figure 29. Minimum clear space for wheelchair person (Government of India, ministry

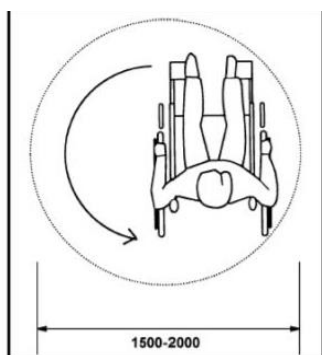


Figure 30. - Turning radius person (Government of India, ministry of urban development)

2. Entrance and door design

The entrance should be detailed with wide doors and the minimum width is 900mm and the maximum is 1250mm. The doors handle should be positioned between 900- 1000mm for both standing and wheelchair people.

Accessible entrances should be clearly signposted and easy to find. To help people with impaired sight to see doors, the doors should be in a color which contrasts, and all the glass doors

and the wall should be clearly differentiated from one to another.

Glass doors may be framed on both sides with a high contrast strip of 25mm in width.

3. Staircases

Staircases provided within the store should be supplemented by lifts and ramps. The tread should be 300mm and the riser should be 150mm. The staircases need a clear width of 1500mm for easy navigation. Spiral staircases should be avoided. Warning blocks should be installed at 300mm before the beginning and at 300mm after the end of each flight of step.

4. Ramps and handrails

Ramps should be designed with slip-resistant materials. The ramps should not be steeper than 1:12 and the width should not be less than 1200mm. The gradient should be constant between two lands and should have a minimum clear space of 50mm from the walls.

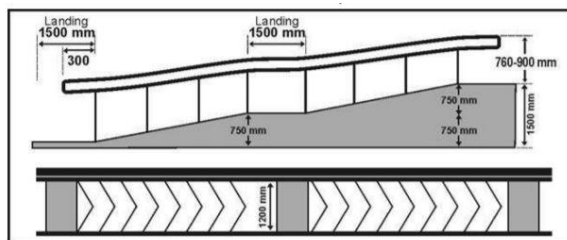


Figure 31. Standard ramp design(Government of India, ministry of urban development)

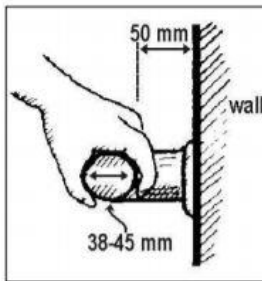


Figure 32. Stand size for handrail(Government of India, ministry of urban development)

5. Signage

All the signboards should be located where clearly visible, and the wall-mounted signs should be centered around 1400mm from the ground floor and the bottom edge not less than 900mm from the finish level and the top edge not less than 1800mm from the finish level. Safety notices provided within the store should be located at high and low levels. 1600mm-1700mm and 1000mm -1100 mm to allow convenient close viewing by wheelchair person. The signs which are located at the ceiling of the building should be 1800mm from the floor level.

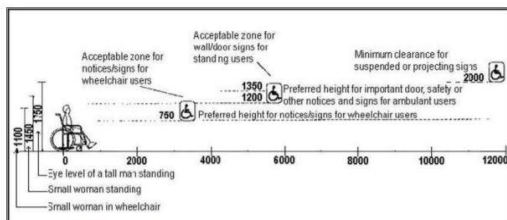


Figure 33. Viewing distance for signage

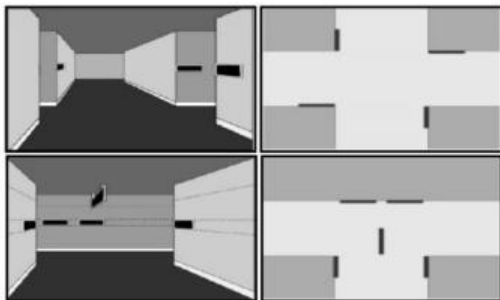


Figure 34. Preferred locations for signage (Government of India, ministry of urban development)

1. Shelf placements

Merchandise displays and shelves should be located as possible in a wheelchair as well. Angled mirrors can be placed above high shelves for visibility.

Because the average height of a wheelchair person is 1200mm and the average height of a standing person is 2000mm, the price labels and product indicators should be located at the vision zone of 900-1800mm. All the essential goods can be located in this vision zone.

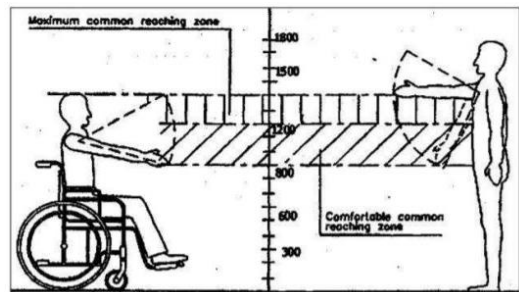


Figure 35. Comfortable reach zone for wheelchair person and standing person (Government of India, ministry of urban development)

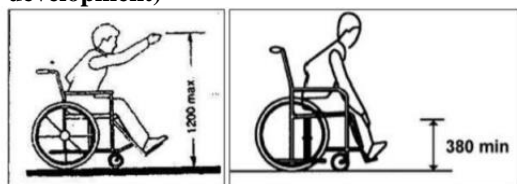


Figure 36. Forward and lower reach of wheelchair user(Government of India, ministry of urban development)

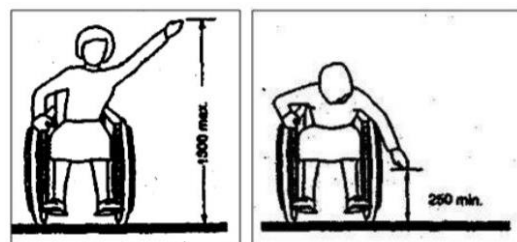


Figure 37. Side upper reach and side lower reach(Government of India, ministry of urban development)

2. Aisle placements

The width between the two aisles should not be less than 1800mm as two wheelchair persons need a minimum width of 1800mm to navigate. One wheelchair person and standing person require a minimum width of 1200mm to navigate within aisles.

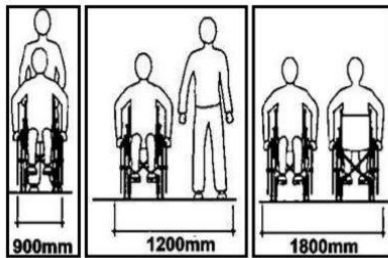


Figure 38. Minimum width for clear walkways within aisles (Government of India, ministry of urban development)

3. Cashier counters

- The maximum counter height should be 800mm. And the wheelchair people require 900mm×1200mm clear floor space within the cashier counter and clear knee space of 680 mm.

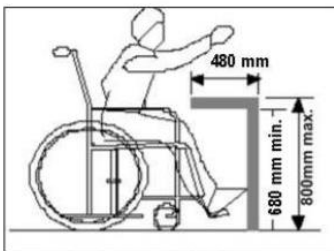


Figure 39. Standard size for counters for wheelchair users (Government of India, ministry of urban development)

4.2.3. Floorings

The floor finishes provided within the store should be stable, level, slip-resistant, and preferably matt finish and should not reflective and should be no greater than 1:20 if greater floor should be designed as a ramp. For people with low vision, lines or brightly colored tape may be

placed on the floor surface to assist mobility in poorly lighted areas. When carpets are used, they should be securely fixed.

4.2.4. Lighting

The lighting provided within the store should be even, diffused, and without glare, reflection, or shadows.

The signs also should be well and evenly lit with uniform lighting and the recommended level is 100 lux- 300 lux. The acceptable lighting level for the text panel is 200 lux. This section briefly described the design standards used within supermarkets by some Asian and European countries.

4.3. Senior citizens needs and their behaviour

4.3.1. Physical factors

1. Vision

Abraham George (2017) stated that physical factors include problems in vision, audibility, walk ability, weakness, etc. One in five people age 50+ live with sight loss (Age UK, 2017) and Betsy Brawley and Mark Taylor in 2003 stated that normal age-related vision problems include, disability to adapt to changes in light levels, sensitivity to glare, reduced contrast sensitivity, sensitivity to glare, reduced contrast sensitivity, restricted color recognition, reduced ability to discern visual details.

2. Audibility

Over 70% of people aged 70+ have some kind of hearing loss (Age UK, 2017). The ability to understand normal conversations is usually not affected at first, but when combined with the presence of background noise, perception is often diminished (Abraham George, 2017). Background noise can be particularly painful when magnified by hearing aids. Excessive noise echoing from hard surfaces, for example, can cause frustration, agitation, and anger. It also can cause elevated blood pressure, heart disease, and ulcers (Betsy Brawley and Mark Taylor, 2003).

3. Mobility

18% of people aged 60-69 have mobility difficulty, as do 38% of those aged 70+ (Age UK, 2017). The main reasons for the mobility problems are the weakness of muscles, problems of the joints, pain, diseases, and neurological difficulties such as memory difficulties, coordination, and balance problems. The common mobility problem faced by elders is falling. Hence it is clear that mobility has a direct link to the psychological state which leads to fear of falling.

4.3.2. Psychological factors

Psychological factors include mental health conditions such as fear of falling, loneliness, and feeling of security. Julie Leobach, associate professor in the department of psychiatry, University of California ALSO stated that fear of falling avoids some physical activities and decreased capacity to perform daily living activities such as shopping. Normally age-related changes in physical ability are one of the reasons for the fear of falling (Abraham George, 017).

4.4. Design factors affecting the shopping experience in the supermarkets for seniors.

4.4.1. Store layout and its environment

As per the supermarket standards mentioned in the literature review, it is better to plan for a single store and it will optimize the customer experience (Jaina Rodriguez), and as per Professor Windy Wills and Dr. Angela Dickinson and Abraham George (2017), the distance has to walk around and climbing lifts and staircases make elderly people uncomfortable. Moreover, as per the physical difficulties of elderly people they cannot open heavy doors (Age UK 2017). As per the literature review it is recommended to have disabled entrances in every supermarket with a good gradient and width, and ACA (Association of Convenience) also stated that installing ramps, automatic doors, widening aisles to improve shopping for disabled customers and make confident to go shopping.

4.4.2. Equipment sizes and placements

As per the supermarket standards mentioned above the best level for placing most items is the eye level and as per the statement of Robert Donven, elderly people are shorter than younger people and face difficulties when they reach products on higher shelves and deeper freezers. Simone Pettigrew, Kathreine Mizerski, and Robert Donven in 2005 also stated that old consumers have the possibility of falls while over-stretching when they reach to products on higher shelves

4.4.3. Floorings

As per the supermarket standards mentioned above, the supermarkets should have non-slippery floorings to avoid accidents and easy navigation and slippery floorings make fear on elders and this psychological issue causes them to avoid physical activities and decrease the capacity to perform daily living activities such as shopping (Juile Leobach, University of California). Non-slippery flooring reduces accidents and slippery floorings cause to increase the fear of falling (Abrahm George in 2017). As the successful supermarkets worldwide the Kaiser's supermarket in Germany and Adeg Aktiv 50+ in Australia have been equipped with non-skid floors to prevent consumers from falling even when wet.

4.4.4. Lighting

As per the document published by John Memorial Health in 2015 and as per the statement of Abraham George (2017), improper lighting causes vision issues in elders and makes it difficult to see things properly. The Adeg Aktiv Markt 50+ had used special lights to reduce glare on elderly customers' more sensitive eyes.

5. DATA COLLECTION AND METHODS

Both primary research and secondary research methods for support findings and the comprehensive literature under the secondary research methods and a case study under the primary research methods. The author has done

the present case study by selecting Sathosa supermarkets and the selected sample for the study is male and female older people over 50 years who are living in the Gampaha district and shopping at Sathosa supermarkets to buy their day to day needs. The selected criteria for the case study are created through the literature review and they are mentioned below.

Criteria	Results
Store layout and environment	
• Level differences	
• Product placements	
• Location indicators and signage	
• Ramp sizes	
• Entrance doors	
Equipment sizes and placements	
• Shelf heights	
• Depth of freezers	
• Shopping baskets and trolley sizes	
• Shopping baskets and trolley arrangements	
• Width between aisles	
Floorings	
• Surfaces	
Lighting	
• Lighting levels	

• Contrast sensitivity	
• Glare	
• Lighting arrangements	

Table 22. Selected criteria for the case study

4. DATA COLLECTION AND METHODS

As per the research methodology, the researcher selected to do a case study within Sathosa supermarkets in Gampaha and realized that the information gathered through the literature review are valid in Sri Lanka as well. Basically, the supermarket environment layout, equipment sizes, and placements, lighting, and flooring affect the shopping experience of senior citizens.

Under the supermarket environment and layout, the researcher observed that level differences within the store environment, product placements, placements of the location indicators, and the width of the ramps and the entrance doors have to be improved.

Secondly, the researcher observed the equipment sizes and the placements within supermarket interiors and found that shelf heights, depth of the freezers, sizes of the trolleys and baskets, arrangements of the trolleys, and baskets, and the width between two aisles also have to be improved.

As per the observations of the case study flooring and the lighting within the Sathosa supermarkets also have to be improved. The case study briefly described that most of the design factors found through the literature review are valid in Sri Lanka as well and have to be improved for providing satisfaction and comfort for elderly people.

Findings	Recommendations
Store layout	

Steep slopes within built environments	The slopes provided in the supermarket-built environments should be in the standard gradient of 1:12.
Inappropriate product placements	The products should have a proper arrangement and should not be organized on the floor or below the 3ft level (should not be organized at the stoop level).
Inappropriate placements of location indicators	The location indicators should be located at the eye level and they should be placed at the 4-5 ft levels.
Narrow ramps	The width of the ramps should be increased to the minimum width of 815mm.
Entrance doors without disabled accesses	The doors should be highlighted in high contrast colours. Entrance should have proper step

	free disabled access.
Equipment sizes and placements	
Inappropriate arrangements of shelf heights	The most essential products should be placed at the eye and touch levels.
Deep freezers	The depth of the freezers should be decreased and the products inside of the freezers should not be placed at the stoop level (below 3 ft).
Inappropriate arrangements of shopping baskets and trolleys.	The supermarket trolleys which are located on the floor and the trolleys which are located in-between of the shelves should be parked at a proper place near the entrance.
Narrow aisles	The width between two aisles should be increased to 2200mm.
Floorings	

Slippery surfaces	The shiny glossy flooring should be changed into matte-finished vinyl or ceramic tiles. The floor at the entrance should be covered with a rubber carpet to reduce accidents.
Lightings	
Low lighting levels	The lighting levels should be increased to 1500 lux. The number of bulbs and the lumen for the area should be increased to achieve the general lighting level of 1500 lux.
Less contrast sensitivity of price labels	The colors of the price labels should be changed to 100% contrast colors of black and white.
Inappropriate lighting arrangements	The shelves should have proper vertical lighting systems for comfortable reading of price labels.

Table 23. Findings and the recommendations of the case study**4. CONCLUSION**

As per the introduction, Sri Lanka is a country in the world that has a rapidly aging population. An increase in the number of older people will create a bigger market for goods and services linked to older people, such as supermarkets and other elder people supportive services. So it is important to identify whether they can face difficulties within built forms and make them age-friendly to avoid their difficulties and provide comfort and satisfaction. And some European countries and Asian countries have specified senior-friendly supermarket standards for the mature market. The literature review also described that supermarket layout, equipment sizes, and placements selection, and placing of lighting, selection of floorings can affect aged people. The researcher wanted to identify that the factors found through the literature review are valid to Sri Lanka as well.

To carry out well-developed research the author has done qualitative data collections to identify the design factors affecting seniors in designing the well-developed senior-friendly built environments. Because of that,

- This research is benefited to elderly people who are doing their household shopping.
- This research will also benefit the supermarket industry and they can study this research and increase their income by providing age-friendly facilities in stores.
- This research will also benefit future researchers to continue this research further. They also can study this research to get more details for their studies and do in-depth research regarding this topic.

- Interior designers and architects can study this research and design aged friendly built environments to provide more comfort for the aging population and they will be able to provide perfect solutions and designs which fit the need of elderly people.

As the limitations of this research the author has identified that,

- The case study for this research was done only with the Sathosa channel and the results will not 100% accurate.
- Doing the case study only within the Gampaha district also narrows down the research.
- Because of the COVID 19 situation the number of customers visiting Sathosa supermarkets dropped, and it affected the observation of the case study.

This research can be extended in several ways. The areas which need to be discussed in depth were recommended as further research and they are mentioned below.

- The research was done only within the Sathosa channels in Gampaha because it has the most senior customers compared to other supermarkets in Sri Lanka. The future researcher can continue this research with other supermarkets in Sri Lanka also for getting accurate results.
- The research paper was done only as a case study by focusing on Sathosa supermarkets in the Gampaha district and the future researcher can extend this research by having live interviews with senior citizens for increasing the accuracy of the results.

REFERENCES

- Ageuk.org.uk. (2000). [online] Available at: <https://www.ageuk.org.uk/Documents/EN-GB/For-professionals/Policy/consumer-issues/age-friendly-business.pdf?dtrk=true>
- Ferrell, B. L. (1999), JSF Prognostics and Health Management. *Proceedings of IEEE Aerospace Conference*. March 6-13, Big Sky, MO. doi: 10.1109/AERO.1999.793190
- George, A. (2007). [online] Crimsonpublishers.com. Available at: <https://crimsonpublishers.com/fsar/pdf/FSA.R.000517.pdf>
- Bowering, T. (2019). Ageing, Mobility, and the City: Objects, Infrastructures, and Practices in Everyday Assemblages of Civic Spaces in East London. Available at: https://www.researchgate.net/publication/330718526_Ageing_Mobility_and_the_City_Objects_Infrastructures_and_Practices_in_Everyday_Assemblages_of_Civic_Spaces_in_East_Londo
- Tiraphat, S., Peltzer, K., Thamma-Aphiphol, K., and Suthisukon, K. (2017). The Role of Age-Friendly Environments on Quality of Life among Thai Older Adults.
- Aging Issues. (2017). How might shopping contribute to healthy aging?. [online] Available at: <https://ageingissues.wordpress.com/2017/02/01/how-might-shopping-contribute-to-healthy-ageing>
- Intelligentdemand.com. (2014). [online] Available at: <https://intelligentdemand.com/newsroom/intelligent-demand-client-kaiser-permanente-recognized-for-marketing-innovation>
- Anon, (2013). [online] Available at: https://www.researchgate.net/publication/274475594_Seniors_in_shopping_centres
- Taylor, M. (2003). Designing for Senior Care Environments. [online] Interiorsandsources.com. Available at: <https://www.interiorsandsources.com/article-details/articleid/3772/title/designing-for-senior-care-environments>.

Rozin Kleiner, A., Galli, M., Araujo do Carmo, A. and Barros, R. (2015). Effects of flooring on the required coefficient of friction: Elderly adult vs. middle-aged adult barefoot gait. Available at: Available at: Available at: <https://www.sciencedirect.com/science/article/abs/pii/S0003687015000332>

Interiorsandsources.com. (2008). Designing for Senior Care Environments. [online] Available at: <https://www.interiorsandsources.com/article-details/articleid/3772/title/designing-for-senior-care-environments>

Staff, E. (2014). Germany: a supermarket tailored to seniors ' needs — Silver Economy. [online] Silvereco.org. Available at: [http://www.silvereco.org/en/germany-a-supermarket-tailored-to-seniors-](http://www.silvereco.org/en/germany-a-supermarket-tailored-to-seniors-Needs/Tiraphat, S., Peltzer, K., Thamma-Aphiphol, K., and Suthisukon, K. (2017). The Role of Age-Friendly Environments on Quality of Life among Thai Older Adults. Aging Issues. (2017). How might shopping contribute to healthy aging?. [online] Available at: https://ageingissues.wordpress.com/2017/02/01/how-might-shopping-contribute-to-healthy-ageing)

Needs/Tiraphat, S., Peltzer, K., Thamma-Aphiphol, K., and Suthisukon, K. (2017). The Role of Age-Friendly Environments on Quality of Life among Thai Older Adults.

Aging Issues. (2017). How might shopping contribute to healthy aging?. [online] Available at: <https://ageingissues.wordpress.com/2017/02/01/how-might-shopping-contribute-to-healthy-ageing>

Intelligentdemand.com. (2014). [online] Available at: <https://intelligentdemand.com/newsroom/intelligent-demand-client-kaiser-permanente-recognized-for-marketing-innovation>

Wilson, M. (2016). Report: Retailers should respond to the needs of 'silver' shoppers. [online] Chain Store Age. Available at: <https://chainstoreage.com/technology/report-retailers-should-respond-needs-silver-shoppers>

IOA Blog. (2018). Aging in Place Interior Design Ideas to Create Safer and More Comfortable Spaces for Seniors - IOA Blog. [online] Available at: <https://blog.ioaging.org/aging/aging-in-place-interior-design-ideas-to-create-safer-and-more-comfortable-spaces-for-seniors/>.

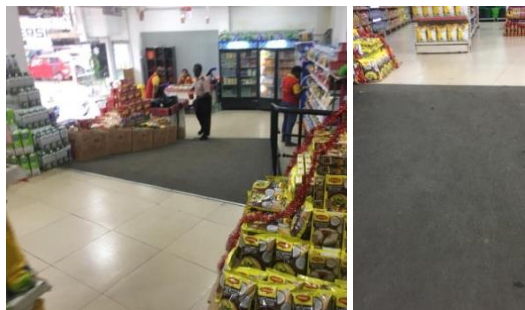
Elbers, T., 2016. The Effects Of In-Store Layout- And Shelf Designs On Consumer Behavior. [online] Edepot.wur.nl. Available at: <https://edepot.wur.nl/36909118>.

BibLus. n.d. How To Design A Supermarket, The Technical Guide - Biblus. [online] Available at: <http://biblus.accasoftware.com/en/how-to-design-a-supermarket-the-technical-guide>

ANNEXURE

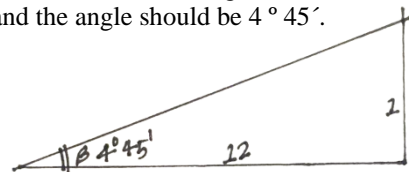
1. Steep slope of Kadawatha branch:

At the entrance, people have to climb a steep slope to get goods.



5. Ramp angle of Sathosa

The standard and comfortable gradient for a ramp is 1: 12 and the angle should be $4^{\circ} 45'$.



The existing height of the steep slope is 3ft and the length is 7ft.

In this scenario the angle is $23^{\circ}11'$. The angle is very high not suited for a ramp. This steep slope can make older people fear and also can cause accidents.

Calculation:

$$\tan \theta = \left(\frac{3}{7} \right)$$

$$\theta = \tan^{-1} \left(\frac{3}{7} \right)$$

$$\theta = 23^{\circ} 11'$$

The provided ramps within Sathosa supermarkets have 600mm width and, it is not sufficient for wheelchair users.



3. Product placements of Sathosa

Some essential products like salt, flour are located in baskets and they do not provide proper rack arrangements for those kinds of food items. People cannot easily identify these products and have to move around to find them.



Some Sathosa branches have provided only steps to climb up. People who are in wheelchairs cannot access them.



8. Equipment and product placements



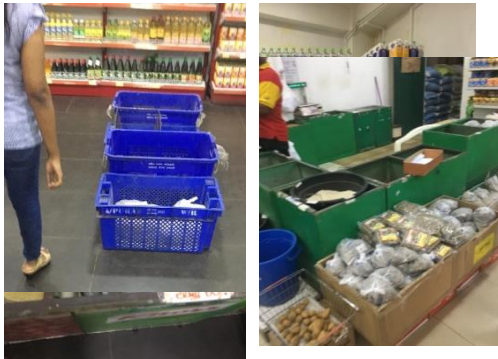
6. Location indicators

Location indicators which are provided within Sathosa supermarket are not in a level that can be easily identified.

7. Ramps



Supermarkets are in the standard levels. But unfortunately, most of the eye level shelves are empty. Not only the eye levels but also the touch levels are empty.



Some essential items have been located at the stoop level by using baskets. The height of a basket is 240mm. It means they are below 3ft (900mm). Older people who have mobility issues such as muscle pains cannot reach those products.

9. Aisle placements

These diagrams showcase the current width between aisles within the Sathosa supermarket. The current width is 900mm and it is not enough for two shoppers with trolleys. Even a shopper with a trolley and another shopper who is in a wheelchair cannot go through it.



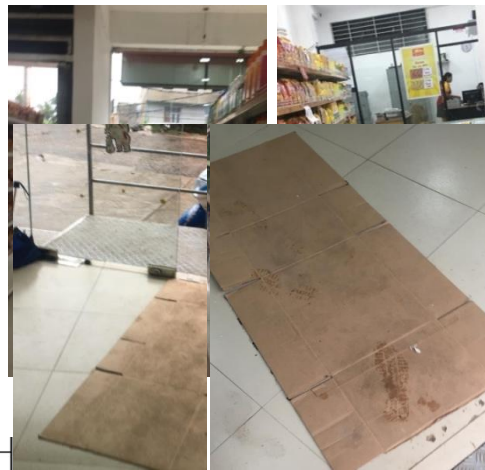
10. Shopping baskets

As per the sizes of the Ernst Neufert data book, the shopping baskets have the standard sizes of 420×250×240 mm and they are located on the floor.



11. Floorings

Within Sathosa supermarket, there are some floors with slippery surfaces. These surfaces can make elders fear navigating within the built environment.



Some Sathosa supermarkets have not provided suitable rubber carpets at the entrance floor to wipe shoes. Most probably these mistakes can cause accidents as well and cause fear in elders.

12. Labeling

The price labels provided within the Sathosa supermarket are not very clear. The letters are on a yellow background and the letter size is also

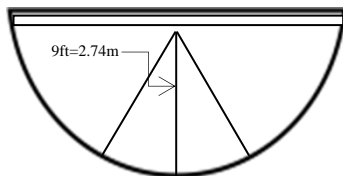
very small. Especially older people who have less contrast sensitivity cannot read these labels easily.



13. Lightings

Generally, 750 lux is recommended for supermarkets, and it is better to use 1500 lux for the elderly. In Sathosa supermarket they have fixed ceiling recessed lights at every 6 ft on the ceiling. As one of the staff members described they have used 30W LED lights at the ceilings. This is not common for all Sathosa layouts because Sathosa supermarket does not have a common layout. To check whether 30 W lights are enough for bright up space, the author has done a calculation within the Kirillawala store.

- Luminous efficiency for 1 LED lamp= 90 lm/ W
- Luminous efficiency for 30W LED lamp
 $90 \times 30 = 2700 \text{ lm/ W}$
- E = Illuminance



Lumens and the requirement of the number of bulbs for the elderly.

$$\begin{aligned} \text{Lumens for the elderly} &= \text{Area} \times \text{lux} \\ &= 5.94579 \times 1500 \\ &= 8918.68 \text{ lm} \end{aligned}$$

$$\begin{aligned} \text{Number of bulbs (30W)} &= 8918.68 \\ &= 2700 \\ &= 3.3 \\ &= 4 \end{aligned}$$

Calculation:

- Luminous efficiency for 1 LED lamp= 90 lm/ W
- Luminous efficiency for 30W LED lamp
 $90 \times 30 = 2700 \text{ lm/ W}$
- E = Illuminance

$$\begin{aligned} \text{Area} &= \frac{1}{2} \times 4 \times \pi \times r^2 \\ &= \frac{1}{2} \times 4 \times 3.14 \times (2.74)^2 \\ &= 17.20 \text{ m}^2 \end{aligned}$$

$$\begin{aligned} E &= \frac{\text{Flux}}{\text{Area}} = \frac{2700}{17.20} = 156.97 \text{ lux} \end{aligned}$$

Calculation for the lumens of cashier area

$$\begin{aligned} \text{Area} &= 8 \times 8 \times \text{ft}^2 \\ &= 64 \text{ ft}^2 \\ &= 64 \times 0.092903 \text{ m}^2 \\ &= 5.94579 \text{ m}^2 \end{aligned}$$

$$\begin{aligned} \text{Lumens (General)} &= \text{Area} \times \text{lux} \\ &= 5.94579 \times 750 \\ &= 4459.34 \text{ lm} \end{aligned}$$

$$\begin{aligned} \text{Number of Bulbs (30W)} &= 4459.34 \\ &= 2700 \\ &= 1.65 \\ &= 2 \end{aligned}$$

Level of Student Collaboration in Online Design Studios

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ABSTRACT

The collaborative learning is a major component in architectural studies. This study is aiming on exploring the level of collaboration of students in the online design studio. For this study 5 collaborative groups were observed, and 25 students were selected through convenient sampling technique. The participants were observed by adopting naturalistic observation and were interviewed with open ended questions at the end of the design process and the data was analyzed through the content analysis. Among the 5 groups, 3 have shown a medium level of engagement and one group has shown a high level of engagement and one group has shown a very poor level of engagement.

