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"TOWARDS A RESILIENT FUTURE - OPPORTUNITIES AND INNOVATIONS"

PROCEEDINGS

UNIVERSITY OF VOCATIONAL TECHNOLOGY, SRI LANKA

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2022

"TOWARDS A RESILIENT FUTURE - OPPORTUNITIES AND INNOVATIONS"

Towards a Resilient Future – Opportunities and Innovations

INTERNATIONAL RESEARCH SYMPOSIUM 2022

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EXTENDED ABSTRACTS

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MESSAGE OF THE VICE CHANCELLOR

I wish to congratulate the organizing committee of the International Research Symposium 2022 for being able to successfully launch the event as an annual activity on the calendar of the University of Vocational Technology. International Research symposium provides an opportunity and a platform for our researchers to present their research findings to a wider research community and receive feedback on their research performance. It also offers the advantage to publish the research findings after presenting the details to the research community and receive wider acceptance and recognition for your research achievements. The symposium is also a platform to prioritize our research agenda and strengthen networking efforts among scientists.

Research is imperative to the development of scientific disciplines and it creates dynamic and vibrant opportunities for innovations. The development of the world spins around the successes and novelties of the research outcomes and systematic and organized action plans to seek new frontiers in every sphere of science. It can also make a significant impact when this knowledge is disseminated through the delivery of educational programs. The strategic positioning of UoVT in vocational education is highly conducive to taking leadership in both research and education and harnessing the research deliverables to strengthen the capacity and the potential of our higher education initiatives.

In the unprecedented economic crisis experienced today, it is encouraging to note that most of the research activities presented at the symposium focus on resolving or addressing the issues directly related to the development of the country. It is noteworthy that the research symposium has been hosted with minimum cost without compromising the quality and the content. Symposium proceedings are also compiled ensuring the highest academic quality both in their content and presentation. Finally, I wish to thank every individual who supported in numerous ways to launch a successful symposium and wish all of you to have a rewarding scientific experience from the research Symposium 2022.

Senior Professor Ranjith Premalal De Silva

Vice Chancellor

University of Vocational Technology

MESSAGE OF THE SYMPOSIUM CHAIR

As the Chair of the research symposium committee, I am delighted and honoured to bring this message to the International Research Symposium -2022.

We identified the theme of the symposium as "Towards a resilient future: Opportunities and Challenges" to bring out new thoughts of research in the current context and for the future. This conference will provide some valuable opportunities for research, showcasing research that are utilizing innovative technologies.

This year, the number of submissions has continued to grow and all the papers have been subject to double blind review process and similarity check using dedicated software.

With a record number of participants expected this year, it is hoped that this annual conference will become larger and more substantial every year.

I hope that this conference will allow the participants a productive discourse not only in aspiring for excellence in research, but also in managing academic endeavors.

I am well aware that the success of the conference depends ultimately on the many people who have worked with us, in planning and organizing the conference. All recognition should go to the committee members who have all worked extremely hard on the details of important aspects of the conference programs. A note of appreciation to the academia for their thorough and timely reviewing of the papers.

Most of all, I thank you, the presenters, for enriching the conference by your presence.

Dr. L. W. S. Kularatne

Symposium Chair

UoVT International Symposium 2022

MESSAGE OF THE KEYNOTE SPEAKER

Prof. Carlos Dinamarca

Leader of the Research Group in Environmental Process Engineering

Institute of Process, Energy and Environment, Faculty of Technology,

University of South-Eastern Norway

Families, the unit-core of society, most fundamental needs are shelter, food, and security. These needs are extrapolated to the whole society where our elected in their institutions must serve this unit core to achieve these needs and much more. Due to the hyper-connectivity of our modern world, global challenges are touching the most private aspects of our lives. This connectivity that has very visible effects on our local economy, trade, and distribution of goods is perhaps not so obvious in other aspects as the effects on our local-intrinsic values. Climate change, economic insecurity, political friction, and some may say the forces of nature are some of the global challenges putting some share of distress in society, it is therefore useful and necessary the open and informed -based discussion about how to act in preparation for a resilient future. Technology and innovation are surely playing an important role, but the implementation of such is a long resource-intense process. Therefore, the knowledge and understanding of the underlying forces such as economic cycles, our governmental institutions, education (investment in our human capital), industrial networks, etc are equally important.

Resilience and sustainability of the systems on which society depends is a global priority indeed, most importantly a local and national necessity. In a market-driven society, we are bound to compete and make our best for the well-being of our local society.

I look forward to hearing your tough and ideas, as to share mine within this very important topic for the safety of our societies.

Carlos Dinamarca

Professor

Institute of Process, Energy, and Environmental Technology

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International Research Symposium 2022

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ADVANCED MECHATRONICS APPLICATIONS
FOR A RESILIENT FUTURE

DESIGNING AND DEVELOPMENT OF AUTOMATIC WATER CONTROL GATE FOR PADDY FIELDS

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ABSTRACT

Agriculture is the main source of livelihood, and rice is the staple food of Sri Lankans. This study is focused on water management in paddy cultivation. In paddy cultivation, "WAKKADA" is traditionally used for water control in paddy fields. In this method, the farmer goes to the paddy field with the help of a hoe and opens and closes the rows. Also, during the rainy season, one has to be constantly on the lookout for WAKKADA in the paddy fields and go to the paddy fields to control water levels, which has become a difficult, labor-consuming, and risky job in the present context due to epidemics and increased occurrences of lightning. In this project, an attempt was made to design a device to control water level by automating traditional WAKKADA and associated processes by integrating technology. By comparing the data provided by the farmer on water requirements to the device and measuring the water level in the paddy field with a sensor, this device automatically controls the water between the paddy fields. This is a single device that can be attached to the WAKKADA, and the devices in each WAKKADA communicate with other devices through Naval Reactors Facility (NRF) technology.

Keywords: *Paddy cultivation, WAKKADA, Naval Reactors Facility Technology, Microcontroller.*

1. INTRODUCTION

Sri Lanka is a country with an agricultural economy. Paddy cultivation, which plays a major role in this, is done on a commercial scale as well as on a small scale. This project can be used to automate the water management of paddy cultivation using the concept we propose. The water level required varies from time to time, depending on whether the paddy is prepared before planting or after planting. In this case, the farmer had to go to the paddy field from time to time and close the WAKKADA or open the WAKKADA to control the required water level. At present, this operation is done manually. There is no automated technology for this yet. Due to this, farmers must go to the paddy fields to remove excess water, even during heavy rains. This device, introduced by us, is programmed to get water from a source of water as needed for paddy cultivation. In some cases, water is obtained from water sources for their paddy fields. In some cases, water is obtained from adjacent paddy fields. At present, in each of these cases, control of the water level is done by the farmer himself. We have proposed an automated system for this problem.

This automated equipment section helps control the water level. In the case of rain, excess water is released, and the water is retained only at the required level. In the event of rain, farmers will even face lightning strikes by going to the paddy fields. For this reason, farmers do not need to go to the paddy fields unnecessarily during the rainy season, at night, or in the early morning. By inputting the water level, that water level flows into the field, which can be set as the farmer wants. We hope this

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project will facilitate the farmer's activities, as he needs to control the water level to suit the situation from the very beginning of paddy cultivation.

Paddy farming is carried out in many areas of Sri Lanka. Some farmers carry out this paddy cultivation on a commercial scale, while some farmers do it only for their consumption. We suggest that this device is more suitable for commercial-scale paddy areas. This device, introduced by us, is programmed to get water from a source of water as needed for paddy cultivation. This device is ideal for the convenience and safety of the farmer

1.1 REVIEW OF LITERATURE.

1.1.1 MECHANISM OF GATE

This project introduced a method of controlling water for paddy fields by extracting water from water sources. It is designed to be automated using wireless technology. In this concept, a water level sensor is placed in the center of the paddy field. Its output is transmitted by radio waves to a remote control room, which is then configured to receive the output as a command to regulate the field water valve. This is programmed by plc. The result is that the water valve can be opened or closed at any opening, depending on the water flow output required by the data analysis and control settings. (Setiawan, Saptomo & Sofiyuddin, 2011).

This project proposed developing an automated water management system for large-scale paddy fields. Its purpose is to automatically irrigate the paddy fields or drain them automatically, reducing water consumption and getting a good harvest. Each field is equipped with a different set of sensors and two plumbing and field units for water supply and drainage. The sensor package is housed in a paddy field and includes semiconductor sensors to measure water level, temperature, and conductivity. There are pipelines and road supply and drain valves that connect to each field. (Sekozawa, 2010).

Hailu and Thakur, (2018) researched the development of sliding gates in the Tigray Region, Mekelle, Ethiopia. They designed and developed a new gate mechanism for diversion dams that reduces operational and structural failure problems. Their design is a mechanical sliding gate that operates with human power. There is no electronic or electrical automated controlling part.

Sanjula et al., (2020) did a project in Sri Lanka and developed a water-gate control system for paddy fields using the Internet of Things (IoT). Mainly they use the IoT method for the system they create to control the paddy field water. The automatic water gate control system added several environmental factors through a smart module fitted with sensors to get to know what the situation on the paddy field is. Users are provided with a graphical interface that facilitates the processing and display of all real-time data and forecasts of rainfall and reservoir water levels. And control depend on users.

2. METHODOLOGY

Figure 1: Traditional WAKKADA & Prototype sluice gate mechanism

2.1 FLOW CHART

Figures 1, 2, and 3 gives an idea of how the project works and how the device differs from each other. Here, we mentioned 2 types of gate types according to the paddy fields. The methods of obtaining water from the paddy fields are to obtain water directly from a water source or to obtain water from the adjacent paddy field.

- Paddy fields in the middle that is not directly connected to the water source (source is adjacent farmer field)- Indirect method
- The first paddy field directly connected to the water source – Direct method

Gate type 1 is the gate device that is mentioned for paddy fields that obtain water from the adjacent paddy field. Gate type 2 is the gate device that is used for the first paddy field which is directly connected to the water source while obtaining water. In the direct method, the same gate type 1 devices are used for other paddy fields. Also, in most cases, the average value is obtained while getting the sensors reading values. These gate devices communicate with each other and for that, we have used the NRF module.

L= the required water level for the paddy field provided by the farmer

I= Sensor reading water level value

X= The distance from the lower limit of the water level of the first paddy field to the lower limit of the water level of the water source

Y= The difference between the distance from the lowest water level in the first paddy field to the lowest water level in the water source and the height of the water level in the first paddy field (L-X)
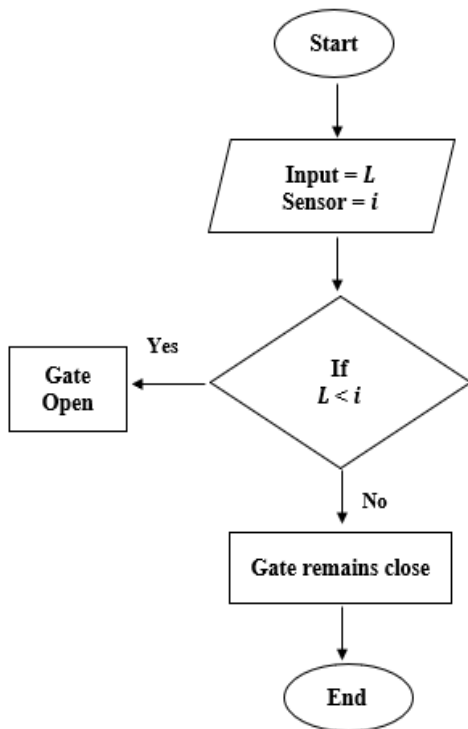
Figure 2: Flow chart of gate type 1   Figure 3: Flow chart of gate type 2
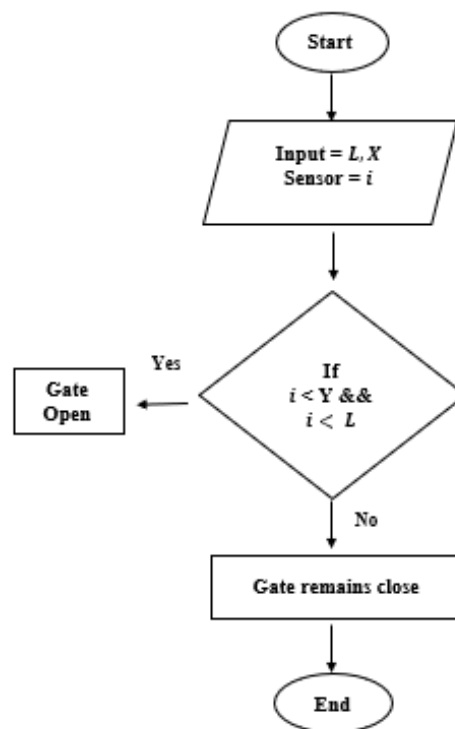
1	Gear motor
2	Thread bar
3	Sensor bracket
4	Lead screw
5	Mesh cover
6	Sensor unit
7	Side plates
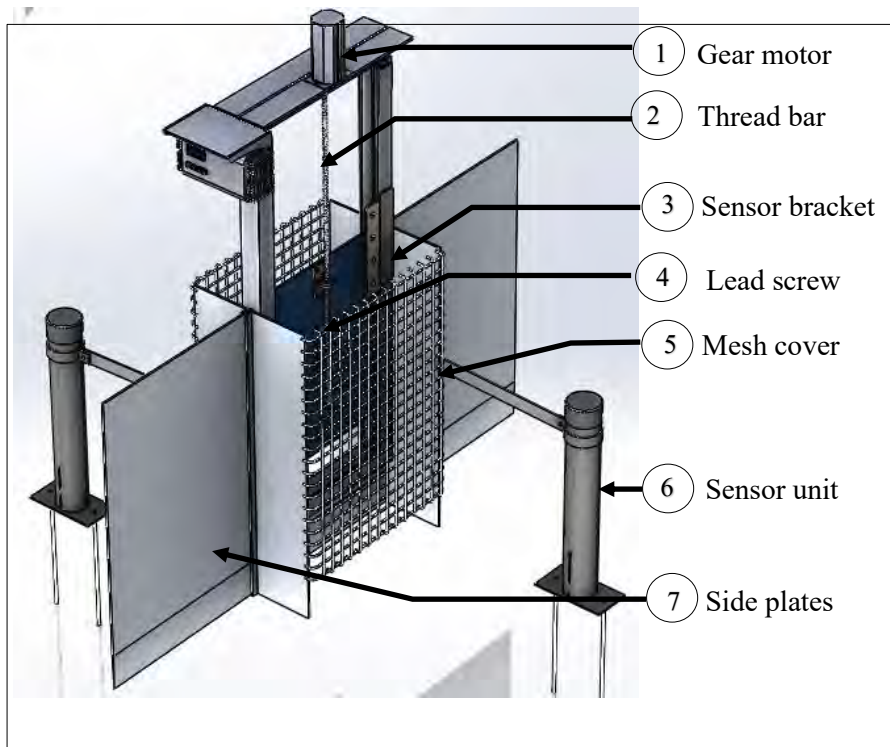
Figure 4: Parts of sluice gate mechanism

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2.2 WORKING METHOD

2.2.1 FRAMEWORK, SLIDE GATE, AND SIDE PLATES

We first build the framework with an aluminum plate. In this U shape frame, the slide gate opens and closes the gate by moving it up and down to get water for the paddy field. In this way, to make the framework in the shape of a U, the whole set is made 90 degrees and welded. It is then fixed using beading to prevent water leakage between the framework and the slide gate. A 3mm thickness iron plate was used to make the side plates. The purpose of using these two side plates is to secure the gate well.

2.2.2 SENSOR DESIGN

We designed a sensor to measure the height of the paddy field water level. We used a two-inch PVC pipe for this. It is slightly larger than the width of the two speakers on the ultrasonic sensor so it's easily placed high in the circular section. The ultrasonic sensor has a top-end cap on the tube to protect it from moisture conditions. PVC pipe height is 300 mm which is the average height. "NIYARA". The tube has two bottom windows. This causes water to enter the inlet pipe. The bottom of the tube has an aluminum plate. This allows the base of the device to be located on a larger area of the field. Also, the aluminum plate has two long wires at both ends. It should hit the ground in the field. This prevents the device from moving around and attaches it to our main gate with another aluminum ring-like holder and an aluminum plate.

2.2.3 SAFETY METHOD

- Waterproofing Method: The electronic circuit is included in the control box of our device. Also, due to the ecosystem in which we install our devices, water can affect the electronic circuit at any time. Therefore, we will inform you here about a method to make our circuit waterproof. We can use nail polish, silicone, and potting compound to waterproof the circuit.

- Thrust Collar: In this case, a thrust collar was used to connect the motor and the gate and prevent the motor from going down. This is used to prevent the thread from coming down from the motor when moving up and down on the follower nut thread. This is due to the increase in the force exerted on the thread. This is a safety device used to prevent the motor from going down due to the increase in weight when the slide gate is lifted by the motor. Applying this will make the slide gate move up and down steadily.

- Mesh Cover: The mesh cover was made of metal and coated with anti-corrosion paint to prevent corrosion. This mesh cover is used to prevent debris such as hooks and debris from entering the gate. This mesh cover is designed as a safety device to prevent damage to the beading, thread screws, and other parts of the gate.

2.2.4 ENCLOSURE

The enclosure mainly contains two circuits. The main circuit here controls the main output device in our design, a motor. To control it, we need inputs. They are obtained by a Hall Effect sensor and ultrasonic sensor and control the motor. This circuit is made on a dot board which is used for circuit soldering. We planned to connect many parts with jumper wires. For that, you can see the female headers here. Also, the NRF module used to communicate between the gates is connected to the microcontroller through a jumper wire. The other circuit here is the relay circuit. A small signal received from the microcontroller is developed and caught by the transistor called bc 547 by changing the direction of the motor with the help of a relay. The material we have used to create this control box is PVC. The farmer can control the operation of our gate by its push button. Also, we did not forget to install a four-segment display here for the farmer to see the values that he changes. The control box can be seen in two parts. They are the top lid and the bottom part that contains the circuit called the "box". Rubber beading should be used to seal the control box and to remove the heat inside, let's think of using windows cut in a shape so that water does not enter inside or a heat sink.

All the above-mentioned parts help in the operation of the prototype gate design. U shape frame helps the slide plate in our gate to move up and down. The slide plate moves up and down and is held between the rubber beadings. The power to move the slide plate up and down comes from a gear motor. Power is transmitted through the motor to the slide gate through a lead screw and a follower nut. According to the amount of rotation of the motor, how much the follower nut moves is determined by the programming given to the atmega328p microcontroller. Hall Effect sensor reading and ultrasonic sensor reading are used as input for that. A hall effect sensor was installed in the gate frame to know the openings of the slide gate. The farmer can input the desired level of water in his paddy field with the help of the input button. Motors require a potential of 12V and a current of approximately 1A. We designed and used a separate relay module to switch them. All the parts here are powered by a 12V AC to DC power supply. The reason for that is use this is a prototype design. There is a separate part in the main control circuit which contains a 7805 voltage regulator transistor to get 5 voltages to the microcontroller and other parts. Also, it was planned to provide 3.3 voltage to the NRF with the help of the resistor at the same place.

3. RESULTS AND DISCUSSION

In this prototype design, the gate operated-accordance with the data provided by the farmer. Here we have installed the sensor designed for each gate. It is necessary to obtain an average of the water level in the paddy field using the same sensors. If the sensor reading value is lower than the water level given by the farmer, the gate opens and receives the necessary water from the water source or from an adjacent paddy field. If the value of the sensor reading is higher than the value given by the farmer, then excess water will be disbursed by opening the gate. Thus the gate will automatically adjust the water level of the paddy field required by the farmer.

4. CONCLUSION AND FUTURE DEVELOPMENT

4.1 CONCLUSION

Water control is an important part of paddy cultivation. It is because the amount of water required varies at different stages of paddy cultivation. At present, the water is controlled by the farmer manually using WAKKADA. It is a difficult and risky task for the farmer to do it manually. Therefore, as a solution we have developed, an automated system. Through it, the water control process can be done automatically as per preset values. This automatic gate is designed to be activated by obtaining the required water level data using sensors and comparing those values with preset water level data fed to the system manually by the farmer. This can be described as a very efficient and convenient device for the daily work of the farmer. This automatic gate can be introduced as a technical solution to a major problem in paddy cultivation. It is more suitable for paddy cultivation as it is designed to operate the gate in a way that is convenient for the farmer and also to get maximum efficiency at the lowest possible cost. However, in the project we only tested the prototype on simulated conditions, therefore system needs to be field tested under real conditions and need to be finetuned based on the field test results.

4.2 FUTURE DEVELOPMENT

- For the device we have set up, the farmer manually enters the value by the button input at the height of the water level required for the paddy field. To do so, the farmer has to go to the paddy field. But as a development part of this device, the farmer can enter the required data without having to go to the paddy field. By creating an app using wireless technology, we can provide the necessary data from home very easily. Then the farmer will have the opportunity to make his cultivation work easier.

- As another development opportunity, it can be done using a GSM module. The gate of the paddy field is activated by taking the data input of the water levels that we provide. If one of these gates becomes inactive, it can be indicated immediately using a GSM module and we can set up a massage. Doing so will allow us to quickly identify any gate or failure. Also by using the GSM module we can know if there is a failure even in adverse weather conditions. GSM is more reliable as it does not have signal issues like IoT.