17. INTRODUCTION

Collaborative learning is placed at a higher level of architectural education. Architectural students are engaging in group tasks as a part of their learning process. The students are learning by doing , with the engagement of their peer learners(Shamsuddin et al. 2010). Due to the pandemic, the architectural studies were transferred into an online platform where one to one learning was replaced in a digital platform. Students got engaged through Zoom or Teams platform where everyone got connected through a device. The typical architectural education domain is heavily based on studio learning, where the design students and lectures are working together (Abdullah et al. 2011).

The architectural learning and teaching processes have been established to place the design studio

at the center. In traditional practice, students learn to solve real world problems through

architectural design solutions while engaging in design studio activities. In characterizing the design studio, it is a collaborative learning environment which allows students to engage in their design processes either individually or as groups with the support of lecturers and tutors (Abdelmonem 2016). The physical setup of the design studio is heavily contributing to the design process of students by providing a material space for them to engage in their design activities (Davey 2019). The change of the design studio context from physical infrastructure to digital platform is indeed influential to the design process of the students, and it could change the use of digital tools during the design process as well.

In the architectural design studio, students are getting the opportunity to work with other peer learners. As depicted by Rahbarianyazd (2019) collaborative engagement with an architectural design studio can increase the design thinking ability of the students (Açikgöz 2015). Students do brainstorming, reflections, and collaborative critics while they are engaging in group works (Al-Mogren 2006).

1. Collaboration in virtual platforms

The pandemic has made a significant difference in the education context across the globe. The students who used to study in classrooms were shifted to online education suddenly. However,

this movement has made drastic changes in the pedagogic design studio education in Sri Lankan context. Before 2020, in Sri Lankan context, there is no evidence found in online or blended learning platforms created for architectural education. The entire architectural education was dependent on the design studio delivery where the design students and design tutors met face to face.

The collaborative engagement was in face to face mode and the students were heavily using paper modeling, paper mockups and on paper demonstrations for their learning purposes. However, the sudden movement made to the online platform has made some changes on the way of collaborating between students. In the pedagogic design studio, students collaborate through brainstorming activities, presentations, and peer critics. The online mode has created a reflective platform for the above activities digitally. There students see the designs of the other students, the comments made by the lecturers through the digitally mediated mechanism.

Online learning has brought, many benefits to the students. It has the ability to network students from different geographical locations. The place they are located in was not an important factor, but the data strength and the networking capacity have made some impact to the online learning mechanism in Sri Lankan context. The students and lecturers were combined through a created platform and they depended on the platform created there were some collaborative options which students could follow in virtual design studio.

1.2 Problem Statement

Within the design studio context, students are engaging in many collaborative activities and their engagement was directly visible to the studio lecturers. However, the movement made to virtual design studios, the student engagement was difficult to view because, they were engaged in the activity by being in various places. The aim of this study is to understand the level of collaboration of design students when they are engaging in online platforms. Despite the many

benefits brought through the online platforms, there are some limitations which could make an impact of the student's learning. Through this study we are exploring the level of student engagement within a virtual design studio.

1.3 Research Questions

In order to find the level of collaboration in the online design studio, we constructed the below research questions. The key focus on this study is to observe the level of collaboration within a set of student groups who are collaborating through an online platform.

1. How the students have collaborated in the online design studio?
2. What is the level of engagement observed in the online design studio?

2.METHODOLOGY

For this study, I adopted the qualitative research methodology. The participants were selected through convenient sampling technique. 25 Interior design undergraduates were selected for this study and they were clustered into 5 groups with 5 students in each group. The students were in their 2nd year 2nd academic semester and the reason to select 2nd year students for this study, because they were having one-year experience on design studio engagement at university. All the students were between the age limit of 19 -23 and there were 12 male students and 13 female students. The students were divided into random 5 groups.

The study context is created through Zoom platform. Students were assigned with a design task and were asked to develop design concepts through an online collaboration. For this study, 12 collaborative hours were assigned. Students were divided in to 5 groups and put them in to 5 breakout rooms to work collaboratively. Researcher has observed the collaboration of each groups and taken notes in a field diary. Each group was observed in intervals of every 15 minutes. Important moments were captured through screen shots and were used for data analysis.

2. Data collection

The data was collected through the field diary which was maintained by the researcher. Further, researcher has recorded the entire meeting by using the recording option available in Zoom. The collaborative moments were captured through screen shots and were saved with a time, date and group number note.

The 12 collaborative hours were assigned for this study with 4 hours of online engagements per day. After 3 days of collaborative engagement with 12 hours of engagement, the groups were interviewed with open-ended questions. The interviews were recorded and were transcribed for the data analysis.

2.2 Data Analysis

Data analysis was guided by 6 phases of thematic analysis and an inductive approach has been undertaken (Hoskyns n.d.). Familiarization with the data, creating initial codes, searching for themes, reviewing themes, defining the themes, and reporting were the steps followed in generating themes. Initially data had been categorized according to the sources of data generation. Observation was mainly analyzed through the field notes taken by the researcher (Tracy 2013). Data was generated through questionnaires and was handled separately. Students field notes and design tutors field notes were coded separately (Tracy 2013). The researcher's own observational records and field diary were coded in the second stage.

Data generated from the questionnaires and all the other modes were analyzed through a thematic analysis (Tracy 2013). All the data were fed in to MAXQDA 11. Before feeding data in to MAXQDA 11, an affinity diagram was created by the author in order to have an initial understanding on codes, categories and themes. The benefit of using thematic analysis was that it supported in identifying patterns in data.

The analysis started with coding the data. The observation notes and interviews have generated primary codes and those primary codes have generated 15 secondary codes. Those 15 codes were further clustered in to 5 categories. We

identified four themes to describe the level of engagement of students.



Fig1: Thematic Map

3. RESULTS

The thematic analysis has shown the various levels of engagement of the students in a virtual platform. The codes which are labeled as; sharing information by using other collaborative platforms instead of Zoom, brainstorming openly in Zoom, multiple leadership, using chat box for brainstorming, making group calls, use of PowerPoint as a tool to store information has been clustered under the category of self-motivated. Those students who were engaged in the above activities were engaged in the given task with self-motivation.

Codes labeled as brainstorming openly in Zoom, made group calls, had white board collaboration, shared information by using other collaborative platforms that have clustered under the category

of continuous engagement which generates the theme of highly engaged in online platform.

The codes labeled as leader is dominating the group. This category involves white board collaboration, no internet access, less signal strength, multiple leadership, use of chat box for brainstorming which has led the researcher to identify as engaged time to time which has generated the theme - moderate level of engagement.

The codes depicted as leader is dominating the group; there is no internet access, lesser signal strength, sketching is done individually and shared in the chat box, own decisions were generated in the fourth category, individualized work was done within a collaborative group. This approach supported on identifying the theme – poor engagement.

Leader is dominating the group, sketching is done individually, and sharing in chat box, being active in social media, sharing ideas time to time, own decisions are made throughout. This pattern has led to the category that indicates that no interest is shown in collaboration. This led to the identification of the theme -no engagement.

In answering RQ 1; “How the students have collaborated in the online design studio?” Researcher has observed that the students have collaborated through various modes of communication platforms. They have used the white board option to draw, write, map and share their ideas, however it was interesting to observe that, even though the white board is a collaborative platform, students have created their own individual spaces when collaborating.

The codes labeled as; brainstorming openly in Zoom, usage of Power point, making group calls, get connected through other social media platforms, white board collaboration, using chat box are the methods that were observed through this study, which students have utilized for collaboration in the online design studio.

In answering RQ 2; “What is the level of engagement observed in the online design studio?” based on the results the researcher has developed 5 models which could explain the

collaboration and inter-student collaborative connections made within each group (refer fig 2).

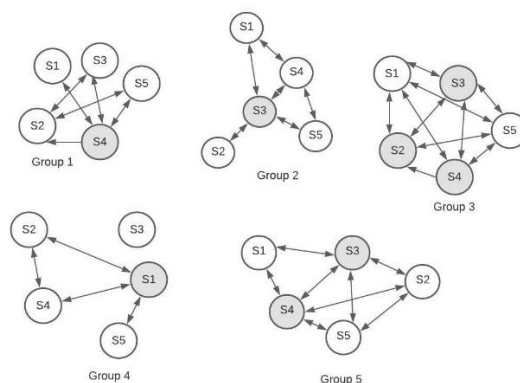


Fig 2 : Collaborative engagement among group members

Among 5 groups group no 1 and group no 3 have shown a high level of engagement. Group 1 was dominated by the group leader, but all the students were giving inputs collaboratively by using the white board option in Zoom, using the chat box and by creating separate chat groups through other social media platforms like WhatsApp. The group no 1 has collaborated, by being centered and activated by the group leader. Group 3 was coordinated by three key student leaders and all of the group members were collaborating with all the members of the group throughout the allocated time period. They have shown a high level of engagement within this collaborative group.

In observing the data generated by group 2, the researcher noticed that four students were actively engaged with the collaboration whereas one student got individualized and kept the collaboration only with the group leader. This group has shown a moderate level of engagement by being in an online platform.

Group no 4 was guided by one leader and the group communication was centralized to the leader. 3 students were collaborating with the group leader and one student got isolated without any collaboration made within the assigned group. Students were engaged in social media chat groups than white board collaboration. This

group has shown a poor level of engagement in the online design studio.

Group 5 was led by two group leaders and the other three students were giving collaborative inputs to both leaders. Both leaders were consistently interconnected throughout the assigned time period. They used the white board for collaboration and made a separate Power point presentation. Moreover, they were very active in the online chat box. The researcher observed that Group 5 has utilized many digital tools available in Zoom for their collaboration. Group 5 has shown a high level of collaborative engagement.

4. DISCUSSION

The aim of this study is to understand the level of collaboration of architectural students in an online platforms. In order to obtain that understanding, 5 collaborative groups with 5 students in each group were observed. For this study, qualitative research methodology was adopted and data was collected through naturalistic observations and open-ended questionnaires. The data was analyzed through thematic analysis. The study has shown the level of collaboration of architectural students in online platforms. Usually in architectural studies, collaboration is happening in face to face mode in design studio context. The student engagement has been seen in four levels such as highly engaged, moderate level of engagement, poor engagement and no engagement.

It was observed that the students who have shown the high level of engagement have utilized many collaborative tools available in Zoom such as the white board and the chat box. They were also connected in other chat forums such as WhatsApp and other social media platforms. The students who have shown the medium level of collaboration have done brainstorming openly in the Zoom forum utilizing the chat box and white board.

Some students have been individualized within the collaborative groups, due to the lack of signal strength or no internet supply at all. Some students have maintained the direct collaboration only with the group leader and have not

maintained a group collaboration throughout. Furthermore, we observed that the exposure to many digital collaborative platforms other than Zoom platform has increased the collaboration amongst students in the online design studio.

This fact needs to be further investigated and there is a gap in literature which needs to be filled with more empirical studies on the online collaboration of architectural students.

REFERENCES

- Abdelmonem, M. G. 2016. "From Propagation to Negotiation of Ideologies in the Architectural Design Studio: Critical Insights in Student-Centred Strategies for Interactive Learning." *Journal of Design Research* 14(1):1–21. doi: 10.1504/JDR.2016.074781.
- Abdullah, N. A. G., S. C. Beh, M. M. Tahir, A. I. Che Ani, and N. M. Tawil. 2011. "Architecture Design Studio Culture and Learning Spaces: A Holistic Approach to the Design and Planning of Learning Facilities." *Procedia - Social and Behavioral Sciences* 15:27–32.
- Açıkgöz, E. K. 2015. "Uncovering Creativity: Structuring Experience in Architectural Design Studio." *Open House International* 40(2):12–21.
- Al-Mogren, A. A. S. H. 2006. "Architectural Learning: Evaluating the Work Environment and the Style of Teaching and Management in Design Studio." *AEJ - Alexandria Engineering Journal* 45(5):603–16.
- Davey, Jon Daniel. 2019. "The Ramifications of Teaching Design Studio Online." *Annual International Conference on Architecture & Civil Engineering* 477.
- Hoskyns, Sarah. n.d. "Thematic Analysis." in *Collected Work: Music therapy research. 3rd ed. rev. Published by: Dallas: Barcelona, 2016. (AN: 2016-21423). Dallas: Barcelona.*
- Rahbarianyazd, Rokhsaneh, and Hourakhsh Ahmad Nia. 2019. "AESTHETIC COGNITION IN ARCHITECTURAL EDUCATION: A METHODOLOGICAL APPROACH TO DEVELOP

LEARNING PROCESS IN DESIGN STUDIOS.” *International Journal of Cognitive Research in Science, Engineering & Education (IJCRSEE)* 61–69.

Shamsuddin, I., F. Hassan, M. Saruwono, R. Takim, and ZM Darius. 2010. “An Expiatory Study on Peer Learning Experiences in the Architectural Design Studio.” Pp. 42-+ in, edited by A. Kallel, A. Hassairi, C. Bulucea, and N. Mastorakis.

Tracy, Sarah J. 2013. *Qualitative Research Methods : Collecting Evidence, Crafting Analysis, Communicating Impact*. Chichester, UK: Wiley-Blackwell.

Impact of Interior Design Elements on Work from Home Spaces

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ABSTRACT

The COVID-19 pandemic, along with the technological advancements of the current day, have given rise to work-from-home (WFH) practices, and is subsequently proving to be a working practice that is suitable and appropriate for use in the future; even post-pandemic. This research was conducted to understand the WFH spaces of Sri Lankans (particularly in the Western and Central provinces) to explore the various interior conditions to improve the WFH practices in terms of comfort and productivity. Questionnaire surveys were distributed among individuals engaging in WFH activities to collect information on their own WFH spaces, and what elements of the interior are of greater importance and believe affect their productivity. The purpose of this research is to gain a better understanding of WFH spaces and how interior elements affect an individual's performance and comfort to improve the designs of WFH spaces in the future. The findings of this research indicate that there is a positive relationship between interior quality (with its various interior elements) and the WFH experience. It was also uncovered that users of WFH spaces perceived the functionality of a WFH space as of more importance than the aesthetical qualities of the space.

1. INTRODUCTION

Working from home, which can also be referred to as remote working or telecommuting interchangeably, first emerged in 1973 when tech company IBM subjected 5 of its employees to work from home. The practice grew since then

and was adopted by several other businesses as well, such as JCPenney, by the 1980s. WFH also became a popular trend among young entrepreneurs who ran business startups from their homes (also referred to as 'garage startups') in the 90s as they lacked adequate funds to rent office spaces initially.

With the onset of the COVID-19 pandemic, people had to convert to working from home in a short span of time; either dedicating a specific room as an office or converting a part of a room into a work space. The initial scramble to create a WFH space dealt with most short-term issues such as having a proper desk, but overlooked the more long-term aspects of working from home such as the quality and comfort of the space and how it affects occupants' performance and mental and physical well-being.

Although working from home has been practiced throughout the past few decades in certain occupations, the COVID-19 pandemic tested the possibilities of even more occupations being able to adapt into remote working. It also revealed the benefits of working from home for both employees and firms, and the possibility that working from home will continue post-pandemic.

Existing studies done on the practice of WFH shows mixed reactions of employees adapting to WFH spaces. Studies suggest that employees experienced boosts in productivity, whereas some studies revealed that productivity often dropped later on due to difficulties in managing employees remotely.

This study will explore how Sri Lankan individuals adapted to remote working amidst the COVID-19 pandemic and their requirements related to WFH spaces to understand interior elements that should be taken into consideration in the future as WFH practices will most likely continue post-pandemic.

2. BACKGROUND

Before the emergence of the COVID-19 pandemic, working from home was practiced in Sri Lanka with IT related occupations and other freelance work. Sri Lankan firms then adapted remote working with a broader range of occupations after the onset of COVID-19 in Sri Lanka. However, some occupations, such as that of the medical field, has operations and activities that cannot be done remotely.

Adapting to a WFH arrangement has proved difficult for Sri Lankan individuals, with the most prominent issue being the lack of proper internet connections, work spaces that clash with home spaces often leading to privacy and noise issues.

The existing studies regarding WFH tend to be based on the contemporary global situation, and therefore, whilst being relevant, still lacks extensive studies that are done throughout a longer period of time, with most studies focusing on productivity and rarely exploring the impact of the spatial quality of the WFH spaces on performance and health.

It is also important to note that previous studies mostly focus on productivity, and not on the impact of the interior environment in the WFH space on an individual's performance and health.

2.1 Telecommuting

Telecommuting is an umbrella term that defines a working arrangement based on a location that does not involve a centralized location like an office. A work-from-home (WFH) arrangement involves an employee or student working exclusively from home. Work-from-anywhere

(WFA) however defines a work arrangement that involves employees or students working outside of their homes at one or several locations (coffeeshops, co-working spaces, etc.) and never at a centralized location.

2.2 WFH Arrangements

WFH spaces can be created either as a dedicated or converted space. A dedicated WFH space refers to a space in a building that is reserved solely for the purpose of working, such as a home office. This could be arranged either in a room or creating a pocket office in an underutilized space in the building such as underneath a staircase for instance (J. G. Gregory, 2017). Converted spaces refer to spaces that have an existing function but also accommodate for the function of WFH; this could be a guest bedroom that is used as an office also for example. According to the space utilized by a user for WFH purposes, the overall WFH experience and implications may vary.

2.3 Positive Aspects of WFH

WFH has brought about a multitude of positive effects on health and well-being that would have otherwise not been possible in a traditional working arrangement.

WFH has minimized the interaction of employees with stressors related to commuting to work such as stressful traffic jams and crowds. Since no commuting is involved it has minimized expenses for traveling as well. On the other hand, it has allowed for individuals to improve the social aspects of their family life as they are now able to spend more time with their loved ones.

The ability to customize one's work environment also allows users to experience greater levels of comfort compared to a traditional work environment where there is less flexibility in customizing the work space to maximize a user's comfort.

Further understanding what and how the customization of interior elements in WFH spaces affect the WFH experience favorably

helps to design WFH spaces with improved productivity and comfort.

2.4 Negative Aspects of WFH

Because of how varied an individual's needs are out of a WFH space based on their specific circumstances, their WFH arrangement could be less than ideal and create negative experiences.

Based on a lot of determinants such as the type of work, family dynamics, etc. the productivity of an individual when switching to a WFH space, productivity could either increase or decrease in the short run. In the long term however, productivity levels could tally with that of when working at an office.

A study by N. F. Mendoza (2021), uncovered that 53% of the respondents to a survey found it difficult to draw a line between work and home life, which led to distractions. The study also highlights that a majority of the respondents spent less time preparing for work when working from home.

According to M. Rund (2021), humans are naturally social animals, and have found the switch to WFH very isolating.

WFH spaces could also lead to bad work habits such as overworking in unsuitable work environments, having little to no breaks, and working in bad postures. This could lead to physiological complications such as repetitive strain injury (RSI).

The identification of these negative effects associated with WFH will provide clues to detect how and whether interior elements of WFH spaces lead to negative experiences.

2.5 Environmental Impact of WFH

It is evident that the shift to WFH has benefited the environment from reduced emissions of greenhouse gases as a result of a sudden drop in commuting to work during the COVID-19

pandemic. Power consumption has also decreased during this period of time as large office buildings were not being operated. The digitization of most work also resulted in cutting down wastage of office resources such as paper and plastics.

However, Hodler S. (2021), discusses how WFH arrangements merely create a shift in the source of carbon emissions from offices to homes and take out the energy and emissions related to commuting out of the equation. Therefore, the degree of the environmental impact of switching to WFH depends almost entirely on how climate-conscious employees and employers are.

The above outlined positive impacts of WFH on the environment, and the likeliness of WFH practices to continue in the future; even after the pandemic, highlights the necessity in creating thoughtful and more permanent WFH spaces within interiors to accommodate for working habits that are more environmentally sustainable.

2.6 Interior elements of WFH spaces

The most prominent elements of an interior of a WFH space that would affect the majority of WFH space users could be identified as spatial requirements, lighting, ergonomics, services and equipment, biophilia, and aesthetics. Colenberg S., Jylhä T., & Arkesteijn M. (2021), found these elements were also a recurring theme in addition to other elements like office layout and control (personalization) in their study done on office spaces.

The above outlined interior design elements of a WFH space, although not encompassing all interior design aspects of a space, help define the most significant functional and aesthetical elements in a WFH space and address the general ambience and physical setting of a WFH space.

3. METHODOLOGY

The primary data collected for this research is done through a survey made in Google Forms consisting of 21 questions that cover elements of

WFH space interior identified through the literature review. The survey aims to collect both quantitative and qualitative data in order to observe information like hours of usage and preferred aesthetics respectively to further understand how WFH spaces are used and what users expect out of WFH spaces. Where appropriate and possible, data will be compared with existing data provided by previous studies to explore WFH patterns.

The questionnaire was made to seek information regarding physical and mental health-related impacts of working from home. It also explores how WFH spaces were created by users, what users consider important interior elements in a WFH space, and the most common issues found in WFH spaces. The questions were formed to retrieve data regarding the following aspects of WFH space interiors: spatial requirements, lighting, ergonomics, services and equipment, biophilia, and aesthetics. The level of comfort in the participants' WFH spaces (both physical and mental) is observed by 5-point Likert Scale (comparative scale) ratings in order to obtain more nuanced answers about an individual's WFH space experience. An image choice question depicting various WFH space interiors is included to gauge the participants' aesthetical preferences. Apart from that, multiple choice questions and demographic questions are included in the questionnaire to gather pre-defined data such as hours of work and age, along with open-ended questions to gather data that cannot be predicted; for instance, occupation.

The questionnaire was distributed among 30 individuals with ages ranging from 19 – 29 years old. The group comprised 17 males and 13 females from the Western, Central, and North Western provinces of Sri Lanka. These specific provinces were chosen for similar socio-economic levels of its residents, which can relate to similar income, occupation, education, and wealth among the participants compared to the other provinces of Sri Lanka. This is to ensure that the participants and their WFH spaces are similar in condition, which allows to better decipher the WFH experience of a similar setting. The age range of the participants also

help identify the experiences of WFH spaces among participants of similar WFH environments, work habits, and concerns.

4. LIMITATIONS

Even though WFH concept has been practiced before the onset of COVID-19, WFH has not been practiced in the same magnitude in the past. With the whole world resolving to WFH, researchers have turned their attention to WFH and has explored its effects on productivity and mental health.

However, there is a considerable gap in research regarding the interior quality of WFH spaces, making it difficult to compare the data retrieved by this specific research. The lack of existing research also gives no precedence to shape the survey.

Due to the lack of existing data on this topic it seems appropriate to use literature regarding office interior design in general to compare certain parts of data retrieved for the research.

The research was also conducted among a participant number of 30 people, residing predominantly in the Colombo and Kandy districts. This would not bring substantial enough data to document the views of all types of employees and students engaging in WFH in Sri Lanka.

It should also be mentioned that the respondents all belong to the age group of 19-29 years. This will also only give insight into the behavioral patterns of 19 to 29-year-old employees in a WFH space, and would not be able to explore the requirements and circumstances of WFH employees in a much older or younger age bracket.

Furthermore, the survey results do not illustrate the behavioral patterns of individuals engaging in WFH over a long period of time and might not account to changes in behavior and impact of interior design on the WFH experience over time.

5. RESULTS

5.1 Physical and mental health-related impacts

Of the 30 respondents of the questionnaire, 11 responded that they have faced issues related to muscle pain and/or headaches. When asked what the respondents would most like to change in their WFH space; 10 respondents replied with wanting to purchase ergonomic furniture to improve physical comfort. Isolation, on the other hand, was the least selected variable with only 7 respondents. Compared to a traditional office space, 73% of the respondents stated that social interaction is what they feel is lacking the most in WFH spaces.

5.2 Work-life balance

Work-life balance issues were predominantly chosen by the respondents when compared to physical and mental health-related issues when working from home. Seventeen respondents found distractions to be the most common issue faced when working from home. Poor scheduling follows next with 10 respondents agreeing to poor scheduling habits. Three respondents also reported feeling bored or wanting to go back to sleep were issues they faced when working from home as their WFH space was set up in their bedroom.

5.3 The creation of WFH spaces

The questionnaire helped illustrate how exactly the respondents went about creating their WFH space.

The most common way (80%) a WFH space was created was by converting a room. I.e., using a room meant for another function for WFH as well. The other 20% of the respondents had a dedicated space for WFH; meaning they set up their WFH space in a room solely meant for WFH purposes.

Of the respondents who converted a room into a WFH space, 80% selected their bedroom. The next popular choice was the living room with

only 10%. Dining room and family room follows next with 2% and 1% respectively.

Working on a desk (computer table or study desk) was the most common WFH space furniture arrangement as reported by about two-third of the respondents. Two respondents reported working at the dining table while 2 other respondents worked on their bed and other places around the house. Only 10% of the respondents had purchased new furniture for their WFH setting, which included items like office tables and chairs.

5.4 Important interior elements in a WFH space

The questionnaire asked the respondents to rate the importance of certain interior elements, namely; ergonomics, spatial capacity, lighting quality, services/equipment, biophilia, and aesthetics, in a WFH space on a scale ranging from 'Not Important' to 'Very Important'.

Ergonomics was rated the most times as a 'very important' interior element in a WFH space with 26 responses. Other elements such as spatial capacity, lighting quality, services/equipment, biophilia, and aesthetics received ratings as 'very important' from only about one-third of the respondents. Spatial capacity and aesthetics were even rated as 'not important' by about 5 respondents.

Further, out of 5 picture options depicting several WFH spaces with distinct aesthetical differences, 24 respondents chose Option 1; a casual WFH space with natural light and greenery. The next most preferred WFH space was Option 5, which shows an airy, minimal WFH space with natural light. Options 2 and 3, which have more of a professional ambience, were also picked by 5 respondents each as aesthetically appealing. Option 4, with a casual ambience but with pops of color was not chosen by any of the respondents.

5.5 Issues in WFH spaces

When considering the ratings respondents gave for the interior elements in their current WFH space, a majority of the respondents rated on spatial capacity, lighting quality, services/equipment, biophilia, and aesthetics ranging from "good" to "neutral". The worst rating belongs to ergonomics with 11 respondents reporting it as "somewhat bad".

Apart from the issues in WFH spaces discussed under subtopic 5.1 and 5.2, 18 respondents felt that their WFH space lacked a professional ambience. Elements related to functionality and physical comfort were reported more as lacking in their WFH spaces than elements related to aesthetics and biophilia.

6. DISCUSSION

Colenberg S., Jylhä T., & Arkesteijn M. (2021), studied features of office interiors that were most often discussed in researches by extracting information from articles consisting of studies done on office interiors and employee well-being. Recurring themes of the studies were; office layout, lighting, furniture, control (personalization), noise, and greenery.

This research forms the premise for the comparison of some qualitative data related to specific aspects of the data gathered through the survey. Although the research is conducted on office spaces, the data will suffice for comparison with data collected on WFH spaces as the function performed in both spaces are fundamentally the same.

6.1 Spatial capacity and social interaction

When it comes to findings related to office layout, most articles reported that workers had very poor physical and mental health when working in cubicles. However, it also revealed that even though open-plan office layouts are more favorable, the scale of the office along with the number of people in the room negatively affected productivity and happiness of employees as it grew. The key takeaway of this aspect of office interiors is that employees felt

more at ease when they had an enclosed space they could divert back to from their open-plan offices.

The data fetched from the survey reveals a similar tendency among employees. Spatial capacity was rated as "very important" by 13 respondents, and, out of the 30 respondents, 22 reported that social interaction is the most lacking aspect of WFH when compared to working at an office. Seven other respondents reported feelings of isolation from WFH. This could be due to the fact that even though an enclosed space is ideal for working, the employees did not have an appropriate secondary space to work in nor adequate social interaction to balance the level of isolation experienced when working from home.

6.2 Lighting

Light in the work place was also found to impact the well-being of employees as long as there was adequate lighting throughout the day. Adequate lighting also ensured that employees were in a better mood and that exposure to daylight improved sleep quality. However, it was found that dynamic lighting that had varying color temperatures throughout the day did not impact the employees' health.

The importance of lighting had an average count of respondents, with about 16 respondents rating it as "very important". Lighting quality also appears to be adequate in the respondents' own WFH space as 17 respondents rated the lighting quality in their WFH spaces to be "good" or "somewhat good", whilst 9 respondents rated "neutral". However, 2 respondents rated their lighting quality as "bad." These two respondents also mentioned lighting to be an aspect they would most like to improve in their WFH space.

6.3 Furniture and ergonomics

The study was also able to find several articles related to furniture of office interiors, namely; i) ergonomic furniture and ii) activating furniture. Ergonomic furniture refers to furniture that are

made considering human interaction in a space, whereas activating furniture refers to furniture that are adjustable to accommodate for several working postures; such as sit-stand work stations. The results, however, fetched varying results related to the use of these types of furniture and impact on musculoskeletal and visual comfort.

Ergonomics and physical comfort were rated "very important" by 26 respondents and was also rated as "somewhat bad" in one's own WFH space by 11 respondents. The response count related to ergonomics was substantially higher than other elements of WFH spaces such as spatial capacity and lighting.

Muscle pain and headaches were also reported by 11 respondents as issues they have faced while working from home; which could be a result of incorrect working postures, extensive periods of work, or furniture not designed ergonomically.

Other responses related to changes the respondent would like to make in their WFH space also referred mostly to being able to change furniture items to improve physical comfort. Respondents who purchased new furniture also purchased furniture items such as office desks, laptop stand, and office chairs.

6.4 Biophilia

Contact with nature was also observed in several of the articles reviewed in this study. The results found that exposure to natural and artificial greenery has varying results. However, no study found that exposure to greenery, deriving either naturally or artificially, has a negative effect on the health of employees.

Respondents rated favorably regarding the importance of biophilic elements in a WFH space, with a count of 15 respondents rating it as "very important". It is also an element of WFH spaces that most respondents were satisfied with in their own spaces, with an exception of 3 respondents.

Accordingly, four responses regarding changes one would like to make in their WFH space also relayed wanting to reorient their work tables to face a window, or be able to have a view of the outside.

The image of the most preferred WFH space, Option 1 (with a count of 24 respondents), had multiple elements of biophilia such as greenery from plants, natural lighting, and a view of the outside. This could indicate that employees prefer to have biophilic elements in their WFH space.

6.5 Control

Control in the workspace can be categorized as i) adjusting physical conditions of workspace and ii) personalization of workspace. Although the studies cannot definitely say that having control over one's workspace enhances health, individual control of a workspace (such as adjusted desk heights) is linked to better physical health.

Most of the responses regarding what the respondent would like to change about their current WFH space revolves around being able to change the layout of their work space or change their furniture for improved comfort.

When it comes to personalization, it could be hypothesized that employees preferred to have a professional-looking WFH space as 18 people found that their WFH space lacked the professional ambience that an office has.

However, it can clearly be observed by the pictures of WFH chosen by the respondents through the survey that employees preferred WFH environments with a subtle casualness. Option 1 of the images, which shows a casual and cozy WFH space, was picked by 24 respondents as the most preferred WFH space. Interestingly, only 5 respondents preferred Option 3, bearing an image of a more sleek, professional WFH space.

Two respondents also commented that they would like to improve their current WFH space

by adding decorative elements such as artwork or having more aesthetically pleasing furniture items.

This could suggest that although employees like to work in professional environments in an office, they like to have some degree of customization and casualness to their WFH space. This shows a clear distinction in preferences for office interior design and WFH space interior design.

6.6 Distractions and privacy

The study also touches on noise in an office space. Higher sound levels from background noises in an office environment led to poor physical and psychological health, with a slight increase in stress. This could also be applied to WFH spaces where background noise from the rest of the house can cause distractions, stress, and lack of privacy.

The most experienced issue of WFH according to the survey is distractions. Close to 57% of the respondents indicated that distractions are a major issue while working from home.

Furthermore, 80% of respondents who converted an existing space in their house to a WFH space chose their bedroom to be converted, which could be indicative of the fact that a bedroom has more privacy compared to other rooms in a house (such as the living room) and therefore, more ideal for working from home.

A respondent that has set up their working space in their dining room replied what they would most like to change about their working space is to move to a more private space to minimize distractions.

7. CONCLUSION AND RECOMMENDATIONS

The participants of the survey seemed to indicate that ergonomics, spatial capacity, lighting quality, and services to be of more importance than interior elements such as biophilia and

aesthetics. The responses also reiterate the preferences and behavioral patterns in WFH spaces outlined by Colenberg S., Jylhä T., & Arkesteijn M. (2021). The research also shows that the elements related to functionality discussed above are the elements in WFH space interiors that participants most struggled with. Therefore, biophilia and aesthetics can be regarded as secondary elements of a WFH space that are of importance as well, but are not a priority until functionality is adequate in the space.

According to the data collected through the survey, the behavioral patterns of users help to highlight issues related to the creation of WFH spaces and the daily usage of WFH spaces. The most pressing concerns would be related to ergonomics, the type of room used for working from home, and also the layout of the room. The type of room used for a WFH space also affects aspects like privacy, distractions, and scheduling. These issues most probably arise due to the sudden switch to WFH that pushed employees to resort to creating temporary work spaces with less than ideal working conditions. Therefore, it is advisable to be thoughtful about the type of room that is used as a WFH space and to also ensure that the furniture used for working from home are appropriate for long hours of work.

The concept of pocket offices is also useful when designing future homes as it allows for dead spaces such as the area underneath staircases to be utilized for functional purposes. However, the level of appropriateness of a pocket office depends immensely on the type of work being performed, spatial requirements, and level of privacy needed.

When considering aesthetics, the research helps highlight a subtle difference between office space design and WFH space design. Since WFH spaces allow for customization, participants of the survey seemed to veer towards WFH spaces that are more personalized, casual, and laid back as opposed to professional, sleek ambiances. This is perhaps the only stark difference of WFH interior preferences compared to office interior design.

Accordingly, the information derived through this research can be used to identify commonly occurring issues with WFH spaces and designing WFH space interiors accordingly to mitigate such issues in the future.

REFERENCES

- Gregory, J. G. (2017). 5 Ways a "Pocket Office" Can Help Boost Productivity. American Express.
<https://www.americanexpress.com/en-us/business/trends-and-insights/articles/5-ways-a-pocket-office-can-boost-productivity/>.
- Mendoza, N. F. (2021). Distractions and the downsides to working from home. Tech Republic.
<https://www.techrepublic.com/article/distractions-and-the-downsides-to-working-from-home/>
- Rund, M. (2021) *Working from home and well-being during the COVID-19 pandemic : a moderated mediation model of supervisor support and loneliness*. University of Twente. <http://essay.utwente.nl/87580/>
- Hodler, S. (2021). The Environmental Impact of the Return to the Office. Bloomberg.
<https://www.bloomberg.com/news/articles/2021-03-29/is-telecommuting-really-greener-it-depends>.
- Colenberg, S., Jylhä, T., & Arkesteijn, M. (2020). The relationship between interior office space and employee health and well-being: a literature review. *Building Research and Information*, 49 (2021)(3), 352-366.
<https://doi.org/10.1080/09613218.2019.1710098>

A Novel Cryptosystem Using Multipartite Graphs

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ABSTRACT

Graph theory has a special role in mathematics, both in the abstract and in the applied sense. Therefore, over the years it has attracted mathematicians in diverse disciplines with wide range of applications such as in Computer Science, Engineering, Biology, etc. One such area of application is the use of Graph theoretic concepts in implementing Cryptography algorithms. The introduction of the notion of a graph dated back to 1736 when Leonhard Euler answered the famous Königsberg Bridge Problem in the negative. A graph G is a union of finite non-empty set of elements called vertices $V(G)$ and a set of unordered pair of elements of $V(G)$ called edges, $E(G)$. Cryptography is the art of securing information so that only the intended party received the information. The process of converting a given message (plaintext) to a secure form (ciphertext) is called encryption while the reverse process is called decryption. In the present study, we encrypt a given message into multipartite graphs to form the ciphertext using the proposed encryption algorithm and it is converted into plaintext by using the decryption algorithm. As a future work, we are planning to introduce an encryption and decryption algorithm by using graph factorizations.

1. INTRODUCTION

Graph Theory is a very important subject area which is used to solve many real-world phenomena. A graph is a structure that consists of vertices and edges. A simple graph G is a pair $(V(G), E(G))$; $V(G)$ is a non-empty finite set of elements called vertices and $E(G)$ is a set of unordered pair of distinct elements of $V(G)$ called edges. Graph Theory is useful in solving

intriguing problems involved in other subject areas such as Computer Science, Biology, Chemistry, Economics, etc. In the present study, some ideas of Graph Theory and Number Theory are used to develop a Cryptography algorithm (Hraiz, and Etaiwi, 2017).

Cryptography is the method of protecting information by converting into unreadable format when the message sends to other parties. This unreadable format is called the ciphertext and the original message is called the plaintext. The method of transforming plaintext to ciphertext is called encryption and recovering the plaintext from the ciphertext is called decryption. The notion of cryptography originates from the era of Julius Caesar. He used this concept for military purposes. Nowadays, this knowledge is used in various applications such as computer and mobile passwords, Emails, Web encryption, storing data, etc. (Rosen, 2011).

There are two main types of cryptosystems; symmetric and asymmetric. In the former, the sender and the receiver use the same key to encrypt and to decrypt the message. But in the latter, the sender encrypts the message using a key known as public key and no need to keep it as a secret key and send it to the receiver. However, when the receiver gets the encrypted message, it needs to be decrypted using another key called the private key and it must be kept as a secret key.

In this study, we encrypt the message into multipartite graphs. In the next section we explain the method of the algorithm in detail and discuss it using a simple example.

2. MATERIALS AND METHODS

In this section, we discuss our algorithm which is based on two main steps; encryption, and decryption. Firstly, we will explain the general procedure of our method and after that illustrate it with a simple example.

2.1. Encryption Algorithm

Step 01: Use the following algorithm (similar to RSA algorithm) to encode the message.

- Let $n = p \cdot q$, where p and q are distinct primes; for example, take $n = 26, p = 2$, and $q = 13$.
- Select an integer e such that, $\gcd(e, (p-1)(q-1)) = 1$.

i.e., $\gcd(e, 12) = 1$.

- Finally, encrypt the message " m " to " m' " using $m' \equiv m^e \pmod{n}$.

Step 02: According to the m' values, the corresponding positions of the English letters are chosen using *Table 2*.

Step 03: Now, the ciphertext obtained using the above table is encrypted by adopting the following method. Construct a set P_l by considering the first " l " primes such that,

$$l = \left\lceil \frac{26}{k} + k \right\rceil,$$

where

$$k = \begin{cases} x & ; 0 < x < 13, \\ \left\lceil \frac{x}{4} \right\rceil & ; 13 \leq x \leq 45. \end{cases}$$

with x being a fixed value according to the

A	B	C	D	E	F	G	H	I	J	K	L	M
3	5	7	11	17	19	23	29	31	37	41	43	47
3	5	7	11	17	19	23	3	5	11	15	17	21
N	O	P	Q	R	S	T	U	V	W	X	Y	Z
53	59	61	67	71	73	79	83	89	97	101	103	107
1	7	9	15	19	21	1	5	11	19	23	25	3

Table 1. The first encoding table using prime numbers.

- Next use the *Table 1* to convert the letters of the English alphabet to numerical values. The third row and the sixth row represent the numerical values of the English alphabet letters under modulo 26. According to these two rows there are some alphabet letters which have the same numerical values and when the message is decrypted using the table, we have to select the corresponding numerical value for the correct letter by infection method.

Let m be the position of the letter according to the *Table 1* chosen to satisfy $\gcd(m, n) = \gcd(m, 26) = 1$. Therefore, $m \neq 2$ or 13 .

- Now, compute " d " such that, $de \equiv 1 \pmod{(p-1)(q-1)}$.
i.e., $de \equiv 1 \pmod{12}$

Step 04: Next, construct a new table with the size $(l - k) \times k$. The English letters are partitioned for the first k^{th} positions and assign the first k^{th} prime numbers horizontally for these partition columns and assign the $(k + 1)^{th}, \dots, l^{th}$ position prime numbers vertically using the set P_l .

Step 05: Now, find the value of each letter using the constructed table with integers i and j such that $a_r = ij$, where i is the value of the row position and j is the value of the column position. After that, multiplying $i \cdot j$ (a_r) and construct the path graph by assigning a_r values for vertices according to the sequence of letters.

A	B	C	D	E	F	G	H	I	J	K	L	M
1	2	3	4	5	6	7	8	9	10	11	12	13
N	O	P	Q	R	S	T	U	V	W	X	Y	Z
14	15	16	17	18	19	20	21	22	23	24	25	26

Table 2. The second encoding table.

Step 06: Construct vertex sets for the multipartite graphs such that $v_k = \{k^{th} \text{ position of the digit of } a_r \text{ by starting right side}\}$. Then the edge set of the multipartite graph becomes $G(v_k, v_{k-1})$.

Step 07: Finally, assign random numbers (in increasing order) to the edges as the corresponding weight and if edges are connected by vertices in each partite set, the same weight is used to label those edges. Then send the final weighted graph with the secret key (d, k) to the receiver.

2.2. Decryption Algorithm

Step 01: Arrange the weights w_i of the edges in ascending order:

$$W = \{w_1, w_2, \dots, w_n\}.$$

Step 02: Using these weights, find the values of a_r 's and draw a path graph by assigning a_r values to its vertices according to the order.

Step 03: Find the prime factorization for each vertex label.

Step 04: Find the required alphabets using the table described in Step 05 in encryption algorithm.

Step 05: Next, find the m' value from the table described in Step 02 of the encryption algorithm.

Step 06: Use the following method to decrypt m' to m .

- Since $m' \equiv m^e \pmod{26}$, we have $(m')^d \equiv (m^e)^d \pmod{26}$
i.e., $(m')^d \equiv m^{ed} \pmod{26}$.
- Since $de \equiv 1 \pmod{12}$, we can write $de = 1 + 12j$, for some integer j .

- Now,

$$(m')^d \equiv m^{1+12j} \pmod{26}$$

$$\Rightarrow (m')^d \equiv m \cdot m^{12j} \pmod{26}$$

- By Euler's theorem,

$$m^{\phi(n)} \equiv 1 \pmod{26}$$

$$(\text{since } \gcd(m, 26) = 1)$$

$$\text{Here, } \phi(n) = (p-1)(q-1) = 12$$

$$\text{i.e., } m^{12} \equiv 1 \pmod{26}$$

- Therefore,

$$(m')^d \equiv m \cdot m^{12j} \pmod{26}$$

$$\Rightarrow (m')^d \equiv m \cdot (m^{12})^j \pmod{26}$$

$$\Rightarrow (m')^d \equiv m \pmod{26}$$

$$\Rightarrow m \equiv (m')^d \pmod{26}$$

Step 07: Finally, select the suitable letters from *Table 1* described in the first step in the encryption algorithm.

3. RESULTS AND DISCUSSION

In the present study, a developed encryption algorithm is introduced using the techniques of Number Theory and Graph Theory. The method is illustrated using the plaintext "**GRAPH**". First, the encryption algorithm is described as follows:

3.1. Encryption Method

Let, $n = 26$, $p = 2$, $q = 13$, and $e = 23$ satisfying $\gcd(e, 12) = \gcd(23, 12) = 1$.

From *Table 1*, we obtain the following values for the English letters:

$$m_1 = G = 23, \gcd(m_1, 26) = 1$$

$$m_2 = R = 71 = 19, \gcd(m_2, 26) = 1$$

$$m_3 = A = 3, \gcd(m_3, 26) = 1$$

$$m_4 = P = 61 = 9, \gcd(m_4, 26) = 1$$

$$m_5 = H = 29 = 3, \gcd(m_5, 26) = 1$$

Now, let us find m' .

$$m_1' \equiv m_1^e \pmod{26} \equiv 23^{23} \pmod{26} \\ \equiv 17 \pmod{26}$$

$$\begin{aligned}
 m_2' &\equiv m_2^e \pmod{26} \equiv 19^{23} \pmod{26} \\
 &\equiv 11 \pmod{26} \\
 m_3' &\equiv m_3^e \pmod{26} \equiv 3^{23} \pmod{26} \\
 &\equiv 9 \pmod{26} \\
 m_4' &\equiv m_4^e \pmod{26} \equiv 9^{23} \pmod{26} \\
 &\equiv 3 \pmod{26} \\
 m_5' &\equiv m_5^e \pmod{26} \equiv 3^{23} \pmod{26} \\
 &\equiv 9 \pmod{26}
 \end{aligned}$$

Let us compute the value "d".

$$\begin{aligned}
 de &\equiv 1 \pmod{12} \\
 23d &\equiv 1 \pmod{12} \\
 d &\equiv (23)^{-1} \pmod{12}
 \end{aligned}$$

Note that,

$$\phi(12) = 12 \left(1 - \frac{1}{2}\right) \left(1 - \frac{1}{3}\right) = 4.$$

Therefore,

$$\begin{aligned}
 d &\equiv (23)^{-1} \pmod{12} \equiv 23^{(2-1)} \pmod{12} \\
 &\equiv 23 \pmod{12} \\
 &\equiv 11 \pmod{12} \\
 \therefore d &= 11
 \end{aligned}$$

According to the Table 2, the new word is "QKICI".

Now, let us convert this message into the respective multipartite graph using the following method.

In the above word, $x = 5 (< 13)$, $k = 5$,

$$l = \left\lceil \frac{26}{5} + 5 \right\rceil = 11 \text{ and } (l - k) = 11 - 5 = 6$$

Then, $P_l = \{2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31\}$

According to the above table,

$$a_1 = 23 \cdot 3 = 69, a_2 = 19 \cdot 2 = 38, a_3 = 17 \cdot 7 = 119, a_4 = 13 \cdot 5 = 65, a_5 = 17 \cdot 7 = 119$$

Then the path graph for the above word is shown in the following diagram.

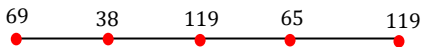


Figure 1. The obtained path graph according to the encryption method.

	2	3	5	7	11
13	A	B	C	D	E
17	F	G	H	I	J
19	K	L	M	N	O
23	P	Q	R	S	T
29	U	V	W	X	Y
31	Z				

Find the vertex sets for $k = 1, 2, 3$ such that $v_1 = \{5, 8, 9\}$, $v_2 = \{1, 3, 6\}$, $v_3 = \{1\}$.

Finally, the following multipartite graph can be obtained as a ciphertext with the secret key $(d, k) = (11, 5)$ for the message "GRAPH". Weights are assigned randomly for its edges.

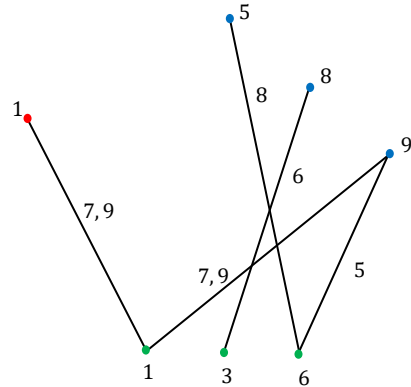


Figure 2. The ciphertext for the word "GRAPH".

3.2. Decryption Method

According to the ciphertext, the weighted set W is, $W = \{5, 6, 7, 8, 9\}$.

Now, using the received graph, let us find the path graph according to the weights.

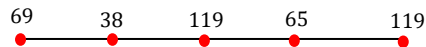


Figure 3. The obtained path graph using weights of the ciphertext.

Prime factors of the above vertex labeling are, $69 = 23 \cdot 3$, $38 = 19 \cdot 2$, $119 = 17 \cdot 7$, $65 = 13 \cdot 5$, $119 = 17 \cdot 7$.

Using *Table 3*, the following word can be obtained.

“Q K I C P”

Now, from *Table 2*, the values of m' are obtained as follows,

$$m_1' = 17, m_2' = 11, m_3' = 9, m_4' = 3, m_5' = 9.$$

Then, decrypt the message using the following formula:

$$m \equiv (m')^d \pmod{26}.$$

Since $d = 11$ (using secret key),

$$m \equiv (m')^{11} \pmod{26}$$

$$m_1 = (17)^{11} \pmod{26} \equiv 23 \pmod{26}$$

$$m_2 = (11)^{11} \pmod{26} \equiv 19 \pmod{26}$$

$$m_3 = (9)^{11} \pmod{26} \equiv 3 \pmod{26}$$

$$m_4 = (3)^{11} \pmod{26} \equiv 9 \pmod{26}$$

$$m_5 = (9)^{11} \pmod{26} \equiv 3 \pmod{26}$$

Finally, using *Table 1*, the following letters can be obtained. After that by choosing the correct letters, the plaintext can be obtained.

$$23 = G, X / 19 = F, R, W / 3 = A, H, Z / 9 = P / 3 = A, H, Z$$

Therefore, the secret message is **“GRAPH”**.

The proposed algorithm is constructed by using two different methods to obtain a multipartite graph as the ciphertext with the use of the well-celebrated RSA algorithm. Hence, it is hard to find the secret key of this encryption algorithm which ensures the security. In addition, the existing algorithm we refer to in literature introduces encryption and decryption algorithm using simple bipartite graphs to find ciphertext but in our study, the ciphertext is in more challenging form since it represents using multipartite graphs. The use of graphs may result in taking more memory space.

4. CONCLUSION(S)

Cryptography is used to secure data transmission in the presence of adversaries. Encryption algorithms are used to transform any given message from readable format to unreadable format and the reverse procedure is called decryption. In this work, we have introduced symmetric key encryption and decryption algorithm by using graph theory concepts to obtain a ciphertext. Two different methods were used to construct multipartite graphs as a ciphertext. First, the plaintext was converted into an unreadable format using a method similar to the RSA algorithm. After that, using prime factorization, the previous ciphertext was transformed to a multipartite graph and it is the final ciphertext that needs to be sent to the receiver with the secret key pair (d, k) . In future, we are trying to find an encryption algorithm using graph factorizations.

REFERENCES

- Athukorala, P., Chathurangi, M., & Ranasinghe, R. (2022). *A variant of RSA using continued fractions*. Journal of Discrete Mathematical Sciences and Cryptography, 25(1), 127-134.
- Hraiz, S. & Etaiwi, W. (2017). *Symmetric Encryption Algorithm Using Graph Representation*. International Conference on Information Technology, 501-506.
- Ni, B., Qazi, R., Rehman, S. U., & Farid, G. (2021). *Some Graph-Based Encryption Schemes*. Hindawi Journal of Mathematics, 1-8.
- Paar, C., & Pelzl, J., (2009). *Understanding cryptography: a textbook for students and practitioners*. Springer Science & Business Media.
- Rivest, R.L., Shamir, A., & Adleman, L. (1978). *A Method for Obtaining Digital Signatures and Public-Key Cryptosystems*. Communications of the ACM, Volume 21, Issue 2, Pp 120–126.
- Rosen, Kenneth H. (6th Eds.) (2011). *Cryptology, Elementary number theory and its applications*. Pp 291-345. Pearson Education, Inc.

Graceful Labeling of Chain Graphs with Pendants

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ABSTRACT

Graph labeling is one of the most popular research areas in graph theory. There is a vast amount of literature available on graph labeling. In this research, we especially concentrate on a special type of graph labeling method called vertex graceful labeling. A simple connected graph G is said to be a vertex graceful if there exists a vertex graceful labeling on the vertices of G starting from 1. *Graceful labeling* of G is a vertex labeling f , which is defined as an injective mapping from $V(G)$ to $[0, |E(G)|]$ such that the edge labeling $f_e: E(G) \rightarrow [1, |E(G)|]$ defined by $f_e(uv) = |f(u) - f(v)|$ is also injective. There is a very famous open conjecture in this area abbreviated as GTC which stands for graceful tree conjecture or Ringel - Kotzig conjecture which hypothesizes that all trees are graceful. In this research work, we introduce graceful labeling for a chain of the key graph with a finite number of pendants and a chain of linear dice graphs with a finite number of pendants.

Keywords: *Graceful labeling, Key graph, Linear dice graph*

1. INTRODUCTION

Graceful Labeling is a famous graph labeling method and is an active research area in graph theory. This labeling method was introduced by Alexander Rosa in 1967 and was originally given the name β -labeling (Rosa, A. (1967) *On Certain*

Valuations of the Vertices of a Graph. Theory of Graphs (International Symposium, Rome, July 1966), Dunod Gordon & Breach Science Publishers, Inc., New York, and Dunod Paris, 349-355. - References - Scientific Research Publishing, n.d.). There are two main types of graceful labeling as vertex graceful labeling and edge graceful labeling. Over the past 50 years, many graphs have been proven to be graceful and recent work on graceful labeling includes linear dice graphs and path-dice graphs (Abdul Kader et al., 2014). In our work, we introduce general graceful labeling for a chain of linear dice graphs with a finite number of pendants and a chain of the key graph with a finite number of pendants with some limitations under Theorem 1 and Theorem 2. Applications of cycle graphs are very much popular in communication networks, and since these graphs represent a chain of cycles, we strongly believe that these graphs also can be used to model computer networks.

2. MATERIALS AND METHODS

In this section will be given the basic information to continue our work.

Preliminaries

So, we will introduce some fundamental definitions first.

Definition 1: Graceful Labeling.

Let $G = G(V, E)$ be a graph with $m = |E(G)|$, where $V(G)$ and $E(G)$ denote the set of vertices and edges, respectively. Graceful labeling of G is

a vertex labeling $f: V \rightarrow [0, m]$ such that f is injective, and the edge labeling $f_e: E \rightarrow [1, m]$ defined by $f_e(uv) = |f(u) - f(v)|$ is also injective. Such a graph is called a *graceful graph*.

Definition 2: Chain of linear dice graph.

This graph is constituted of a chain of C_4 graphs in which among two consecutive dices there is a common vertex and each C_4 is termed as dice (Abdul Kader et al., 2014).

Definition 3: Chain of linear dice graph with pendants.

Here we consider the above linear dice chain with at least one edge (pendant) at each vertex of the C_4 as in Figure 1.

Definition 4: Chain of the key graph.

This graph can be considered as a derivation of a linear dice chain. Let's consider a linear dice, one of its four vertices connected to an edge that looks like a key, and let it be the main block. Then this graph is designed as a chain of the above block so that any consecutive two dices have one common edge.

Definition 5: Chain of the key graph with pendants

Here we consider the above chain of the key graphs with at least one edge (pendant) at each vertex of the C_4 as in Figure 2.

RESULTS AND DISCUSSION

Theorem 1

Linear dice graph is graceful with a finite number of pendants; $m_i \geq 1$.

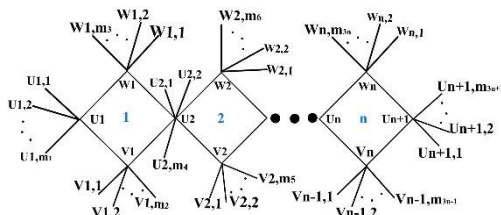


Figure 40: Chain of linear dice graph with pendants

$$f(U_1) = |E| = \sum_{i=1}^{3n+1} m_i + 4n \quad (1)$$

$$f(U_i) = f(W_{i-1, m_{3(i-1)}}) - 1; i = 2, 3, \dots \quad (2)$$

$$f(U_{i,j}) = \begin{cases} j-1; & \begin{cases} i-1 \\ j-1, 2, 3, \dots, m_1 \end{cases} \\ f(V_{i-1}) + j; & \begin{cases} i-2, 3, \dots \\ j-1, 2, 3, \dots, m_{3i-2} \end{cases} \end{cases} \quad (3)$$

$$f(W_i) = f(U_{i, m_{3i-2}}) + 1; i = 1, 2, 3, \dots \quad (4)$$

$$f(W_{i,j}) = f(V_{i, m_{3i-1}}) - 1 - j; \begin{cases} i-1, 3, \dots \\ j-1, 2, \dots, m_{3i} \end{cases} \quad (5)$$

$$f(V_i) = f(W_i) + 1; i = 1, 2, 3, \dots, n \quad (6)$$

$$f(V_{i,j}) = f(U_i) - j; \begin{cases} i-1, 2, 3, \dots \\ j-1, 2, 3, \dots, m_{3i-1} \end{cases} \quad (7)$$

Using Eq. (1), $f(U_1)$ can be calculated. Then using Eq. (3), we can calculate $f(U_{i,j})$ values for the first block. Then using Eq. (4), $f(W_i)$ can be calculated for $i = 1$ and using Eq. (6), $f(V_i)$ can be calculated for $i = 1$. By using the $f(U_1)$ value and Eqs. (5) and (7) we can calculate $f(W_{i,j})$, $f(V_{i,j})$ values for the first block. Finally using Eq. (2), $f(U_2)$ can be calculated.