REFERENCES

Arduino Project Hub. (2022). Control AC Light Using Arduino. [online] Available at: https://create.arduino.cc/projecthub/mayooghgirish/control-ac-light-using-arduino-80c093

Electronic tutorial. (2022). 7-segment display counter. [online] Available at: https://www.electronics-tutorials.ws/counter/7-segment-display.html

Electronicscomp.com. (2022). A3144 Hall Effect Sensor Module buy online at Low Price in India, *ElectronicsComp.com*. [online] Available at: https://www.electronicscomp.com/a3144-hall-effect-sensor-module

Hailu, M.G. and Thakur, A., (2018). Design analysis of water control gate for diversion dams. Available at: https://www.researchgate.net/publication/326177594_Design_analysis_of_water_control_gate_for_diversion_dams

Indiamart.com. (2022). *3v Dc Relay Module*. [online] Available at: https://www.indiamart.com/proddetail/3v-dc-relay-module-23047614891.html

Sanjula, W.A.K.L., Kavinda, K.T.W., Malintha, M.A.K., Wijesuriya, W.M.D.L., Lokuliyana, S. and De Silva, R., (2020), Automated Water-Gate Controlling System for Paddy Fields. *2nd International Conference on Advancements in Computing (ICAC)* (Vol. 1, pp. 61-66). IEEE.

Sekozawa, T., (2010), An automatic water management system for large-scale rice paddy fields, [online] Available at: https://www.semanticscholar.org/paper/An-automatic-water-management-system-for-rice-paddy-Sekozawa/9eeeb1d0eb238f2e4e056d09e2f93427971cc1ca

Setiawan, B.I., Saptomo, S.K., and Soflyuddin, H.A., (2021), Wireless automatic irrigation to enhance water management in Sri Lanka paddy field, [online] Research gate. Available at: https://www.researchgate.net/publication/236167174_WIRELESS_AUTOMATIC_IRRIGATION_TO_ENHANCE_WATER_MANAGEMENT_IN_SRI_PADDY_FIELD

DESIGNING AND IMPLEMENTATION OF BEDSORE PREVENTING SYSTEM WITH PREDICTING AND MONITORING BEDSORE-CAUSING PARAMETERS

H.A.I. Chandimal, W.H.K.P. Werahera, M.H.A.P. Bandara, Sondarangallage D.A Sanjeewa*

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ABSTRACT

Bedsores are a type of injury that occurs in a person who is completely or partially paralyzed and has been staying in the same position for a long time. Bedsores are extremely painful and inconvenient for the patient. Due to the effect of bedsores on patients, bedsores must be prevented. The primary goal of the research is to control the temperature and pressure to prevent bedsores, which are the primary causes of bedsores. A mattress, specially designed for use in the medical profession, and a special water cover are utilized. A computer provides input data to the interface. The DS18B20 sensor monitors the patient's body temperature fluctuations, and the data is sent back to the Raspberry Pi3 model B through the WIFI module. The programme analyses the data and operates the solenoid valve to allow water to flow through Peltier. The data is obtained by a pressure sensor, and the solenoids are operated accordingly to regulate pressure by directing water to an inclining mattress. The objectives could be met while the clinical application for direct patients and various clinical circumstances were noted as project limits.
Keywords: *Bedsores; Pressure ulcers; Bedsore preventing.*

1. INTRODUCTION

In the twenty-first century, several biomedical advancements and ideas are offered to the world to improve human life and well-being. A few devices only provide therapy in combination with proper regulatory methods and practices. Bed sores are typically developed by patients who must spend a significant amount of time in bed in the same position. They are also known as pressure ulcers and decubitus ulcers. They are occurred reducing the blood circulation to vulnerable areas of the body joints such as heels, shoulders, elbow, and tailbone. (Mayo Clinic, 2020).

The ability to change body positions and time spent in the same position are the key risk factors for developing bedsores, therefore if the patient spends a long time in the same position, the probability of bedsore formation increases. Even with treatments, some of them are difficult to heal. Therefore, prevention of the development of bedsores is important (New England Journal of Medicine. 2018). This project entails the development of a hardware-software integrated system for preventing bedsores by utilizing primary contributing parameters, temperature, and pressure.

Various ideas and implementations from the field of biomedical engineering are brought forward to monitor bed sores, taking into account all patient factors and providing knowledge to the research facilities (New England Journal of Medicine, 2018). This treatment method is used for the convenience of the patient and to ensure the patient's good health. Therefore, the main focus is to

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provide additional support for the survival of the patient in a way that doesn't harm his life. For this purpose, this has been introduced as a patient care device, under the doctor's recommendations, conclusions, and full supervision.

1.1 BACKGROUND STUDY/ REVIEW OF LITERATURE

Certain drugs are used to treat bed sores both internally and externally to avoid the further deepening of ulcers caused by pathogenic activity (Johns Hopkins Medicine Health Library, 2018).

Even though there are several existing bedsore monitoring systems, they do not track patients' vital metrics for bedsore occurrences, such as temperature and pressure. However, reducing the risk of bedsores over time enables medical professionals to monitor patient movements over time.

To keep the patient's body regulated at a constant temperature without increasing body heat in areas. There are air mattress systems in which cold air or air that maintains room temperature is circulated orderly across the mattress (Indian Journal of Plastic Surgery, 2012). Using the same principle, cold water is also utilized in those mattresses.

Taking into account all of the aforementioned factors, the project's main goal was to design and implement a hardware-software integrated system to predict and monitor bedsore-causing parameters and to provide an effective therapeutic output to prevent bedsore occurrence.

2. METHODOLOGY
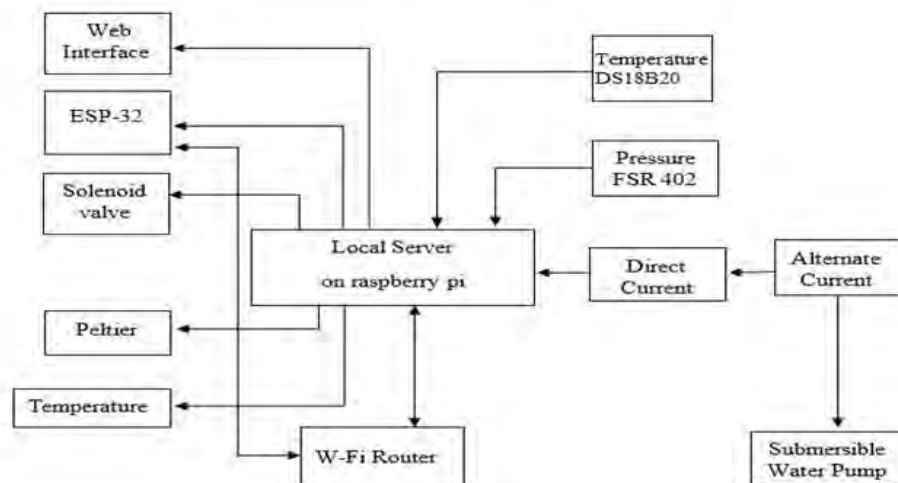
Figure 1: Hardware block diagram

Here, the Peltier element and the flow rate of the water pump affect the temperature control. The pressure is affected by the flow rate of the water pump. To check the temperature, mattresses filled with water at different temperatures were used. Also, to check the pressure, water mattresses filled with different weights of water were used.

The pressure and temperature sensors capture the patient's blood pressure and body temperature. These values were transmitted over the internet to a local server running on the Raspberry Pi 3 single-board computer. This local server has a database where sensor readings are stored. This local server also hosts the HTML-based web user interface. During this period, the Peltier, submersible water pump, and solenoid valve are used to circulate the water on the mattress. Peltier translates the circulating water's temperature variation. The hot and cold water flows are controlled by the water pump and solenoid valve. An AC-to-DC converter powers all of these electronics.

The system was built using hardware components to perform three key functions: data collection, data processing, and data transmission to the database. Furthermore, peace fair Through the sensors, the ESP-32 controller was used to collect temperature and pressure. In addition, a controller was used for data processing and control. The ESP-32 module was used to transport data to the database over the internet. To connect to the internet in this module, a WIFI network was employed. A relay module was also employed to control the output of the solenoid valve. The node red platform was used to implement the GU.
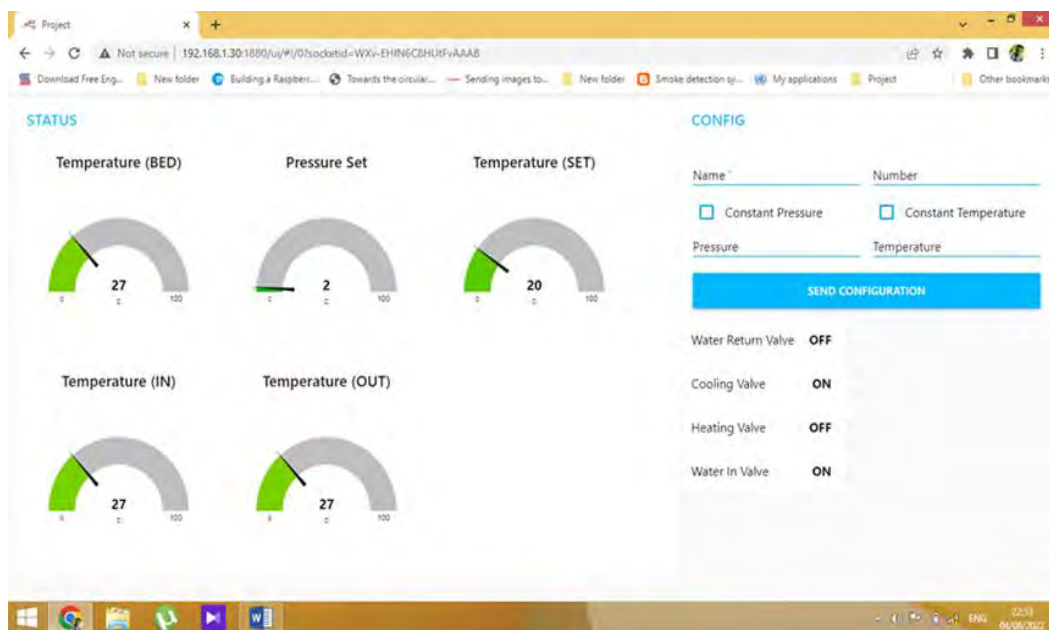
Figure 2: Node red user interface

The node-red user interface was implemented to monitor bed temperature, pressure value set by the user, temperature set by the user, temperature of water flowing into bed, and temperature of water flowing out of bed, as shown in Figure 2. Also, through this user interface, it is possible to monitor the ON/OFF status of the water return valve, cooling valve, heating valve, and water valve. Three operation modes (Constant temperature & pressure mode, Constant pressure mode, and Constant temperature mode) could be set by changing the software configuration.

Figure 3: View of the final product

3. RESULTS AND DISCUSSION

When checking this out, we mainly focused on how long the temperature and pressure can be raised to a suitable level. According to medical opinion, it is important to reach this level gradually.

It was concluded that approximately 24 s of time is taken to change the pressure applied on 1 kg. When considering this time, it takes more time to regulate the pressure applied to a higher weight. The reason for that is that it should be regulated under control to maintain the functions of this system optimally.

Table 1: Time changes with weight increasing

Weight (Kg)	Time(s)
2	54
5	117
10	248

It was also found that approximately 32.4 S is required to change the temperature by 10 C. Serious health issues can occur if we change our body temperature rapidly. Therefore, the flow rate is set to the level where the temperature regulates gradually.

Table 2: Time changes with temperature variation

Actual Temperature (C)	Time(s)	Target Temperature (C)
20	354	27
25	110	27
30	40	27

Several factors affect the regulation of temperature. Those factors are the room temperature at that time, the body temperature of the patient, and the target temperature of this treatment. When the target temperature is higher than the room temperature and the body temperature is lower than the room temperature, it may take a longer time than mentioned here. Such cases can rarely occur, and on such

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occasions, the process can happen as mentioned above. But, in cases where the body temperature is higher than the room temperature and the target temperature is lower than the room temperature, it is easier to reach that temperature level. Therefore, the time taken may be lower than expected. But, as the flow rate is controlled, it may not appear to be a huge difference.

This device works in two ways to prevent bedsores. That means receiving data from the sensors and changing the parameters according to them and controlling the pressure and temperature. The above results show that the temperature of the relevant mattress can be changed according to the body temperature. It is observed that the body temperature can reach a favorable temperature value from the risk temperature zone of bedsore occurrence.

And when we focus on pressure, we can see that pressure can also be regulated according to different values. Therefore, by varying the pressure, this risk can be reduced to a pressure value. Therefore, since the patient's temperature and pressure are constantly measured, it is possible to reach some preliminary conclusions by comparing those values. Considering all this, this device can monitor the factors related to the occurrence of bedsores and prevent the occurrence of bedsores following the data. If necessary, some scope is also open to making predictions by analyzing the data.

Finally, considering this, it can be concluded that the bedsore prevention system with predicting and monitoring bedsore-causing parameters has been completed properly in the relevant industry.

We are unable to test this equipment on humans because before going for human trials there is a long procedure to obtain permission to do human trials. Permission should be obtained from particular government organizations. Also, that includes working under some rules and regulations. For the testing procedures, we need to get permission and approvals from the national medicine regulatory authority, which is under the ministry of health. Therefore, this equipment has been tested under the preliminary testing procedures.

4. CONCLUSION(S) RECOMMENDATIONS & LIMITATIONS

Due to the economic changes in the world, people have become busier. They spend most of their time trying to fulfil the main requirements for living. But today's workforce will get old in the next several years. At that time, they require the help of another person to fully fulfill their needs. In this case, they have to face several problems, like the fact that the caring person doesn't have enough knowledge of caring. If they have, there may not be enough time to care for them or her well. The problem that is being considered here is an issue that a great number of elderly people have to face. When people get older or get into a paralyzed situation, the main issue they have is bed sores. Two water mattresses were used, and a system was developed to continuously circulate the water through them. The body temperature of the patient was compared with the temperature that was recommended by the doctor, and the water was circulated by the system by increasing or decreasing the temperature and keeping the patient's body at the recommended temperature. The same procedure was carried out in the case of pressure. By maintaining the temperature and pressure that are the main factors in the formation

of bedsores, the occurrence of bedsores could be effectively prevented by this bedsores-preventing system.

Bedsores are precisely caused by the friction and pressure between the person and the surface he touches, causing the body surface to heat up. But since it is very difficult to measure, body temperature is considered a factor. To check the accuracy, it has to be done with the authority and permission of the patient as well as various parties.

For the future development of this, since water is used here, it is hoped to include a water leak detection system and safety methods; to obtain and store data related to body temperature changes daily; and to refer to the study of medical complications during those days.

REFERENCES

Agrawal, K. and Chauhan, N., (20120. Pressure ulcers: Back to the basics. *Indian Journal of Plastic Surgery*, *45*(02), pp.244-254.

Johns Hopkins Medicine (2019). Bedsores. *Johns Hopkins Medicine.* Available at: *https://www.hopkinsmedicine.org/health/conditions-and-diseases/bedsores*.

Learnesp32.com. (2022). Learn ESP32. Available at: *https://learnesp32.com* [Accessed 10 March 2022].

Mayo Clinic (2020). Bedsores (pressure ulcers) - Symptoms and causes*. Mayo Clinic.* Available at: *https://www.mayoclinic.org/diseases-conditions/bed-sores/symptoms-causes/syc-20355893*.

New England Journal of Medicine. (2018). NEJ. Available at: *https://www.nejm.org/doi/pdf/10.1056/NEJM194009122231101*. [Accessed 23 September 2018].

Nodered.org. (2022). Running on Raspberry Pi : Node-RED. Available at: *https://nodered.org/docs/getting-started/raspberrypi* [Accessed March 2022].

DESIGNING AND DEVELOPMENT OF SMART ELECTRIC FENCE FAULT FINDING SYSTEM

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ABSTRACT

Every human and animal need to live free from any disturbance. But these days, human-elephant conflict is the biggest crisis that people have faced in rural areas of Sri Lanka. Every day, the villagers have to walk along the electric elephant fence to find out if the electric fence is broken or if there is a fault. If a fault is identified, it will be reported to the wildlife ranger officer. Villagers who go to check electric fences do not properly inspect; they do not properly communicate with the wildlife officers. Time is wasted trying to find a fault in an electric fence. Conventional fault-finding methods' cost is high. Therefore, this research paper introduces a device to mitigate the above problems. We install the device on every strain post in the electric fence (the length between two strain posts is 250 m). If a fault occurs, we can determine that it is located between the fault-detecting device and the pre-strain post device. As a result, wildlife officers can pinpoint the location of a fault within 250 meters. Fence faults can be quickly identified because this device identifies faults using a voltage divider circuit. The voltage divider circuit measures the voltage difference in the wire. This device uses a 900A GSM module to send SMS to wildlife ranger officers.

Keywords: Electric Fence, Fence fault finding, Human - Elephant conflict, Location detecting.
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1. INTRODUCTION

One of the significant problems in Sri Lanka right now is the loss of life, property, and crops caused by human-elephant conflicts. The government of Sri Lanka has erected electric fences in areas where there is human-elephant conflict to prevent damage caused by human-elephant conflicts. The conventional way of doing electric fence fault-finding in Sri Lanka is that an authorized person goes along with the electric fence to search for faults every day. It is time-consuming work and adds additional workload to the wildlife rangers.

This research aims to design and manufacture a cost-friendly electric fence fault-finding system that helps detect electric fence faults easily and quickly by using new technologies. The novelty of this system is the use of a wireless communication system (GSM) to quickly find the faults and send the data to the wildlife ranger officers to maintain the electric fence. This project's main objective is to develop a mechanism to reduce the time to find faults and get data from those devices.

The Smart Electric Fence Fault Finding System uses a voltage-detecting device every 250 meters. One electric fence has 20 devices within a 5 km range. Therefore, the rangers can get an update on the status of the electric fence and where the first damage occurred on the fence within a short period. All voltage detectors were indicated at their first damage point. Rangers must focus their attention on the first indicated damage point, after it is repaired, they can get an update on the rest of the fence.

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This system works using wireless ss 7 (GSM) protocols to transmit data. and an individual mini solar panel is used to power up those voltage detector devices.

1.1 BACKGROUND STUDY/ REVIEW OF LITERATURE

Human-elephant conflict is one of the biggest issues in Sri Lanka (Köpke et al., 2021). Human-elephant conflict has gradually increased in the past decade. It causes harm to the Sri Lankan elephant population and the lives and properties of humans (Fernando et al., 2008). An average of over two hundred elephants and seventy to eighty human lives were lost during the human-elephant conflict. The last official elephant count issued by the Department of Wildlife Conservation in 2011 counted 5879 elephants in the Sri Lankan wild. According to Prakash, Wijeratne, and Fernando (2020), the failure of traditional physical fences to prevent deaths caused by human-elephant conflict and elephant-train collisions necessitated the development of novel approaches to problem management. The elephant is an enormous and clever animal that cannot be effectively controlled by physical barriers; the majority of construction has been built without considering long-established elephant passages. Therefore, human habitats and infrastructure, such as highways, should be pre-planned following a larger strategy to allocate natural resources to each party in such a way that natural habitats are not affected even more than is feasible. Instead, they invented bee sounds, tiger sounds, and drone sound alarm systems (Dampage et al., 2021). As a result, a proposed system that detects the presence of elephants, raises alarms for concerned parties, and coordinatively and tactically repels the animals back to safer places has been suggested. According to experimental data, the sounds of a drone and the sounds of tiger growls both have a significant preventive effect on elephants. In terms of encounter and retreat reactions, the sound of bees and the low-frequency burst had similar results, but elephants that had faced this alarm for a long time were shaped up for those sounds. so further that an alarm system was not an effective solution to the human-elephant conflict. As the solutions to the human-elephant conflict have been invented many times over many years (Dissanayake et al., 2018). James Eastwood invented the electric fence alarm system. It mainly has two parts: an alarm transmission unit and an alarm receiving unit. The breakpoint was found with the help of an alarm transmission unit, which sent a unique transmission signal to the receiver (Jayasuriya et al., 2017). This system can only detect two conductors and also wants an additional power line to energize the transmission unit. So, it was suitable for short-distance electric fences and low-cost electric fences. If you wanted to transmit long-range, you should have used long-distance transmitters and an additional high-quality power line with the fence. Therefore, the Department of Wild Life Conservation in Sri Lanka has used General Electric fences across the country. (Osterburg, *n.d.*) The electric fence has many conflicting requirements. It needs to be safe for humans and animals. It means it should not cause death or injury to any animal or human.