In each block first, we label the node U_i first, then we use that label to get the pendant values of the $V_{i,j}$, $W_{i,j}$, $U_{i,j}$ values for $i > 1$ will be calculated using the previous block's V_i value and So, likewise repeating the above procedure we can get the rest of the labels easily.

Theorem 2

Chain of the key graph is graceful for a finite number of pendants; $m_i \geq 1$.

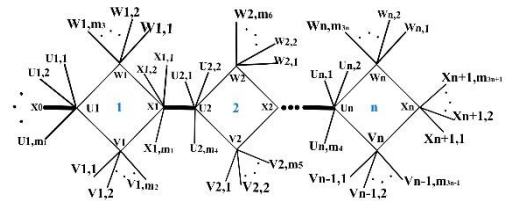


Figure 41: Chain of key graph

$$f(X_0) = 0 \quad (8)$$

$$f(U_1) = |E| = \sum_{i=1}^{4n} m_i + 5n; m_i \geq 1 \quad (9)$$

$$f(X_i) = \begin{cases} f(W_{i,m_{4i-1}}) - 1; & i = 1, 3, 5, \dots, n \\ f(W_{i,m_{4i-1}}) + 1; & i = 2, 4, \dots, n-1 \end{cases} \quad (10)$$

$$f(U_i) = \begin{cases} f(X_{i-1,m_{4(i-1)}}) + 1; & i = 2, 4, \dots \\ f(X_{i-1,m_{4(i-1)}}) - 1; & i = 1, 3, \dots \end{cases} \quad (11)$$

$$f(V_i) = \begin{cases} f(W_i) + 1; & i = 1, 3, 5, \dots, n \\ f(W_i) - 1; & i = 2, 4, \dots, n-1 \end{cases} \quad (12)$$

$$f(W_i) = \begin{cases} f(U_{i,m_{4i-3}}) + 1; & i = 1, 3, 5, \dots \\ f(U_{i,m_{4i-3}}) - 1; & i = 2, 4, \dots \end{cases} \quad (13)$$

$$f(U_{i+1,j}) = \begin{cases} f(X_i) + j; & \begin{cases} i = 0, 2, 4, \dots \\ j = 1, 2, \dots, m_{4i+1} \end{cases} \\ f(X_i) - j; & \begin{cases} i = 1, 3, 5, \dots \\ j = 1, 2, \dots, m_{4i+1} \end{cases} \end{cases} \quad (14)$$

$$f(V_{i,j}) = \begin{cases} f(U_i) - j; & \begin{cases} i = 1, 3, \dots \\ j = 1, 2, \dots, m_{4i-2} \end{cases} \\ f(U_i) + j; & \begin{cases} i = 2, 4, \dots \\ j = 1, 2, \dots, m_{4i-2} \end{cases} \end{cases} \quad (15)$$

$$f(W_{i,j}) = \begin{cases} f(V_{i,m_{4i-2}}) - 1 - j; & \begin{cases} i = 1, 3, \dots \\ j = 1, 2, \dots, m_{4i-1} \end{cases} \\ f(V_{i,m_{4i-2}}) + 1 + j; & \begin{cases} i = 2, 4, \dots \\ j = 1, 2, \dots, m_{4i-1} \end{cases} \end{cases} \quad (16)$$

$$f(X_{i,j}) = \begin{cases} f(V_i) + j; & \begin{cases} i = 1, 3, \dots \\ j = 1, 2, \dots, m_{4j} \end{cases} \\ f(V_i) - j; & \begin{cases} i = 2, 4, \dots \\ j = 1, 2, \dots, m_{4j} \end{cases} \end{cases} \quad (17)$$

As I have mentioned, the first label X_0 as 0 and U_1 as the total number of edges using Eq. (8) and Eq. (9) respectively. Using Eq. (14) we can compute $f(U_{1,j})$ values for $i = 0$ then, applying these values to Eqs. (12) and (13) we can calculate $f(V_i)$ and $f(W_i)$. As usually in Figure 2, $f(V_{i,j})$ and $f(W_{i,j})$ values can be calculated for the first block using $f(U_1)$ value using Eqs. (15) and (16). Using the $f(V_1)$, we can compute $f(X_{i,j})$ using Eq. (17). Using Eqs. (11) and (17), $f(U_i)$ can be calculated for $i > 1$. Using the $f(W_{i,j})$ value and Eq. (10), we can get $f(X_i)$ value too.

Likewise, we can get the labels for the other blocks by repeating this procedure.

Now, we illustrate Theorem 1 & 2 by using the following examples given under Figure 3 & Figure 4 respectively.

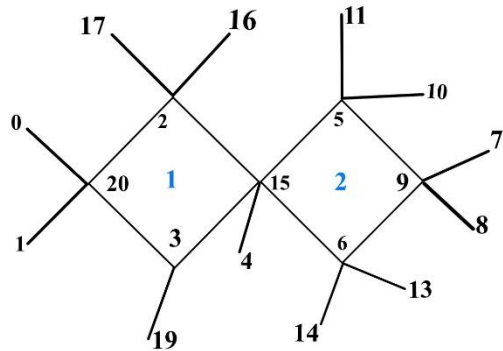


Figure 42: Graceful labeling of a chain of linear dice graph with a finite number of pendants

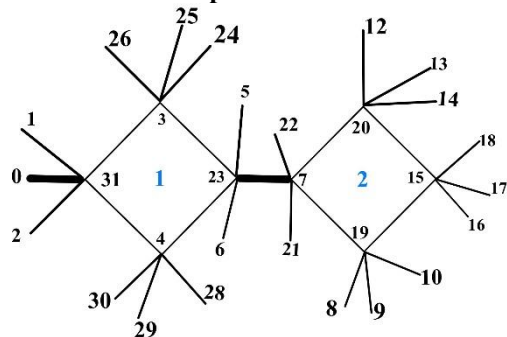


Figure 43: Graceful labeling of a chain of the key graph with pendants

3. CONCLUSION

In our research, we discussed the vertex graceful labeling of a chain of the key graph with a finite number of pendants and a chain of linear dice graph with a finite number of pendants. Under two theorems, we have given the method of construction of the two graphs and the existence of the gracefulness of some arbitrary graphs obtained for different n and m_i values and verified that they are graceful.

4. REFERENCES

Abdul Kader, M., Manjur, S., & Manzur Ankon, Md. T. (2014). *A Critical Assessment of Graceful*

Graphs and Trees: Study and Development of New Approaches.
<http://dspace.mist.ac.bd:8080/xmlui/handle/123456789/151>

Graceful labeling - Wikipedia. (n.d.). Retrieved September 1, 2022, from https://en.wikipedia.org/wiki/Graceful_labeling

Rosa, A. (1967) *On Certain Valuations of the Vertices of a Graph. Theory of Graphs (International Symposium, Rome, July 1966)*, Dunod Gordon & Breach Science Publishers, Inc., New York and Dunod Paris, 349-355. - References - Scientific Research Publishing. (n.d.). Retrieved September 1, 2022, from [https://www.scirp.org/\(S\(czeh2tfqw2orz553klw0r45\)\)/reference/referencespapers.aspx?referenceid=2964508](https://www.scirp.org/(S(czeh2tfqw2orz553klw0r45))/reference/referencespapers.aspx?referenceid=2964508)

Smash – Hom Duality for Pointed Simple Reflexive Graphs

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ABSTRACT

Graph theory has a wide range of applications in natural sciences such as biology, chemistry, physics, computer science, engineering, etc. Since the second half of the last century, mathematicians have tended to rewrite existing mathematics in the language of category theory, as it provides a more transparent and conceptual foundation. Other advantages of this approach, over set theory, include uncovering previously unseen relationships and providing a gateway to transport ideas between different fields of mathematics. Following this idea, we apply some categorical concepts to graph theory in this research. First, we recognize a new product for pointed simple reflexive graphs, and the binary product in the category of such graphs is called the smash product. We also realize the set of based point preserving graph homomorphisms between two given pointed simple reflexive graphs as another such graph. Finally, we establish a duality result between smash product and graph of based graph homomorphism, which is reminiscent of the classical smash-hom adjunction for pointed topological spaces. In future work, we will show this correspondence is a genuine adjunction and prove that simple reflexive graphs form a symmetric monoidal category with the smash product.

1. INTRODUCTION

Classical graph theory plays a vital role in discrete mathematics, both in the abstract and in the applied sense. A graph G is a geometrical object representing a set of objects and connections, possibly more than in one way,

between them. According to the precise formulation, there are few different types of graphs, namely, simple graphs, directed graphs, weighted graphs, etc.

Category theory is the subject that describes abstract structures and their relations in mathematics. For instance, class of all graphs, of a particular kind, and homomorphisms between them form a category. In this study we study some properties of special type of graphs called the pointed simple reflexive graph from category theoretical point of view.

First, we are recognized a new product for pointed simple reflexive graphs, which is the binary product in the category of such graphs, called the smash product. After that a graph representing the based point preserving graph homomorphisms (internal hom) is introduced between two given pointed simple reflexive graphs. As the culminating result, we establish a duality between smash product and graph of based graph homomorphisms.

2. MATERIALS AND METHODS

In this section will be introduce the basic information and notations needed to understand our work.

2.1. Preliminaries

Below we provide definitions of each of the concepts we used in this study.

Definition 1 (Pointed Simple Reflexive Graph)

A pointed simple reflexive graph G is a pointed set V (set of vertices with a distinguished vertex) equipped with a reflexive and symmetric relation E (adjacency) on V .

We can elaborate these technical terms differently as follows:

- a) Simple: There is a symmetric function $\text{Adj}_G : V \times V \rightarrow \mathbb{Z}_2$ representing the adjacency. Consequently, edges are bidirectional and there are no multi-edges between vertices.
- b) Reflexive: Adj_G assigns 1 to each element in the diagonal of $V \times V$. In other words, there is a self-loop at each vertex $v \in V$.
- c) Pointed: There is a distinguished graph homomorphism $e_G : \bullet \rightarrow G$. Image of this map in G will be referred as the base point of G .

Definition 2 (Based Graph Homomorphisms)

Let G and H be pointed simple reflexive graphs. A based (or pointed) graph homomorphism $f : V(G) \rightarrow V(H)$ is a relation and base point preserving function.

Definition 3 (Tensor Product of Pointed Simple Reflexive Graphs)

The tensor product $G \otimes H$ is the canonical relation defined on the cartesian product $V(G) \times V(H)$.

i.e., Two points (g_1, h_1) and (g_2, h_2) are related in $V(G) \times V(H)$ if and only if g_1 is related to g_2 in $V(G)$ and h_1 is related to h_2 in $V(H)$.

Also, when component graphs are pointed with $e_G \in V(G)$ and $e_H \in V(H)$ there is an obvious based point (e_G, e_H) in $V(G) \times V(H)$.

Definition 4 (Smash Product of Pointed Simple Reflexive Graphs)

The quotient $V(G) \times V(H) / \sim$ by the equivalence relation $x \sim y$ if both are in the set $(\{e_G\} \times H) \cup (G \times \{e_H\})$ has a natural base point (e_G, e_H) given by equivalence class of the base point. Smash product $G \wedge H$ is the (reflexive and symmetric) relation on this set defined by

- a) When none of the components are the base point $(g_1, h_1) \sim (g_2, h_2)$ (i.e., adjacent in the smash product graph) provided $g_1 \sim g_2$ in $V(G)$ and $h_1 \sim h_2$ in $V(H)$;
- b) $(g_1, h_1) \sim (e_G, e_H)$ or $(e_G, e_H) \sim (g_1, h_1)$ provided the existence of some $(g_2, h_2) \in (\{e_G\} \times H) \cup (G \times \{e_H\})$ such that $g_1 \sim g_2$ in $V(G)$ and $h_1 \sim h_2$ in $V(H)$.

One can think of the smash product as the quotient graph $G \otimes H / (\{e_G\} \times H) \cup (G \times \{e_H\})$. Observe that there is a surjective based graph homomorphism $\pi : G \otimes H \rightarrow G \wedge H$ given by

$$\pi((g, h)) = \begin{cases} (g, h), & \text{if no entry is a base point} \\ (e_G, e_H), & \text{if one entry is a base point} \end{cases}$$

In particular, when G, H are finite graphs with $|V(G)| = m + 1$ and $|V(H)| = n + 1$ their smash product is another finite graph with $V(G \wedge H) = mn + 1$.

Definition 5 (Internal Hom of Pointed Simple Reflexive Graphs)

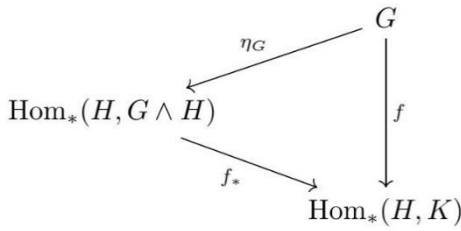
Let G and H be pointed simple reflexive graphs. The set of base graph homomorphisms $G \rightarrow H$ form a pointed simple reflexive graph itself under the following relation: $\varphi \sim \phi$ provided that for all $g_1 \sim g_2$ in $V(G)$ we have $\varphi(g_1) \sim \phi(g_2)$ in H . This graph is denoted by $\text{Hom}_*(G, H)$, and its base point is the constant graph homomorphism $e_{\text{Hom}_*(G, H)}(g) = e_H$ for all $g \in G$.

3. RESULTS AND DISCUSSION

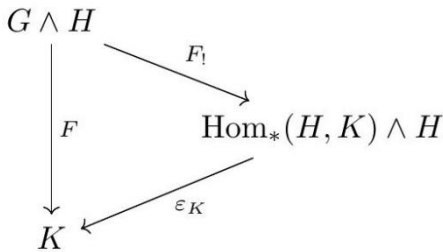
Theorem

For any pointed simple reflexive graphs G, H and K , there are two universal based graph homomorphisms $\eta_G : G \rightarrow \text{Hom}_*(H, G \wedge H)$ and $\varepsilon_K : \text{Hom}_*(H, K) \wedge H \rightarrow K$ with following factorizations:

- i. for any $f : G \rightarrow \text{Hom}_*(H, K)$ there is a unique based graph homomorphism $f_* : \text{Hom}_*(H, G \wedge H) \rightarrow \text{Hom}_*(H, K)$ such that $f = f_* \circ \eta_G$.



- ii. for any $F : G \wedge H \rightarrow K$ there is a unique based graph homomorphism $F_! : G \wedge H \rightarrow \text{Hom}_*(H, K) \wedge H$ such that $F = \varepsilon_K \circ F_!$.



Proof

Let us prove the existence of $\eta_G : G \rightarrow \text{Hom}_*(H, G \wedge H)$ as a base point preserving graph homomorphism. Define the underlying map between set of vertices as $\eta_G(g)(h) = (g, h)$.

First, we shall show that this map is well defined, i.e., $\eta_G(g)$ is a based graph homomorphism between $H \rightarrow G \wedge H$ for each $g \in G$.

- Note that $\eta_G(g)(e_H) = (g, e_H) = \overline{(e_G, e_H)}$, and therefore a base point preserving map.
- Let $h_1 \sim h_2 \in V(H)$ (that is, adjacent in H), then according to definition of the smash product, $\eta_G(g)(h_1) = (g, h_1)$ and $\eta_G(g)(h_2) = (g, h_2)$ are adjacent in $G \wedge H$. Therefore $\eta_G(g)$ is a graph homomorphism.

Since η_G is well defined, we can proceed to show that it preserves the base point of G and it is indeed a graph homomorphism.

- For any $h \in H$

$$\eta_G(e_G)(h) = (e_G, h) = \overline{(e_G, e_H)}$$

and therefore $\eta_G(e_G) = e_{\text{Hom}_*(H, G \wedge H)}$ is the base point of $\text{Hom}_*(H, G \wedge H)$.

- Suppose $g_1 \sim g_2 \in V(G)$. By the definition of smash products, we have the adjacency of

$$\begin{aligned}
 \eta_G(g_1)(h_1) &= (g_1, h_1) \sim (g_2, h_2) \\
 &= \eta_G(g_2)(h_2)
 \end{aligned}$$

in $G \wedge H$ for any $h_1 \sim h_2 \in V(H)$. Hence $\eta_G(g_1) \sim \eta_G(g_2)$ in $V(\text{Hom}_*(H, G \wedge H))$. In other words, η_G is a graph homomorphism.

Finally, we prove the factorization property of the universal map η_G . Take an arbitrary based graph homomorphism $f : G \rightarrow \text{Hom}_*(H, K)$. In particular, we know that $f(e_G)(h) = (e_G, h) \in V(\text{Hom}_*(H, K))$ for any $h \in H$, where $e_G \in G$ is the base point. For this, we shall find a map $f_* : \text{Hom}_*(H, G \wedge H) \rightarrow \text{Hom}_*(H, K)$, and let's take it to be such that $f_*(\varphi)(h) = f(\pi_1(\varphi(h)))(h)$. It can be easily shown that f_* is well defined base point preserving graph homomorphism, and its composition with η_G recovers f . i.e., $f = f_* \circ \eta_G$.

Second part of the theorem follows from a mutatis mutandis proof.

4. CONCLUSION

In this work, we establish a duality result between smash product and graph of based graph homomorphisms, which reminiscent the classical smash-hom adjunction between pointed topological spaces such that for any pointed simple reflexive graphs G, H and K , there are two universal based graph homomorphisms $\eta_G : G \rightarrow \text{Hom}_*(H, G \wedge H)$ and $\varepsilon_K : \text{Hom}_*(H, K) \wedge H \rightarrow K$. In addition to that, these two graph homomorphisms have unique factorization properties $f = f_* \circ \eta_G$ and $F = \varepsilon_K \circ F_!$ respectively. These two factorization properties were established by creating factor maps $f_*, F_!$ And showing they have all the desired properties. As a future work, we wish to show simple reflexive graphs form a symmetric monoidal category with the smash product, and implement this duality to an honest categorical adjunction.

REFERENCES

- Dochtermann, A. (2009). *Hom complexes and homotopy theory in the category of graphs*. European Journal of Combinatorics, 30(2), 490-509.
- Patterson, E. (2021). *Graphs and C-Sets III: Reflexive graphs and C-Set homomorphisms*. Algebraic Julia blog. [Graphs and C-sets III: Reflexive graphs and C-set homomorphisms \(algebraicjulia.org\)](https://algebraicjulia.org/).
- Bednarczyk, P. (2021). *On (2-d)- Kernels in the Tensor Product of Graphs*. Symmetry 2021, 13, 230. (<https://doi.org/10.3390/sym13020230>).
- Babson, E., Barcelo, H., Longueville, M., and Laubenbacher, R. (2006). Homotopy theory of graphs. *Journal of Algebraic Combinatorics*, 24(1), 31-44.

Another Quadratic Form on the Tangent Space at a Point on a Smooth Surface Embedded in \mathbb{R}^3

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ABSTRACT

The second fundamental form of an embedded surface evaluated at a tangent vector is the component of the shape operator of that vector in the same direction. However, the orthogonal component of the shape operator seems neglected, and this study will be an insight into this idea. This component of the shape operator gives rise to a new quadratic form on the tangent space which will be called as the *fourth fundamental form*, and it measures the *geodesic torsion* of the surface. Unlike the first two fundamental forms which would together describe all the geometric properties of a considered surface, the fourth fundamental form will be victimized to certain disadvantages. But once restricted to constant mean curvature or constant Gaussian curvature surfaces, it successfully reconstructs all geometric properties. Here, we will discuss the special case of minimal surfaces in detail.

1. INTRODUCTION

The theory of smooth surfaces embedded in Euclidean space has been studied at least from the time of Archimedes which was put into solid ground after introducing differential calculus by Leibniz. The theory was well understood after Carl Friedrich Gauss whose work clarifies various earlier results by others including Euler, Clairaut, Meusnier, Monge, and Dupin. In two remarkable papers published around 1830, Gauss introduced some fundamental notions such as the *Gauss map*, *first and second fundamental forms*, *Gaussian curvature* and *geodesic curves*. Later, many other mathematicians including Wilhelm Blaschke, Julius Weingarten, Jean-Gaston

Darboux, Elwin Bruno Christoffel, and Bernhard Riemann expanded and explained his ideas by introducing other foundational concepts. See [4] for more details on the history of the classical theory of embedded surfaces.

The present study establishes a certain smoothly varying quadratic form on each tangent space of a regular surface, which will be called the *geodesic torsion tensor*, and it can also be considered as the *fourth fundamental form* of the surface. The newly identified quadratic form at a point on a surface will describe geodesic torsion of the surface at that point in each direction. Moreover, it can be completely recount once the first and second fundamental forms are established, i.e., resulting coefficients can be expressed using coefficients of the first and second fundamental forms of the surface.

2. PRELIMINARIES

Let $S \subseteq \mathbb{R}^3$ be an embedded surface and $p \in S$ be a point on it. Let $n(p)$ be a surface normal and $T_p S$ be the tangent space to S at p . One of Gauss's genius ideas was to study the surface normal map $n : S \rightarrow S^2$ (which exist everywhere on an orientable surface, otherwise on each coordinate patch) and its differential $dn_p : T_p S \rightarrow T_p S^2$ at $p \in S$. The tangent space $T_p S$ has a canonical inner product $\langle _, _ \rangle : T_p S \times T_p S \rightarrow \mathbb{R}$ induced from \mathbb{R}^3 and with relation to this, there are three natural quadratic forms on S ; namely,

- $I(w) = \langle w, w \rangle$ (metric tensor)
- $II(w) = \langle S_p(w), w \rangle$ (shape tensor)
- $III(w) = \langle S_p(w), S_p(w) \rangle$,

where $S_p = -dn_p$ is called the shape operator, and $w \in T_p S$. These three are known as first, second and third fundamental forms of the surface, respectively. Given a coordinate patch (U, r) of S containing $p \in U$ such that $(u, v) \in \mathbb{R}^2 \mapsto r(u, v) \in U \subseteq S$ there is an induced basis $\{r_u, r_v\}$ for $T_p S$, and with respect to this basis one can express surface normal and all three fundamental forms. Refer [1] and [3] for more on the theory of surfaces.

The fundamental forms are not independent and first two together completely determine the third. If we let H be the mean curvature of the surface and K be the Gaussian curvature of the surface,

$$\text{III} - 2H\text{II} + KI = 0.$$

In contrast to the second fundamental form, the remaining orthogonal component of the shape operator will be utilized for our study.

Another tool to study surfaces is studying properties, such as curvature and torsion, of space curves on it. Provided a unit speed curve $\gamma : [-\epsilon, \epsilon] \rightarrow S \subseteq \mathbb{R}^3$ on S , there is a moving orthonormal reference frame $\{T, n, u\}$ on it with $T = \gamma'(t)$, $n = n(\gamma(t))$ and $u = n \times T$, known as the Darboux frame. The system

$$\begin{pmatrix} T \\ n \\ u \end{pmatrix}' = \begin{pmatrix} 0 & \kappa_n & \kappa_g \\ -\kappa_n & 0 & \tau_g \\ -\kappa_g & -\tau_g & 0 \end{pmatrix} \begin{pmatrix} T \\ n \\ u \end{pmatrix}$$

describe the rate of change of this frame with respect to arc-length of γ . The scalars κ_n, κ_g and τ_g are known as normal curvature, geodesic curvature and geodesic torsion, respectively. Because of Meusnier's theorem, normal curvature is independent from the choice of the curve, and it is another geometric interpretation for the second fundamental form. In other words, normal curvature is the component of $S_p(w)$ in the direction of w :

$$\text{II}(w) = -\langle dn_p(w), w \rangle = \kappa_n.$$

The purpose of this work is to study the component of $S_p(w)$ orthogonal to w . For any choice of a unit vector $w \in T_p S$ we get another unique unit vector $u \in n(p) \times w \in T_p S$. Thus, we can construct a "Darboux" type stationary orthonormal frame at p without a curve on S .

Take any unit-speed curve on S with $\gamma(0) = p$ and $\gamma'(0) = w$. Now, consider

$$\begin{aligned} & \langle dn_p(w), u \rangle \\ &= \langle (n \circ \gamma)', u \rangle \\ &= -\langle n \circ \gamma, u' \rangle \\ &= -\langle n \circ \gamma, -\kappa_g w - \tau_g n \rangle \\ &= \tau_g. \end{aligned}$$

Observe that, the inputs of this formula are independent of the curve. Therefore, like the normal curvature, the geodesic torsion is an extrinsic property of the curve, not a property determined by the curve. One can consider this as the analogue of Meusnier's theorem for geodesic torsion. It would be worthwhile studying this entity as another fundamental form, though it may not reveal any new geometric information.

3. RESULTS

As we already noticed, chosen a point $p \in S$ and a unit vector $w \in T_p S$, the geodesic torsion τ_g of S at p in the direction of w is given by $-\langle S_p(w), n(p) \times w \rangle$, where $n(p)$ is the value of the Gauss map at p . This quantity will be called the *geodesic torsion tensor*, which can also be considered as *the fourth fundamental form* of the surface evaluated at w and with that in mind it will be denoted by $\text{IV}(w)$. One can express this quadratic form in local coordinates as follows. Let $w = ar_u + br_v$ for two scalars $a, b \in \mathbb{R}$, then

$$\begin{aligned} & |r_u \times r_v| (n(p) \times w) \\ &= (r_u \times r_v) \times (ar_u + br_v) \\ &= -(a(r_u \cdot r_v) + b(r_v \cdot r_v))r_u + (a(r_u \cdot r_u) + b(r_u \cdot r_v))r_v. \end{aligned}$$

Consequently,

$$\begin{aligned} & -|r_u \times r_v| \langle S_p(w), n(p) \times w \rangle \\ &= \langle dn_p(ar_u + br_v), -(a(r_u \cdot r_v) + b(r_v \cdot r_v))r_u \\ & \quad + (a(r_u \cdot r_u) + b(r_u \cdot r_v))r_v \rangle \\ &= \langle an_u + bn_v, -(a(r_u \cdot r_v) + b(r_v \cdot r_v))r_u \\ & \quad + (a(r_u \cdot r_u) + b(r_u \cdot r_v))r_v \rangle \end{aligned}$$

$$\begin{aligned}
&= -(a^2(r_u \cdot r_v) + ab(r_v \cdot r_v))(n_u \cdot r_u) \\
&\quad + (a^2(r_u \cdot r_u) \\
&\quad + ab(r_u \cdot r_v))(n_u \cdot r_v) \\
&\quad - (ab(r_u \cdot r_v) \\
&\quad + b^2(r_v \cdot r_v))(n_v \cdot r_u) \\
&\quad + (ab(r_u \cdot r_u) \\
&\quad + b^2(r_u \cdot r_v))(n_v \cdot r_v) \\
&= a^2((r_u \cdot r_u)(n_u \cdot r_v) - (r_u \cdot r_v)(n_u \cdot r_u)) \\
&\quad + ab((r_u \cdot r_u)(n_v \cdot r_v) \\
&\quad - (r_v \cdot r_v)(n_u \cdot r_u)) \\
&\quad + b^2((r_u \cdot r_v)(n_v \cdot r_v) \\
&\quad - (r_v \cdot r_v)(n_v \cdot r_u))
\end{aligned}$$

By letting $IV(w) = a^2P + 2abQ + b^2R$ one can obtain

$$\begin{aligned}
P &= \frac{(r_u \cdot r_u)(n_u \cdot r_v) - (r_u \cdot r_v)(n_u \cdot r_u)}{|r_u \times r_v|} \\
&= \frac{FL - EM}{\sqrt{EG - F^2}} \\
2Q &= \frac{(r_u \cdot r_u)(n_v \cdot r_v) - (r_v \cdot r_v)(n_u \cdot r_u)}{|r_u \times r_v|} \\
&= \frac{GL - EN}{\sqrt{EG - F^2}} \\
R &= \frac{(r_u \cdot r_v)(n_v \cdot r_v) - (r_v \cdot r_v)(n_v \cdot r_u)}{|r_u \times r_v|} \\
&= \frac{GM - FN}{\sqrt{EG - F^2}}
\end{aligned}$$

where (E, F, G) and (L, M, N) are the first and second fundamental coefficients, respectively. From these quantities, we can immediately notice that

$$\begin{aligned}
GP - 2FQ + ER &= 0, \\
NP - 2MQ + LR &= 0.
\end{aligned}$$

Therefore, it appears that (E, F, G) and (P, Q, R) together cannot determine the shape operator. Another way to see this is, to observe that

$$\sqrt{EG - F^2} \begin{pmatrix} P \\ 2Q \\ R \end{pmatrix} = \begin{pmatrix} F & -E & 0 \\ G & 0 & -E \\ 0 & G & -F \end{pmatrix} \begin{pmatrix} L \\ M \\ N \end{pmatrix}$$

and the determinant of the coefficient matrix is zero, and therefore these equations cannot uniquely determine (L, M, N) in terms of other fundamental magnitudes. Given the matrix

representation of the shape operator S_p (in ordered basis $\{r_u, r_v\}$ for $T_p S$)

$$\begin{pmatrix} a & c \\ b & d \end{pmatrix} = \begin{pmatrix} E & F \\ F & G \end{pmatrix}^{-1} \begin{pmatrix} L & M \\ M & N \end{pmatrix}$$

we can find that

$$\begin{aligned}
b &= -\frac{P}{\sqrt{EG - F^2}}, & c &= \frac{R}{\sqrt{EG - F^2}}, \\
a - d &= \frac{2Q}{\sqrt{EG - F^2}}.
\end{aligned}$$

However, given any other geometric information, such as Gaussian/mean curvature or principal curvatures, we can find a, d and hence the shape operator and second fundamental form.