2. METHODOLOGY
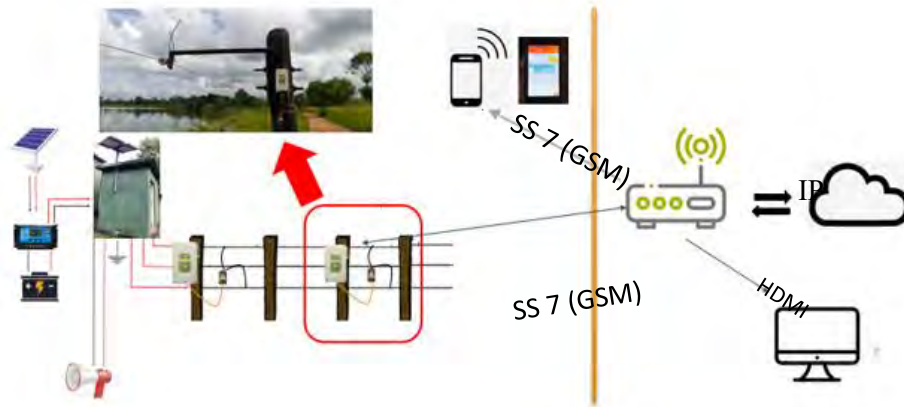
Figure 1: System layout of the smart electrical fence fault finder

Figure 1 describes the system layout of the smart electrical fence fault finder. In Sri Lanka, electric elephant fences use strain posts every 250m. This fault-finding system is installed on every strain post. Every fault-finding system consists of a voltage-detecting system and a GSM module. If the fault happens, the voltage detection system will detect that there is no voltage on the fence. Wildlife officers, via the GSM module, will be notified via an SMS about which pole of the fence is faulty. Then wildlife range officers can quickly fix the faults of the electric fence. Voltage-detecting devices are used in the solar system to power up the device. every device has a 6 V mini solar panel on the top of the device to charge the battery. device powered by a 3v battery and uses a boost circuit to get 5V output.
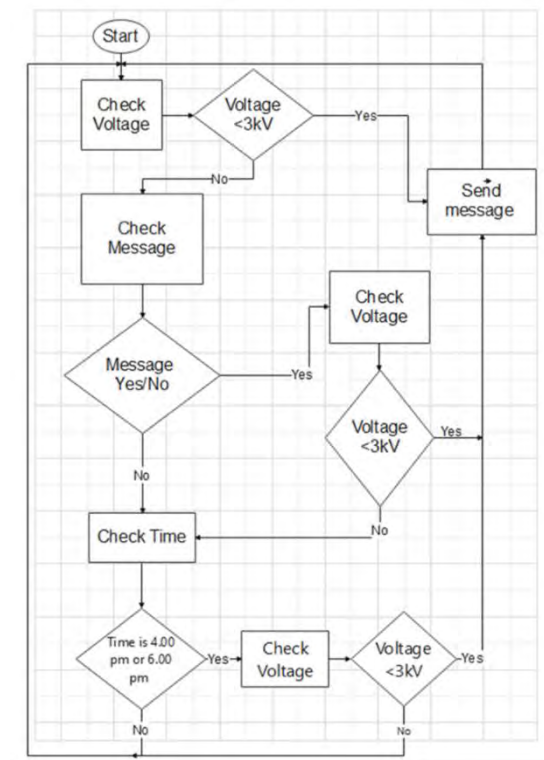
Figure 2: Fault finding block diagram

Figure 2 describes the Smart Electric Fence Fault Finding Method. First, the system checks if there is a voltage on the fence. The system is programmed to collect the number of pulses in one minute. After one minute, the system will compare the number of pulses detected and the voltage of the fence. If the system detects more than 30 pulses within one minute, it means there is a current flowing along the fence. If the current flows through the fence wires, the Smart Electric Fence Fault Finding System checks if the voltage is less than 3 kV. If so, it sends a message through the GSM module to the wildlife ranger officer to report a fault in the electric fence. If NO (greater than 3kV), it doesn't send the message. Then the Smart Electric Fence Fault Finding System checks the messages for a message from a wildlife ranger officer. If wildlife ranger officers want to inspect the electric fence, they can send the message "check" to the Smart Electric Fence Fault Finding System. The Smart Electric Fence Fault Finding System then begins to determine whether the electric fence voltage is less than 3 kV. If so, notify the wildlife ranger officer via the module that the electric fence is damaged. If the voltage is greater than 3kV Smart Electric Fence Fault Finding System, verify that the time is 4.00 pm or 6 am. If the time is 4.00 pm, the system will turn on and automatically turn off at 6.00 am. When it is turned on, it starts measuring the voltage through the electric fence wires. If the voltage was less than 3 kV If so, notify the wildlife ranger officer that the electric fence is broken. If the voltage is greater than 3kV, return to the start position and start the system.

2.1 DEVELOPMENT OF THE PROJECT

Figure 3(a) describes the voltage-reducing device. It has a high voltage resistor bank that is parallel connected with two 10MΩ resisters and connected serially with six 1MΩ resistors. All resistors are covered by high voltage insulating flux to avoid current leakage between the ends of the resistors. This device connects the electric fence wire and the voltage-detecting device in parallel. It reduces 11kV to 5V, which can be detected by the microcontroller. To connect devices to the fence wire, a high-voltage DC wire is used.
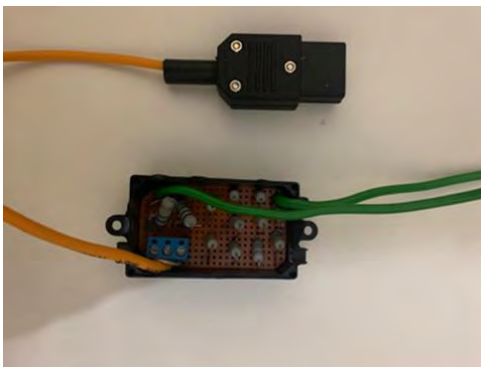
Figure 3 (a): Voltage Reducing device
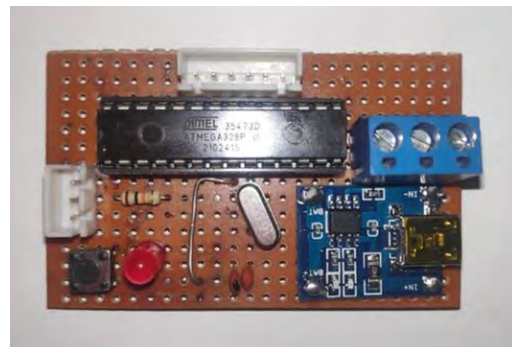
Figure 3(b): Micro Controller Circuit

Figure 3(b) describes the microcontroller circuit. The AT Mega 328P IC is used to control this device. because it has low power consumption and is easy to program. The 12V solar charging battery management device is used to charge the battery. A red LED is used to indicate the power-on status of the device.

Figure 3(c): Inside of the Electric Fence Fault Finding System

Figure 3(c) describes the inside of the final prototype of the Smart Electric Fence Fault Finding Device. It consists of a GSM module, a microcontroller circuit, a 12V solar battery management system, and a Li-Ion battery. The prototype enclosure is a normal waterproof enclosure.

3. RESULTS AND DISCUSSION

When final testing is done, you will get the message from the Smart Electric Fence Fault Finding System when it detects an electric fence voltage of less than 3kV.
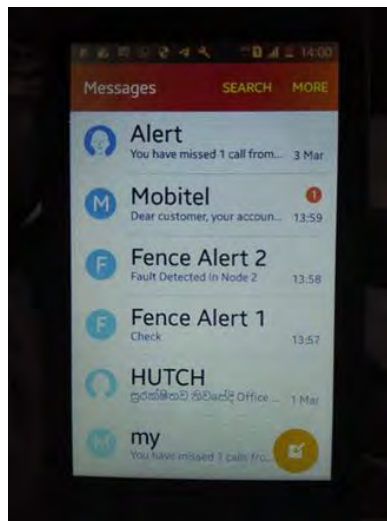
Figure 4: Send "Check" SMS

Figure 4 shows when sending the "Check" messages to the Fence Node 1, Node 2 only. Node 1 (Fence Alert 1) does not send the fault-detecting message. Node 2(Fence Alert 2) sends the fault-detecting message. Then the officer can identify that there is a fault between Node 1 and Node 2.

Node 1 is working correctly because Node 1 did not send the message. But Node 2 sends the fault-detecting message.

Figure 5: Final Output of Smart Electric Fence Fault Finding System

Figure 5 shows the final view of the prototype of the Smart Electric Fence Fault Finding System. It has a plastic enclosure box with a high voltage insulation vax. High voltage insulation vax protects from high voltage electricity. The enclosure box is also weather-resistant. It protects the components on the inside.

4. CONCLUSION(S)/ IMPLICATIONS/ RECOMMENDATIONS & LIMITATIONS

The Smart Electric Fence Fault Finding System is designed to minimize the errors of traditional electric fence fault-finding methods. Conventional electric fence fault-finding systems are traditional, time-consuming, and require people to walk along the electric fence to find the fault. It can also cause human errors by not finding the faults in the electric fence. Smart Electric Fence Fault Finding uses new technologies to find the faults in the electric fence and minimize the errors of conventional fault-finding methods, focusing mainly on the maintenance of the electric fence in the event of a fault. When it comes to designing and completing the Smart Electric Fence Fault Finding System, we first gather information about the human-elephant conflict, the electric fence systems and components of the system, and the methods used to find faults. We got information from the wildlife conservation department, and we visited Wasgamuwa National Park. We gathered more information from the wildlife ranger officers about the practical situation of the current fault-finding methods. From the gathered information, we design the device to minimize the current fault-finding method errors. But when it comes to designing and completing the Smart Electric Fence Fault Finding System, we face a lot of difficulties. Finally, we designed this prototype and tested it on our homemade electric fence. When this device is installed on the real fence post, the enclosure must be made using waterproof material. The estimated cost of the installation of this system is LKR 12000.00 per unit device. There is a cost of LKR 240000.00 per fence. but it will save wasting time finding fault, transportation costs for travel, and salaries of the employee who allocates the find fault.

REFERENCES

Dampage, U., Thajudeen, R., Jasenthuliyana, S. and Jayawardena, J., (2021). Automated virtual elephant fence based on detection, alarming, and coordinated redirection of wild elephants. *Environmental Monitoring and Assessment*, *193*(4), pp.1-14.

Dissanayake, S., Fernando, D., Suduwella, C., Dabare, M., De Zoysa, K. and Keppetiyagama, C., (2018), September. Sensor Based Fence Breakage Detection System. In *2018 18th International Conference on Advances in ICT for Emerging Regions (ICTer)* (pp. 351-356). IEEE.

Fernando, P., Kumar, M.A., Williams, A.C., Wikramanayake, E., Aziz, T. and Singh, S.M., (2008). *Review of human-elephant conflict mitigation measures practiced in South Asia*. Gland, Switzerland: WWF.

Fernando, P., Kumar, M.A., Williams, A.C., Wikramanayake, E., Aziz, T. and Singh, S.M., (2008). Review of human-elephant conflict mitigation measures practiced in South Asia. *Gland*, Switzerland: WWF.

Jayasuriya, N., Sayakkara, A.P., Suduwella, C., Keppitiyagama, C., De Zoysa, K., Hewage, K. and Voigt, T., (2017), Wire is not dead": Wired-backscatter Communication for Breakage Detection in Electric Fences. In *EWSN* (pp. 300-304)

Köpke, S. *et al.* (2021), Human—elephant conflict in sri lanka: A critical review of causal explanations, *Sustainability (Switzerland)*, 13(15), pp. 1–14. doi: 10.3390/su13158625.

Köpke, S., Withanachchi, S.S., Pathiranage, R., Withanachchi, C.R., Gamage, D.U., Nissanka, T.S., Warapitiya, C.C., Nissanka, B.M., Ranasinghe, N.N., Senarathna, C.D. and Schleyer, C., (2021). Human–elephant conflict in Sri Lanka: A critical review of causal explanations. *Sustainability*, *13*(15), p.8625.

Osterburg, G. (1977), A fence with several safety wires with alarm equipment. Germany (Mehrere Sicherungsdraehte aufweisender Zaun mit Alarmanlage). Available at: http://inis.iaea.org/ search/search. aspx?orig_q=RN:09367785.

Prakash, T. G. S. L., Wijeratne, A. W. and Fernando, P. (2020), Human-Elephant Conflict in Sri Lanka: Patterns and Extent, *Gajah*, 51(June), pp. 16–25.

Designing and Development of Solar-Powered Farm Assisting Robot

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Abstract

The consequences of chemical weeding methods in the agriculture field become an important global issue for sustainability in food production and the weeding process of farming is a challenging task. Among all renewable energy sources, solar energy is the most suitable for agricultural activities. Therefore, the solar-powered farm assisting robot was designed and developed to contribute to farming operations. The aim of the project is the replacement hand weeding and fertilizing in farming with a farm-assisting robot working at the field level. Most of the previous inventors have developed agricultural robots with fuel consumption, which will not only be consuming more financial resources but also reduce the sustainability of food production. This proposed method, contained a solar panel and rechargeable battery for power consumption to reduce air pollution and designed a mechanical weeding mechanism such as a plough-type rotary tool. The advantage of this solar-powered farm-assisting robot is that it does not require any fuel or petrol to perform. This robot was designed to be remote control. For fertilizing task, there are three fertilizing outputs each on the left and right side. The flow of fertilizer from the tank will be controlled by solenoid valves.
Keywords: Agriculture, Agribot, Solar-powered, Weeding, Fertilizing.

1. Introduction

The agriculture sector in Sri Lanka always acts as a major economic strength to the national economy as it ensures the food security, employment, and poverty alleviation of rural communities. Nowadays, the effect of weeds on the crop is a dangerous threat to the organic farming system in Sri Lanka. It leads to the pull-down of the economy of Sri Lanka.

Bambaradeniya et al. (2001) weeds are an important biotic constraint to achieving increased productivity having direct and or indirect interferences with crop production. Rao et al. (2017) indicate that weeds have caused about 50% of crop yield losses, in addition to reducing the quality of the crop harvest and threatening the native biodiversity of Sri Lanka.

The majority of small-scale farmers are suffering to reduce the threats of weeds and manpower for fertilizing. The main goal of this project is to reduce the effects of weeds and fertilizing without manpower.

The solar-powered farm assisting robot was designed and developed including a few agricultural tasks. This farm-assisting robot was designed with a pair of two front wheels and rear wheels and the robot is a two-wheel drive. The pair of front wheels are powered by motors to perform in the field. This farm-assisting robot can perform two multi-tasking to reduce or remove weeds and spread fertilizer, by using resources. It can perform various agricultural tasks automatically without wasting time and use of manpower in the farming field. Structure of the autonomous robot, with a mobility

platform that has four lags (wheels) that can able to move independently at any point in the farming field. The robot can able to remove 95 percent of the weed in a single row.

Figure 1: Solid work design of the robot

Figure 2: Farm-Assisting Robot

1.1 BACKGROUND STUDY/ REVIEW OF LITERATURE

From a literature survey, one of the developers developed an autonomous weeding robot for an organic farming system and the objective of this project is, the replacement of hand weeding system in organic by use of an autonomous robot. This autonomous robot was developed with a diesel engine and hydraulic transmission system. they also used mechanical actuators to remove weeds between the crops (Intra-row). In this paper, they mentioned many other solutions for weeding but the only solution for intra-row weeding is the use of a mechanical actuator.

This project addresses the new agricultural robot with solar energy consumption because nowadays it's cost-efficient and convenient. The solar-powered farm assisting robot is able to perform from 6 to 8 hours per day. For this operation, the suitable power source is solar energy. Because solar energy is long-term. Also, solar energy is sustainable for crops and the environment.

2. METHODOLOGY

The Solar-Powered Farm Assist Robot was designed with four lags (Wheels) robot platform. This robot is based on Atmega328p Microcontroller, Bluetooth communication method, DC motors and relays. Other components are interfaced with a microcontroller to perform various performances which are weeding and fertilizing. This farm assist robot is controlled by a remote by using Bluetooth communication method. The wireless Bluetooth protocol is used to operate the robot in four directions (front, back, left, and right), releasing fertilizer by solenoid valves and operating the weeding tool. The development of this farm assist robot has followed a few major key points such as low-cost, Autonomous, solar-powered, user friendly, easy maintenance, lightweight and non-hazardous.

To get a proper prototype of the farm-assisting robot and accomplish our objectives, we followed some stages from the beginning.

- Proper literature survey
- Got ideas by Hand sketching
- Converted to engineering drawing using SOLID WORKS

- Designed circuit diagrams using Proteus
- Motors and controller selected by proper calculations
- Chassis designed with proper material
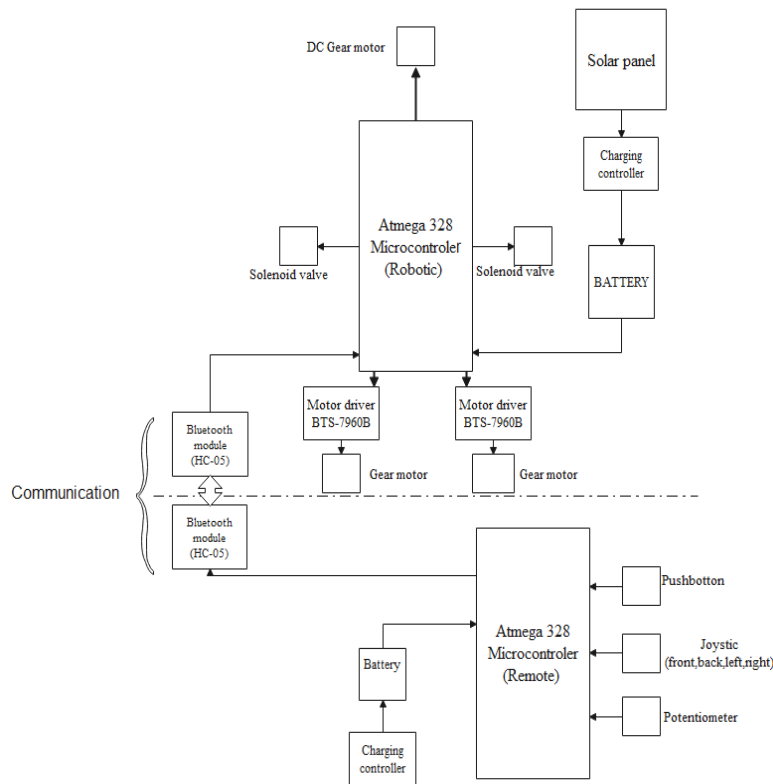
Figure 3: Block Diagram of Farm Assisting Robot

2.1. ROBOT CHASSIS

This part mainly focused on the robot structure/ body with lightweight, therefore the solar-powered-farm assisting robot body was built using a galvanized iron square tube (ASTM A36). The robot has four wheels that can move independently in the farming field. It can be able to adjust the high and width of the body according to the type of farming field.

2.2. PLOUGH-TYPE WEEDING METHOD

Mechanical weeding has been regarded as an important part of agriculture. In this project, a plough-type mechanical weeding mechanism was designed and mounted to the front of the robot platform to archive the weeding task. For the weeding process, there are four major technologies (thermal, electrical, mechanical, and chemical). Already indicate the advantages of the mechanical method and the disadvantages of other methods. The solar-powered farm assisting robot can reduce 95 percent of weeds between rows without injuring crops by using this mechanical method.

Figure 4: Plough Type Weeding Mechanism

2.3. FERTILIZING METHOD

In fertilizing task, a customized fertilizer tank was designed and mounted on the top of the robot body. There are two fertilizing outputs on each left and right side. The flow of fertilizer from the tank control by solenoid valves. When the user presses the pushbutton where in our remote-control device, the solenoid valves open for fertilizing task. Also, can adjust the distance of fertilizing output nozzles according to crop distance.

2.4. POWER MANAGEMENT SYSTEM

One of the most complicated sub-systems in Solar-powered farm assisting robot is the power management system. Solar power is the best way to get free energy. The main objective of using solar power is every dry cultivation farmer gets the best quality optimum harvest with positive environmental impact and low cost. This system is containing a photo voltaic (PV) panel, solar charger controller, and rechargeable battery. In a few surveys of a related project, the existing robots were archived the related tasks by using fuel energy or rechargeable battery. The main objective of using solar energy is to reduce burning fuel and cost. Already indicated the effects of burning fuel above. Another problem was identified from the literature survey, a single rechargeable battery was used to archive this related task. These types of robots can use only 2 hours of work per day or have to recharge again and use. But in solar-powered farm assisting robot, has a 12V rechargeable battery and solar panel on the top of the robot body in the robot chassis and it will recharge automatically by solar energy, therefore it was designed with a 12V-20V output range solar panel. The robot can work 12 hours a day and can also work in any weather conditions by use of the battery.

$$\text{Battery charging time} = \frac{\text{Battery capacity}}{\text{Solar charger output}}$$

$$\frac{35Ah}{12A}$$

2.91 h
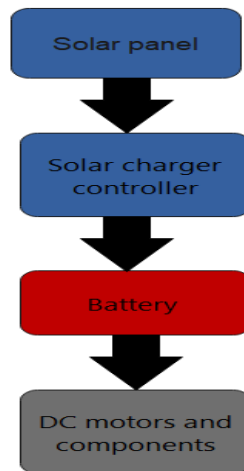
Figure 5: Block Diagram of Power Management System

2.5. REMOTE CONTROL METHOD

For this part, the specific circuit diagram was designed and customized with a microcontroller including a Bluetooth module, and potentiometer, and fixed some buttons such as the pushbutton and joystick buttons. The remote device can be operated easily by farmers also. When providing a command to the robot by remote control device the signal will send through the Bluetooth module which is fixed in the remote controller and the command signal will receive by another Bluetooth module were interfaced in the robot microcontroller circuit. After the command signal is received, the microcontroller will execute the command.