Especially, a minimal surface has no mean curvature, i.e., $2H = a + d = 0$, and therefore we have

$$\begin{pmatrix} a & c \\ b & d \end{pmatrix} = \frac{1}{\sqrt{EG - F^2}} \begin{pmatrix} Q & R \\ -P & -Q \end{pmatrix}.$$

In this case, we can recover all the geometric properties of the surface relevant to the shape operator. In particular, the Gaussian curvature is

$$K = \frac{PR - Q^2}{EG - F^2}.$$

4. DISCUSSION AND CONCLUSION

Despite worthwhile studying the geodesic torsion as a separate fundamental form, it would not describe every geometrical property of the surface like the first and second fundamental forms together would. This will remain as a major drawback and can be rendered towards a progression with future efforts.

As an example, for what we have accomplished, let us compute the fourth fundamental form for a *helicoid* which is a well-known minimal surface. The helicoid can be regularly parametrized as

$$r(u, v) = (u \cos v, u \sin v, kv)$$

where k is a non-zero constant. Using these parameters, fundamental magnitudes P, Q, R can be computed as

$$P = \frac{k}{u^2 + k^2}, \quad Q = 0, \quad R = -k.$$

Since this is a minimal surface, first and fourth fundamental forms together describe all the metric, curvature, and torsion properties of it. In particular, the Gaussian curvature can be computed as

$$K = \frac{PR - Q^2}{EG - F^2} = \frac{-k^2}{(u^2 + k^2)^2}.$$

REFERENCES

- [1] Carmo M. P. (1976), *Differential Geometry of Curves and Surfaces*. Instituto de Matematica Pura e Aplicada (IMPA), Rio de Janeiro, Brazil.
- [2] Ciarlet P. G., Larssonneur F. (2002), *On the recovery of a surface with prescribed first and second fundamental forms*, Journal de Mathématiques Pures et Appliquées, Volume 81, Issue 2, p. 167-185.
- [3] Shifrin, T. (2016), *Differential Geometry: A First Course In Curves and Surfaces*. University of Georgia, Athens.
- [4] Struck, D.J. (1933), *Outline of a History of Differential Geometry (II)*. Isis, 20(1), p.161.

Forecasting Performance Comparison of ARIMA and VAR Models in Dengue Cases Prediction for Five Districts in Sri Lanka

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ABSTRACT

Currently, there is an increase in the number of dengue cases reported in Sri Lanka. Therefore, the main objective of this study is to build a suitable time series model to predict the number of dengue cases in Sri Lanka. We considered the five districts, Colombo, Kurunegala, Nuwara Eliya, Trincomalee, and Puttalam, for the study. Also, we are interested in identifying a pattern of dengue cases in each district and studying the effect of climatic factors on dengue disease as the dengue vector mosquito lays its eggs in water. The data used in this study was the number of dengue cases reported in each district and the precipitation and temperature data as the climatic factors from 2010 January to 2022 June. Dengue data sets were collected from monthly reported dengue cases in Epidemiology Unit, Ministry of Health in Sri Lanka. Daily precipitation and temperature data were obtained from National Centers for Environmental Information which are publicly available, and monthly data was calculated. A comparative study of Vector Auto Regression (VAR) and Auto Regression Integrated Moving Average (ARIMA) in predicting dengue cases was carried out. The VAR and ARIMA models were fitted to the data predicted the dengue cases, and the accuracy by was checked by calculating Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and

Mean Absolute Percent Error (MAPE). Finally, the results of our study show that the VAR (1) model, which used only the climatic factor with a MAPE of 41%, is the best model to predict the dengue cases of Kurunegala. VAR (5) model with only the climatic factor precipitation with a MAPE of 51% is the best model to predict the dengue cases of Colombo, ARIMA (1,0,1) (1,0,0) [12] model with a MAPE of 40% is the best model for Nuwara Eliya. ARIMA (1,0,1) is the best model for the Puttalam and Trincomalee districts, with a 31% and 24% MAPE respectively.

1. INTRODUCTION

Time series forecasting is a technique for predicting future events by analyzing past trends based on the assumption that future trends will be similar to historical trends. Forecasting involves using models fit on historical data to predict future values. VAR models with different lag orders are used for the multivariate time series data and ARIMA models for univariate time series data. According to the National Dengue Control Unit (NDCU), dengue has a seasonal transmission in Sri Lanka, with two peaks occurring with the monsoon rains in June-July and October-December, respectively. Most cases occur during June- July, the summer one monsoon. Dengue is a flavivirus transmitted by

mosquito vectors, such as *Aedes aegypti* and *Aedes albopictus*. Mosquitoes require standing water to reproduce, and the average temperature of Sri Lanka which varies from 17°C to 35°C is ideal for transmission. Some of the previous research on dengue disease suggests that there might be some relationship between the number of reported dengue cases and climatic factors such as rainfall and temperature. But some of them indicate that there is no such relationship between those factors and dengue cases. However, these conclusions highly depend on the geographical area in which they conducted their research. The opposite findings and the increasing trend of dengue cases in Sri Lanka have motivated us to achieve this research. The principal objective of this research is to find the best time series model that forecasts the number of dengue cases in each of the five districts in Sri Lanka. The other objective is to investigate the relationship between dengue cases and the climatic factors in each district.

2. MATERIALS AND METHODS

The data for this study was the number of dengue cases reported in each district and the precipitation and temperature data as the climatic factors. Dengue data sets were collected from monthly reported dengue cases in the Epidemiology Unit, Ministry of Health in Sri Lanka. Daily precipitation and temperature data were obtained from National Centers for Environmental Information which are publicly available, and monthly data was calculated. The data from 2010 to 2021 were used for model construction, and the rest from January to June 2022 were used for model validation. The univariate time series model ARIMA and multivariate time series model VAR were used to predict the number of Dengue cases in each district. At first, data were checked for stationary data series dengue cases, total precipitation, and average temperature with the help of a time series graph and the Augmented Dickey-Fuller test. Then both models need to identify the optimal parameters for ARIMA (p, d, q) and VAR(p). The analysis was done using R statistical software. The *auto.Arima()* and *lagselect()* functions were used to find the optimal parameters for the ARIMA and VAR models.

3. RESULTS AND DISCUSSION

3.1. Preliminary Analysis

The dataset does not follow normal distribution according to the normal Q-Q plot and Shapiro-Wilks test. Then Kendall's rank correlation and Spearman's rank correlation were used for testing the correlation between dengue cases and climate factors.

Table 24: Kendall's rank coefficient dengue vs. total precipitation

District	Dengue vs. Total PRCP		Accept / Reject
	Correlation Coefficient	P-value	
Colombo	-0.1206	0.0309	Correlated
Kurunegala -ala	-0.1406	0.0120	Correlated
Nuwara - Eliya	-0.0584	0.3002	Uncorrelated
Trincomalee	-0.1116	0.0471	Correlated
Puttalam	-0.0688	0.2192	Uncorrelated

Table 25: Kendall's rank coefficient dengue vs. average temperature

District	Dengue vs. average temperature		Accept / Reject
	Correlation Coefficient	P-value	
Colombo	-0.0478	0.3928	Uncorrelated
Kurunegala-a	-0.0149	0.7905	Uncorrelated
Nuwara -Eliya	-0.1195	0.0343	Correlated
Trincomalee-e	-0.0711	0.2055	Uncorrelated
Puttalam	-0.1696	0.0025	Correlated

Table 26: Spearman's rank coefficient dengue vs. total precipitation

District	Dengue vs. Total PRCP		Accept / Reject
	Correlation Coefficient	P-value	
Colombo	-0.1832	0.0269	Correlated
Kurunegala	-0.2042	0.0134	Correlated
Nuwara Eliya	-0.0937	0.2608	Uncorrelated
Trincomalee	-0.1641	0.0478	Correlated
Puttalam	-0.1011	0.2249	Uncorrelated

Table 27: Spearman's rank coefficient dengue vs. average temperature

District	Dengue vs. Total PRCP		Accept / Reject
	Correlation Coefficient	P-value	
Colombo	-0.0639	0.4437	Uncorrelated
Kurunegala	-0.2014	0.8094	Uncorrelated
Nuwara Eliya	-0.1918	0.0204	Correlated
Trincomalee	-0.1113	0.1809	Uncorrelated
Puttalam	-0.2460	0.0028	Correlated

3.2. Model fitting

Researchers have found a direct relationship between precipitation and the increase of dengue cases. According to Edirisinghe (2017) findings, the numbers of dengue cases reported in June, July, January, and February are the highest annually, irrespective of the geographical locations of the country. Therefore, six models were fitted with $ARIMA(p,d,q)$, three VAR models with both total precipitation and average temperature with lag orders 1,2, and p , and another three VAR models only considering the

effect of total precipitation with lag orders 1,2, and p .

Table 28: Fitted ARIMA models

District	ARIMA
Colombo	ARIMA (1,0,0) (1,0,0) [12]
Kurunegala	ARIMA (5,0,1) (1,0,0) [12]
Nuwara Eliya	ARIMA (1,0,1) (1,0,0) [12]
Puttalam	ARIMA (1,0,1)
Trincomalee	ARIMA (1,0,1)

Table 29: Fitted VAR models

District	VAR with both climate factors (lag order)	VAR with only total precipitation (lag order)
Colombo	1,2,5	1,2,9
Kurunegala	1,2,5	1,2,5
Nuwara Eliya	1,2,7	1,2,3
Trincomalee	1,2,10	1,2,3
Puttalam	1,2,5	1,2

For each district, at least six models were tested, and the conclusions are made based on the tested models. Tables 5 and 6 contain all the tested models.

3.3. Model selection

The number of dengue cases for January to June 2022 was predicted using fitted models. The Root Mean Squared Error (RMSE), Mean Absolute Percentage Error (MAPE) and Mean Absolute Error (MAE) were used to check the accuracy of the fitted models and then to select the best fit model to predict the number of dengue cases for each district.

In table A1, A2, A3, A4, and A5, the error measurements were included for the tested models for each district. The best model was selected depending on the minimum error measurements for at least two measurements of

tested models and with several modifications and advancements, these models can be changed.

The following are the graphs of forecasted data using the selected model and actual data and future predictions for the next two years for each district.

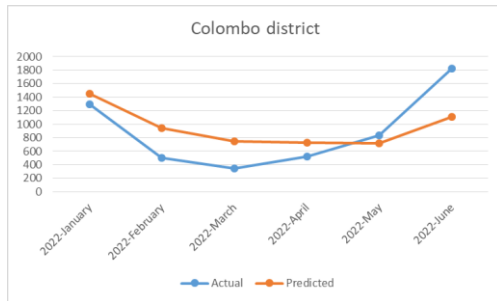


Figure 44: Forecasted values for Colombo district

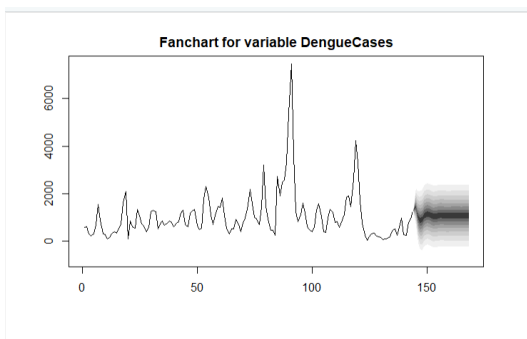


Figure 45: Forecasted values for the next two years of Colombo district

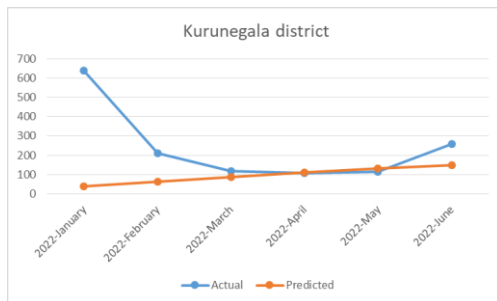


Figure 46: Forecasted values for Kurunegala district

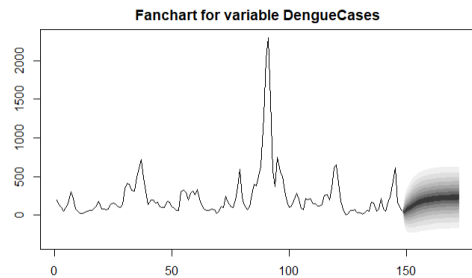


Figure 47: Forecasted values for the next two years of Kurunegala district

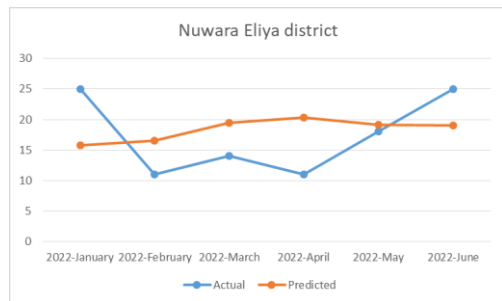


Figure 48: Forecasted values for Nuwara Eliya district

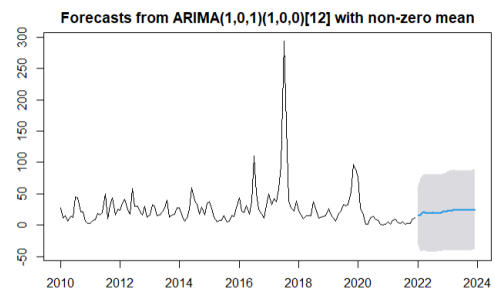


Figure 49: Forecasted values for the next two years of Nuwara Eliya district

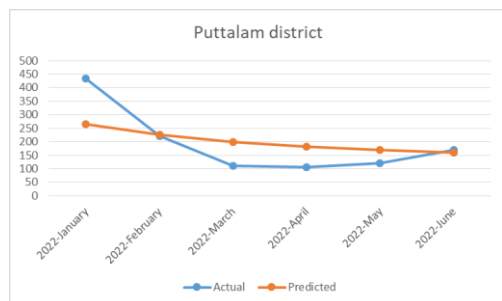


Figure 50: Forecasted values for Puttalam district

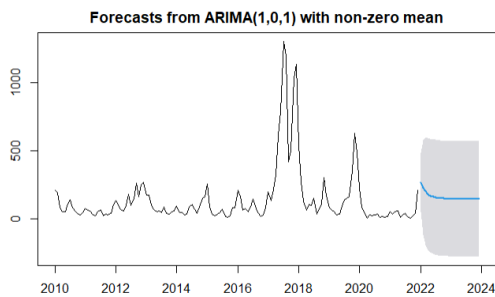


Figure 51: Forecasted values for the next two years of Puttalam district

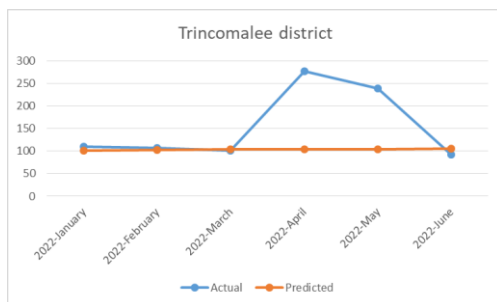


Figure 52: Forecasted values for Trincomalee district

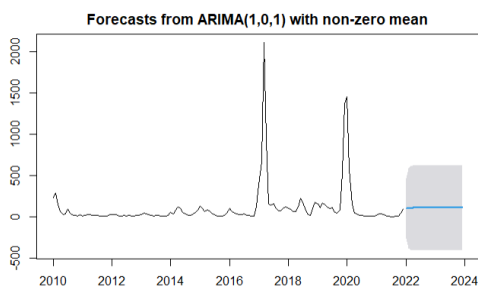


Figure 53: Forecasted values for the next two years of Trincomalee district

4. CONCLUSION

The forecasting comparison of ARIMA and VAR models shows that if the variables are strongly correlated for a particular district, the VAR model will give the most accurate predictions. When modeling with climatic factors that are not highly correlated, there is no noticeable difference in the performances of ARIMA and VAR models. Finally, in our study,

we found that for Colombo district VAR (5) model with total precipitation, for the Kurunegala district VAR (1) model with total precipitation, for Nuwara Eliya district ARIMA (1,0,1) (1,0,0) [12], for Puttalam and Trincomalee districts ARIMA (1,0,1) models can be selected as the best models according to the above accuracy measurements. Also, according to these selected final models, the monthly average temperature will not affect the number of dengue cases in five considered districts in Sri Lanka. Results suggested that paying attention to conducting dengue prevention and controlling programs in the Colombo district is important. This study can be further improved by considering other environmental factors that affect the number of dengue cases in Sri Lanka with VAR models. Also, this can be extended to the other districts in Sri Lanka.

REFERENCES

- Edirisinghe, G. (2017). Contribution of rainfall patterns for an increased dengue epidemic in Sri Lanka. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)* ISSN (Print) 2313-4410, ISSN (Online) 2313-4402
- N.D.B. Ehelepola, Kusalika Ariyaratne, W. M. N. B. S. R. N. W. (2015). A study of the correlation between dengue and weather in Kandy city, Sri Lanka (2003 -2012) and lessons learned. *Infectious Diseases of Poverty* (2015) 4:42 DOI 10.1186/s40249-015-0075-8.
- Parvin, S. and Khanam, M. (2018). Comparison between Arima and var model regarding the forecasting of the price of jute goods in Bangladesh. *Dhaka Univ. J. Sci.* 66(2): 91-94, 2018 (July). Schwabacher, M., & Goebel, K. F. (2007).
- Khan, M. S. and Khan, U. (2020). Comparison of forecasting performance with var vs. arima models using economic variables of Bangladesh. *Asian Journal of Probability and Statistics* 10(2): 33-47, 2020; Article no. AJPAS.63149 ISSN: 2582-0230.
- Deshmukh, S. S. and Paramasivam, R. (2016). Forecasting of milk production in India with arima and var time series models. *Asian J. Dairy Food Res*, 35(1) 2016: 17-22.

- Gayan P. Withanage, Sameera D. Viswakula, Y. S. G. M. H. (2018). A forecasting model for dengue incidence in the district of Gampaha, Sri Lanka.
- Goswami, S. (2014). Study of effectiveness of time series modeling (arima) in forecasting stock prices. International Journal of Computer Science Engineering and Applications.

APPENDIX**VAR2 – VAR model with only climate factor**

VAR1 – VAR model with both climate factor
and temperature

Table A1: Error measurements of Colombo District

Error Measurement		Lag =1		Lag =2		Lag=5	
	ARIMA	VAR1	VAR2	VAR1	VAR2	VAR1	VAR2
RMSE	506.6072	537.0368	554.524	557.6992	588.3101	399.3010	389.3298
MAE	445.0541	490.5952	507.8715	506.452	534.9025	350.3069	340.8404
MAPE	70.2830	81.6529	86.3769	85.6656	92.0595	56.7515	51.3436

Table A2: Error measurements of Kurunegala District

Error Measurement		Lag =1		Lag =2		Lag =5	
	ARIMA	VAR1	VAR2	VAR1	VAR2	VAR1	VAR2
RMSE	229.1245	256.9124	253.6411	271.6045	258.6238	223.9638	235.8672
MAE	212.2675	151.6317	149.4061	167.1987	156.033	170.9449	187.8177
MAPE	149.3748	41.9245	41.6299	58.3314	53.8747	90.0517	106.9178

Table A3: Error measurements of Nuwara Eliya District

Error Measurement		Lag =1		Lag =2		Lag =7	Lag =3
	ARIMA	VAR1	VAR2	VAR1	VAR2	VAR1	VAR2
RMSE	6.7178	9.0828	8.4597	15.1626	11.5796	25.5136	12.7408
MAE	6.1276	8.1396	7.5468	13.5701	10.5577	22.5049	11.2072
MAPE	40.2804	59.3167	53.4356	94.9026	71.9998	162.5242	82.7065

Table A4: Error measurements of Puttalam District

Error Measurement		Lag = 1		Lag = 2		Lag =10	Lag = 3
	ARIMA	VAR1	VAR2	VAR1	VAR2	VAR1	VAR2
RMSE	85.8027	148.1345	435.8258	160.9142	162.4876	154.6141	146.6201
MAE	65.4920	90.0798	258.2348	108.1175	94.8088	121.7522	90.1872
MAPE	39.1985	33.0665	168.5866	47.3234	31.9705	63.9549	34.9652

Table A5: Error measurements of Trincomalee District

Error Measurement		Lag = 1		Lag =2	
	ARIMA	VAR1	VAR2	VAR1	VAR2
RMSE	89.9479	94.4568	88.6405	114.7482	93.8781
MAE	55.9922	60.0952	59.8489	77.7555	63.5639
MAPE	24.3755	26.5185	28.5869	37.3337	30.3140

A Novel Cryptography Scheme as a Variant of the ElGamal Algorithm

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ABSTRACT

ElGamal algorithm was introduced by Taher ElGamal in 1985 and it is one of the most widely used public key algorithms in the world. Many researchers throughout the world propose new variants for the ElGamal algorithm to increase its security. In the present study, we introduce a new variant for the ElGamal encryption which is designed under three basic steps: key generation, encryption, and decryption. We have improved the key generation using the key generation technique of the RSA algorithm and ElGamal algorithm. As we combine both algorithms, the security of the proposed algorithm is achieved by the *discrete logarithm problem* from the ElGamal algorithm and the *factorization assumption* from the RSA algorithm, both of which are considered advantageous. Moreover, the use of multi-primes enhances the security of the proposed system.

1. INTRODUCTION

In the modern world, cryptography has become an indispensable discipline associated with secure communication. Cryptosystems can mainly be divided into two sections, symmetric and asymmetric according to their key distribution. Among them, asymmetric or public key cryptography is widely used as we do not require a private information link to share keys and the existence of high security. In 1970, the introduction of the Diffie Hellman key exchange by Whitefield Diffie and Martin Hellman was the origin of public key cryptography. Later in 1977, the RSA algorithm was introduced by Ronald Rivest, Adi Shamir, and Leonard Adleman. In

1985, Taher ElGamal introduced the ElGamal algorithm.

The rest of the paper is organized as follows. In the next section we explain the ElGamal algorithm and textbook RSA algorithm in detail. Then we will introduce the general procedure for the proposed algorithm and discuss it with a simple example. Finally, we will prove that our system is more secure than the textbook RSA and ElGamal algorithm.

1.1 ElGamal Algorithm

ElGamal cryptosystem is one most popular public key cryptosystems whose security is based on the most popular discrete logarithm problem. It was introduced in 1985 by Taher ElGamal in his paper *A public key cryptosystem and a signature scheme based on discrete logarithm*. The general steps of the ElGamal encryption are given below. Suppose Alice (A) and Bob (B) are the two parties who want to communicate over an unsecured channel where B is the sender and A is the receiver.

Key generation:

A selects a large prime p and computes a primitive root g modulo p . Then he selects an integer x such that $1 \leq x \leq p - 2$ and computes the integer h , where

$$h \equiv g^x \pmod{p}$$

Next, he selects the encryption key y such that $1 \leq y \leq p - 2$

Private keys = (x, y) Public keys = (p, g, h)

Encryption: Let M be the plaintext message which B wants to send which is encrypted as follows.

$$S \equiv h^y \pmod{p}$$

$$C_1 \equiv g^y \pmod{p}$$

$$C_2 \equiv M \times S \pmod{p}$$

Ciphertext = (C_1, C_2)

Decryption: Once the ciphertext is received, A decrypts it as follows.

$$C_1^x \equiv S \pmod{p}$$

$$C_2 \times \bar{S} \equiv M \pmod{p}$$

where \bar{S} is the inverse of S under modulo p .

1.2 RSA Algorithm

The RSA algorithm which was introduced in 1977 is one of the well-celebrated members of public-key cryptography family. It was named after the three inventors Ron Rivest, Adi Shamir, and Leonard Adleman and is one of the most widely used public-key cryptosystems for secure, sensitive data transmission. The security of RSA derives from the difficulty of factoring large integers into product two large primes which is known as the “Factoring Problem”. No efficient algorithm exists to solve the problem in polynomial time and hence the RSA algorithm is secure with large enough keys of size 1024 bits or more.

Suppose A and B are two parties who want to communicate over an insecure channel where A is the receiver and B is the sender.

Key generation: The key generation is done by A and the general steps are given below.

Step 1 : Chose two large primes p and q (size of p and q is recommended to be at least 512 bits or more)

Step 2 : Calculate the modulus n as $n = p \times q$.

Step 3 : Calculate the Euler Totient Function of n ; $\varphi(n) = (p-1) \times (q-1)$

Step 4 : Choose an integer e such that $\gcd(e, \varphi(n)) = 1$ where \gcd denotes the greatest common divisor).

Step 5 : Calculate d such that $1 \leq d \leq \varphi(n)$ and $de \equiv 1 \pmod{\varphi(n)}$.

Public Keys : (e, n) Private Keys : (d, n)

Encryption: B divides the message into blocks, then encrypts the message M as follows:

$C \equiv M^e \pmod{n}$ where C denotes the ciphertext.

Decryption:

A receives the ciphertext C and decrypt it as follows.

$$M \equiv C^d \pmod{n}$$

2. PROPOSED ALGORITHM

Our algorithm is designed under three basic steps: key generation, encryption, and decryption. We will first explain the general procedure of our scheme and next illustrate it with a simple example.

Consider two parties *Alice* (A) and *Bob* (B) and suppose that A wants to send messages to B .

Key Generation: The key generation part is done by B .

1. Suppose p, q , and r are primes.
2. Compute the modulus $n = p \times q \times r$
3. Select the encryption key e such that $\gcd(e, \varphi(n)) = 1$ where \gcd denotes the greatest common divisor.
4. Calculate d such that $1 \leq d \leq \varphi(n)$ and $de \equiv 1 \pmod{\varphi(n)}$.
5. Now consider g and x where $g = e$ and $x = d$.
6. Suppose m as another prime.
7. Select an integer y such that $1 \leq y \leq m-2$.
8. Compute h and s , where

$$h \equiv g^x \pmod{m}$$

$$S \equiv h^y \pmod{m}$$

Public Keys : (m, g, h)

Private Keys : (x, y)

Encryption: Now let M be the plaintext message which A wants to send and it is encrypted as follows.

$$C_1 \equiv g^y \pmod{m}$$

$$C_2 \equiv M \times S \pmod{m}$$

$$\text{Ciphertext} = (C_1, C_2)$$

Decryption: Once receiving the ciphertext, B decrypts it as follows.

$$C_1^x \equiv S \pmod{m}$$

$$C_2 \times \bar{S} \equiv M \pmod{m}$$

where \bar{S} is the inverse of S under modulo m .

2.1. Example

Key Generation

- Suppose $p = 5, q = 7$, and $r = 11$.
- Compute the modulus $n = 7 \times 5 \times 11 = 385$.
- Let encryption key $e = 7$ such that $\gcd(7, 240) = 1$
- Calculate d such that $1 \leq d \leq \phi(n)$ and $7d \equiv 1 \pmod{240}$. Hence $d = 103$
- Now consider g and x where $g = e = 7$ and $x = d = 103$.
- Let $m = 197$ be a prime.
- Suppose integer $y = 11$ such that $1 \leq y \leq m - 2$

$$\text{Private keys} = (x, y) = (103, 11)$$

$$\text{Public keys} = (p, g, h) = (5, 7, 62)$$

Encryption

- Find h and s , where
$$h \equiv 7^{103} \pmod{197} = 62$$

$$S \equiv 62^{11} \pmod{197} = 157$$
- Let $M = 20$. Compute C_1 and C_2 , where

$$C_1 \equiv 7^{11} \pmod{197} = 116$$

$$C_2 \equiv 20 \times 157 \pmod{197} = 185$$

$$\text{Ciphertext} = (C_1, C_2) = (116, 185)$$

Decryption

- Once the ciphertext is received, find S and M where

$$S \equiv 116^{103} \pmod{197} = 185$$

$$M \equiv 185 \times 64 \pmod{197} = 20$$

Thus the plaintexts $M = 20$ is recovered.