2.6. VEHICLE MOVING SYSTEM

The robot moving system performs a major role in the entire robot system. This system was implemented as a two-wheel drive (2WD) with two DC 12V, 45 rpm wiper motors. The robot moving system controls the robot and its four directions (front, back, left, and right). This system consists of two DC motors to handle the robot and they are controlled by the motor driver and the motor driver is controlled by the user using the remote controller. In the selection of a motor controller to control the motor, the most suitable one that BTS7960B. with this motor controller it is very easy to generate a high signal and PWM signal. These two signals can control the rotation and speed of the wiper motor.

Figure 6: Windscreen Wiper Motor

Figure 7: BTS7960B Motor Controller

3. RESULTS AND DISCUSSION

The solar-powered farm assisting robot is based on 2WD system with two wiper motors. Only the wiper motors can archive the objectives at a low cost. Some information was collected namely the speed of the motor with time.

Table 1: Wiper Motor Speed Test Results

Time (s)	Speed (rpm)
0	0
1	3
2	7
3	11
4	15

According to the test result, the motor will take 8-10 seconds to work with high rpm.

3.1. MOTOR SELECTION CALCULATION

Requirement power calculation for motor (without load(fertilizer)

$F_{moving} = m \times a$

$= 16kg \times 2ms^{-2}$

$= 32Kgms^{-2}$

$= 32N$

$F_{normal} = m_{SFAR} \times g$

$= 16Kg \times 9.8ms^{-2}$

$= 156.8N$

$F_{Friction} = c \times F_{normal}$

$= 0.04 \times 156.8N$

$= 6.27N$

$F_{SFAR} = F_{moving} + F_{Friction}$

$= 32N + 6.27N$

$= 38.27N$

$\zeta = F_{SFAR} \times R_{eff.wheel}$

$= 38.27N \times 0.25m$

$= 9.56Nm$

$P = F_{SFAR} \times V$

$= 38.27N \times 1.19ms^{-1}$

$= 45.54W$

$\approx 46W$

Requirement power calculation for motor (with load(fertilizer))

$F_{moving} = m \times a$

$= 21kg \times 2ms^{-2}$

$= 42Kgms^{-2}$

$= 42N$

$F_{normal} = (m_{SFAR} + m_{fertilizer}) \times g$

$= (16Kg+5Kg) \times 9.8ms^{-2}$

$= 205.8N$

$F_{Friction} = c \times F_{normal}$

$= 0.04 \times 205.8N$

$= 8.23N$

$F_{SFAR} = F_{moving} + F_{Friction}$

$= 42N + 8.23N$

$= 50.23N$

$\zeta = F_{SFAR} \times R_{eff.wheel}$

$= 50.23N \times 0.25m$

$= 12.55Nm$

$P = F_{SFAR} \times V$

$= 50.23N \times 1.19ms^{-1}$

$= 59.77W$

4. CONCLUSION/ IMPLICATIONS/ RECOMMENDATIONS & LIMITATIONS

The prototype of a Solar-powered farm-assisting robot will be more beneficial for both small- and large-scale farmers. Weeding and fertilizing are essential and high-cost operations in any farming.

Collected some information by discussing with a few farmers about the cost which were spent to accomplish weeding and fertilizing for their farming and the effect of weeding and effects for a crop without fertilizing. However, according to their information, it can be concluded that more consumer costs and time are consumed to accomplish this operation manually.

The main thing about this robot is, this is an electric vehicle with zero emissions. When compared to other types of agricultural robots, it has zero-emission therefore, no effects on crops and a positive impact on the environment. Hope this will reduce the problems that farmer face in the farming field and increase the efficiency of plant growth.

REFERENCES

Agricultural Robots (n.d). Agricultural Robots Advantages, Automation, History, Future. Available at: www.agrifarming.in/agricultural-robots-advantages-automation-history-future

Association for advancing automation. (2017). *Robotics in Agriculture*. Types and Applications.

Bawden, O., Kulk, J., Russell, R., McCool, C., English, A., Dayoub, F., Lehnert, C. and Perez, T., (2017). Robot for weed species plant-specific management. *Journal of Field Robotics*, *34*(6), pp.1179-1199.

Chain, D. (2020). Available at: https://policies.google.com/terms?hl=en-US (Accessed: 27 January 2020).

Chang, C.L., Xie, B.X. and Chung, S.C., (2021). Mechanical control with a deep learning method for precise weeding on a farm. *Agriculture*, *11*(11), p.1049.

Eli, W. (1974). *History of Cotton Gin.*, Available at: https://www.google .com/amps/www.history.com/.amp/topics./inventions/cotton-gin-and-eli-Whitney.

Marambe, B. and Wijesundara, S., (2021). Effects of climate change on weeds and invasive alien plants in Sri Lankan agro-ecosystems: policy and management implications. *Frontiers in Agronomy*, *3*, p.641006.

Ranathunga, L.N., Wijemanna, W.M.D.I.S., Sathsara, M.G.S. and Gamage, R.G.B.K., (2018). Agriculture in Sri Lanka: The Current Snapshot. *International Journal of Environment, Agriculture and Biotechnology*, *3*(1), pp.118-125.

Slaughter, D.C., Giles, D.K. and Downey, D., (2008). Autonomous robotic weed control systems: A review. *Computers and electronics in agriculture*, *61*(1), pp.63-78.

DEVELOPMENT OF SMART WATER METER

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ABSTRACT

A water meter is used to measure water consumption. They are used to measure the volume of water used by residential and commercial buildings, supplied by the public water supply system. Water consumption in Sri Lanka is calibrated in liters. According to the traditional method of water meter reading, the meter reader visits the meter once a month and takes the meter readings. But the smart water meter allows consumers and water suppliers to automatically monitor the amount of customer water usage, in addition, it's giving consumers greater visibility and control over their usage and water bills. It is displayed on the water meter display and can be read by customers using their mobile devices. In this system, a web application enables stopping the flow of water at a specific rate specified by the customer. It provides data on peak utilization and other information that can be used by consumers and utilities. Using smart water meters allows water suppliers to quickly find and fix leaks. Furthermore, water suppliers can send monthly bills to customers without visiting the customer's location. Also, the customer can stop the water supply after exceeding the limit by entering the water or water bill to limit the water consumption as required.

Keywords: *Consumption, development, monthly bill, web application, water meter.*

1. INTRODUCTION

Water is a human basic need. In a busy life, humans need to manage their life easier because it will be affected the human economy. So smart water meter has been designed to help human day-to-day life easier. It will save time and money for the consumer and water supplier. The smart water meter has been designed to work with national grid power and solar power. Instant meter reading has been saved to memory in the control board and data will be uploaded to the cloud system in periodical time intervals. Customers can be logging into the cloud system (unpaid trial version) and be able to view daily consumption and analytical information during the given period. In addition, meter readers can download meter readings via WiFi to handheld devices using the meter reader mobile application with this system, it is expected to facilitate consumers to make better service, save water as a resource and reduce the meter reading cost of the national water supply board. Sustainable energy can be used in areas where well sunlight. It will help to use this device in a wide range of rural areas.

1.1 REVIEW OF LITERATURE

In Sri Lanka Water Supply Schemes cover 34 % of the total population with pipe-borne water supply. 10.5% of the population is served with pipe-borne water supply by some Local Authorities, NGOs, and Community Based Organizations. 13% of the population is served with hand pump tube wells. So, 44% of the population uses a conventional water meter to measure the volume of water used by

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residential and commercial building consumers. Most of the meters are calibrated in cubic meters (m3). The traditional method of water meter reading is for the meter reader to visit the meter once a month and takes the meter readings. In the water meter, there are two different color numbers where red numbers are liters and white color numbers are kilo liters. here, the monthly water consumption is measured by subtracting the previous month's meter reading from the current meter reading. In a busy life, human needs to manage their life easier because it will be affected the human economy. So smart water meter has been designed to help human's day-to-day life easy. It will save time and money for the consumer and water supplier.

In 1790 Reinhard Woltman, Hamburg Germany applied a multi-bladed fan to measure flowing air and water. The pilot tube was first described in 1732 by Henri de Pitot as a device for sensing water velocity and ship speed. In 1850 Werner von Siemen designed the Woltman meter to be applied in a closed conduit. In 1884 L H Nash for an oscillating piston meter. This semi-positive metering principle is currently used in a large number of modern designs. The first commercial meter appeared in 1950. In this project also electromagnetic Hall Effect sensor is used for the development of a water meter *(Asia-Pacific Legal Metrology Forum APLMF, October 2019)*

According to introduce and studied An Efficient IoT-based Smart Water Meter System of a Smart City Environment. That was different from other systems that we discussed. They used two separate nodeMCU for cloud services and measuring purposes. Also, they are using only AC power to charge the battery but we are using solar power and ac power to charge the battery. *(Raad AL-Madhrahi et al, June 2021)*

A Smart Meter for Water Utilization using IoT research discussed a system for measuring water flow and volume display on a serial monitor, it also discusses sending data to the cloud but the paper did not describe it clearly. In this project, we are including a water flow controlling part of their project. (Anandhavalli, April 2018). According to domestic-type water meter measurement errors under varying flow rates and water pressures. He determined measurement accuracy affected by water pressure is negligible. Whereas water pressure affects the measurement accuracy at lower flow rates. (Karadirek, 2020)

2. METHODOLOGY

The connectivity of hardware modules, protocols, and software tools are required for the designing of a smart water meter. This section explains the building blocks of the systems. The smart water meter block diagram is shown in Figure 1.

The smart water system consists of three major systems.

I. Water Measuring system

We used the YF201C water flow sensor to measure water consumption. When water flows through the rotor, the rotor rolls, and its speed changes with different rates of flow. This change of speed is known as the Hall Effect signal and is sent to the raspberry pi board.
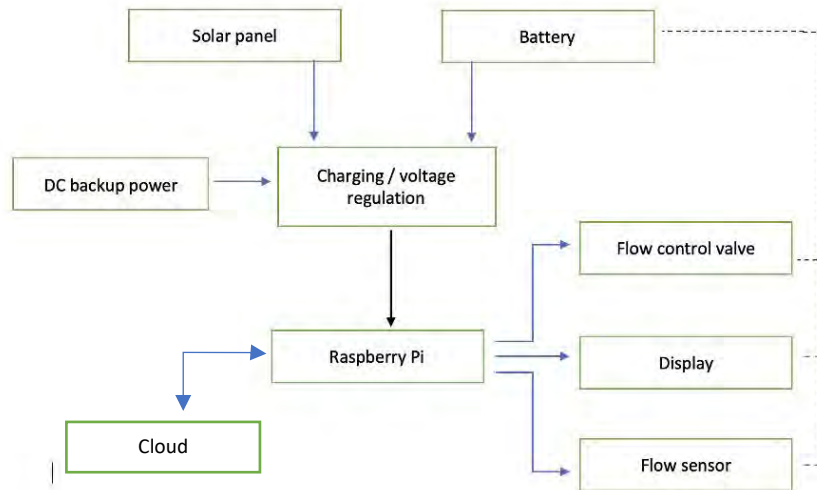
Figure 3: Block Diagram

The basic relationship for determining the liquid's flow rate in such cases is X=VxA,

Where,

X is flow rate

V is average velocity of the flow

A is the cross-sectional area of the pipe

Pulse y (Hz) = 7.5X, X is flow rate in L/min

Flow Rate (L/h) = (Pulse frequency x 60 min) / 7.5X

Sensor Frequency (Hz) = 7.5 * X (Liters/min)

Liters .= X * time elapsed (seconds) / 60 (seconds/minute)

Liters = (Frequency (Pulses/second) / 7.5) * time elapsed (seconds) / 60Liters = Pulses / (7.5 * 60)

II.   Main Power supply and charging system

The whole process is powered by a Li-Ion battery. The battery is charged by the solar power system and main power supply. There is an additional dc 12V input as per customer requirement. All of the calculations are done assuming the water meter has a 24/7 working time

- The relay module is working with 5V voltage and 70mA current so, it gets 0.35 W power

  Power consumption of the relay module (per month) 0.35W x 24h x30 = 252Wh

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- 0.96 OLED display gets 0.06W power so, its monthly power consumption is
        0.06W x 24h x 30 =xs 43.2Wh

- The solenoid valve working voltage is 12v and it gets 4.8W power in working mode
        Power consumption (per month) =4.8W x 24h x 30 = 3456Wh

- The water flow sensor works with 5V DC and 15mA current .so it gets 0.075w power
        Power consumption of water flow sensor (per month) = 0.075W x 24h x 30 =
    54Wh

- Total power consumption per month=**3805.2Wh**

III.   Data Communication system and information display

The sensed data will be processed and sent to the cloud through a using Wi-Fi connection. Real-time data saving on the raspberry pi board can be achieved every 5 minutes and the update interval can be changed by the supplier. The database is updated through Wi-Fi. Then the user can log into the web page application to check the consumption, also he can control the water consumption through the user interface. Suppliers also can check the water consumption of the user. If the user exceeds the user limit, the supplier can stop the flow of the water. In addition, Suppliers can identify unauthorized usage of the water through their database analysis.

3. RESULTS AND DISCUSSION

The water flow sensor is used to measure the flow rate. oscilloscope waveform and its parameters such as Frequency, Amplitude, Pre-shoot, etc as shown in Figure 2. We conduct this test, we used a water flow sensor, raspberry pi board, display, and power supply unit. After preparing the code (needed to measure the flow rate) we checked the code and uploaded it to the raspberry pi board. then water flow sensor, display, and power supply unit were installed.
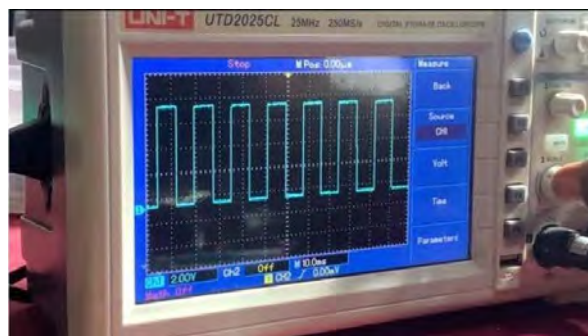
Figure 4: Flow sensor Oscilloscope waveform

Then started the run this and send stream of water through the sensor. Then we could see the flow rate using the display and calibrate the flow rate using raspberry thonnyID as shown in Figure 3.

Figure 5: Flow sensor reading

WEB Application (Liqua X)

We created the local host server using raspberry pi and we named it LIQUAX as shown in Figure 4. It helped consumers and suppliers to control and get an idea about water usage. Using this smart water meter system consumers and suppliers can control the valve without reaching the place. If consumers use a water supply connection without payment or using of limited volume supplier can disconnect the supply remotely.
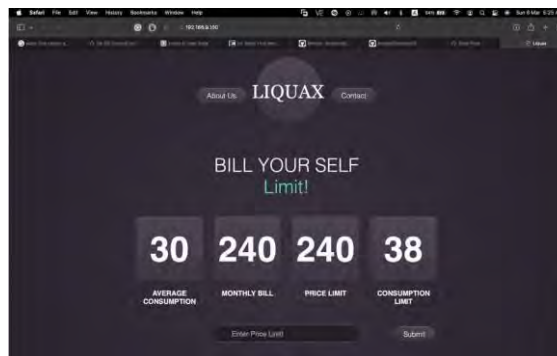
Figure 6: LiquaX website

Figure 5 shows the final overview of the final product.

Figure 7: Final Product

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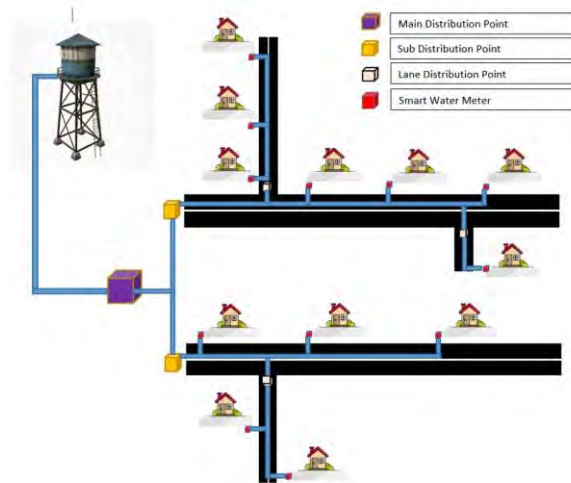
Figure 8: Smart water meter distribution point locations

4. CONCLUSIONS/ IMPLICATIONS/ RECOMMENDATIONS & LIMITATIONS

A water meter is a device that can measure the volume of water. Especially water meters can measure the volume of water used by residential and commercial buildings that supply water from the supply chain. Normally traditional water meters work with a mechanical system, therefore meter readers should collect data one by one. But in the traditional meter, customers cannot get an easy idea about average usage, monthly usage, etc. in smart water meters have more benefits for suppliers and users. In this system, customers can view their daily consumption, monthly consumption, average consumption, price limit, and consumption limit. When exceeding the water limit, or leakage of the domestic line, customers can identify easily and disconnect the supply easily as shown in figure 6.

The supplying parties, also have special benefits. It can reduce the labor cost of the meter readers. When suppliers add this smart water meter according to the purposed grid system they can get a lot of benefits. This is the method of applying this system to new housing schemes. in this method suppliers can get more important data such as,

• Find the leakage of the system - When the supply chain works properly, supply volume must equal the total volume of users. In some cases, it unbalances suppliers can find the leakage lane easily.

• Find unauthorized users - Some peoples use water for commercial purposes but they use the domestic connection. This system can monitor this type of unauthorized use.

• Disconnect water supply remotely - Somebody uses a water supplying connection without payments or overusing of limited volume then the supplier can disconnect the connection remotely.

When maintaining selected areas, the supplier can access for disconnect the water supplying the connection. This system can disconnect the supply separately by the distribution point or the beginning of the lane.

REFERENCES

Amir, A., Fauzi, R. and Arifin, Y., (2022). The smart water meter for automatic meter reading. *IOP Conference Series: Materials Science and Engineering*, 1212(1), p.012042.

Anandhavalli, D., Sangeetha, K.S., Dharshini, V.P. and Fathima, B.L., (2018). Smart meter for water utilization using IoT. *International Research Journal of Engineering and Technology (IRJET)*, *5*(04).

APLMF (2019) Domestic water meters, APLMF. Available at: https://www.aplmf.org/domestic-water-meters.html (Accessed: October 21, 2021).

Bawden, O., Kulk, J., Russell, R., McCool, C., English, A., Dayoub, F., Lehnert, C. and Perez, T., (2017). Robot for weed species plant-specific management. *Journal of Field Robotics*, *34*(6), pp.1179-1199.

Ethem Karadirek, I., (2020). Experimental analysis on accuracy of customer water meters under various flow rates and water pressures. *Journal of Water Supply: Research and Technology-Aqua*, *69*(1), pp.18-27.Hong, Y. and Lee, C., (2019). A design and implementation of a low-power ultrasonic water meter. Smart Water, 4(1).

Jun, Z. and Sheng, Z., (2015). Wireless Remote Water Meter Design of Automatic Meter Reading System. *International Journal of Smart Home*, 9(12), pp.289-298.

Li, X. and Chong, P., (2019). Design and Implementation of a Self-Powered Smart Water Meter. *Sensors*, 19(19), p.4177.

Designing and Development of Asbestos Roof Painting Robot

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Abstract

The roofs of most houses in the suburbs are very high, making it impossible for them to repair the roof. Due to the changing climate, the roofs of the houses become discolored and change their durability. There, asbestos roofing sheets deteriorate due to the inability to paint the roof on time. The objective of this project is to coat roofs with asbestos roofing sheets using the latest technology and paint on roofing sheets by the required standards. People in many urban homes are suffering from these conditions. After asbestos roofing, the paint will peel off and the sheet will rot. But nowadays most of the people who lead a busy life are not able to dedicate time to this. As a result, people in those homes continue to suffer. As a solution to this, it is proposed to create a robot to paint roofs with asbestos using modern technologies and knowledge. It can spray paint evenly, covering even the smallest pores, giving it a good look and durability. This painting robot can do more work in less time than a human-intervention painter. Further enhancement of this robot will enable it to apply paint not only on the roof but anywhere in the house.

Keywords: *Automation, Mechatronics, Robotics, Safety, Spray painting. Obstacle sensor.*

1. Introduction

In the past, people used wood parts, such as straw, coconut twigs, and palm branches as roofing materials and their durability were low. They used various tactics to increase it. The new technology methods are roof tiles, asbestos sheets, Zinc aluminum sheets, and I-roof sheets. These things are gradually getting to use. The special thing is that the materials used today have a better finish and durability than the materials used in the past. Over time, things like algae appear on the roof. Also, changes in physical stretchers are caused by processes such as expansion and contraction in the presence of ambient temperature. Due to the acidity of the rain and the salinity of the sea breeze in the coastal areas, it undergoes a chemical process. The above defects interfere with the durability and finish of the roof. Therefore, the roof is painted as an alternative to this. It can bring great benefits to the homeowner. They are resistant to algae and water-sealing, thermal-sealing, and chemical-resistant properties, and can have a color and finish that suits the individual's preferences. There are several methods of painting. Two of them are painting the paintbrushes and painting the spray gun. There are paint lines when applying paint with a brush, but there is a high finish when applying spray paint. You can also save on paint. The paint sprayer method is widely used in roof painting. There are two methods of painting. Air spray and Airless paint spray. This robot uses the air spray method. The

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painting process consists of two layers. The first coating mixes 30% water with paint. In the second coat, 20% water is mixed with the paint and applied. This takes about 30 minutes at 30 ℃ to dry (touch dry). It takes an hour at 30 ℃ to dry completely. It can also cover an area of 12 to 15 m^2 per liter. Its thickness is about thirty microns. After painting the roof with the above, its durability is longer than before. There are several reasons to use robotics for painting. The ability to save the life of the person being painted, the ability to minimize damage to the roofing material when a person is on the roof, and the ability to do more work in less time and at a lower cost. There are several roof restoration companies in Sri Lanka as well. Their people climb on the roof and paint. Therefore, after the production of this robot, the painting roof is moving in a technically new way.

1.1 REVIEW OF LITERATURE

Xu (2021) developed a repairing cable of cable-stayed bridges. This system has two types of operation methods. It is automatic and manual. manly try detecting in repairing damaged and overlay this system has two structures. first is the structure of the grinding, cleaning, and spray mechanism and it includes the Rotary platform, The grinding mechanism, The cleaning mechanism, spraying mechanism. The second is the winding mechanism and it includes the Lifting platform, the Rotary platform, the pressing mechanism, and the tape-wrapping mechanism.STM32F103CBT6 controller uses this system and transmitting part and reserving part connect by NRF24L01 radiofrequency transgressed module. All parts have been said to be successful. It uses a spray tank for spraying paint and a linear solenoid to activate it. The process of moving down and up is done by the climbing mechanism. The painting process is done by rotating the rotating platform. (Xu *et al.*, 2021) .
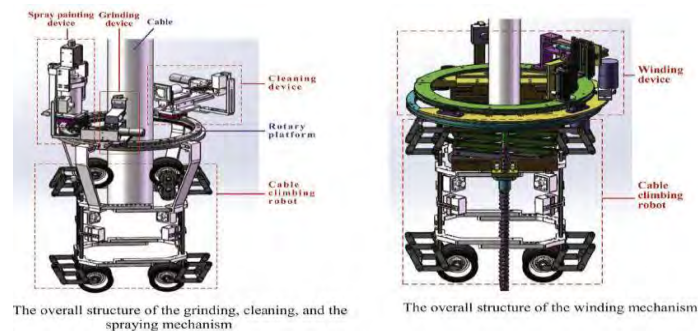
Figure 1. The overall structure of the spraying mechanism & winding mechanism

Iqbal (2013) published A Novel Track-Drive Mobile Robotic Framework for Conducting Projects on Robotics and Control Systems. This system uses a space system consisting of a lander and a robotic rover. The robot is connected to the wire with a tether that serves the purpose of power delivery and communication. it's landing on a planetary surface. the lander directs and navigates the robot to the location from where soil samples need to be collected. The tracking resolution is ±6cm. Although the implementation of a trivial control algorithm (PID) has been discussed the framework can be used to realize more sophisticated control strategies like Sliding Mode Control (SMC), Linear Quadratic

Regulator (LQR), etc. they are used ATMEL family controller AT90CAN128 chip, LMD18200 motor driver, 10500 rpm dc brush motor and 84:1 ration Planetary gearhead use for rubber tracks (Iqbal, 2013).
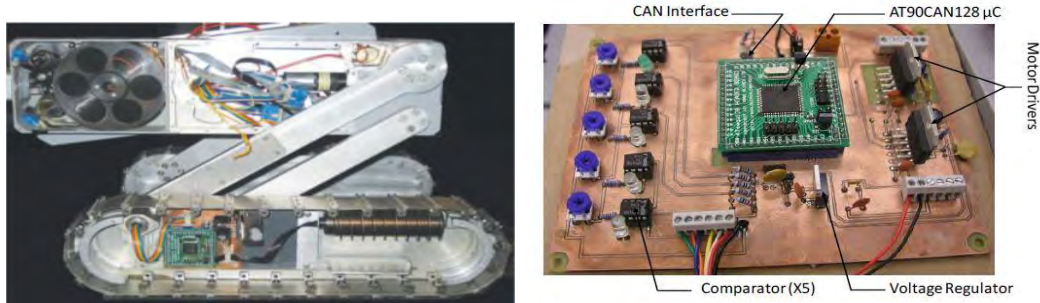
Figure 2. End elevation of robot

Vishal (2020) published a design of flying robot painting system for Indian railway passenger coaches. It is said that a small amount of paint can be applied over a large area and the environmental impact can be minimized. Drone DJI M. 200 technology is also used to apply the paint. This system is used the airless spray paint method in Graco LW025A pneumatically operated pump. The spray nozzle of the gun is blocked by any fine paint particles and the pump will stop painting, but the drone continues to move. In the system, presented here, the human has to pause and bring the drone to the home position, clear the blockage, and then the drone shall go to the paused location by start painting. They were assumed to be designed the pause the drone and clean the nozzle automatically. In this design, they use a hose of 6 m. When the drone moves beyond 6 m, but the coach length is 25 m, the worker has to move the pump (Vishal, 2021)
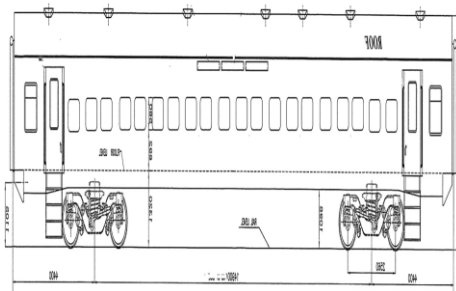
Figure 3: Dimension of railway passenger coaches   Figure 4: Drone
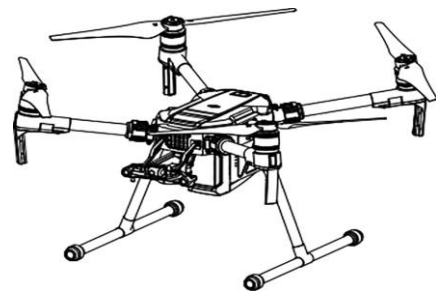
Nalawade (2019) published an Industrial Roof Painting Robot. They have used relays, ultrasonic sensors, and motor drivers interfaced with it to control the locomotion and spray painting. they made efforts to develop a system to get the industrial as well as domestic metal roofs painted efficiently. Arduino is used to take the input with the help of a keypad and LCD and input from an ultrasonic sensor. Output to the motor drivers and relay module for spray painting. The robot is designed using CREO and analyzed by ANSYS. Open-source Arduino Software (IDE) is used to develop a program.

They state that all attempts have been successful and that it is possible to vary the distance between the spray and the surface.

Figure 5: RP robot

2. METHODOLOGY

Block Diagram
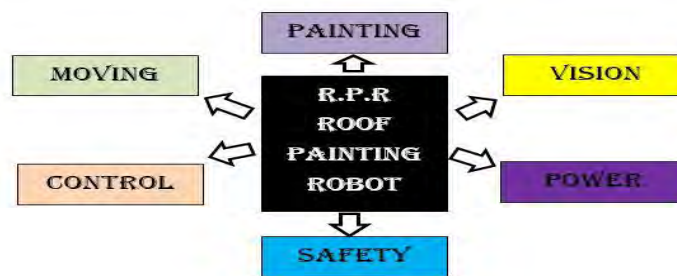
Figure 6: Block Diagram

In the creation of this robot, it was divided into six parts, designed and developed. There, we control the part by rf remote control, lithium iron battery pack to provide power, dc gear motors and chain wheel system to move, height system and rotation system, and painting system. It was set up to be airless and connected to the smart camera to capture images for the vision system. In addition, IR distance measuring sensors have been designed for the safety system.
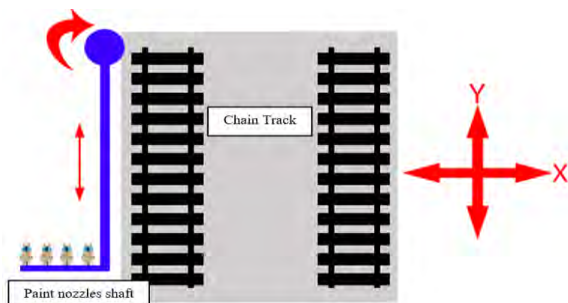
Figure 7: Side Basic View   Figure 8: End Basic View
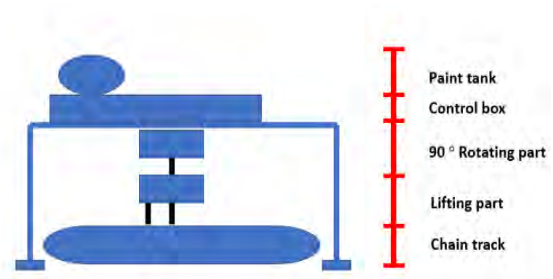
First step - First, the robot was placed on the roof. should be placed on the roof. The left wheel was placed on the left end slot of the roof. should be placed on the left end slot of the roof. Then paint tank was filled as required for painting and the tank was closed. fill the paint tank as required for

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painting and close the tank. After switching on the system, calibration was started and shifted to the second step. start the calibration and shift to the second step.

Second step - The second step was started at the end of the calibration. This starts at the end of the calibration. the starting point for applying the paint was applied manually. The robot was moved by using the remote to the starting position to paint the roof.

Third step - The robot then moves the nozzle part up and down, spraying ink. The camera can monitor and check the situation. Then the robot moves down and sprays paint from the painting part again as before. That way the first strip was painted.

Fourth step - A 90-degree turning section and a lifting section were used to move to the second column. First, the rubber track was lifted by the lifting part and the track is rotated 90 degrees and then placed by the lifting part itself. Now the track can move left and right. After that, the robot will turn the track 90 degrees and move to the top of the roof to move to the right and go to the second section and go up and down again. After that paint was applied as before.

Fifth step - This process begins with painting the last Colum of the roof. The paint nozzle part was turned 90 degrees and the robot moves down applying paint from top to bottom. When looking at the last position, a box of about 40*40 is left. It has to be painted manually.

Figure.9: Asbestos Roof Painting Robot

3. RESULTS AND DISCUSSION

Figure 10: Actual view of the project

Result of the Moving Part

After the robot was built, its movement instructions are associated with three parts. It was observed that the three parts of the moving part (Chain track, lifting part and 90-degree rotating part) easily walked on an asbestos roof with 30^0 angles. It also can move up and down and left and right separately on the roof.

Figure 11: Up to down mode

Capable of reading up to 500M in remote areas when remote controlled. However, a Wi-Fi facility should be provided for smart cameras. Or the robot can connect directly to the operator's phone. Then the robot can shoot scenes without any problem while moving. This robot can shoot at low speed very easily due to the use of ESC. The remote can handle the robot very easily due to the channel mixing capability. In addition to the visuals of the camera, the sound can also be heard, so even the sound of a technical error in the device can be identified.

Result of the Painting Part

The nozzle can be moved by the linear travel stage, and the pump sends ink to the four nozzles. The same nozzle has the ability to change the way the dot is shot. In addition, the nozzle panel can be lowered in height.

Figure 12: up to down mode

4. CONCLUSION

Create a robot that can move on an asbestos roof and paint over it using the latest technology. Most houses in urban areas are covered with asbestos roofing sheets. Roofs with those asbestos roofing sheets are discolored due to climate change over time. Using a robot can have a more systematic finish and be a safer operation than having a person climb on the roof and paint on it. It is also possible that asbestos roofs may explode due to their body weight due to people walking on asbestos roofs in

most homes. Also, in the sale of paints by individuals, it is not possible to apply the paint to a finished surface. There are also many problems, such as the paint not moving well into the small holes in the asbestos sheets. To overcome this situation, we used the latest technology to create a robot that paints asbestos roofs. Because of this, there is no risk to life, and even small holes in the paint can be sprayed in a tactile manner. Therefore, a good finish can be obtained on the surface. Further development and use of this robot can solve many problems that arise in Sri Lanka.

REFERENCES

Iqbal, J., Nabi, R.U., Khan, A.A. and Khan, H., (2013). A novel track-drive mobile robotic framework for conducting projects on robotics and control systems. *Life Science Journal*, *10*(3), pp.130-137.

Kumar, N.M. *et al.* (2018), Dust cleaning robots (DCR) for BIPV and BAPV solar power plants-A conceptual framework and research challenges, *Procedia Computer Science*, 133, pp. 746–754. doi:10.1016/j.procs.2018.07.123.

Nalawade. (2019), Published Industrial Roof Painting Robot. Available at; http://www.j-asc.com/gallery/193-april-2508.pdf

Vishal, S. (2021), Design of flying robot painting system for Indian railway passenger coaches, *Materials Today: Proceedings*, 46, pp. 9630–9635. doi:10.1016/j.matpr.2020.07.147.

Xu, F. *et al.* (2021) , Developing a climbing robot for repairing cables of cable-stayed bridges, *Automation in Construction*, 129, p. 103807. doi:10.1016/j.autcon.2021.103807.

DESIGNING AN AUTOMATED TRAFFIC CONTROL SYSTEM FOR CONSTRUCTION ZONES

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ABSTRACT

To maintain safety and smoothness in traffic flow on any type of construction zones connected to roads, the usage of a manual traffic controller or human controller is very essential. An Automated Traffic Control System for Construction Zones is designed to replace a manual traffic controller on a construction site. In the first stage, one or both flagmen are expected to be replaced with our design device during the two-lane closures in the event of road traffic in any construction area. Mistakes and inefficiency can be made during the manual traffic controlled by flagmen. It could be a fatal traffic accident to a flagman during manual operation. Additionally, construction projects require 24 hours and 07 days of traffic control in different weather conditions. Implementing new technologies in automating the traffic flow in construction sites could possibly eliminate the usage of conventional flagmen at all times. Therefore, an Automated Traffic Control System for Construction Zones is a practical solution to solve problems that will be contributed to hazards at the construction site and to be in line with the safety regulations which will be taken into granted by the relevant authorities. An Automated Traffic Control System can be reduced time and money wasted on both parties, direct costs in manpower utilization, and increase safety for road users and construction workers by eliminating the need for a flagman.

Keywords: Automated Traffic Control, Flagman, Microcontroller, Ultrasonic Sensors, Wireless Connections.

1. INTRODUCTION

Using a manual traffic controller as a flagman is essential in maintaining safety and smoothness in traffic flow at a construction area or a site. Such a practice was introduced a long time ago; since then, it has been widely in practice worldwide. Figure 1 shows the present practical scenarios at said locations. Mainly there are two scenarios as shown in Figure 1(a) and Figure 1(b).

Figure 1(a): Traffic controlled without using Flagman   Figure 1(b): Traffic controlled by using Flagman
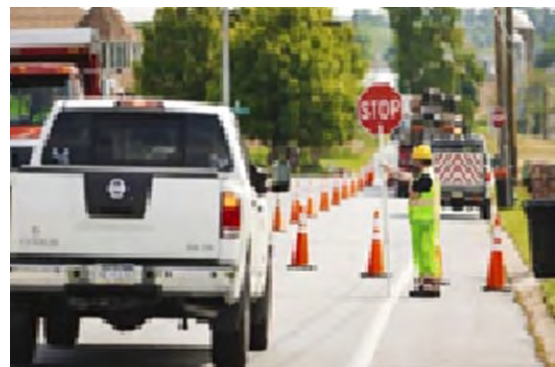
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1.1 BACKGROUND STUDY/ REVIEW OF LITERATURE

Construction zones-traffic accidents are a continuing problem in many countries around the world. The safety regulations are revised by responsible authorities periodically to ensure a safer working environment in a typical construction site area. The prime concern in a construction zone connected to roads is the safety of construction workers and road users.

An automated traffic control system for Construction Zones has been designed to replace a manual traffic controller on a construction site attached to roads. At the outset, one or both flagmen are to be replaced with this designed device during the two-lane closures in the event of traffic control in a construction area. This is an around-the-clock automated traffic control system for construction zones; no equal system has yet been implemented in the local context. Figure 2 shows the model assembled for the demonstration of our design, which will overwrite the conventional flagmen practice.
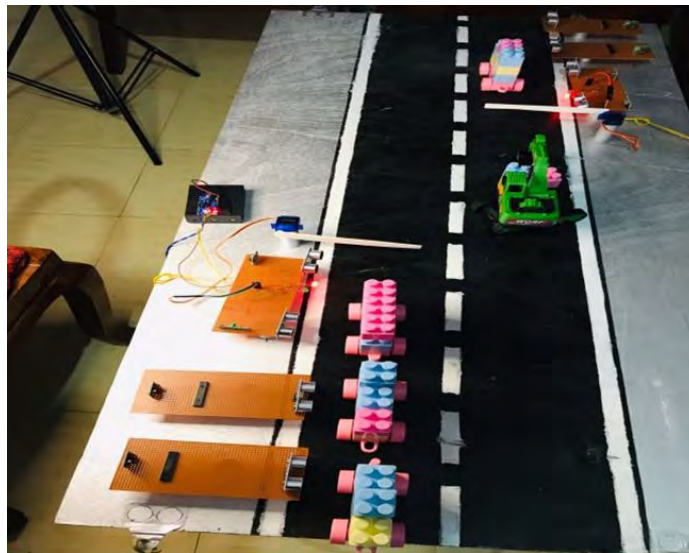
Figure 2: View of our Model (Under the initial design stage)

There has been a requirement to implement an automated system for the manual operation of construction zone traffic by construction companies or contractors. Our design increases the accuracy and efficiency of construction area traffic control. Implementing new technologies in automating the traffic flow at the construction site could be eliminating the critical duties of conventional flagmen at all times. An automated traffic control system for construction sites is a practical solution to solve problems that will contribute to prevent from hazards in the construction area connected to roads and be in line with the safety regulations which will be taken into consideration by the contractors and the relevant parties

1.2 AIM

Our main focus is to design an Automated Traffic Control System for Construction Zones connected to roads, replacing the existing manual traffic control system.

1.3 OBJECTIVES

- To design an intelligent automated road traffic control system for construction zones.
- To introduce a safe & easy handling construction zone-road-traffic control system.
- To assemble the control circuits to check the viability of the solution.

1.4 FIELD SURVEY

Before implementing our design, some preliminary data was collected by contacting some Construction Companies in Sri Lanka to get their feedback about our design of an Automated Traffic Control System for Construction Zones. Table 1 shows the summary of the field survey.

Table 1: Summary of Field Survey

No.	Name of the Company	Present System	Proposed System by our group	Remarks by Company
1	M/s. Ceylex Engineering (Pvt) Ltd	Manual	Accepted	Cost & Durability
2	M/s. Sierra Construction (Pvt) Ltd	Manual	Accepted	Durability
3	M/s. Sanken Construction (Pvt) Ltd	Manual	Accepted	Performance & Accuracy
4	M/s. Finite Lanka (Pvt.) Ltd	Manual	Accepted	Cost
5	M/s. K.D.A. Weerasinghe & Co. (Pvt) Ltd	Manual	Accepted	Cost
6	M/s. Vasisri Construction (Pvt.) Ltd	Manual	Accepted	Cost
7	M/s. Squire Mech. Engineering (Pvt.) Ltd	Manual	Accepted	Cost, Performance & Accuracy

2. METHODOLOGY
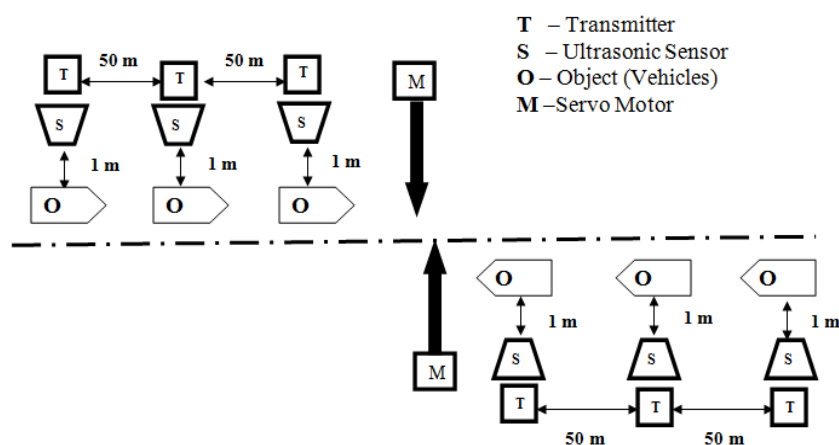
Figure 3: Device distance gap in the actual condition

Road traffic on each side of the construction site is monitored using three numbers of ultrasonic sensors per side. Each sensor was located every 50m distance gap and connected to the main controller unit through the wireless connection. The following dimensions are shown in Figure 3 is the calculated values for each component after completing the field study with the selected equipment.