2.2. Cryptanalytic Approach

Mainly the security of the proposed system is based on the *Discrete Logarithm Problem* (DLP) similar to ElGamal algorithm. The DLP refers to the difficulty of finding x in $g^x = h$, where elements g and h are elements of a finite cyclic group G . In addition, the use of RSA key generation part enhances the security.

The security of the RSA cryptosystem is based on the previously mentioned Factorization problem as well as the *RSA problem* which can be defined as obtaining the private RSA keys given only the public RSA keys. The most efficient method to solve this problem is by factoring the modulus n which is a product of two prime numbers p and q . According to the structure of the RSA algorithm, p and q are two large primes chosen randomly and approximately of the same size. Hence, the prime factorization of n is computationally hard and impractical to perform in polynomial time. In this algorithm we use three prime numbers p, q , and r and compute $n = p \times q \times r$. As we use multi-primes in the factorization, it enhances the security of the proposed algorithm rather than the original RSA algorithm.

3. CONCLUSION

In the present study, we have introduced an asymmetric key cryptosystem based on the ElGamal algorithm with the use of RSA key generation procedure. The security of the proposed system is based on the *discrete*

logarithm problem similar to the security of ElGamal algorithm. The key generation is performed using the RSA algorithm and it increases the security as well. As we use multi prime numbers system, this algorithm is secure than the textbook RSA. We are currently working on developing this scheme to overcome other possible attacks.

REFERENCES

- Rivest, R.L., Shamir, A. and Adleman, L., 1978. A method for obtaining digital signatures and public-key cryptosystems. *Communications of the ACM*, 21(2), pp.120-126.
- Verma, S. and Garg, D., 2011. Improvement in RSA cryptosystem. *Journal of Advances in Information Technology*, 2(3), pp.146-151.
- Katz, J. and Lindell, Y., 2020. *Introduction to modern cryptography*. CRC press.

AI-Based Vocal Judging Application

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ABSTRACT

Some contesters in musical contests and singing competitions are lacking a proper coach and there may be misjudgments by the judges of the competitions. To overcome that it is possible to apply AI and Deep Learning and get a computer to give an average reasonable score for the performance by analyzing the frequencies. In this research, A possible solution for this occasion is described. The objective of this research is to help the judges or the individual users to give a fair and more accurate grading for the songs. The introduced solution uses FFT Algorithm as the main method to analyze the frequencies. And this will get a final average grade by analyzing, Pitch, Musical Notations and Tempo of the performance. The accuracy of the analyzing system is about 97% at the current time. This may be varied by the selection of separation, Frequency analyzing, and Midi note detection algorithms. These detections are evaluated by comparing it to FL Studio which is a software that is available for professional music development.

1. INTRODUCTION

When it comes to the musical contests and singing contests some contesters don't have a proper coach and if there are multiple judges in a judging panel, sometimes they misjudge, and judges based on appearance of the contestant

without caring about the actual signing performance. (Forbes, 1994; Wilson, 1930). Also, there are some incidents they bribe the judges. If we can introduce an AI-based platform that will run on a computer which can analyze the voice and give the exact judgement that is given by a judge, this will choose the actual competitors without any personal interests. But as these are running on a computer, a machine without any emotional intelligence, some judgment factors must be done by a human judge.

Most of the singing competitions judge the competitors by the **Vocal Techniques, Rhythm and tempo, Timing, and harmony**. As for this Application, The Tone/ Pitch and Vocal Techniques will be detected and graded as for a reference or the Judge. Also, the expressions are a main part of a judging contest.

AI Based Music Analyzing Application is a tool that can use by individuals and music judges to get a computer-generated score for a performance to get a better understanding of a singer or a competitor related to vocals and singing. These results will be based on the technologies and factors which are **Judging Factors, Vocal Techniques, Pitch Identification Algorithms, and FFT Algorithms**.

Vocal Techniques are huge variety of techniques that is used by the singers. Mostly, **Breath Control, Humming, Dictation, Pitch, and Tone**. These items will be used to judge the

sinning quality of a singer. These Vocal Techniques can be detected using a spectrum graph with frequencies. The vocal separation and technique detection will be possible with this generated frequencies data.

Fast Fourier Transform (FFT) Algorithm can be used in audio processing requirements. When working with sound waves, **FFT algorithm** helps to convert the input wave signal into a frequency graph that can be used to determine the **Pitch, Harmony, Notes**, and other music related data (Bharathi et al., 2011; Hastuti et al., 2019; Krause et al., 2021; Kumaraswamy et al., 2019; Pandiaraj et al., 2011; Yang et al., 2012). This transformed data will be helpful when identifying **Frequency Peaks**.

2. LITERATURE REVIEW

These values can be plotted in a **Spectrum** for a better understanding. These data can be used to analyze the pitch and other vocal techniques to get a better grading. Also, these **Spectrums** can be used to identify the **beat** and the **tempo** of a song (Tiwari et al., 2010). These Findings will help the current project to determine a better grade.

REPET-SIM method identifies the repeating background audio using **REPET (Repeating Pattern Extraction Technique)** and uses a **Similarity Matrix**. And this identified data is used to subtract the background from the foreground (Vocals) (Drugman et al., 2018; Rafii et al., 2010). With that, more accurate separation can be done by using that as shown in Figure 1. This is a better solution when it comes to opensource and free section. Although this is not accurate as the paid libraries, this will help the vocal judge system to gather enough data for most recordings with wide variety of vocals. This method is used on the **Librosa Library**.

To detect the **Pitch** of the instrumental track and the vocal track, a Template based Recognition algorithm will be used. This template-based recognition system will use the **chord templates** from **audio, speech, instruments** and other **pre trained model**. For the time being, the selected

Pitch Detection algorithm is **librosa** algorithm in the reason of having Template based **Chord detection** compatibility.

Template Based Chord Recognition is based on the hypothesis that only the chord definition is necessary to extract chord labels from a musical piece. A **Chord Template** is a 12- dimensional vector representing the 12 semi notes (or chroma) of the chromatic scale (Oudre et al., 2011). This Recognition will be used to identify the corresponding pitch for the instrumental and vocal track.

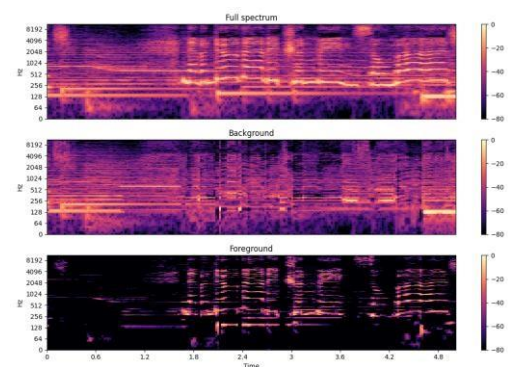


Figure 1. - Separated Song Spectrums. First one is the Raw Song, second one is the Separated Instruments, third one is the separated vocals.

The Musical Notation Detection can be done by comparing the frequency to the A4 Concert Pitch which is 440Hz ($f_n = 2^{n/12} * 440$) (Cooper et al., 1996; Kumaraswamy et al., 2019; Scheerer et al., 2018; Yang et al., 2012). These Data can be used to compare the Notes on the two tracks. To find the correct octave Equation 1 can be used.

$$O_n = \log_2(f_2/f_1) \quad (1)$$

Equation 1 – Equation for calculating the Octave of the Midi Notation. O is the Octave, f2 is Upper Frequency and F1 is the Lower Frequency

To calculate the midi notation the Equation 2 can be used.

$$m = 12 * \log_2(f_m/440 \text{ Hz}) + 69 \quad (2)$$

Equation 2 – Calculation of the Midi notation Using Concert C and Frequency. M is Midi Note, Fm if the Frequency that needs to find the mini note.

In Musical Programs and Competitions, the song will be recorded into multiple **Stems** (Rovito, 2016). These stems are the files that contain separate recordings such as instruments (drums, harmony, guitar, etc.). Usually, these stem files are in the original form that which when it is recorded, so it takes a larger space on the disk. These stem files can be used for better enhanced detection for more accurate analysis.

3. Methodology

To detect the Pitch of the Instrumental and the Vocal track, the targeted method is to apply the Template-Based Chord Recognition for the track using FFT Algorithm. If the users don't have the Stem Files for Vocal and instrumental data, REPET-SIM method can be used to separate the Vocal data from the Raw Audio file. With this method it will be possible to get a Chroma-Based Feature Representation that can be used to apply Template-Based Pattern Matching (Bartsch and Wakefield, 2005). This data will be useful to compare between the tracks for overlapping pitch changes, chord mismatches, and to give a grade for the pitch difference. These comparisons can be converted to graphical formats such as charts to give a better understanding of the pitch comparison for the user. The comparison is shown by the Figures 2, 3, and 4.

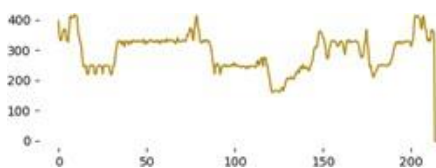


Figure 2. Detected Vocal Pitch.

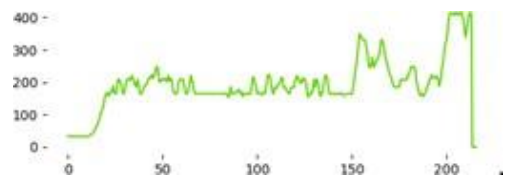


Figure 3. Detected Instrumental Pitch

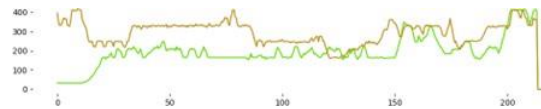


Figure 4. Pitch Comparison on the detected values

These generated pitch ranges can be used to identify the musical notation. This can be done when comparing to the frequency to the **concert A (440Hz)** (Firth, n.d.; Jha et al., 2022; Yang et al., 2012). These results can be used to compare with the song data. These similar notations can be used to detect the frequency changes on the instrumental track and the vocal track.

To minimize the error which is generated from the background noise, A **noise gate** can be added to the detected values array. Also, it is possible to use a technology such as **Noise Suppressor** such as **Krisp** to minimize the noise which is recorded at the audio (Carlisle, 2020).

Using the Musical Notation Data Detected from Above methods, it is possible get a comparison on the vocal and instrumental track to see how well the singer performed in the pitch balance in the song. This grading is one of the main **grading components** of the system.

This data is detected by getting the difference of the matching musical notation from the tracks. Next stage is to determine the unmatched notations is matching to a musical chord. If it is not, that must be reduced from the total grade. Also, it is possible get a grading from the matching musical chords (Figure 5).

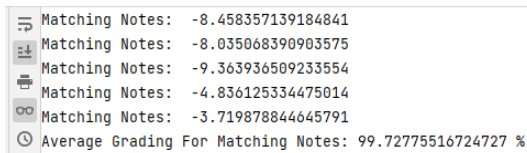


Figure 5. Sample output from matching musical notation which is detected from the CREPE Algorithm

Since the Singing techniques detection is still in the research level (Krause, Müller and Weiß, 2021; D'Amario, Daffern and Bailes, 2018; Sheldon, 1998) using it in this application will reduce its total accuracy on the grading mechanism that is used in this implementation. To reduce that factor, current implementation of the application uses an advanced analysis of the detected pitch of the vocal track as **Perfect Frequency Match Occurrences, Musical Chords Comparison, Total Pitchouts, and Matched Musical Notations**.

After getting analysis mentioned, System will calculate average grading for the detected changes and The Difference from the perfect match. This will help to get a more accurate grade of the song analysis. A sample analysis is shown in Figure 6 by using the song Burn by Ellie Goulding¹.

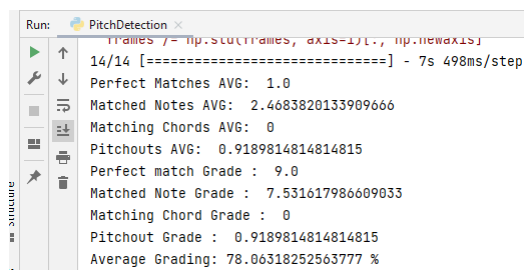


Figure 6. Sample Output of Advanced analysis of the Frequency Data

As for the grading algorithm, system will generate an average grade based on the advanced analysis of pitch and tempo balance.

To detect the tempo of each track, this will check for Frequency peaks and click on the song file

and get the median of these peaks and clicks. Also this is known as the Rhythm Histogram (Folorunso et al., 2022; Schuller et al., 2008). For calculate the grade for the tempo, this uses the Equation 3.

$$\text{Tempo Diff} = \text{tempo} - \text{vtempo} \quad (3)$$

$$\text{Tempo Diff} = \text{tempo} - \text{vtempo}$$

Equation 3 – Formula to calculate the Tempo Difference

From the calculation (Equation 3), **tempo** is the Detected tempo value from the instrumental track and the **vtempo** is the detected tempo value from the Vocal track. It is possible to detect the tempo using the frequency peaks as beat time and gets an average tempo by calculating the average time between the beats (Schuller et al., 2008; Yang et al., 2012). These values can be used to get a grade out of 100 as the first grading step. For the Pitch Comparison, Absolute comparison on Vocal and Instrumental track alone is not a most accurate method. The Algorithm must also look at the Matching Chords and Overlapping Musical Notes.

Perfect Matches are calculated by comparing the instrumental frequency value and the filtered vocal frequency value. This will subtract the vocal frequency value from the instrumental frequency and flip it to a positive number if it is negative and check whether the difference is less than 0.5. This 0.5 works like the border of the note. Frequencies have likely 0.5 difference from each note (Faghih et al., 2022; Krause et al., 2021; Scheerer et al., 2018).

To calculate the **Matching Notes**, first using the midi note conversation equation, The vocal and instrumental frequency will be converted into the midi notes. After that conversation, it will compare for equal values, if it is equal, that means it is a Matched Note. This will be the second stage of Pitch grading.

Matching Chords will calculate from the detected musical notation from the above. This

¹ <https://www.youtube.com/watch?v=CGyEd0aKWZE>

will search through a database that contains musical chords with notations and look for similar ones. If the singer sang according to the musical chord, this would add a point to the grade. This is the third step on overall grading system.

Pitchout Comparison is the last step on grading mechanism, this will check for the **pitchouts** and **range outs** of the vocal track. For this value, instead of average pitchout frequency this will check how many pitchouts singer done in the full song. And those marks will be deducted from the overall grading. This will be the last step on **Advanced Grading Mechanism**.

After calculating all mentioned steps above, Overall grading will be calculated by getting an average out of above values. The system is using the formula mentioned below to get a score out of the above values,

$$\begin{aligned}
 \text{Score} = & ((10 - \text{tpm}) \text{ if } 0 < \text{tpm} \\
 & \leq 10 \text{ else } 0) \\
 & + (10 \\
 & - \text{tmn}) \text{ if } 0 \\
 & < \text{tmc} \\
 & \leq 10 \text{ else } 0) \\
 & - (\text{tpo} \text{ if } 0 < \text{tpo} \\
 & < 10 \text{ else } 10)
 \end{aligned} \quad (4)$$

Equation 4 - Formula used to get the score out of analysed values from the pitch detection

tpm = Total Perfect Matches

tmn = Total Matched Notes

tmc = Total Matching Chords

tpo = Total Pitch Outs

After getting the score, the system will calculate an average from the score that is calculated. This will be the user average grade for the pitch detection.

4. DISCUSSION

This new approach on analyzing songs and applying a performance score is evaluated by manually comparing it with FLStudio's Individual Plugins.

The first comparison is the generated spectrum is shown in Figure 7 and 8,

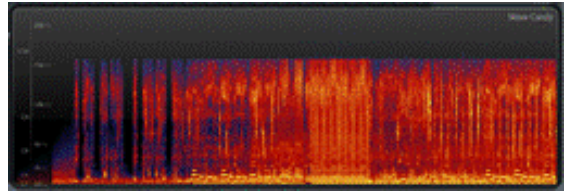


Figure 7. The spectrum of the song Burn from 20k Hz 8192 res Monitor (First 125 frames) from FL Studio

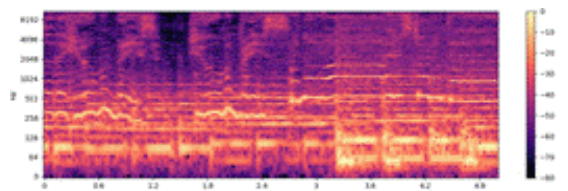


Figure 8. Spectrom of the full song mentioned above with 8192 Hz, 558 res Monitor from the algorithm

Next testable versions were the musical notation of the songs. As this contains a larger dataset and the FL Studio only supported Realtime feedback (Febrian et al., 2020), The data were tested by checking whether the cord shown on the FL Studio Monitor matched the musical Notation detected by the Algorithm on a specific time

frame. Figure 9 and 10 shows the comparison of both methods.



Figure 9. Midi note of 90th time frame detected by FI Studio

```

1250, ',', 'E2 40', ',', 'F#2 42', ',', '52
15241, ',', 'E2 40', ',', 'F#2 42', ',', '52
1463, ',', 'F2 41', ',', 'E2 40', ',', '53.
1491, ',', 'F2 41', ',', 'D#2 39', ',', '53.
.0923, ',', 'E2 40', ',', 'E2 40', ',', '52.
1038, ',', 'F2 41', ',', 'E2 40', ',', '53.4
'5196, ',', 'F#2 42', ',', 'E2 40', ',', '53
13405, ',', 'G2 43', ',', 'E2 40', ',', '54.
10353, ',', 'G#2 44', ',', 'F#2 42', ',', '5

```

Figure 10. Midi Note which is detected from the matching Time Frame

For determining the accuracy of tempo detection, it is validated through the Manual tempo tap of FL Studio. Samples are shown in Figure 11 and 12



Figure 11. Tempo of the song Happier² from FL Studio Tempo Tapper.

```

Instrumental track
C:\Users\pasan\AppData\Local\Tempo
keyword args. From version 0
tempo, beat_times = libro
49.69200721153846

```

Figure 12. Tempo detected by the Algorithm

From these Factors we can get an average accuracy of 97% on the Pitch, Tempo, and Frequency detection.

5. CONCLUSION

An AI based Vocal judging System will help the individual singers and judges get a better understanding about how they perform and give a reasonable score for the performance. The limitation of this system is the emotional intelligence, as for that judging factor, a human Judge will be needed. The overall objective is successfully achieved and addressed. The general accuracy of this system will depend on the algorithms that are used to detect Pitch, Tempo, and Frequencies.

² <https://www.youtube.com/watch?v=m7Bc3pLyij0>

REFERENCES

- Bharathi, V., Asaph Abraham, A., & Ramya, R. (2011). Vocal pitch detection for musical transcription. *2011 - International Conference on Signal Processing, Communication, Computing and Networking Technologies, ICSCCN-2011*, 724–726. doi: 10.1109/ICSCCN.2011.6024645
- Carlisle, M. (2020). *Krisp. New York: Time Incorporated*, 196, 0–100.
- Cooper, D., & Ng, K. C. (1996). A Monophonic Pitch-Tracking Algorithm Based on Waveform Periodicity Determinations Using Landmark Points. In *Music Journal*, Autumn (Vol. 20, Issue 3). Retrieved from <https://about.jstor.org/terms>
- Drugman, T., Huybrechts, G., Klimkov, V., & Moinet, A. (2018). Traditional Machine Learning for Pitch Detection. *IEEE Signal Processing Letters*, 25(11), 1745–1749. doi: 10.1109/LSP.2018.2874155
- Faghih, B., Chakraborty, S., Yaseen, A., & Timoney, J. (2022). A New Method for Detecting Onset and Offset for Singing in Real-Time and Offline Environments. *Applied Sciences*, 12(15), 7391. doi: 10.3390/app12157391
- Febrian, A., Rante, H., Sukaridhoto, S., & Alimudin, A. (2020). Music Scoring for Film Using Fruity Loops Studio. *E3S Web of Conferences*, 188. doi: 10.1051/e3sconf/202018800004
- Firth, M. (n.d.). *Minimising latency of pitch detection algorithms for live vocals on low-cost hardware*.
- Folorunso, S. O., Afolabi, S. A., & Owodeyi, A. B. (2022). Dissecting the genre of Nigerian music with machine learning models. *Journal of King Saud University - Computer and Information Sciences*, 34(8), 6266–6279. doi: 10.1016/j.jksuci.2021.07.009
- Hastuti, K., Syarif, A. M., Fanani, A. Z., & Mulyana, A. R. (2019). Natural automatic musical note player using time-frequency analysis on human play. *Telkomnika (Telecommunication Computing Electronics and Control)*, 17(1), 235–245. doi: 10.12928/TELKOMNIKA.v17i1.11606
- Jha, A., Gupta, S., Dubey, P., & Chhabria, A. (2022). Music Feature Extraction And Recommendation Using CNN Algorithm. *ITM Web of Conferences*, 44, 03026. doi: 10.1051/itmconf/20224403026
- Krause, M., Müller, M., & Weiß, C. (2021). Singing voice detection in opera recordings: A case study on robustness and generalization. *Electronics (Switzerland)*, 10(10). doi: 10.3390/electronics10101214
- Kumaraswamy, B., & Poonacha, P. G. (2019). Octave Error Reduction in Pitch Detection Algorithms Using Fourier Series Approximation Method. *IETE Technical Review (Institution of Electronics and Telecommunication Engineers, India)*, 36(3), 293–302. doi: 10.1080/02564602.2018.1465859
- Oudre, L., Févotte, C., & Grenier, Y. (2011). Probabilistic template-based chord recognition. *IEEE Transactions on Audio, Speech and Language Processing*, 19(8), 2249–2259. doi: 10.1109/TASL.2010.2098870
- Pandiaraj, S., Gloria, L., Keziah, N. R., Vynothini, S., & Kumar, K. R. S. (2011). A proficient vocal training system with pitch detection using SHR. *ICECT 2011 - 2011 3rd International Conference on Electronics Computer Technology*, 3, 303–307. doi: 10.1109/ICECTECH.2011.5941760
- Rafii, Z., & Pardo, B. (2010). *REPET-SIM FOR SINGING VOICE SEPARATION*.
- Rovito, M. (2016). HOW-TO Make Multitrack Stems with NI Stem Creator. *Electronic Musician*, 32(1). Retrieved from <https://www.proquest.com/magazines/how-make-multitrack-stems-with-ni-stem>
- Scheerer, N. E., & Jones, J. A. (2018). Detecting our own vocal errors: An event-related study of the thresholds for perceiving and compensating for vocal pitch errors. *Neuropsychologia*, 114, 158–167. doi: 10.1016/j.neuropsychologia.2017.12.007
- Schuller, B., Eyben, F., & Rigoll, G. (2008). Tango or Waltz?: Putting ballroom dance style into tempo detection. *Eurasip Journal*

on Audio, Speech, and Music Processing,
2008. doi: 10.1155/2008/846135

- Tiwari, M. D., Tripathi, R. C., Agrawal, Anupam., & Association for Computing Machinery. (2010). *Proceedings of the First International Conference on Intelligent Interactive Technologies & Multimedia (IITM 2010): December 27-30, 2010, Indian Institute of Information Technology, Allahabad, India*. Association of Computing Machinery (ACM IIIT Allahabad chapter).
- Yang, R., Bian, J., & Xiong, L. (2012). Frequency to MIDI converter for Musical Instrument Microphone System. *2012 2nd International Conference on Consumer Electronics, Communications and Networks, CECNet 2012 - Proceedings*, 2597–2599. doi: 10.1109/CECNet.2012.6201463

Feasibility Study of Detecting the Angle of Elevation and Angle of Bearing using OpenCV

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ABSTRACT

OpenCV is a widely used computer vision tool used for image processing and computer vision and machine learning applications. OpenCV can be used to detect the angle of elevation and angle of bearing of a linear object using the principles of object detection. This approach can be applicable for different types of computer vision/Artificial Intelligence and robotics applications in real-time object detection. Detecting the angle of elevation and angle of bearing can be resolved by taking 2 points at a certain distance in a linear body and by obtaining the coordinates of these points with respect to a fixed reference line specified. Then the angle of elevation and angle of bearing can be obtained in radians using the basic trigonometric concepts. This technique is currently developed in C++ language using OpenCV library, also this can be implemented in other programming languages as Python and C# and other computer vision tools like MATLAB, Tensorflow and Pytorch. But the concept explained here is original, straightforward and anyone can easily implement this concept to their applications.

1. INTRODUCTION

1.1. Computer Vision

Computer Vision is a field of artificial intelligence and machine learning that enables computers and systems to gain high level understanding and to derive data from digital

images, videos, and visual inputs. Computer vision can be applied for object detection through image processing.

1.2. OpenCV

OpenCV (Open Computer Vision) is a popular open-source computer vision library used in real time computer vision applications. Open CV is a computer vision library developed in C and C++ languages by Intel and later supported by Willow Garage. OpenCV is used in object detection, image processing, pattern recognition and machine learning.

In this research we intend to use image processing techniques to detect objects in order to find the angle of elevation and angle of bearing of a linear object like robotic arms, weapons, sports equipment etc.

To test this approach, 2 LEDs will be used at the end points of a linear rod and a web cam will be used to detect the 2 LEDs. OpenCV library modules will be used to detect the LEDs and the x, y coordinates of the LED points will be taken with respect to a fixed reference line. Then the calculation will be generated to find the elevation angle and the bearing angle of the linear rod.

In this approach, basic image processing techniques are used for object detection instead of popular object detection techniques and algorithms like Haar Cascade classifiers used in face recognition or advanced deep learning algorithms like YOLO and deep neural networks. Here we use image processing techniques such as converting the RGB image to

HSV colorspace, using filters and finding the contours of the object.

2. METHODOLOGY

The software development will be done using C++ language in Microsoft Visual Studio 2022 IDE and OpenCV library.

CORE - core functionality in OpenCV, contains basic functions and data structures used by other modules

VIDEOIO - module read and write video or images sequence with OpenCV.

VIDEO - module contains video analysis features like motion estimation and object tracking algorithms.

HighGUI - module contains the basic I/O interfaces and multi-platform windowing capabilities. This module provides easy interface to create and manipulate windows that can display images and "remember" their content and add trackbars to the windows, handle simple mouse events as well as keyboard commands.

IMGPROC - module contains image processing related functions like linear and non-linear image filtering, colorspace conversions, motion analysis and object tracking, object and feature detection, geometrical image transformations and image segmentation etc.

2.1. Access the Webcam

HD web camera is used to take the input video feed. The camera is opened using 'videoCapture' class in OpenCV.

cv::VideoCapture - Class for video capturing from video files, image sequences or cameras.

```
int main() {
    Mat frame;
    namedWindow("Display window");
    //opening the camera
    VideoCapture capture(0);
    if (!capture.isOpened())
    {
        cout << "Error cant initialize camera capture" << endl;
        return 1;
    }
}
```

Figure 1. C++ code for opening the camera.

2.2. Detect LEDs

The input video frames from the web cam are converted into HSV frame by converting the RGB image to HSV colorspace and use erosion and dilation filters and then find the contours of the object and finally obtain the object position.

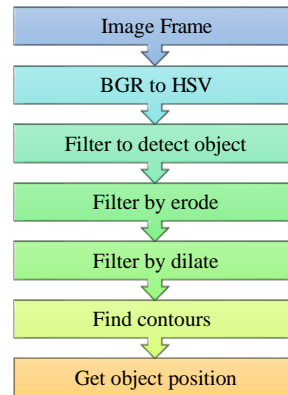


Figure 2. LED detection method.

Using::cvtColor - RGB image frames are converted to HSV images.

Using::inRange – performs basic thresholding operations

Using::erode – filter by erosion

Using::dilate – filter by dilation

Using::findContours – find contours of the image

Using::moments – get the position of the object

2.3. Take x, y Coordinates

x,y coordinates are the most important data to calculate the angle of elevation and the angle of bearing, hence the coordinates should be taken accurately with respect to a fixed reference line and the coordinates are generated through the code.