Another two numbers of ultrasonic sensors are used as counters, to be fixed at both ends of the critical zone in a two-lane. The total number of vehicles passing each traffic light unit is to be temporarily saved in the control unit and compared with another end to make sure all the vehicles are passed before the transition of the traffic light changes.
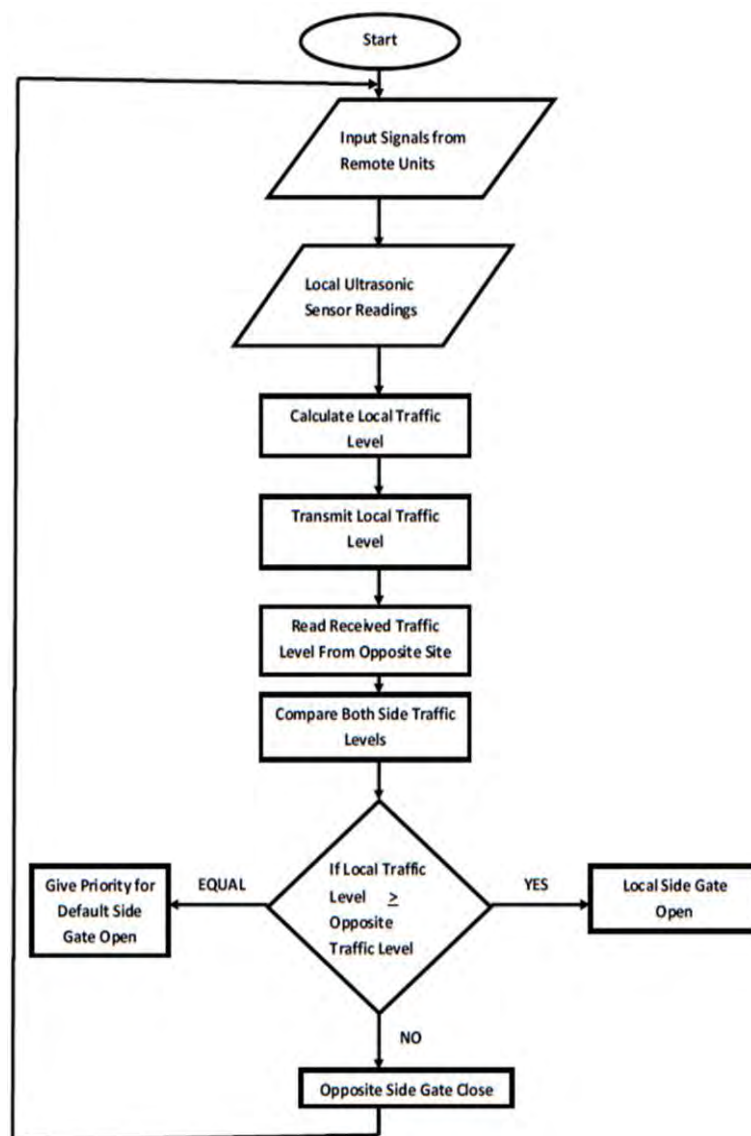
Figure 4: System Flow-chart

The length of the traffic is identified by the microcontroller as per the sensor inputs and gives priority to selecting the traffic lane to move the vehicle through the critical zone. The conventional flagman is replaced by a servo motor-operated gate with two indicator lights (Display as Red=STOP and Green=GO). The Figure 4 demonstrates the Flow Chart of our design.

2.1 DESIGN ARCHITECTURE

The Design Architecture of our design is shown in Figure 5,
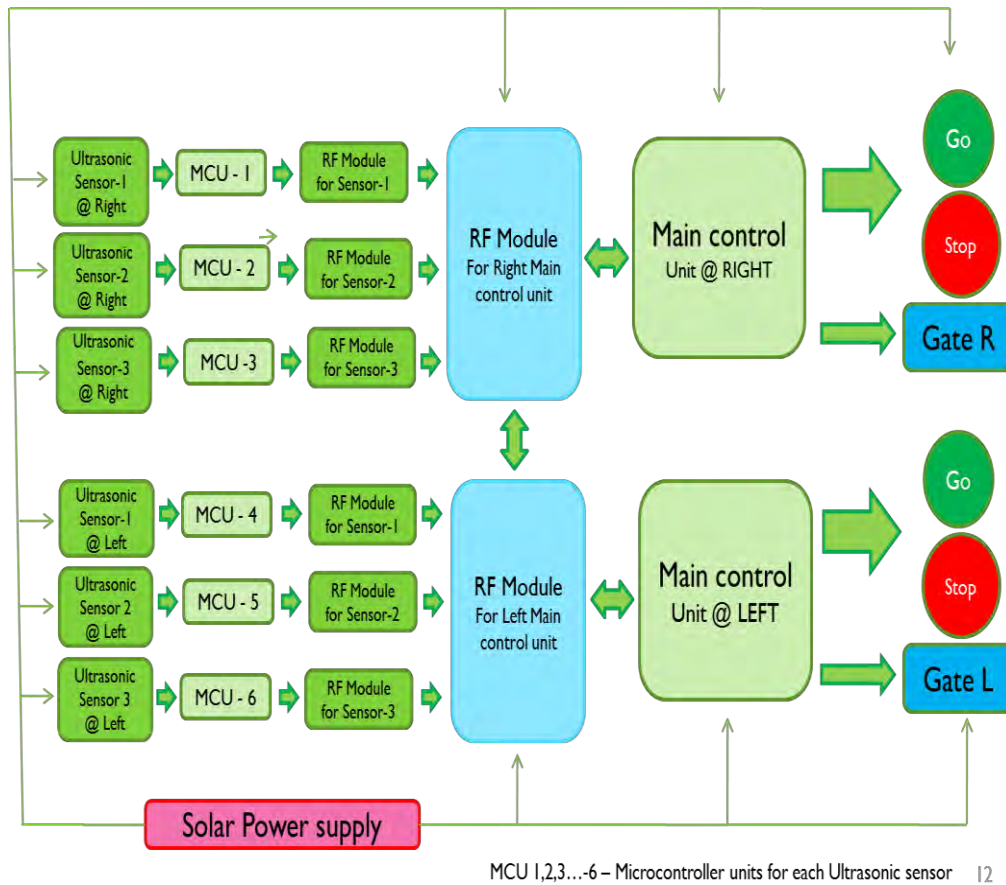
Figure 5: Design Architecture

3. RESULTS AND DISCUSSION

Determine the vehicle blocked side,

Let's say it is Side-A (Left Side)

Side-B (Right Side) is not blocked

Note: NO= Vehicle is Not Coming   YES= Vehicle is Coming

Table 2: Possible Results of both Sides at Two Lane

#	Side-A	Side-B	Action Taken as Result	Remarks as Analysis
1	NO	YES	Keep Side-B Open only	Side-A is Closed
2	YES	NO	Keep Side-A Open only	Side-B is Closed
3	YES	YES	Detect the Length of the vehicle on Side-A Close Side B and Open Side-A	Provide priority for Open the Gate
4	NO	NO	Both Gates are Closed	STOP light (RED) is kept ON
5	Emergency Situation		The automated function is Paused and operation by Manually	As per the requirements
6	System Fault		Gates are Half-Open and Lights are Blinking	No Automated Function is available till it is back to normal

3.1. MAIN COMPONENT ARRANGEMENT

The main component placement of our design is shown in Figure 6.

1. Programmable Microcontroller

2 Servo Motor

3 Communication Module used as Wireless Connection

4, 7, 10 Ultrasonic Sensor

5, 8, 11 Microcontroller

6, 9, 12 Communication Module used as Wireless Connection

13 Flag

14 LED-Green- "GO"

15 LED-Red- "STOP"

16 Solar Panel

17 Solar Panel Control Unit (Regulator, Battery & etc.)

18, 19, 20 Vehicles
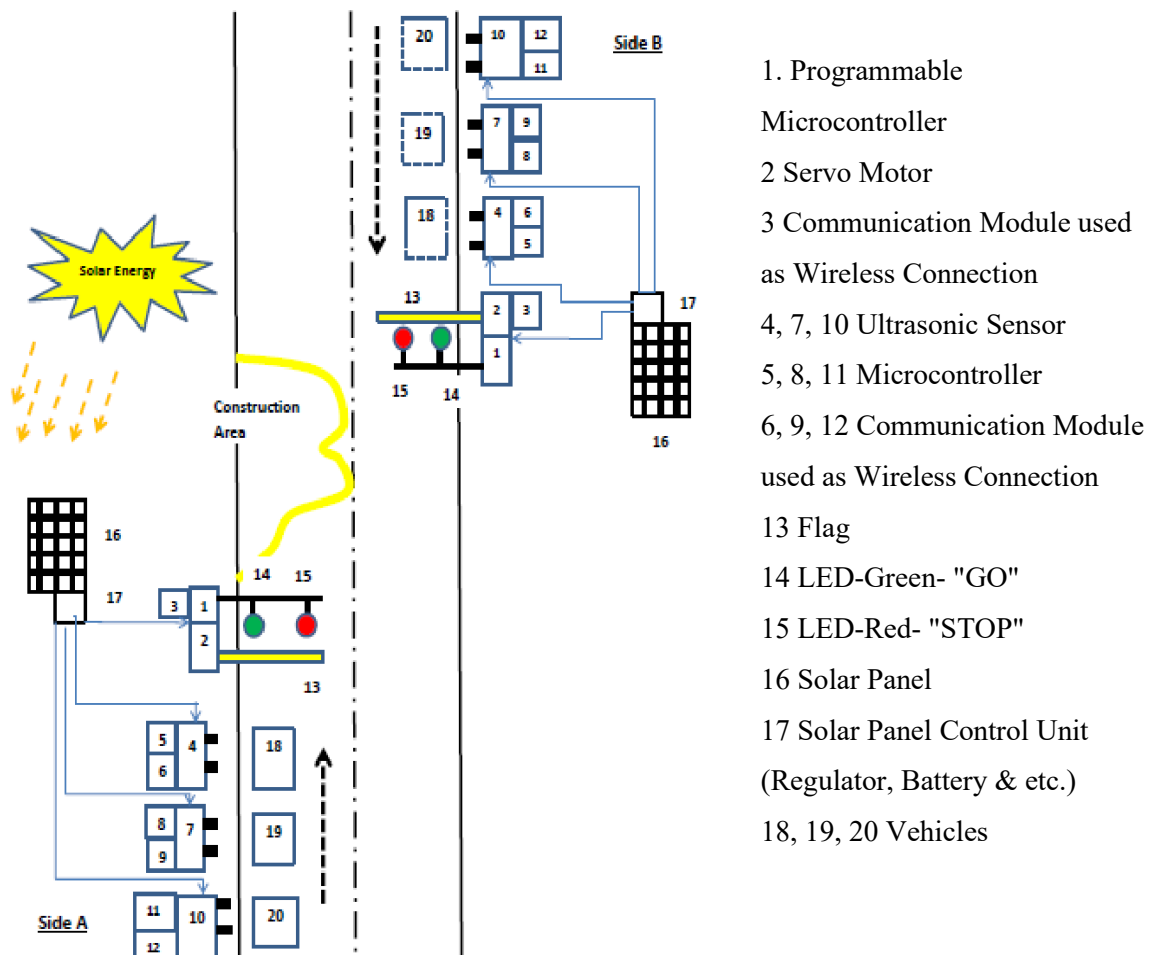
Figure 6: Component Arrangement

Initial Step

To determine the side with more traffic by comparing Count 1A and 1B -

Time interval for comparison can be given as an Input

When One Side is closed, the number of vehicles in the queue is to be determined,

For Side-A, Count 1A- Count 2A

Rate of accumulation = <u>Number of vehicles in queue</u>

Time elapsed

If, Rate of accumulation > Count 1B,

Then, it can be determined that More traffic is on Side-A.

4. CONCLUSION & RECOMMENDATIONS

The implementation of a new technology shall be a wise step in ensuring the safety of flagmen and road users on a construction site. Visualization of technology growth has shown mass changes to mankind in many ways in their daily lives.

The revolution of an Automated Traffic Control System for a construction zone attached to roads creates a compact solution for more hazardous situations as highlighted in this project. The implementation of such technology could result in saving a considerable amount of time and Rupees in damage, and the most important factor is to prevent life losses.

Such an approach has been taken in developing an Automated Traffic Control System for Construction Zones, which is believed to provide a better and safer indication to the Construction Companies, Contractors and the public.

In common practice, the human controller is always placed in a high-risk location in a construction site area. The awareness of safety signs and safety regulations should be complied with by both the contractors and the road users as the first avoiding to avoid unwanted accidents to happen. Appropriate measures should be taken by the responsible authorities in affording to minimize the risk involved to the flagman on a typical construction site.

Therefore, an Automated Traffic Control System emphasizes the elimination of a human controller from the conventional practice in many construction site areas.

REFERENCES

Construction Industry Development Authority in Sri Lanka. Available at:
https://www.cida.gov.lk/index_e.php (Accessed: 21st September 2021)

Google search. Available at: www.slideshare.net; www.scholar.google.com;
www.sciencedirect.com (Accessed: 24th September 2021, 10th October 2021)

National Building Research Organization. Available at:https://www.nbro.gov.lk/index.php?lang=en
(Accessed: 10th October 2021)

National Institute of Occupational Safety and Health in Sri Lanka. Available at
https://www.niosh.gov.lk/index.php?lang=en (Accessed: 21st September 2021)

Research Gate. Available at:www.researchgate.net (Accessed: 24th September 2021, 10th October 2021)

Road Development Authority in Sri Lanka. Available at: https://www.rda.gov.lk/ (Accessed: 16th September 2021)

Development And Characterization Of An Automated Coconut Husk Chips Drying Machine

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Abstract

Drying is used to attain the quality of coconut husk chips in most Asian countries. Fluidized bed drying (FBD) outperforms here as it prevents adverse impacts on product quality, such as cell rupturing and case hardening. To date, there has been no effort to apply FBD to manufacturing coconut husk chips. Thus, an automated fluidized bed dryer, which utilizes a Proportional-Integral-Derivative controller to keep the hot air temperature constant throughout the dryer is proposed. A published work was referred to obtain the optimum design ranges of machine components that were made from mild steel. The machine's performance was evaluated at two hot air temperatures (60 and 90℃) by using two moist chip sizes (0.5 and 0.9 cm³). Overall, the machine is capable of efficiently attaining and maintaining the desired drying temperature. It can fully dry 5 kg bed of moist materials in less than 20 min and is recommended for respective industries as a convenient way of assuring product quality.

Keywords: *Fluidized bed dryer; Coconut husk chips; PID temperature controller; Drying rate.*

1. Introduction

Coconut husk chips, which are consisted of coir pith and fibre, are ideal moisture retainers due to their considerably high water-holding capacity (up to 8-9 times their dry weight) (Paramanandham et al., 2014). They are also advantageous in terms of high availability, quality, consistency, and comparatively low production costs. Due to these reasons, coconut husk chips are used as an alternative to popular growing mediums (e.g., grow bags), animal residue absorbers, water purifiers, and organic fertilizers (Arancon, 2008, Ambagahakumbura, 2015). India and Sri Lanka are the primary producers of coir products (Arancon, 2008). In commercial manufacturing of coconut husk chips, drying is mainly used to meet the quality requirements (Adikari, 2016). Sun drying is a common practice for wet coconut husk chips to a safe moisture level before they are compressed (Fernando and Amarasinghe, 2016, Elmehri, 2020). However, sun drying has prominent drawbacks such as process slowness, weather uncertainties, long rainy seasons, high labor costs, and large area requirements. Flash drying, oven drying, and rotary drying are also practiced in Sri Lanka to dry coconut husk chips. However, due to non-uniform drying usually taking place in these techniques, cell rupturing and case hardening of coir pith may occur (Fernando and Amarasinghe, 2016).

Fluidized bed drying has been reported as an effective way of drying moist solids (Jangam et al., 2009). Some notable advantages of this technique include a high drying rate, relatively low capital

cost, ease of process control due to stable conditions, assurance of uniform temperature across the dryer, robustness to rapid temperature changes, and applicability for large- or small-scale operations (Varghese et al., 2014, Obregón et al., 2013). Nevertheless, there has been no research to process dried coconut husk chips by fluidized bed drying. This study aimed to build an automated fluidized bed dryer for drying coconut husk chips that can ensure even temperature distribution throughout the dryer to fill the research gap. This work is significant as it offers a convenient way to prepare quality dried coconut husk chips for the appropriate industries. The three research objectives include, (1) designing and fabrication of the machine, (2) setting up a suitable temperature control system (to achieve constant hot air temperature) and (3) characterization of drying kinetics performed by the machine. In this article, the design and fabrication strategy of the machine is discussed first, which is followed by the evaluation of the machine's performance. Here, the performance is discussed under temperature controller and drying kinetics, and a cost analysis of the machine is also provided to shed light on financial aspects. The conclusions of the study and recommendations for future work are detailed last.

2. METHODOLOGY

2.1 DESIGN AND FABRICATION OF THE MACHINE

A fluidized bed dryer is composed of a drying chamber (plenum), hot air pipe (nozzle), gas chamber, distribution plate, and blower (or heat pump), with facilities to measure the temperature and airflow rate (Senadeera et al., 2003). During the design, the sizing of each component is specified while ensuring that fluidization is taken place. As shown in Figure 1, there is a minimum velocity for air to initiate the fluidization (i.e., minimum fluidization velocity or U_{mf}).
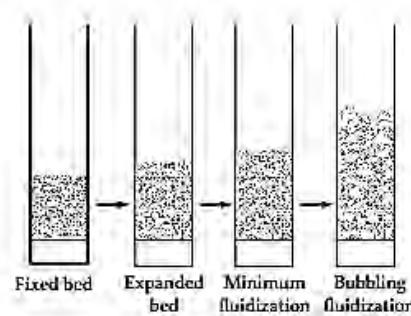
Figure 1: Fluidization patterns in a fixed bed of materials (Mujumdar, 2014)

U_{mf} is given by Eq. (1) (Mujumdar, 2014), where ρ_p, ρ_p and d_p denote for the density of moist materials, density of air and diameter of an equivalent spherical particle. For this dryer, two particle sizes were used, namely 0.5 cm³ and 0.9 cm³ (See "Analysis of drying kinetics" for more details). For those, U_{mf} values were computed as 0.74 m/s and 0.82 m/s, given $\rho_p = 0.15$ g/cm³ and $\rho_a = 0.001059$ g/cm³. Usually, the air velocity inside a fluidized bed dryer is maintained around 1 m/s in

most reported works and the hot air blower was selected for the dryer considering these facts while ensuring that velocity is more than U_{mf} .

$$U_{mf}^2 = \frac{d_p(\rho_p - \rho_a)g}{24.5\rho_a} \qquad (1)$$

The gas distributor has a significant impact on the performance of a fluid bed dryer. Some notable design parameters in this regard are: the ratio of orifice diameter (d_0) to the distribution plate thickness (t), percentage of the open area of the distribution plate, the aspect ratio of the drying chamber (or plenum chamber) (i.e., H/D, where H is the height and D is the diameter), and position of the gas inlet nozzle (Jangam et al., 2009). Jangam et al. (2009) determined the optimum value ranges for these parameters through computer simulation and experimental study. In this study, three experimental setups with a drying chamber diameter of 200 mm (note: chamber height differed), distribution plate diameter of 150 mm and nozzle diameter of 76.2 mm were developed and tested. Here, the decision parameter was the *maldistribution function* (M), which is the percentage deviation of air distribution in the dryer from the uniform distribution. Table 1 shows the optimum conditions for each parameter recommended by this work.

Table 1: Optimum values of parameters indicated in published work (Jangam et al., 2009)

Parameter	Optimum condition	Best value tested
Orifice diameter to plate thickness ratio (d_0/t)	Lower the better	1.413
Drying chamber height to diameter ratio (H/D)	Higher the better	2
Nozzle position	Side bottom	-
Orifice diameter (d_0)	Smaller the better	5 mm
Percentage open area of the distributor	Smaller the better	10%
Nozzle diameter	Larger the better	76.2 mm

The dryer was designed by considering the optimum ranges outlined above, and it was fabricated in the Engineering Workshop of Uva Wellassa University of Sri Lanka. The design was targeted to process approximately 5 kg of moist coconut husk chips (this occupies approximately 0.78 l in the drying chamber). During the fabrication, mild steel was used to make all components considering its low-cost, high availability, and the ability to withstand internal stresses. Mica sheets were also used as electrical insulation for the relevant areas. As described previously, it is vital to have a constant temperature during the operation of the dryer. For this purpose, a Proportional-Integral-Derivative (PID) temperature control system was employed to adjust the hot air temperature to the "set" value. The control and instrumentation unit consists of a temperature controller (Type: FT803-GQ2-B PID),

a hotplate heating element (1000 W), a SS Relay (XSSR-DA4840W1240A), a thermocouple (4mm PRO J TYPE 2M), plug with 13A fuse, and 15A switch.

2.2 PERFORMANCE ANALYSIS OF THE PID TEMPERATURE CONTROL SYSTEM

Coconut husk chips (dimensions: 0.5×1×1cm) collected from a factory in Palai, Sri Lanka were used for this task. After soaking the chips in clean water for about 2 min, they were loaded into the drying chamber to a 10 cm bed height (0.78 l of volume). The PID controller was initially set to a temperature of 60°C before trials. In a PID controller, the proportional (K_P), integral (K_I) and derivative (K_D) controller parameters should be adjusted when setting the temperature. Following a series of trial experiments, the stable values of these parameters were obtained as $K_P = 42$, $K_I = 20$ and $K_D = 5$. After this step, the hot air temperature was recorded in 1 s time intervals and the whole performance analysis experiment was repeated four more times to have five experimental trials altogether.

2.3 ANALYSIS OF DRYING KINETICS

Drying kinetics are used to determine how the moisture content of the material changes with time and these are vital to characterize a particular drying process along with the materials and machine. Drying experiments were conducted to obtain the drying kinetics, which describes how a moisture content (X) of a moist material varies with drying time t. To further elaborate on drying kinetics, two particle size ranges (0.5×1×1 cm and 0.6×1×1.5 cm and respective volumes were 0.5 cm^3 and 0.9 cm^3), and two hot air temperatures (60°C and 90°C) were used. The experiments were conducted for each particle size-temperature combination and the mass of a particle chosen from the bed (m) was weighed in 1 min time intervals. The weighing procedure was conducted until a constant particle mass (m_c) was obtained, which implies that the particle has been fully dried.

By assuming the equilibrium moisture content is zero, the dry particle mass (m_d) was obtained by this constant particle mass (i.e., $m_d = m_c$). Given that dry particle mass (m_d) was known, the moisture mass (m_W) at each t value was computed (i.e., $m_W = m - m_d$). The moisture content was expressed as the wet basis moisture content X_{wb} (defined as $X_{wb} = \frac{m_W}{m_W + m_d}$). To this end, normalized moisture content (moisture content at time t / initial moisture content) is usually used as a key parameter in literature to compare different drying experiments (Senadeera et al., 2003). Thus, four normalized moisture content–drying time curves were plotted and used to analyze drying kinetics.

3. RESULTS AND DISCUSSION

3.1 DRYER SPECIFICATIONS

Figure 2 shows the 3-D wire drawing of the fluidized bed dryer. This fluidized bed dryer comprises an inlet pipe, gas distributor, drying chamber, removable lid, distribution plate, a heating element

with PID controller (not shown), wire mesh filter (not shown), and handle. The materials are fed into the drying chamber by removing the removable lid. A handle is attached to the top of the removable lid to lift it conveniently. The air is supplied via a blower of 650W (not shown), which is connected to the inlet pipe (nozzle). The air is heated using a hot plate element which is fixed in the gas distributor section of the dryer. The heated air is distributed via the distribution plate of 2 mm thickness. As mentioned in Section 2.1, to meet the air velocity of around 1 m/s and more than U_{mf}, the blower flow rate is chosen as 0.14 m³/min. In addition, a wire mesh filter (not shown) is placed slightly above the distribution plate to avoid the falling of moist particles.
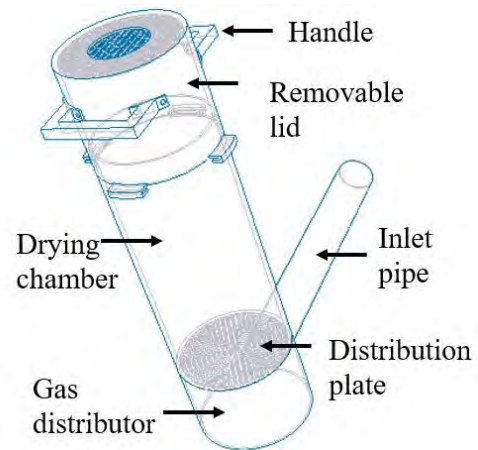
Figure 2: 3-D wire drawing of the dryer

Table 2 provides the dimensions of each component used in the dryer, where the dimensions of the drying chamber and gas distribution area agree with recommended values outlined in Table 1. However, the dimensions of the removable lid and the thickness of the drying chamber were designed by considering the convenience in use. Based on the dimensions, the dryer can handle a 1.96 l volume of moist materials (approximately 12.6 kg). Based on the results discussed so far, the design and fabrication stage of the dryer is now complete, which directs to the achievement of research objective 1.

Table 2: Selected dimensions of the fluidized bed dryer

Component	Dimension name	Value
Removable lid	Height	102 mm
	Thickness	4 mm
Drying chamber	Internal diameter	100 mm
	Thickness	4 mm
	Height	250 mm
Inlet pipe (Nozzle)	Internal diameter	76.2 mm
	Thickness	4 mm
	Length	300 mm
Gas distribution chamber	Height	75 mm
	Internal diameter	102 mm
	Thickness	2 mm
Distribution plate	Thickness (t)	2 mm
	Orifice diameter (d_0)	3 mm
	Number of holes	250

3.2 VARIATION OF DRYER TEMPERATURE WITH TIME

Figure 3 shows how the PID controller described in Section 2.2 performs. During the trials, the initial temperature inside the dryer was 34°C and it was expected to reach 60°C (i.e., drying temperature). According to the trials, the response is underdamped and the PID controller can adjust the temperature to the set value within 60 s of operation and maintain the same value afterward. In drying, quick adjustment of the dryer temperature to a constant value is highly desirable in terms of achieving quality dried products. During this process, an overshoot can be observed in all trials at about 17s of operation.
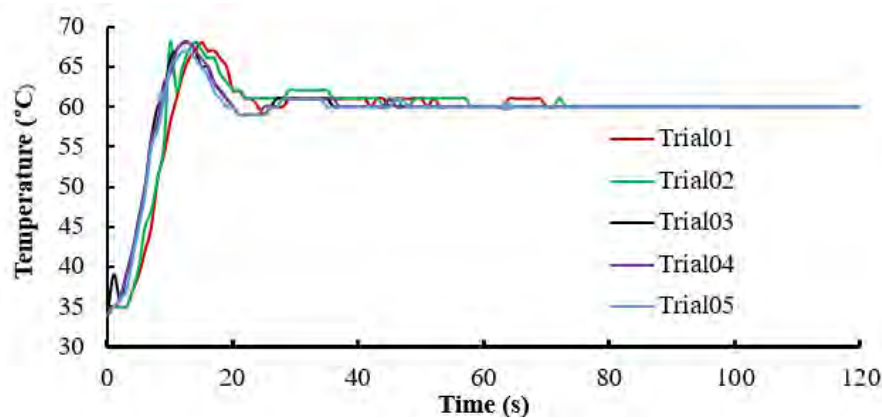
Figure 3: Performance curve of the PID temperature controller

To analyze the control characteristics further, an additional set of parameters were derived, as shown in Table 3. Key parameters in this regard are overshoot, settling time (T_s), rise time (T_r) and peak time (T_p). T_s refers to the time required to reach the output and remain within a given error band, where T_p refers to the time required to reach the first peak of the curve. T_r can be defined as the time required to reach the temperature from a lower specified value (usually the initial value) to a specified high value (usually 90% of the set value). Overshoot refers to the maximum deviation of the temperature from its set value.

Table 3: Parameters extracted from the PID temperature controller curve

Parameter	Value
Maximum (°C)	67.8 ± 0.4
Overshoot (°C)	7.8 ± 0.4
%Overshoot	13.0 ± 0.6
Settling time (T_s) (s)	23.6 ± 6.3
Rise time (T_r) (s)	7.8 ± 1.0
Peak time (T_p) (s)	12.2 ± 1.6

Accordingly, the average percentage of overshoot is 13%, which shows a low deviation of the dryer temperature from the set value. By referring to values T_s and T_r, it is evident that the PID controller efficiently increases the temperature to the set value. However, some PID controllers reported a 0% percentage overshoot with less than 1s of T_s and T_r (Madhankumar et al., 2021). Some studies also

achieved comparatively low overshoots by combining the PID controller with an actor-critic-based intelligent system (Bi et al., 2020). Thus, further tuning of the PID controller in a future study is expected to achieve lesser overshoot, T_s and T_r. As per research objective 2, it was required to maintain a uniform temperature throughout the drying time, which has now been achieved.

3.3 DRYING KINETICS

As shown in Figure 4, the variation of the normalized moisture content ($\frac{X}{X_0}$) with drying time was used in this analysis where X represents the moisture content at any time t, and X_0 corresponds to X value at $t = 0$.
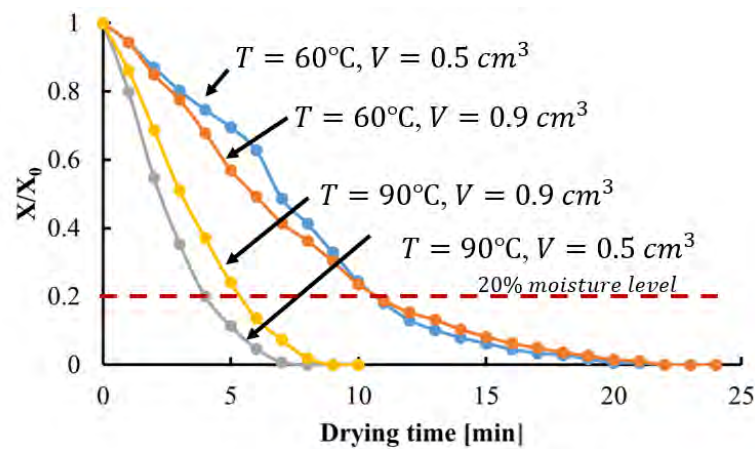
Figure 4: Variation of moisture content with the drying time of different samples

Accordingly, the drying of coconut husk chips at the examined sizes and hot air temperatures follows a falling rate period of drying, where the moisture content drastically drops with time. The behaviour is commonly observed for drying most plant materials (Senadeera et al., 2003). Furthermore, a chip of examined sizes requires around 8 min to completely dry at 90°C, while it requires about 20 min at 60°C. Therefore, the initial drying rate for a chip at 90°C is around 0.07 kg/min, which is about seven times higher than that at 60°C. However, to ensure product quality, the dried products do not always have to be fully dried. Considering coconut husk chips, it is recommended to have a final moisture content of around 20% [6]. Therefore, the developed dryer could be operated for about 10 min at 60°C and about 5 min at 90°C to achieve the above moisture level. Furthermore, with a satisfactory analysis of the drying kinetics, it is evident that research objective 3 has been achieved. Apart from the research objectives, a cost analysis is presented next to obtain insights into the financial aspects of the dryer.

3.4 COST ANALYSIS

Table 2 presents the cost breakdown for each item used in the dryer. Accordingly, around 23,000 LKR budget can be anticipated for fabricating the fluidized bed dryer to dry coconut husk chips.

Table 4: Cost breakdown for the fabrication of the dryer

Component	Total cost [LKR]
Mild steel pipes	2,000
Temperature controller	4,850
SS relay	1,750
Thermocouple	825
Mica sheets	1,400
Hot plate heater (1000W)	150
Heating sleeves	125
Plugs and switches	340
Blower (650 W)	5,800
Labour cost	5,000
Total cost	22,240

4. CONCLUSIONS

In this study, a fluidized bed dryer was designed and fabricated to dry coconut husk chips, and a performance analysis of the machine was performed. The following can be concluded.

- About 5 kg of coconut husk chips (approximately 0.78 l volume) with maximum particle volume of 0.9 cm^3 can be completely dried within 20 min at 60°C, and within 10 min at 90°C.

- The PID controller of the dryer only requires 60 s to reach the set temperature and it corresponds to 13% of average overshoot, 23.6 s of average settling time, 7.8 s average rise time, and 12.2 s average peak time.

- The fabrication cost of the machine is approximately 23,000 LKR to cater 12.6 kg (approximately 1.96 l volume) of coconut husk chips.

Further research may lie in finetuning the PID controller to minimize the overshoot etc., to achieve the desired "set" values quickly. Furthermore, as humidity is also essential for the quality of a dried product, the PID controller can be improved to control the humidity.

REFERENCES

Adikari, A. (2016). Devolopment of a mechanical dryer for drying coco peat to use growing media.

Ambagahakumbura, W. 2015. Reduction of Tannin Level in Coconut Husk Chips. Uva Wellassa University of Sri Lanka.

Arancon, R. Coir fibre in Asia. Proceedings of Symposium on Natural Fibres, 2008. 63-70.

Bi, S., Zhang, B., Mu, L., Ding, X. & Wang, J. (2020). Optimization of tobacco drying process control based on reinforcement learning. Drying Technology, 38, 1291-1299.

Elmehri, M. A. (2020). Design of a control system for an indirect solar dryer.

Fernando, J. & Amarasinghe, A. (2016). Drying kinetics and mathematical modeling of hot air drying of coconut coir pith. SpringerPlus, 5, 1-12.

Jangam, S. V., Mujumdar, A. S. & Throat, B. N. (2009). Design of an efficient gas distribution system for a fluidized bed dryer. Drying Technology, 27, 1217-1228.

Madhakumar, S., Harish, V., Jayanth, C., Manikandan, R. & Aswin, N. Automated Moisture Remover for Drying Agricultural Products. (2021), 7th International Conference on Advanced Computing and Communication Systems (ICACCS), 2021. IEEE, 1096-1100.

Mujumdar, A. S. (2014). Handbook of industrial drying, CRC press.

Obregon L., Quinones, L. & Velazquez, C. (2013). Model predictive control of a fluidized bed dryer with an inline NIR as moisture sensor. Control Engineering Practice, 21, 509-517.

Paramanandam, J., Ross, P. R., Abbiramy, K. & Muthulingam, M. (2014). Studies on the moisture retention capacity of coir pith, as a function of time. International Journal of ChemTech Research, 6, 5049-5052.

Senadeera, W., Bhandari, B. R., Young, G. & Wijesinghe, B. (2003). Influence of shapes of selected vegetable materials on drying kinetics during fluidized bed drying. Journal of Food Engineering, 58, 277-283.

Varghese, H. G., Ahamed, M. S. & Sreekanth, M. (2014). Design and Development of Fluidized Bed Dryer for Domestic Purposes. International Journal of Innovation and Scientific Research, 2351-8014.

INNOVATIVE APPROACHES IN BUILT ENVIRONMENT

A Study On The Management Of Critical Risk Factors For Public-Private Partnership Construction Projects In Sri Lanka

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ABSTRACT

The success of Public-Private Partnership (PPP) construction projects in developing nations is lower than in developed countries owing to a lack of financial capacity, knowledge, and exposure to managing the hazards of big complex building projects over a long period of time. Without an effective risk management approach, the majority of the risks associated with PPP projects are challenging to evaluate, regulate, and meet the goals and receive value for money for both sides. This research aimed to determine which party should carry the most important risk elements while implementing PPP projects in Sri Lanka. A questionnaire survey was conducted as part of a quantitative research strategy. Quantitative analysis was used to rank and evaluate the 62 responses through a simple random sampling method. The findings of this study revealed six (6) categories of risk factors and thirty-six (36) risk factors. Despite that, Operational Risks factors were able to rank as the most crucial among the identified risk factors. There are 14 Most critical out all & 11 factors must be managed by the public & 9 must be managed by the private & the rest factors risk management depends on the project.

Keywords: *Public-Private Partnership (PPP); Risk Management; Risk Factors; Sri Lanka.*

1. INTRODUCTION

Since the turn of the century, Public-Private Partnerships (PPP) have grown in popularity in developing countries as a means of engaging the private sector in the building of public infrastructure (Javed et al. 2013). The success of the PPP construction projects is less in developing countries compared to other developed countries due to several aspects (Loosemore and Cheung 2015). Hwang, et.al, (2013) has stated that the majority of the risks involved with PPP projects are difficult to control & analyze; therefore, proper risk management is critical to achieve its ultimate objective & to obtain value for money spent for both parties. Moreover, in the government context, it is critical to identify who's responsible to the handle different kinds of risks. This is owing to the fact that shifting risks to the private sector comes at a cost, and inappropriate risk allocation among private and public parties may have an impact on the project's success level (Hayford, 2006). Consequently, the government must strike a balance by distributing the best possible amount of risk to each participant in order to reduce the project's hazards (Hayford, 2006). Further, the past researchers depict that every country must have a proper objective, reliable, practical & fair risk allocation & management method for PPP construction projects among different parties for the success of the projects (Jin and Doloi 2008). Hence, there should be a carefully designed contractual partnership in which every party must have an in-depth understanding of the roles & responsibilities of them & their counterparts regarding the risk management process, especially in most developing countries, where PPPs are still at an early stage (Babatunde, Perera, Adeniyi, 2018). Thus, the purpose of this study was to determine which party should carry the most important risk elements while implementing Public-Private Partnership (PPP) construction projects in Sri Lanka. Accordingly, a set of objectives were established in order to achieve the

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study's purpose: (1) Identify all the risk factors for PPP construction projects in Sri Lanka; and (2) Assess the most significant risk categories for PPP construction projects in Sri Lanka. (3) Determine which principal party in PPP construction projects in Sri Lanka should bear each risk factor.

1.1 BACKGROUND STUDY/ REVIEW OF LITERATURE

1.1.1 PUBLIC- PRIVATE PARTNERSHIPS (PPP) AS A PROCUREMENT STRATEGY

PPP is a framework between a public (government) agency and a private corporation in which the private party delivers assets and services formerly done by government agencies (Chan, et.al, 2011). PPP covers all the contractual relationships between the public and the private sectors to deliver projects efficiently by providing financial assistance to the private sector & reducing the financial burden of the government institute. (Sarvari et.al,2014). Furthermore, public and private parties contribute their complementing abilities to a project and manage the tasks at various degrees and capacities, which will help them to reach a greater achievement that cannot be attained separately (Efficiency Unit, 2008).

1.1.2 RISK MANAGEMENT PROCESS

According to PMI (2017), there are 7 iterative process groups in the risk management process. Namely: Plan Risk Management, Identify Risks, Perform Qualitative Risk Analysis, Perform Quantitative Risk Analysis. Plan Risk Responses, Implement Risk Responses, Monitor Risks. The identified risk should be prioritized by the construction stakeholders by utilizing the following tools & techniques during the risk analysis stage such as sensitivity analysis, probabilistic analysis, influence diagrams. Then in the next stage, the stakeholders must develop options, select the most suitable strategies to manage the risks and agree on how to handle the risk & assign the most suitable party to handle the risks. According to Jin (2010), the risk must be distributed while taking into account a number of factors, including: the most suitable agent, who can ably bear the risk and is able to influence and control the risky outcome, should be borne by the agent, who can bear the risk at the lowest cost and who exhibits willingness or commitment to bear the risk.

1.1.3 CATEGORIES OF RISKS IN PUBLIC-PRIVATE PARTNERSHIPS (PPP) CONSTRUCTION PROJECTS

Risks were categorized into general risks and project-specific risks in the form of a checklist. Construction risks and operational risks were grouped under project-specific risks, whereas political risks, commercial risks, and legal concerns were under the general risk category. Additionally, Xu et al. (2010) identified 37 risk variables connected to Chinese PPP projects. However, Li et al. (2005) found that primary project patricians can manage risk distribution in PPP projects with ease, either individually or collectively. Specifically, risks in the public, private, and joint sectors. Moreover, Ibrahim et al., (2006) has grouped five main categories: Solely bear by the private sector, solely bear by the public sector, mainly bear by the private sector, mainly bear by the public sector, shared by both parties. The allocation of risks as above mentioned must be done before finalizing of project procurement method and contract negotiation to recognize the value engineering process & cash flow for both private & public sector parties (Roumboutsos and Anagnostopoulos, 2008). Chen et al. (2017) has identified six financing risk categories in Chinese PPP projects as follows: political risks, social risks, financial risks, construction risks and operational risks. Political risks are risen because of the alterations in the legal framework, the poor decision-making process

of the government & unfavorable macro policies & regulations implemented by the government for the PPPs. The government policies are changing due to the unreliable application of new rules and regulations, which are more common & frequent in developing countries than in others. According to Sarvari et.al, (2014), market risks are generated when there is a deviation of the demand & price of a commodity from the expected level which gains lower revenue & lower profit than the stakeholder expectation. Delayed payments & non-payments are the most critical risks in revenue risks which occur due to poor customer economic status, high taxes implemented by most of the governments in developing countries, poor payment attitudes of public institutions (Ameyaw & Chan,2013). Financial risks such as fluctuating exchange rates, interest rates & inflation risk immensely influence PPP construction projects in Asian countries. Due to unexpected changes in the exchange rate during the project life cycle, there is a high risk of income reduction from foreign currency. Further, unexpected market interest rate changes inflation, the devaluation of the currency and the value of the assets of the developing countries are reducing their net income & return on investment. Jingning and Li Wenkang, (2015) has mentioned that design change risks & design unreasonable risks are done mainly by the designing team after finalizing the approved designs before or after the construction work is undertaken by the contractor party. Sarvari et.al, (2014) has identified that operational cost & maintenance cost overrun than plan cost is the main operational risks that should be mainly considered by the public & private parties. Stakeholder Risks are generated due to different views, objectives, ethics, practices & strategies that implement to resolve the private and public sectors' PPP projects (Ibrahimet al., 2006).

2. METHODOLOGY

The questionnaire surveys are commonly applied in explorative research which seeks the general views of a sample population (Berg, 2009). Hence, this study has adopted a questionnaire survey which is one of the quantitative research approach methods that is an easy & most convenient way of collecting mass data sources from a social experiment. The questionnaire survey was circulated among well-experienced construction stakeholders who have first-hand exposure to PPP projects in Sri Lanka. The questionnaire survey was based on the data collected through an in-depth analysis of past researchers' publications. 18 study papers from each literature were first marked down by reference, and 36 identical risks were then found and assessed under the six major risk categories (Refer Table 2). The questionnaire survey was prepared by using google forms & distributed google form links among the sample population by using social media such as WhatsApp, Messenger, Email as they are the most convenient & one of the quickest approaches to collecting data from respondents. The five-point scale (4- Critical Impact or Probability to 0- Negligible Impact or Probability) was adopted to retrieve the views of the respondents of the questionnaire survey regarding the probability of occurrence and impact on the public & private sector partners separately in a PPP project. Due to the lack of accessibility for all the stakeholders, the study was conducted among 100 different types of stakeholders who have been involved in the Sri Lankan PPP construction projects by using the simple random sampling method. The simple random sampling method provides an equal probability of being chosen from each sample that has a known non-zero probability of selection. (Showkat

2017). The response rate is 62% from professionals who are having diversified views regarding the management of critical risk factors for PPP construction projects in Sri Lanka. Additionally, Millward (2001) has stated that the medium effect size of the sample is around 14 to 50 participants & large effective rate is between 35 to 133 participants. Hence the response sample for this study falls at a large effective rate. Besides, Easterby-Smith et al. (2002), presented a rough formula for calculating sample size (n) in terms of (E) the maximum error required, as shown in Equation 1.

$$n= 2500/E^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{Equation 1}$$

the accepted error level is less than 10% & which means for a questionnaire survey study the response rate is at least 25. According to the responses considered for this study, the error of the sample is 6.35%. The profiles of the respondents are depicted in table 1. The sample covers almost all the experienced levels of professionals, but there are considerably fewer responses from the architectural profession compared to their counterparts.