2.4. Calculate Angles

One end of the linear rod is assumed to be in a fixed position. Accordingly, Point O is assumed to be fixed in Figure 3 and Figure 4.

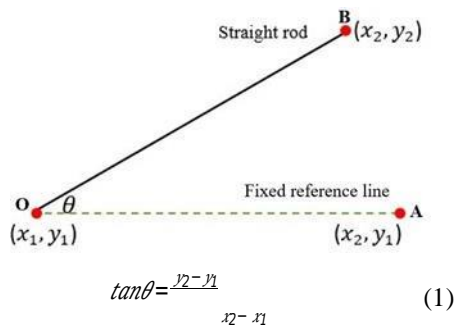


Figure 3. Representation of angle of elevation.

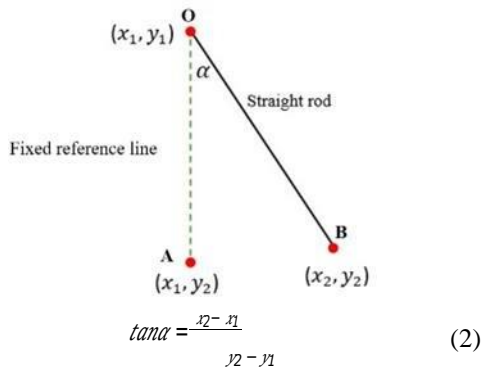


Figure 4. Representation of angle of bearing.

At certain instances, there can be slight movements, where one end of the linear rod is changing its position continuously instead of staying at the same position. At such instances the angles obtained are inaccurate, hence, to minimize the error, several coordinates of that end of the rod (point B in the Figure 3 and Figure 4) are taken frame by frame and a mean value is calculated in order to gain the respective angles.

3. APPLICATIONS

3.1. Rocket Propelled Grenade (RPG) Simulators

Basically, in simulator-based applications used for military trainings, simulators like RPG and other weapon system simulators can be used

with this method to calculate both angle of elevation and angle of bearing of the weapon.

RPG (Rocket Propelled Grenade) is a weapon used in military that launches rockets (ammunition) operated with an explosive warhead. RPG is operated by placing the weapon on the operators' shoulder. The RPG simulator has been designed to train military personnel without using live ammunition. Hence, the after effect of firing is shown in a virtual environment using Unity Game Engine. The moment when firing happens, the RPG

starts to move, and need to take the angle of elevation and bearing of the RPG weapon that is used to move. Then the coordinates of three positions are taken to calculate the angles and the effect of firing is created by Unity using these data.

3.2. Golf and Cricket Batting Simulators

In Golf and Cricket when the player holds the bat, we can determine if the player holds the bat in correct positions and how he would hit the ball and to identify the movement of ball after batting and if it hits the wicket. Also, we can detect batting styles of players using this technique. This type of simulators can be used to train players the strategies used when batting.

3.3. Robotics

The process of producing programmable machines called robots, which can complete different tasks can be or cannot be completed by humans. When we implement autonomous robots who appear as a human and can do the similar tasks as a human, we need to move their arms and legs. To that process we can apply this, getting the angle of elevation and angle of bearing theory to the machine.

Target tracking systems also can implement these two types of angles separately.

3.4. Manufacturing and Industrial Automation Systems

Abbreviation: RGB – Red Green Blue, HSV – Hue Saturation Values

4. CONCLUSION

This entire approach proves that detection of angle of elevation and angle of bearing can be deployed in numerous systems with computer vision applications. This technique can be widely used in fields like military training, healthcare, sports, manufacturing and industrial automation, agriculture, robotics etc. so this approach can be implemented to perform tasks automatically without human intervention through the power of computer vision.

REFERENCES

- Bradski, A. K. (n.d.). *Computer Vision with the OpenCV Library*.
- doxygen. (2022, August 19). *OpenCV Open Source Computer Vision*. Retrieved from OpenCV:
<https://docs.opencv.org/4.x/>
- Guenouni Souhail, A. A. (2015 January). Multiple Object Detection using OpenCV on an Embedded Platform. *ResearchGate*, 377.
- Souhail Guennouni, Ahaitouf Ali, Anass Mansouri. (2015). Multiple Object Detection using OpenCV on an Embedded Platform. *ResearchGate*.

ERP Implementation Critical Success Factors; A Study from Sri Lankan Context

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ABSTRACT

Purpose: The paper aims to research and investigate about the factors that influence the success of ERP system implementation at Brown and Company PLC. The study was framed through DeLone, Petter & McLean's (D&M) Model of IS success and the Technology Acceptance Model (TAM).

Design/Approach: The research paper uses the past literature and conceptual framework developments to illustrate that Top Management Support, User Involvement and Satisfaction and Change Management practices of an organization to be key drivers that could contribute to the success of an ERP project. The primary data was obtained using a 'Web-Based Questionnaire', which was then used for further statistical analysis since this research intended to develop the correlative relationship between dependent and independent variables.

Results: Key findings demonstrated that Top Management Support and User Involvement and Satisfaction to positively relate to the success of ERP implementation, and that they

also positively influence the implementation success. On the other hand, Change Management practices did not result in a relationship or any significant impact on the success of ERP implementation. The findings of this study offer valuable insights to organizations in Sri Lanka as it demonstrates the critical factors ERP project management teams need to consider when implementing an ERP system or when upgrading one. However, further research is deemed necessary to analyze why Change Management practices in the company did not produce the expected results.

Key Words: ERP Implementation; Success Factors; Top Management Support; User Involvement and Satisfaction; Change Management Practices; DeLone, Petter & McLean's (D&M) Model of IS success and the Technology Acceptance Model (TAM).

1. INTRODUCTION

The purpose of this research is to investigate the critical success factors that could affect the successful implementation of an Enterprise Resource Planning (ERP) System at Brown and Company PLC. ERP can be identified as a Software Platform that allows organizations to streamline business operations (Jatty & Manujunatha, 2017) into a single platform architecture (Klaus & Rosemann, 2000). An ERP System can automate processes, handle BigData, remove data duplication, minimize costs, and eventually increase business performance (Hayes, 2019). However, majority of ERP implemented projects have been reported to fail due to various reasons (Lapiedra, Alegre & Chiva, 2011). Hence, it is deemed crucial to identify the critical success factors that can support the successful implementation of an ERP System at Brown and Company PLC.

Brown and Company PLC is a Sri Lankan conglomerate which was established 143 years ago. The company implemented the Microsoft Dynamics AX-2009 ERP Platform in 2012 which enabled the organization to streamline its business processes whilst providing an opportunity to expand the business as flexibility, faster decision-making and data was easily accessible. Currently, the ERP system has been upgraded to the Microsoft Dynamics 365 Business Central Cloud Platform (Annual Report, 2019). The research problem stems from a practitioner perspective as the main author of this study identified that many change requests from the users were generated for the current ERP System. However, the support tickets in the system

decreased over the years, specifically in the last six months.

As such, technology currently is rapidly advancing where organizations are required to upgrade their business processes accordingly if they wish to sustain competitive advantage (Lapiedra, Alegre & Chiva, 2011). Hence, upgrading the ERP system to reflect current advancements is crucial and is identified as the post-implementation stage as a mechanism of responding towards industrial demands (Faja & Cata, 2001). Indeed, it is recommended that ERP systems should be upgraded every three years (Olson & Zhao, 2006). Nonetheless, due to various costs an organization needs to bear (Chan, Ng & Gable, 2010), and the complexity of the system which requires human, financial, and knowledge-based resources (Olson & Zhao, 2006); the success rate of ERP implementation is argued to be low and prone to failure. Further, it is claimed that up to 90% of ERP projects are delayed or over-budgeted (Xu, Rondeau & Mahenthiran, 2019). Further, the literature also suggests that 72% of ERP projects to have failed (Panorama Consulting Group, 2010). Hence, scholars have called for research to be conducted where the success factors of ERP Implementation can be correlated to the contextual factors of each ERP applying sector (Tsai, Li, Lee & Tung, 2011).

In order to achieve an effective ERP Implementation, it's crucial to have the appropriate groundwork for an ERP implementation project. After analyzing several ERP Projects and Articles, the author found that **'Business Commitment'** is a key factor that has a direct effect on the total project success rate and it's a key component that impacts towards the overall project

performance. The below figure (Refer Figure_1) depicts crucial factors discovered during the initial secondary data collected from

the company's internal documentation and research papers.

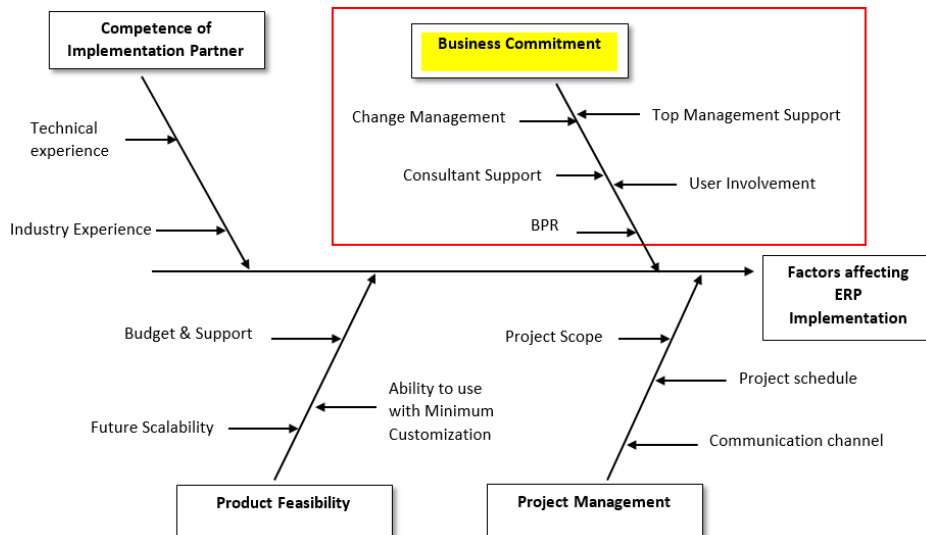


Figure 1: Fish Born Diagram (Source: Author's Work)

The research aims to study the *critical success factors that affect the implementation of an ERP system at Brown and Company PLC*. Hence, the research question established is “What are the critical factors that affect the success of ERP implementation and up to what extent those factors will affect towards Brown and Company PLC for ERP implementation projects?”. The objectives of this study are as follows:

Main Objective:

- ✓ Identify the critical success factors in ERP implementation and recognize the criticality of each factor from the company perspective. By doing this, the Browns Group can easily judge and allocate its resources effectively to achieve higher performance in ERP implementation projects. Further,

from a business perspective, it will help to make quick decisions for the organization.

Sub Objectives:

1. Identify whether the **Top Management Support** does have a positive impact on the success of ERP implementation.
2. Identify whether **User Involvement and Satisfaction** does have a positive impact on the success of ERP implementation.
3. Identify whether the **Change Management Practices** does have a positive impact on the success of ERP implementation.

2. LITERATURE REVIEW

2.1. The Evolution of ERP Platforms

The evolution of the ERP platforms can be traced back to the 1970s where organizations started implementing systematic versions of inventory management (Jacobs & Weston, 2007). Eventually these inventory management applications evolved into the Material Requirements Planning (MRP) Platforms in the 1970s by J.D. Edwards where concepts such as SAP were introduced (Egdair & Rajemi, 2015). MRP Platforms consisted of closed-loop scheduling, improved production, floor monitoring, and forward scheduling also known as MRP-II. In the 1980s, the world witnessed the introduction of ERP vendors such as SAP, IBM, J.D. Edwards, Baan, PeopleSoft, and Oracle (Goldston, 2020). However, in the 1990s due to the dynamic nature of competition, ERP applications were combined into single platforms (McCue, 2020). Currently, ERP systems are advanced where cloud-based platforms are used consisting of Internet of Things (IoT) and Artificial Intelligence (AI) technologies (BigBang, 2020).

The current ERP platforms offer numerous advantages for businesses and these for instance include it helps to standardize business operations, offers better access to information, and could lead to better economic advantages for the firm (Hemanth K., 2013). Better decision-making capabilities can be gained where internal units and regional locations can connect too (Chatzoglou, Fragidis, Chatzoudes & Symeonidis, 2016). This means that better collaboration and

overall productivity can be achieved through ERP system implementation. Nevertheless, the ERP implementation process needs to be carefully planned for these benefits to be gained because when introducing a new ERP system there is many responsibilities to be born and structural adjustments may be needed (Odhiambo, 2010).

2.0 ERP Software and Implementation Methodologies

The Life Cycle Model can be used for the new ERP software implementation which contains four stages (Huang & Yasuda, 2014). These are namely (1) Project Chartering Phase, (2) The Project Phase, (3) The Shakedown Phase, and (4) The Onward and Upward Phase (Diceus, 2022). Further, ERP software can be used for the implementation and these for instance include an application also known as Line of Business Solutions (The Digital Group, 2020). This application offers a Tier solutions system which are divided into three tiers (Singh, 2006). Additionally, ERP implementation methodologies should be followed such as the Big Bang Approach, the Phased Approach, and the Parallel Approach (Lumenia, 2020). More importantly, empirical studies indicate various factors to impact the success of ERP systems implementation. These include firstly top management support, secondly user involvement and satisfaction and thirdly change management as critical success factors.

2.1 Theoretical Framework

This research used the (DeLone, Petter & McLean's (2008)) (D&M) Model of IS success and the Technology Acceptance Model (TAM) to theoretical frame the study. The IS success model enables research such as this one to comprehend the end-user satisfaction and perceived system efficiency whilst linking system quality, customer satisfaction and a system's net benefits (Lin, Hsu & Ting, 2006). As such, the model utilizes the constructs of information quality, system quality and service quality to analyze the relationships with usage and customer satisfaction. Therefore, the benefits and end user experiences can be investigated through this model for ERP systems. The TAM Model is also a theoretical framework which is popular when investigating the adoption of cutting-edge technology and customer attitudes (Salam & Amoako, 2004). As an ERP system is complex and adaptation is a lengthy process where high costs are associated with it where ERP adaptation can fail easily (Umble, Haft & Umble, 2003). Hence, the TAM Model can be used to understand the perceived functionality of an ERP system and the effects it has on user adaption.

2.2 Hypothetical Framework on ERP Critical Factors

Base on the literature review results, the author of this research came up with the below hypothesis.

Dependent Variable :
Success in ERP Implementation.

Independent Variables :

- A. Top Management Support.
- B. User Involvement and Satisfaction.
- C. Change Management Practices.

- **HA₁:** Top Management Support does have a positive impact on the success of ERP implementation.
- **H0₁:** Top Management Support does not have a positive impact on the success of ERP implementation.
- **HA₂:** User Involvement and Satisfaction does have a positive impact on the success of ERP implementation.
- **H0₂:** User Involvement and Satisfaction does not have a positive impact on the success of ERP implementation.
- **HA₃:** Change Management Practices does have a positive impact on the success of ERP implementation.
- **H0₃:** Change Management Practices does not have a positive impact on the success of ERP implementation.

3. METHODOLOGY

3.1. Conceptual Framework of the Research

A Conceptual Framework is a visual representation, where it displays the relationship between dependent and independent variables (Swaen, 2022). Base on

the literature review, the researcher has identified Top Management Support, User Involvement, and Change Management as the independent variables and the success of ERP Implementation as the dependent variable (Refer Fig_2). The results of an appropriate relationship for the research hypothesis are highlighted by the research process, and analytical methods will illustrate the correlation.

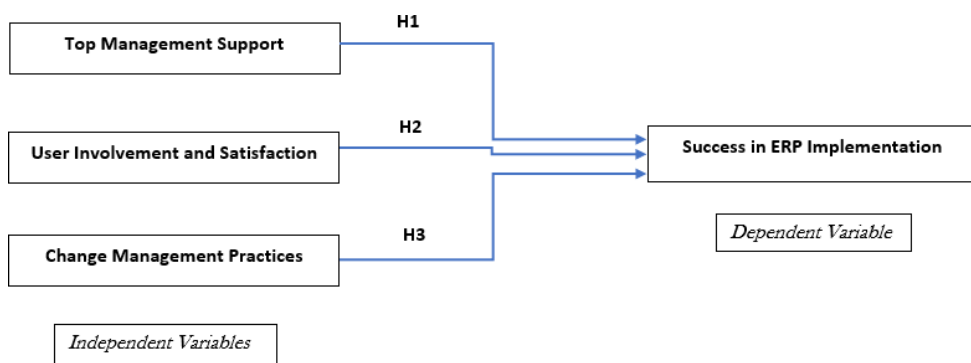


Figure 2: Conceptual Framework (Source: Author's Work)

3.2. Hypothetical Framework of the Research

The hypotheses that were derived using the Conceptual Model while describing the

research question are explained in the below table and through this analysis, the researcher can identify up to what extent those ERP Critical factors will affect towards the success of ERP Implementation (Refer Fig_3).

H1	HA ₁	Top Management Support does have a positive impact on the success of ERP implementation.
	H0 ₁	Top Management Support does not have a positive impact on the success of ERP implementation.
H2	HA ₂	User Involvement and Satisfaction does have a positive impact on the success of ERP implementation.
	H0 ₂	User Involvement and Satisfaction does not have a positive impact on the success of ERP implementation.
H3	HA ₃	Change Management Practices does have a positive impact on the success of ERP implementation.
	H0 ₃	Change Management Practices does not have a positive impact on the success of ERP implementation.

Figure 3: Hypothetical Framework (Source: Author's Work)

3.3.Hypotheses Analysis

3.3.1. Top Management Support and ERP Implementation Success

Top Management involvement and support has been identified as one of the crucial factors that can influence the success of a new ERP system implementation (Basir, Vakilian & Mobarakabadi, 2014). Indeed, scholars argue that ERP users need to be trained and educated on the new system which implies a strong need for Top Management initiation for such practices. This is because when implementing an ERP system employee resistance can occur and negatively affect the project where it could even lead to the failure of the implementation. Indeed, past empirical research by (Motwani, Subramanian & Gopalakrishna, 2005) through a survey established that Top Management Support to have a strong positive relationship with Change Management, Network Relationships and Cultural Preparation when it came to ERP implementation. Other studies suggest that transformational leadership to impact corporate culture during ERP Implementations where Top Management needs to proactively take actions to ensure not only the smooth flow of the ERP Implementation project but the long-term progress of the project (Shao, Feng & Hu, 2017).

Top Management Support can influence the success of ERP Implementation mainly through providing leadership and allocating sufficient resources for the project (Al-Fawaz, Al-Salti & Eldabi, 2008). Hence, literature argues that Top Management Support should also include appropriate planning and the monitoring of the ERP Project (Bhatti, 2005). Allocating adequate funds for the training and education of end users has also been identified as a key component of Top Management Support towards the success of ERP Implementation by (Umble, Haft & Umble, 2003). They suggest that 10-15% of the total ERP budget to be allocated for the training of end users which could lead to a better chance of successful ERP Implementation. Further, coordination of the data flow in the new system needs to be one of the main goals of the Top Management as it will affect the successful implementation of ERP systems (Kim, Lee & Gosain, 2005). Therefore, based on the literature, the below hypotheses have been established to investigate the roles of Top Management Support on ERP Implementation.

HA1: Top Management Support has a positive impact on the success of ERP Implementation.

3.3.2. User Involvement and Satisfaction and ERP Implementation Success

User Participation and Involvement helps understand how the ERP Platform is performing according to various user needs (Basir, Vakilian & Mobarakabadi, 2014). Hence, their satisfaction with the ERP system can affect the success of the project. This also provides an opportunity to receive feedback and improve the ERP Platform as needed for the target audience. It also facilitates two-way communication between the user and the project management team. Research findings by (Bhatti, 2005) noted that user can be involved in projecting ideas towards the success of the ERP Implementation. This is by firstly the user becoming involved in the requirements of the ERP system which enables automatic participation of the user in the ERP Project. Other scholars suggest that when a vendor and a customer collaborate, it leads to an effective execution of the ERP Implementation process (Ahmed, 2012). As such it is deemed vital to investigate the relationship and effect between user involvement which can produce user satisfaction and ERP Implementation success.

Nonetheless, for ERP Implementation to be successful, End-Users need to be trained through user level involvement. By providing training to the end users, it will support the

confidence building of the ERP System usage and help gain experience for the end-user too. Such training courses should help the end user to recognize the new processes, learn them and integrate them to work (iTech, 2020). Indeed, (Basir, Vakilian & Mobarakabadi, 2014) suggested that it is crucial to first identify the potential users, make clear contact with them by the project team and to establish the users' needs in the ERP System adaptation.

However, when implementing a new ERP System, it can be argued that many organizations face difficulties. Hence, literature indicates that end-user engagement to be a fundamental cause that could stymie the implementation process performance (Pries-Heje, 2008). Therefore, for an ERP implementation process to be successful, it is recommended that end-user engagement processes to be put in place with training and adequate communication channels (Gyampah & Salam, 2004).

Further, scholars recommend people, process, and technology approaches to be taken into consideration when striving to achieve the desired results of the ERP Project Implementation (Lewis, 2020). With regards to people, it is first necessary to identify the key stakeholders where the management of people throughout the implementation process is needed incorporating user involvement.

Further, the process needs to be analysed appropriately during each stage of the ERP Implementation. Once this is done, the project team needs to match the existing business functionalities with the new ERP Platform. If appropriate processes are not followed according to guidelines and adjustments made, much resistance can arise from the stakeholders involved. Finally, technology needs to be updated during the ERP Implementation. This needs to be approached in a manner where technology is combined with the support services offered with the aim of meeting the business requirements and allocated budgets. Based on these details, the below hypotheses will be tested in this research.

HA2: User Involvement and Satisfaction has a positive impact on the success of ERP Implementation.

3.3.3. Change Management Practices and ERP Implementation Success

Another crucial factor that influences the success of ERP Project Implementation is how well the organization engages in Change Management (Matende & Ogao, 2013). Indeed, it is argued that many ERP Implementations fail because project teams may have underestimated the effort required in managing change (Bhatti, 2005). Further, resistance to

change has been identified as a key factor that hinders ERP Project Implementation (Shehab, Sharp, Supramaniam & Spedding, 2004). This could be mainly since when a new ERP Platform is implemented many modifications are made to the existing system which in turn could lead to opposition, confusion and errors made by the users. Hence, effective Change Management is needed from the project team to demonstrate how the new system can be used and to create user readiness (Aladwani, 2001). Nonetheless, it is argued that project administration needs to pay adequate attention to the changes where Change Management needs to happen with people, procedures, and technologies been considered at the core (Newmann, 2020).

Change can be managed by utilizing models such as the Three-Stage Process of Change by Kurt Lewin (Guide, 2009). The first stage of the model which is known as unfreeze is said to be the most challenging one the organization may face as employees need to be aware of the need for change. This can be done through educating the users and motivating them to accept the new ways of working. Hence, operational communication is critical at this stage during the ERP Implementation. The second stage involves the change being implemented where the modifications for the ERP System will take place. In this stage the status quo will be unfrozen, and project

management team needs to be diligent, have effective communication and create enthusiasm from the users towards the change. The final step involves refreezing where the change becomes a part of the organizational culture. However, once the ERP System is implemented, it is still important to continuously motivate, respect, praise and provide support for the stakeholders involved. Hence, this research considers Change Management to have a key influence in the success of ERP Project Implementation and the below hypotheses have been developed.

HA3: Change Management practices does not have a positive impact on the success of ERP Implementation.

3.4. Research Design

3.4.1. Research Philosophy

A framework of assumptions and beliefs about the source, nature, and development of knowledge is referred to as Research Philosophy (BRM, 2020). According to (Saunders, Lewis & Thornhill, 2020), a valid research philosophy is built with a very clear collection of assumptions base on the research question and data collection methods, etc. Further, when performing research, it's crucial to understand the study's fundamental research philosophies, since this means a specific way of looking at the factors of the research. When analyzing the research philosophies, there are four different types of methodologies including Positivism, Realism, Interpretivism, and Pragmatism that can be used when conducting research. Acting with an observable social fact to make law-like generalizations is what positivism implies (Saunders, Lewis & Thornhill, 2020) and this positivism will be used when analyzing the external environmental factors through a quantitative approach.

As a result, the researcher of the study would use a '*Positivism Approach*' to conduct the analysis since the data collection process is considered a quantitative method. When studying the environment, it became clear to the researcher that the analysis would not be

interrupted by external environmental influences, so a positivism theory would be the best fit for the research.

3.4.2. Research Approach

When considering the research approaches, there are two common approaches to do the research analysis (Saunders, Lewis & Thornhill, 2020): deductive, and inductive. In the deductive approach, the researcher will analyze what others have done, reads current theories about whatever phenomena that the researcher is researching, and then put certain theories to the test using a hypothetical framework. The aim of the inductive approach is to develop a hypothesis based on empirical evidence gathered by qualitative methods.

This research's hypothesis began with an established theory and was then put to the test through a quantitative approach to see whether the theory held up in practice, implying that the *'Deductive Approach'* is the most appropriate method for this research. Furthermore, by using measuring metrics, the research results would map the outcome of an accurate relationship based on the dependent and independent variables.

3.4.3. Research Strategy

According to (Saunders, Lewis & Thornhill, 2020), the deductive method typically entails a link with a survey technique, which is present in this research study. In addition to quantitative analysis, the deductive approach emphasizes quantification in data collection and interpretation (BrymanBell, 2011). Survey analysis is a cross-sectional design in which data were gathered primarily through a questionnaire; it is intended to identify associations between variables after receiving a body of quantitative data in relation to two or more variables. The researchers were able to characterize the population in terms of various attributes and test hypotheses and conclusions based on this population by performing a questionnaire (Jackson, 2015).

The primary data was obtained using a **'Web-Based Questionnaire'**, with the use of **'BOS Web Platform'** (www.onlinesurveys.ac.uk), which was then used for further statistical analysis since this research intended to develop the correlative relationship between dependent and independent variables. In order to identify the Candidates, the **'Mono Method'** will be chosen by the researcher.

3.5. Population and Sample Selection

When considering the above research, the author's aim is to identify the ERP Critical success factors and arrive at a conclusion on up to what extent those factors will affect the success of ERP implementation in Browns and Company PLC.

As the key ERP users of the company have experience in working with ERP Platforms and have knowledge in ERP System Implementation phases; they were considered as the most suitable population for this study. Among the 668 Employees at Brown and Company PLC (D & B Business Directory, 2021), the target population amounted to 94 Employees (Refer Fig_4). These employees

belonged to different divisions of the company such as the Agriculture Division, Battery Division, PSD Division, and AC Division which consisted of the company's ERP implementation team and the employees of the implementation partner - ZILLIONE.

This highly specialized group of employees resulted in a relatively small pool of potential respondents; however, the employees selected were highly trustworthy because they closely matched the study's objectives. In the research '**Purposive Sampling Technique**' was chosen for this analysis because it is most widely used for survey research techniques that include inferences from a sample of a population to address the research question.

The screenshot shows a web-based sample size calculator. At the top, a green header reads 'Result'. Below it, the text 'Sample size: 76' is displayed in green. A paragraph explains: 'This means 76 or more measurements/surveys are needed to have a confidence level of 95% that the real value is within $\pm 5\%$ of the measured/surveyed value.' Below this is a form with four input fields: 'Confidence Level' (set to 95%), 'Margin of Error' (set to 5%), 'Population Proportion' (set to 50% with a note 'Use 50% if not sure'), and 'Population Size' (set to 94 with a note 'Leave blank if unlimited population size'). At the bottom of the form are two buttons: a green 'Calculate' button with a right-pointing arrow, and a grey 'Clear' button.

Figure 4: Sample Size Calculator (Source: Sample Size Calculator, 2022)

The data collection process took approximately a week's time, where the total number of responses obtained was 94, which is a response rate of 85.11%. However, two surveys were incomplete and was eliminated from further data analysis, resulting in a final sample size of 76.

Among 76 employees, 31% were from the ERP implementation team of the company, followed by 19% each in the Agriculture and Battery Divisions. A cumulative of 27% employees were from the PSD and AC Divisions, while only a 4% belonged to the implementation partner- ZILLIONe. A cumulative of 62% of employees have been in the ERP industry between 1-5 years, while a

17% have experience for more than 5 years, and a 12% for less than one year. Half of the users of ERP (50%) belonged to the services and maintenance department of the company, while the rest belonged to the ICT (36%) and the Finance and Insurance Department (14%). Most of the employees involved with ERP implementation played the role of an IT coordinator/ERP support staff (31%), where both managers and assistant managers accounted for a 38% among the respondents. Super user executives accounted for a 18%, while only a 6% of employees were identified to be playing the role of a data entry user (Refer Tab_1).

Variable	Category	Frequency	Percentage [%]
Sub-Division	ERP Implementation Team	24	31
	Agriculture Division	15	19
	Battery Division	15	19
	PSD Division	8	10
	AC Division	13	17
	ZILLIONe	3	4
Time in ERP Industry	< 1 year	9	11
	1-3 years	26	33
	3-5 years	30	39
	5-10 years	7	9
	> 10 years	6	8
Department	ICT	28	36
	Finance & Insurance	11	14
	Services & Maintenance	39	50
Role Played	Data Entry User	5	6
	IT Coordinator/ ERP Support Staff	24	31
	Super User Executive	14	18
	Manager	13	17
	Assistant Manager	17	22
	Functional Consultant	3	4
	Business Analyst	1	1
	Engineer	1	1

Table 1: Demographics of respondents (Source: Author's Work)

3.6. Validity and Reliability

The critical factors of ERP including the Top Management Support, User Involvement and Satisfaction, and Change Management Practices were measured using a *five-point Likert Scale* ranging from Strongly Disagree to Strongly Agree. Each of these factors consisted of six items to be rated by the respondents, where contrary to this, the success of ERP implementation consisted of four items, however, used the same five-point Likert scale as above.

Scales for the Top Management Support was adapted from (Pettersson & Desalegn, 2018) and (Jiwa, Siagian & Jie, 2020), where sample items included Higher Management support is important for ERP Implementation, and Higher Management is familiar with the ERP system's functionalities. However, the factor analysis performed to ensure construct validity identified that only five items were valid out of the six (Hair Jr, Black, Babin & Anderson, 2010), thereby excluding the statement, Higher Management is supportive while taking business decisions for ERP Implementations. The final items resulted in a *Cronbach's Alpha Score of 0.887*, indicating that the measurements are internally consistent.

The measurements of User Involvement and Satisfaction were adapted from (Mao & Pan, 2009) and (Matende, Ogao & Nabukenya,

2015), which included sample items of User Involvement in each stage is important for the success of ERP Implementation, and Users were allowed to perform tests in the ERP system before it was implemented. All the six items under this construct were found to be valid based on the factor analysis, while the *Cronbach's Alpha Score of 0.871* indicated high internal consistency among the measurements.

Measurements for Change Management Practices were adapted from (Doan & Nguyen, 2020) and (Barth & Koch, 2019), where the employees were asked to rate statements, such as Change Management plays a major role in ERP Implementation, and Change Management team considered input from a variety of people involved during ERP Implementation. However, post factor analysis, one item was found to be invalid (Hair Jr, Black, Babin & Anderson, 2010), which was, The Change Management team was helpful in managing change. This led to the construct having five items for the data analysis with a *Cronbach's Alpha Score of 0.709*.

Success of ERP Implementation included items such as ERP selection is an important part for the success of ERP Implementation, and Data Migration from previous system to ERP System was accurate, which were adapted from (Barth & Koch, 2019), and (Madininos,

Chatzoudes & Tsairidis, 2012). The four items used to measure the variable was found to be valid based on the factor analysis, where the *Cronbach's Alpha Score of 0.782* indicated that the measurements were reliable. Once the validity and reliability were tested, descriptive statistics were calculated, and a

correlation analysis was performed to identify relationships between variables. Regression modeling was then used to find the impact from critical factors of ERP on the success of ERP Implementation at Brown and Company PLC.

4. DATA REPRESENTATION AND ANALYSIS

4.1.Descriptive Statistical Analysis

Descriptive Statistics are used to explain the basic characteristics of data in a sample. In the context of this study, descriptive statistical measures such as the mean and the standard deviation were used to describe all the key variables, as discussed below.

	N	Minimum	Maximum	Mean	Std. Deviation
Top Management Support	78	3	5	4.12	.521
User Involvement and Satisfaction	78	2	5	4.07	.558
Change Management Practices	78	2	5	4.23	.434
Success in ERP Implementation	78	3	5	4.27	.496

Table 2: Descriptive Statistics (Source: Authors Work)

According to the above table (Refer Tab_2), the Mean values of all variables are more than 4, indicating that on average, the respondents have answered 'Agree' to most of the items. The maximum and minimum values show that at least one respondent has rated the items as 'Strongly Agree' for all variables, and none have 'Strongly Disagreed' to any of the items.

However, for User Involvement and Satisfaction, and Change Management practices; some have 'Disagreed' with certain items, where none have 'Disagreed' to any item under Top Management Support, and the success of ERP Implementation. Further, the standard deviation values indicate less volatility and no major deviations in data.

4.2. Top Management Support and ERP Implementation Success

When tested for the relationship between Top Management Support and the success of ERP Implementation, it was found that there is a significant relationship between the two, and that the relationship is both positive and strong ($r = 0.722$, $p < 0.01$) (Refer Tab_3). This indicates that when high support is received by the Top Management of Brown and Company PLC towards ERP, the success of its implementation is high. On the other hand, Regression Analysis showed that the Top Management Support positively influences the success of ERP Implementation (Beta = 0.500, $p < 0.01$) (Refer Tab_4). This means that when ERP Implementation receives support from the Top Management of the organization, it influences the ERP process to be successful. Accordingly, the first Hypothesis, *H_{A1}: Top Management Support has a positive impact on the success of ERP Implementation* is supported.

As an ERP Project could entirely fail due to employee resistance, support of a company's Top Management is a critical component for the success of ERP Implementation (Basir, Vakilian & Mobarakabadi, 2014). These findings seem to support previous empirical research as (Motwani, Subramanian &

Gopalakrishna, 2005) found positive relationships between Top Management Support and the success of ERP Implementation. As the key users of ERP of the company seem to believe that the support of the Top Management is highly important for the success of ERP Implementation, and that the Top Management should clearly define proper goals and have effective communication. Further, this suggests that the Top Management needs to ensure that they engage in the ERP process in a proactive manner (Shao, Feng & Hu, 2017), plan and monitor the ERP project (Bhatti, 2005), allocate sufficient resources, and provide leadership (Al-Fawaz, Al-Salti & Eldabi, 2008); to ensure that they are successfully implemented and carried out in the long-term.

4.3. User Involvement & Satisfaction and ERP Implementation Success

The results show that there is a moderate and a positive relationship between User Involvement and Satisfaction, and the success of ERP Implementation ($r = 0.673$, $p < 0.01$) (Refer Tab_3). This means that when the User Involvement and Satisfaction is high in the company with respect to ERP Implementation, success of its implementation becomes high. Results from the Regression Analysis showed that there is a positive impact from User Involvement and Satisfaction on the success of ERP Implementation (Beta = 0.371, $p < 0.01$) (Refer Tab_4). This indicates that, when the users of ERP are more involved and are satisfied, it tends to influence its implementation to be successful at Brown and Company PLC. Consequently, the second hypothesis, *HA₂: User Involvement and Satisfaction* has a positive impact on the success of ERP Implementation is supported.

The findings suggest that high User Involvement in the ERP Implementation process increases the success of its implementation, and that, when the employees are satisfied with the process, it tends to improve the chance of successful ERP Implementation. User Participation and Involvement helps understand how the ERP Platform is performing according to various

user needs (Basir, Vakilian & Mobarakabadi, 2014), where the key users of ERP in the company perceive that user involvement in each phase of the project is important for its success, and that user training and education to play a major role in the success of ERP Implementation. Also, supporting the claims of (Pries-Heje, 2008) and (Gyampah & Salam, 2004); when users are allowed to perform tests in the ERP system before it gets implemented, and the users perceive that better communication between users and the project team is in place; the success of ERP Implementation at the organization becomes high.

4.4. Change Management Practices and ERP Implementation Success

The key users of ERP at Brown and Company PLC, data revealed that Change Management Practices do not relate to the success of ERP Implementation. The correlations between these variables were also found to be weak and insignificant ($r = 0.121$, $p > 0.05$) (Refer Tab_3). As may then expected, Change Management Practices did not significantly influence the success of ERP Implementation for the organization ($\text{Beta} = 0.047$, $p > 0.05$) (Refer Tab_4). These findings provided lack of support for the third hypothesis, *HA₃: Change Management practices have a positive impact on the success of ERP Implementation*, which indicated that there is no relationship as well as there is no influence from the Change Management practices of Brown and Company PLC for the success of their ERP Implementation.

Even though a positive impact from Change Management practices on the success in ERP Implementation was assumed (*HA₃*) as

literature (Newmann, 2020; Matende & Ogao, 2013; Bhatti, 2005; Aladwani, 2001) demonstrated; the findings suggested otherwise. This means that the key users of ERP are indifferent to whether there exist better Change Management practices or not, on the success of ERP Implementations. The users do not believe that Change Management practices play a major role in ERP Implementation, and do not perceive that ERP Implementation success depends on how well the Change Management team communicated the reasons for the change. Further, even if the Change Management team considered input from a variety of people during the implementation, and the team was helpful in managing change; the users of ERP at Brown and Company PLC may not think that it influences ERP Implementation success. The results may vary from previous findings due to the contextual differences, or due to perceptions of the key users of ERP with regards to Change Management practices and their effectiveness, which requires further investigation in the future.

		TMS	UIS	CMP	SEI
TMS	Pearson Correlation	1	.593**	.049	.722**
	Sig. (2-tailed)		.000	.672	.000
	N	78	78	78	78
UIS	Pearson Correlation	.593**	1	.134	.673**
	Sig. (2-tailed)	.000		.243	.000
	N	78	78	78	78
CMP	Pearson Correlation	.049	.134	1	.121
	Sig. (2-tailed)	.672	.243		.290
	N	78	78	78	78
SEI	Pearson Correlation	.722**	.673**	.121	1
	Sig. (2-tailed)	.000	.000	.290	
	N	78	78	78	78

Table 3: Correlation Matrix (Source: Authors Work)

TMS = Top Management Support/ **UIS** = User Involvement and Satisfaction/ **CMP** = Change Management Practices/ **SEI** = Success of ERP Implementation
 [N = 78 / ** p < .001]

	B	Std. Error	Beta
TMS	.476	.085	.500**
UIS	.330	.080	.371**
CMP	.054	.083	.047

Table 4: Regression Analysis (Authors Work)

TMS = Top Management Support/ **UIS** = User Involvement and Satisfaction/ **CMP** = Change Management Practices/ **SEI** = Success of ERP Implementation
 [N = 78 / ** p < .001]

Based on the results, (Table_5) presents the summary of Hypotheses tested.

Critical Factor	Hypothesis (H0)	P value	Decision (H0)
Top Management Support	H0 ₁ : Top Management Support does not have a positive impact on the success of ERP implementation.	0.000	Reject
User Involvement and Satisfaction	H0 ₂ : User Involvement and Satisfaction does not have a positive impact on the success of ERP implementation.	0.000	Reject
Change Management Practices	H0 ₃ : Change Management Practices does not have a positive impact on the success of ERP implementation.	0.518	Do not reject

Table 5:Summary of Hypotheses Testing

5. CONCLUSION

The objective of this study was to investigate how various factors contributed to the success of ERP Implementation at Brown and Company PLC. Hence, this research firstly analyzed how Top Management Support impacted the success of ERP Implementation. Secondly, it tested the impact of User Involvement and Satisfaction against ERP implementation and thirdly the effects of Change Management Practices on the success of ERP Implementation at Brown and Company PLC. Surprisingly, only the *first two hypotheses were supported* where significant positive relationships existed between Top Management Support and the success of ERP implementation. Further, one of the major findings included that Top Management Support was also able to predict the success of ERP Implementation at Brown and Company PLC. The second, major finding is that User Involvement and Satisfaction also positively correlated with the success of ERP Implementation and was found to be able to influence it. However, contradictory to what was hypothesized, Brown and Company PLC's Change Management practices during the ERP implementation was not perceived to be correlated with the success of ERP

implementation and neither did it have any predictive power.

A few implications for practitioners and researchers can be drawn from the results of this study. For instance, the project team and management of the organizations need to pay attention to the role played by Top Management when initiating ERP Implementations or upgrades. As the findings suggest, Top Management can have a major influence in guiding the project towards success. Employee resistance towards change initiatives could be prevented through Top Management Support and Involvement from the first phases of the project. Further, clearly defined goals, clear communication of the project requirements, timelines, and resources allocation through effective leadership from the top management can aid organizations to successfully implement ERP Systems. Secondly, an important aspect is to comprehend how end-user and stakeholder involvement could lead to generating feedback and assuring the satisfaction of them will help ERP Implementations to become successful. This means that organizations need to pay attention to the end users training requirements prior to launching ERP Systems. Providing sufficient training could lead to better success rates of the ERP Implementations. However, the organizational cultural setting, the scope of the ERP Implementation project, leadership

styles and employee resistance could affect the success of implementation of ERP projects.

As with any research, there are a few limitations that must be noted. Firstly, the findings of this study cannot be generalized as the number of responses is limited, and due to the fact that data was collected only from one organization in Sri Lanka. The data was quantitative in nature; hence, social dynamics were not captured. In the future, researchers can consider a mixed methods approach where interviews are included with key stakeholders, or focus group studies can be conducted with end users for example. Future research also can investigate how the success of ERP Implementation could be affected due to the critical factors, by including mediating variables such as leadership styles, or the organizational/ national cultural aspects.

5.1.Recommendations

Base on the results of the research study, the researcher has recommended few concerns in order to establish a successful ERP implementation phase for upcoming phase-outs or future implementations in Browns Group PLC.

5.1.1.Maintain realistic ways to implement ERP Platforms.

For future work, ERP researchers should try and find realistic ways to

plan and motivate human resources, define and clarify the skills required by the ERP development team, management approaches used before and after the implementation of ERP.

✓ **Selecting a proper ERP Platform.**

When selecting a proper ERP Platform for the organization, First the company should check the company objectives and need to check whether those objectives can be aligned with the ERP Implementations. Then the company should implement BPR (Business Process Reengineering) to meet the organizational objectives. It's also a good idea to make sure that the cost of customizations results in benefits that justify the extra cost.

✓ **Top Management needs to have proper solutions to mitigate risks.**

In the majority of ERP implementations, top management will assign a project team to oversee all aspects of the project. As a result, due to a lack of proper guidance from the top management, some conflicts can occur. Therefore, it's crucial to maintain a proper project plan for resolving conflicts and mitigating undesirable risks.

REFERENCES

- Al-Fawaz, K., Al-Salti, Z., & Eldabi, T. (2008). Critical success factors in ERP implementation. Retrieved 11 August 2022, from https://www.researchgate.net/publication/49401950_Critical_success_factors_in_ERP_implementation_A_review
- Annual Report. (2019). Browns Group Annual Reports - Investor Relations - Brown & Company PLC. Retrieved 3 August 2022, from <https://www.brownsgroup.com/investor-relations/>
- Barth, C., & Koch, S. (2019). Critical success factors in ERP upgrade projects. Retrieved 16 August 2022, from <http://www.emeraldinsight.com/0263-5577.htm>
- Basir, H., Vakilian, M., & Mobarakabadi, H. (2014). The Study of Critical Success Factors (CSF) in the Implementation of Enterprise Resource Planning (ERP) Systems. Retrieved 11 August 2022, from [https://www.semanticscholar.org/paper/The-Study-of-Critical-Success-Factors-\(CSF\)-in-the-Basir-Vakilian-Mobarakabadi-Basir/191f829037d62321b46658b9c7fb9db2d3f0c162](https://www.semanticscholar.org/paper/The-Study-of-Critical-Success-Factors-(CSF)-in-the-Basir-Vakilian-Mobarakabadi-Basir/191f829037d62321b46658b9c7fb9db2d3f0c162)
- Bhatti, T. (2005). Critical success factors for the implementation of enterprise resource planning (ERP): Empirical validation. Retrieved 11 August 2022, from https://www.researchgate.net/publication/228627026_Critical_success_factors_for_the_implementation_of_enterprise_resource_planning_ERP_Empirical_validation
- BigBang. (2020). What are the ERP industry trends for 2017? - Big Bang. Retrieved 7 August 2022, from <https://bigbang360.com/what-are-the-erp-industry-trends-for-2017>
- Business Research Methodology (BRM). (2020). Research Philosophy - Research Methodology. Retrieved 15 August 2022, from <https://research-methodology.net/research-philosophy/>
- Chan, T., Ng, C., & Gable, G. (2010). An ERP Maintenance Model. Retrieved 4 August 2022, from https://www.researchgate.net/publication/232650925_An_ERP_Maintenance_Model_PDF
- Chatzoglou, P., Fragidis, L., Chatzoudes, D., & Symeonidis, S. (2016). Critical success

- factors for ERP implementation in SMEs. Retrieved 5 August 2022, from https://www.researchgate.net/publication/316214469_Critical_success_factors_for_ERP_implementation_in_SMEs
- D&B Business Directory. (2021). D&B Business Directory. Retrieved 14 August 2022, from [https://www.dnb.com/business-directory/company-profiles.brown_and_company_plc.cadce42bf0ebd38926186c597861d9e.html#:~:text=BROWN%20AND%20COMPANY%20PLC%20has,million%20in%20sales%20\(USD\)](https://www.dnb.com/business-directory/company-profiles.brown_and_company_plc.cadce42bf0ebd38926186c597861d9e.html#:~:text=BROWN%20AND%20COMPANY%20PLC%20has,million%20in%20sales%20(USD))
- DeLone, W., McLean, E., & Petter, S. (2008). Measuring information systems success: models, dimensions, measures, and interrelationships. Retrieved 2 August 2022, from https://www.researchgate.net/publication/253168139_Implementation_of_Enterprise_Resource_Planning_ERP_Systems_in_the_Construction_Industry
- Diceus. (2022). 10 Phases and Models of ERP Implementation Life Cycle | DICEUS. Retrieved 5 August 2022, from <https://diceus.com/10-erp-lifecycle/>
- Doan, H., & Nguyen, H. (2020). Driving change management strategy in ERP Implementation. Retrieved 16 August 2022, from <https://www.theseus.fi/bitstream/handle/10024/335234/Nguyen%20%26%20Doan.pdf?sequence=2&isAllowed=y>
- Egdair, I., & Rajemi, M. (2015). Technology Factors, ERP System and Organization Performance in Developing Countries. Retrieved 6 August 2022, from https://www.researchgate.net/publication/295375221_Technology_Factors_ERP_System_and_Organization_Performance_in_Developing_Countries
- Faja, S., & Cata, T. (2001). Characteristics of ERP software maintenance: A multiple case study. Retrieved 3 August 2022, from https://www.researchgate.net/publication/220674096_Characteristics_of_ERP_software_maintenance_A_multiple_case_study
- Goldston, J. (2020). The Evolution of Digital Transformations: A Literature Review. *International Journal of Innovative Science and Research Technology*, 5(4), 9-17. doi: 10.38124/ijisrt20apr065
- Gyampah, K., & Salam, A. (2004). An extension of the technology acceptance model in an ERP environment. Retrieved 11 August 2022, from <https://www.researchgate.net/publication/222>

- 687128_An_extension_of_the_technology
_ac
ceptance_model_in_an_ERP_environment
- Hair Jr, Black, Babin, & Anderson, R. (2010). Multivariate Data Analysis A Global Perspective. Retrieved 15 August 2022, from [https://www.scirp.org/\(S\(i43dyn45teexjx455qlt3d2q\)\)/reference/ReferencesPapers.aspx?ReferenceID=1839925](https://www.scirp.org/(S(i43dyn45teexjx455qlt3d2q))/reference/ReferencesPapers.aspx?ReferenceID=1839925)
- Hayes, K. (2019). Benefits of ERP | A Look at ERP Advantages & Disadvantages. Retrieved 4 August 2022, from <https://www.selecthub.com/enterprise-resource-planning/erp-advantages-and-disadvantages/>
- Hemanth K., M. (2013). Critical Success Factors for the Implementation of PeopleSoft Enterprise Resource Planning in a Public Organization. Retrieved 7 August 2022, from <https://eric.ed.gov/?id=ED563860>
- Huang, T., & Yasuda, K. (2014). ERP Life Cycle Models: An Annotated Bibliographic Review. Retrieved 6 August 2022, from https://www.researchgate.net/publication/289518675_ERP_Life_Cycle_Models_An_Annotated_Bibliographic_Review
- iTech. (2020). Importance of End-user Training for Successful ERP Implementation. Retrieved 12 August 2022, from <https://itechind.com/blog/importance-of-end-user-training-for-successful-erp-implementation/>
- Jatty, G. and Manjunatha, S. (2017). Enterprise Resource Planning can streamline the business operations and play a role as a key Successful. Retrieved 3 August 2022, from https://www.researchgate.net/publication/340916846_ENTERPRISE_RESOURCE_PLANNING_CAN_STREAMLINE_THE_BUSINESS_OPERATIONS_AND_PLAY_A_ROLE_AS_A_KEY_OF_SUCCESSFUL_-_A_STUDY
- Jacobs, F., & Jr, Weston. (2007). Enterprise resource planning (ERP). Retrieved 6 August 2022, from https://www.researchgate.net/publication/229338919_Enterprise_resource_planning_ERP-A_brief_history
- Jackson, S. (2015). Research Methods and Statistics: A Critical Thinking Approach. Retrieved 15 August 2022, from https://books.google.lk/books/about/Research_Methods_and_Statistics_A_Critic.html?id=rTZ-BAAQBAJ&redir_esc=y
- Jiwa, Z., Siagian, H., & Jie, F. (2020). The Role of Top Management Commitment to Enhancing the Competitive Advantage Through ERP Integration and Purchasing

- Strategy. Retrieved 17 August 2022, from https://www.researchgate.net/publication/338319328_The_Role_of_Top_Management_Co_mmitment_to_Enhancing_the_Competitive_Advantage_Through_ERP_Integration_and_Purchasing_Strategy
- Kim, Y., Lee, Z., & Gosain, S. (2005). Impediments to successful ERP implementation process. Retrieved 13 August 2022, from https://www.researchgate.net/publication/295230_Impediments_to_successful_ERP_implementation_process
- Klaus, H., & Rosemann, M. (2000). What is ERP?. Retrieved 3 August 2022, from https://www.researchgate.net/publication/220199006_What_is_erp
- Lapiedra, R., Alegre, J., & Chiva, R. (2011). The importance of management innovation and consultant services on ERP implementation success. *The Service Industries Journal*, 31(12), 1907-1919. doi: 10.1080/02642069.2011.556189
- Lewis, B. (2020). The Role of Automation in Managing Governance of Enterprise Data | eprentise. eprentise | Accelerating the time for change in E-Business Suite. Retrieved 12 August 2022, from <https://www.eprentise.com/blog/data-quality/the-role-of-automation-in-managing-governance-of-enterprise-data>
- Lin, H., Hsu, P., & Ting, P. (2006). ERP systems success: An integration of IS success model and balanced scorecard. Retrieved 5 August 2022, from https://www.researchgate.net/publication/228982447_ERP_systems_success_An_integration_of_IS_success_model_and_balanced_scorecard
- Lumenia. (2020). Big Bang Versus Phased ERP Implementation Strategies | Lumenia Consulting. Retrieved 7 August 2022, from <https://lumeniaconsulting.com/insights/blogs/big-bang-versus-phased-erp>
- Maditinos, D., Chatzoudes, D., & Tsairidis, C. (2012). Factors affecting ERP system implementation effectiveness. Retrieved 15 August 2022, from https://www.researchgate.net/publication/220306358_Factors_affecting_ERP_system_implementation_effectiveness
- Mao, J., & Pan, M. (2009). Enabling effective user participation in ERP implementation. Retrieved 15 August 2022, from http://www.pacis-net.org/file/2009/%5B62%5DEnabling%20effective%20user%20participation%20in%20ERP%20implementation_%20A%20case%20study%20on%20the%20role%20of%20brai.pdf

- Matende, S., Ogao, P., & Nabukenya, J. (2015). User participation in ERP Implementation: A Case-based Study. *International Journal Of Computer Applications Technology And Research*, 4(1), 518-526. Retrieved from https://www.researchgate.net/publication/283441618_1_Matende_S_Nabukenya_J_and_Ogao_P_2015_User_Participation_in_ERP_Implementation_A_Case-based_Study_International_Journal_of_Computer_Applications_Technology_and_Research_Vol4_1_ISSN_2319-8656
- Matende, S., & Ogao, P. (2013). Enterprise Resource Planning (ERP) System Implementation: A Case for User Participation. Retrieved 12 August 2022, from <https://www.sciencedirect.com/science/article/pii/S2212017313002120#!>
- McCue, I. (2020). ERP: Through the Decades. Retrieved 7 August 2022, from <https://www.netsuite.com/portal/resources/articles/erp/erp-history.shtml>
- Motwani, J., Subramanian, R., & Gopalakrishna, P. (2005). Critical factors for successful ERP implementation: Exploratory findings from four case studies. Retrieved 16 August 2022, from https://www.academia.edu/9354530/Critical_factors_for_successful_ERP_implementation_Exploratory_findings_from_four_case_studies
- actors_for_successful_ERP_implementation_Exploratory_findings_from_four_case_studies?auto=download
- Odhiambo, O. (2010). Enterprise resource planning systems implementation and upgrade (a Kenyan study) - Middlesex University Research Repository. Retrieved 8 August 2022, from <https://eprints.mdx.ac.uk/6458/> Olson, D., & Zhao, F. (2006). Critical Success Factors in ERP Upgrade Projects. Retrieved 4 August 2022, from https://www.researchgate.net/publication/45815745_Critical_Success_Factors_in_ERP_Upgrade_Projects
- Panorama Consulting Group. (2010). Overview of 2010 ERP Benchmark Report from Panorama Consulting. Retrieved 4 August 2022, from <https://www.panorama-consulting.com/resource-center/erp-report-archives/>
- Pettersson, A., & Desalegn, J. (2018). Investigation of Critical success factors for ERP implementation. Retrieved 16 August 2022, from <https://hj.diva-portal.org/smash/get/diva2:1213409/FULLTEXT01.pdf>
- Salam, A., & Amoako, K. (2004). An extension of the technology acceptance model in an ERP implementation environment. Retrieved 5 August 2022, from

<https://www.sciencedirect.com/science/article/abs/pii/S0378720603001228>

Saunders, M., Lewis, P., & Thornhill, A. (2020). *Research Methods for Business Students*. Pearson, 8. Retrieved from <https://www.pearson.com/en-gb/subject-catalog/p/research-methods-for-business-students/P200000005358/9781292208800>

Shao, Z., Feng, Y., & Hu, Q. (2017). Impact of top management leadership styles on ERP assimilation and the role of organizational learning. Retrieved 11 August 2022, from <http://modir3-3.ir/article-english/isi445.pdf>

Shehab, E., Sharp, M., Supramaniam, L., & Spedding, T. (2004). *Enterprise resource planning: An integrative review*. Retrieved 14 August 2022, from https://www.researchgate.net/publication/44843025_Enterprise_resource_planning_An_integrative_review

Singh, N. (2006). Tiers of Enterprise Resource Planning Softwares. *Asia-Pacific Business Review*, 2(2), 68-80. Retrieved from <https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.849.9698&rep=rep1&type=pdf>

Swaen, B. (2022). What Is a Conceptual Framework? | Tips & Examples. Retrieved 10

August 2022, from

<https://www.scribbr.com/methodology/conceptual-framework/#:~:text=A%20conceptual%20framework%20is%20a,and%20theories%20about%20the%20topic>

Tsai, M., Li, E., Lee, K., & Tung, W. (2011). Beyond ERP implementation: The moderating effect of knowledge management on business performance. Retrieved 4 August 2022, from <https://www.tandfonline.com/doi/abs/10.1080/14783363.2010.529638>

Umble, E., Haft, R., & Umble, M. (2003). *Enterprise Resource Planning: Implementation Procedures and Critical Success Factors*. Retrieved 12 August 2022, from https://www.researchgate.net/publication/222409354_Enterprise_Resource_Planning_Implementation_Procedures_and_Critical_Success_Factors

Xu, H., Rondeau, P., & Mahenthiran, S. (2019). The Challenge of Implementing an ERP System in a Small and Medium Enterprise. Retrieved 4 August 2022, from <https://chrome.google.com/webstore/detail/adobe-acrobat-pdf-edit-co/efaidnbnmnnibpcjpcglclefindmkaj?hl=en-GB>



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