Table 1: Profiles of the Questionnaire Survey Respondents

Respondents		Total Experience in Construction Industry					
		1-5	5-10	10-15	15-20	20-25	**Total**
Professionals	Project Manager		2	5	7	4	18
	Architect	1		3	4		8
	Engineer	3	4	2	5	2	16
	Quantity Surveyor	8	3	2	4	3	20
Total		12	9	12	20	9	62

Collected data through the questionnaire survey was analyzed by using Mean Probability of Occurrence (MPO) & Mean Impact of Severity (MIS). MPO & MIS were adopted to identify the behavior of each and every risk factor compared to the rest of the factors to determine the most critical risk according to criticality for the public sector & private sector. For both, the following equation is adopted in this study for the average mean (See Table 2 Columns B & C).

$$AM = \frac{1}{n}\sum_{i=1}^{n} a_i = \frac{a_1 + a_2 + \cdots + a_n}{n} \ldots\ldots\ldots\ldots\text{Equation 2}$$

In Equation 2, AM - Arithmetical Mean (Range from 0-4), a_i – Frequency of responses (Range from 0-4), n – Total number of respondents. Further, calculated the average mean of the data set for probability & for the impact according to the two stakeholder parties. Additionally, probability & impact are clustered into high & low based on the average mean of probability & impact (See Table 2 Columns E & F). This method was adopted due to all the factors the individual probabilities & impacts were more than 2 (i.e. high probability & impact cluster) & the study needs to identify the most critical factors. According to Saravi,(2014) the risk score was determined based on the following equations: (See Table 2 Column D)

Risk Score = Probability of Risk x Impact of Risk ………………Equation 3

Then based on the risk score all the risks are ranked within the risk category & they are considered risks for both private & public parties separately. (See Table 2 Column I)

Table 2: Most critical risk factors depending upon the severity, probability, criticality, type & rank for PPP projects in Sri Lanka

Risk factors	Risk Code (A)	MIS(B)		MPO (C)	Risk Score (D)		MIS (E)		MPO (F)	Risk Criticality (G)				Risk Mgt. Type (H)	Rank (I)			
										PUB		PRI			Category		Overall	
		PUB	PRI		PUB	PRI	PUB	PRI							PUB	PRI	PUB	PRI
Lack/ inconsistency of legal & regulatory framework	PR1	2.64	2.74	2.58	6.81	7.07	L	L	L	LESS	4	LESS	4	P1	5	5	16	17
Delay in project approvals & decision-making process	PR2	2.57	2.89	2.85	6.63	7.46	L	H	H	MODE	3	MOST	1	P4	6	2	30	3
Strong political interference & corruption	PR3	2.87	2.83	3.04	7.40	7.30	H	H	H	MOST	1	MOST	1	P3	1	3	2	5
Inconsistence government policies	PR4	2.83	2.83	2.85	7.30	7.30	H	H	H	MOST	1	MOST	1	P3	4	5	3	3
Lack of government support/ grantee	PR5	2.85	2.96	2.75	7.35	7.64	H	H	H	MOST	1	MOST	1	P4	3	1	2	1
Unstable government/ strong political opposition	PR6	2.77	2.74	2.62	7.15	7.07	H	H	L	MODE	2	MODE	2	P1	4	5	7	17
Market demand	MR1	2.45	2.81	2.6	6.32	7.25	L	-H	L	LESS	4	MODE	2	P4	5	1	33	9
Change in Tax/ Tariff	MR2	2.55	2.74	2.7	6.58	7.07	L	H	L	LESS	4	MODE	2	P4	3	3	31	17
Inadequate competition in tender	MR3	2.34	2.64	2.58	6.04	6.81	L	L	L	LESS	4	LESS	4	P2	6	5	34	29
Rate of return restriction	MR4	2.51	2.64	2.81	6.48	6.81	L	L	H	MODE	3	MODE	3	P4	4	5	32	29
Poor financial market	MR5	2.62	2.74	2.96	6.76	7.07	L	H	H	MODE	3	MOST	1	P1	2	3	23	17
Import/ export restriction	MR6	2.77	2.81	2.85	7.15	7.25	H	H	H	MOST	1	MOST	1	P4	1	1	7	9
Interest rate & inflation volatility	FR1	2.74	2.77	2.72	7.07	7.15	H	H	H	MOST	1	MOST	1	P1	4	3	11	14
Foreign exchange fluctuation	FR2	2.83	2.83	2.79	7.30	7.30	H	H	H	MOST	1	MOST	1	P3	1	1	4	5
Less attraction for investors	FR3	2.75	2.68	2.7	7.10	6.91	H	L	L	MODE	2	LESS	4	P1	2	5	9	25
High initial cost	FR4	2.75	2.83	2.87	7.10	7.30	H	H	H	MOST	1	MOST	1	P4	2	1	9	5
Long payback period	FR5	2.64	2.68	2.91	6.81	6.91	L	L	H	MODE	3	MODE	3	P1	6	5	16	25
High residual risk	FR6	2.66	2.74	2.77	6.86	7.07	H	H	H	MOST	1	MOST	1	P1	5	4	15	17

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Risk	Code																	
Contractual Variation & Contractual risk	DR1	2.62	2.62	2.85	6.76	6.76	L	L	H	MODE	3	MODE	3	P1	4	4	23	31
Variation in time, cost, quality & scope	DR2	2.64	2.74	2.66	6.81	7.07	L	H	L	LESS	4	MODE	2	P1	3	3	16	17
Late design changes/ design deficiency	DR3	2.58	2.57	2.51	6.66	6.63	L	L	L	LESS	4	LESS	4	P1	6	6	28	35
Failures of contractors, sub-contractors, suppliers	DR4	2.72	2.75	2.7	7.02	7.10	H	H	L	MODE	2	MODE	2	P1	1	2	12	16
Availability of material & labor	DR5	2.7	2.81	2.77	6.97	7.25	H	H	H	MOST	1	MOST	1	P4	2	1	13	9
Unproven engineering techniques	DR6	2.62	2.58	2.45	6.76	6.66	L	L	L	LESS	4	LESS	4	P1	4	5	23	33
Operation cost overrun	OR1	2.62	2.98	2.83	6.76	7.69	L	H	H	MODE	3	MOST	1	P2	5	1	23	1
Higher maintenance cost	OR2	2.64	2.62	2.74	6.81	6.76	L	L	H	MODE	3	MODE	3	P1	3	5	16	31
Low operating productivity	OR3	2.64	2.77	2.83	6.81	7.15	L	H	H	MODE	3	MOST	1	P1	3	2	16	14
High frequency of maintenance work	OR4	2.58	2.68	2.7	6.66	6.91	L	L	L	LESS	4	LESS	4	P1	6	4	28	25
Low operational revenue	OR5	2.92	2.58	2.68	7.53	6.66	H	L	L	MODE	2	LESS	4	P3	1	6	1	33
Delays/ interruptions in operation & maintenance	OR6	2.7	2.72	2.62	6.97	7.02	H	L	L	MODE	2	LESS	4	P1	2	3	13	23
Inadequate distribution of authority, responsibility and risk	SR1	2.6	2.81	2.66	6.71	7.25	L	H	L	LESS	4	MODE	2	P4	4	2	27	9
Lack of commitment from public/private partner	SR2	2.64	2.85	2.49	6.81	7.35	L	H	L	LESS	4	MODE	2	P4	2	1	16	4
Third party liability	SR3	2.28	2.66	2.53	5.88	6.86	L	L	L	LESS	4	LESS	4	P2	6	5	36	28
Inadequate experience in PPP	SR4	2.83	2.72	2.7	7.30	7.02	H	L	L	MODE	2	LESS	4	P3	1	4	4	23
Organization and coordination risk	SR5	2.64	2.81	2.72	6.81	7.25	L	H	H	MODE	3	MOST	1	P4	2	2	16	9
Different working methods	SR6	2.3	2.49	2.47	5.93	6.42	L	L	L	LESS	4	LESS	4	P2	5	6	35	36

Risk Code: PR- Political & Regulatory Risks, MR- Market & Revenue Risks, FR - Financial & Economical Risks, DR- Design & Construction Risks, OR- Operational Risks, SR- Stakeholder Risks

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Criticality& Impact: High: H, Low: L, Criticality: Less: Less Critical, Mode: Moderately Critical, Most: Most Critical
Stakeholders: PUB - Public Sector   PRI. – Private Sector
Risk Mgt. Type: Depend On The Project: P1, Solely Bear By PUB: P2, Primarily Be Bear By PUB: P3, Primarily Be Bear By PRI:P4

3. RESULTS AND DISCUSSION

3.1 RISK FACTORS FOR PPP CONSTRUCTION PROJECTS IN SRI LANKA

Thirty-six (36) risk factors were identified by referring to eighteen (18) journal articles that were published from year 2005 to 2014 under six (6) main categories which consist of Political & Regulatory Risks, Market & Revenue Risks, Financial & Economical Risks, Design & Construction Risks, Operational Risks and Stakeholder Risks. Each category has consisted of six (6) risk factors as demonstrated in Table 2.

3.2 MOST CRITICAL RISK FACTORS FOR PPP CONSTRUCTION PROJECTS IN SRI LANKA

Table 2 provides the results of MIS & MPO for each factor according to the main two stakeholders. Furthermore, the criticality of the risk factors was categorized into three categories: most critical, moderately critical and less critical (See Table 2 Column E, F, G). For the public sector, 9,15 & 12 risk factors were respectively considered as Most Critical, Moderately Critical & Less critical. Respectively, 14, 11 & 11 risk factors were considered for the private sector. OR5 has ranked first in the overall context categorization of the public sector and respectively, PR5 & PR3 ranked second in the overall category. Then, PR4, FR2 & SR4, PR6 & MR6 have ranked third, fourth and fifth in the overall categorization. Besides, OR1, PR5 and SR2 have ranked first, second & third in the private sector overall categorization. FR2 & F4R4 and PR3 have ranked fourth and fifth. Despite that, under the Political & Regulatory Risks, PR3 and PR5 have ranked first in the public & private sectors, respectively. Under the Market & Revenue Risks, MR6 and MR1 & MR6 have ranked first in the public & private sectors. FR2 and FR2 & FR4 have ranked first in the public & private sectors from a Financial & Economical Risks perspective. Moreover, DR4 and DR5 have ranked first in the Design & Construction Risks category. For Operational Risks, OR5 and OR1 have ranked first in the public & private sectors. SR4 and SR2 have ranked first in the Stakeholder Risks category.

3.3 RESPONSIBLE PARTIES FOR BEARING EACH RISK FACTOR IN PPP CONSTRUCTION PROJECTS IN SRI LANKA.

According to Ibrahim et al., (2006), the percentage score has been interpreted as follows. If the score is more than 75% that risk should solely bore by the Private/ Public party, If the score is within 74%-70% the risk should primarily be bored by the relevant party if 69%-65% that risk factor was projected as dependent, if 64%-60% that risk factor should bear primarily by other party, if 59%- 50% risk should solely bear by other party and less than 40% that risk should be shared by both parties (See Table 2 Column H). All 36 factors can be managed by each party as per Table 2. Depending on the project, 3 Nos. CRFs were Most critical to one party & moderately critical to the other party; hence, it has been considered as one of the most critical factors. Further, 2 Nos. CRFs were moderately critical to one party & less critical to the other party. Hence, those were considered moderately critical risk factors. There were 16 risk factors that should

be managed by either public or private sector depending upon the situation, 4 risk factors must be solely born by the public sector and 5 risk factors should be primarily borne by the public party. Finally, there were 11 risk factors that should be primarily borne by the private party.

4. CONCLUSIONS/ IMPLICATIONS/ RECOMMENDATIONS & LIMITATIONS

This study has revealed thirty- six (36) risk factors under six (6) main categories and among all the risk factors low operational revenue has ranked first most critical risk factor in the public sector and operation cost overrun has ranked first in the private sector. Moreover, this study has been able to identify which party has to bear the responsibility for all identified 36 risk factors from the literature review. This study assists as a baseline for any future studies carried out in other developing nations to investigate CRF in executing PPP projects. Moreover, the study can be used to justify changes in public policy aimed at improving the value for money in PPP construction projects in Sri Lankan context. Due to COVID- 19 constraints, the sample size for the questionnaire survey was only sixty - two (62) respondents, which is a significant study limitation. The study has identified 14, 15 & 7 factors which can be categorized as Most critical, Moderately critical and Less critical according to their criticality. As a recommendation, 9 of the most critical factors should be primarily borne by either party and the rest must be borne by the main parties depending on the project. All the less critical factors should be solely borne by the public sector depending on the project private sector may handle some of the less critical factors. Further, 11 factors should be borne by the private party, 9 factors should be borne by the public party & rest of the factors' risk management can be decided depending on the characteristics of PPP construction project.

REFERENCES

Babatunde, S., Perera, S., & Adeniyi, O. (2018). Identification of critical risk factors in public-private partnership project phases in developing countries. Benchmarking: *An International Journal*, 26(2), 334-355.

Berg, B. (2009) Qualitative Research Methods. *7th Edition*, Allyn & Bacon, Boston.

Chan, A., Yeung, J., Yu, C., Wang, S., & Ke, Y. (2011). Empirical Study of Risk Assessment and Allocation of Public-Private Partnership Projects in China. *Journal Of Management In Engineering*, *27*(3), pp136-148.

Chen, Z., Yuan, J. and Li, Q. (2017), Financing risk analysis and case study of public–private partnerships infrastructure project, in Wu, Y., Zheng, S., Luo, J., Wang, W., Mo, Z. and Shan, L. (Eds), Proceedings of the 20th International Symposium on Advancement of Construction Management and Real Estate, Springer, Singapore, pp. 405-416.

Easterby-Smith, M., Thorpe, R., & Lowe, A. (2002). Management research: An introduction. *London: Sage Publications.*

Efficiency Unit (2008). Serving the community by using the private sector - An introductory guide to Public Private Partnerships (2nd Edition) March, 2008. *The Hong Kong Special Administrative Region*, Government.

Hayford, O. (2006), Successfully allocating risk and negotiating a PPP contract*, Proceedings of the 6th Annual National Public Private Partnerships Summit*: Which Way Now for Australia's PPP Market? Rydges Jamison, Sydney, 16 May.

Hwang, B., Zhao, X., & Gay, M. (2013). Public private partnership projects in Singapore: Factors, critical risks and preferred risk allocation from the perspective of contractors. *International Journal Of Project Management*, *31*(3), 424-433. doi: 10.1016/j.ijproman.2012.08.003

Ibrahim, A.D., Prince, A.D.F. and Dainty, A.R.J. (2006), The analysis and allocation of risks in public-private partnerships in infrastructure projects in Nigeria, *Journal of Financial Management of Property and Construction*, Vol. 11 No. 3, pp. 149-163.

Javed, Arshad Ali, Patrick T. I. Lam, and Patrick X. W. Zou. (2013). Output-based specifications for PPP projects: Lessons for facilities management from Australia. *Journal of Facilities Management* 11: 5–30.

Jin, X.-H. (2010), Model for efficient risk allocation in privately financed public infrastructure projects using neuro-fuzzy techniques, *Journal of Construction Engineering and Management*, Vol. 137 No. 11, pp. 1003-1014.

Jin, X.-H. and Doloi, H. (2008), Interpreting risk allocation mechanism in public-private partnership projects: an empirical study in a transaction cost economics perspective, *Construction Management and Economics*, 26 (7), 707-721.

Jingning, Y., & Wenkang, L. (2015). Risk Assessment Model of Urban Subway Based on Public Private Partnership Mode. *2015 Sixth International Conference On Intelligent Systems Design And Engineering Applications (ISDEA)*.

Li, B., Akintoye, A., Edwards, P. J., and Hardcastle, C. (2005). The allocation of risk in PPP/PFI construction projects in the UK. *International Journal of Project Management* 23(1), 25–35.

Project Management Institute (PMI) (2017). *A Guide to the Project Management Body of Knowledge* (PMBOK®Guide), 6th ed. Newton Square: Project Management Institute.

Sarvari, H., Valipour, A., Nordin, Y., & Norhazilan, M. (2014). Risk Ranking of Malaysian Public Private Partnership Projects. *Applied Mechanics And Materials*, *567*, 613-618. doi: 10.4028/www.scientific.net/amm.567.613

Showkat, N. (2017) Probability and Non Probability Sampling. Asian Research Journal of Business Management, 4(4).

Xu, Y., Yeung, J. F., Chan, A. P. C., Chan, D. W., Wang, S. Q., Ke, Y. (2010). Developing a risk assessment model for PPP projects in China—A fuzzy synthetic evaluation approach. *Automation in Construction*, 19(7), 929-943

GAP IN QUANTITY SURVEYOR KNOWLEDGE FOR LIFE CYCLE COSTING OF BUILDINGS

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ABSTRACT

Buildings that are the consequence of construction projects have a lengthy lifespan and a high cost. Currently, clients expect buildings to provide value for money for a lengthy lifespan. In order to get the best value for money, it is necessary to assess all costs incurred over the life span of the building. Therefore, life cycle costing (LCC) can be used as a technique to select the suitable solution with the lowest life cycle cost. However, in the Sri Lankan context, the LCC concept was at a very early stage. This study was focused on the implementation of building LCC within the Quantity surveyors (QS) perspective. QS is the professional who has the responsibility of managing the cost of the construction. As a result, QS must inevitably have the ability to collaborate with LCC. Thus, this research aimed to find the knowledge gap among quantity surveyors to perform the total life cycle costing of building projects. Literature analysis was used to summarise the required knowledge areas for LCC implementations. there were twenty interviews were used to evaluate QS knowledge levels relate to LCC implementations. A qualitative research approach was followed and the content analysis method was used to analyze the data. The findings of this research show that there were unsound knowledge areas related to LCC. However, most of the unsound areas have been dragged within the entire career because QSs have limited interference with the building post-construction phases.

Keywords: Life cycle costing (LCC), Quantity Surveyors, Life span.

1. INTRODUCTION

The building construction industry plays a vital role in the social and economic growth of the country (Liu and Lin,2016). To successfully contribute to the country's economy, the construction industry must complete projects within three key parameters: time, cost, and quality (Fung, Salleh, and Rahim,2014). Cost can be viewed as the most important of these three factors because the entire project cost should always fall within the client's budget (Fung, Salleh, & Rahim, 2014) (Goh & Sun, 2015). In general, clients worry about the upfront construction costs, and the construction industry places more emphasis on the aesthetic design of the buildings (Deore and Ambre,2019). Currently, In order to reduce the overall costs associated with the buildings, clients concern their vision into account throughout the entire life cycle. Therefore, the life cycle cost estimate can be used as a technique to determine the design solution that will have the lowest overall project life cycle cost (Fuller, 2006). Life cycle costs typically include related costs for construction, operation, maintenance, and demolition throughout the life span (Han, Srebric, and Promme,2014). In the global context, construction professionals have narrow awareness of LCC (Lim, Zhan, & Lan, 2018). In the meantime, lack of access and reliability of LCC data lack of standardisation and guidance documentation professionals do not tend to practice LCC (Oduyemi & Okoroh, Barriers to Life Cycle Costing Usage, 2014). When considering the Sri Lankan context, there is a lack of consideration regarding the

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implementation of the LCC concept into the construction industry. Further, there is a knowledge gap among quantity surveyors when involving the LCC process. This becomes a challenge in any action taken to assure Sri Lankan QS readiness to conduct proper LCC.

Therefore, this study aims to find the knowledge gap of quantity surveyors that affects when performing the process of life cycle costing. The objectives encompassing this study are to, (1) Identify the theoretical knowledge required to perform LCC of a building project, (2) Identify knowledge acquired by quantity surveyors relate to LCC in building construction, and (3) Analyse the gaps between required and acquired knowledge on building LCC.

1.1 BACKGROUND STUDY/ REVIEW OF LITERATURE

Lifecycle costing is a valuable thing that should be applied to the construction industry, though the application of the LCC is still in the limited stage in practical scenarios (Dwaikata & Ali, 2018). As a quantity surveyor, there should be adequate knowledge to apply the LCC concept to the construction industry (Langdon ,2007). There have been a few obstructions when considering the realistic LCC method inside the construction industry such as knowledge barriers, lack of standardisation and guidance, and lack of awareness (Oduyemi, Okoroh, and Dean, 2014). In the Sri Lankan context, there are limited occurrences that have applied the LCC concept to the construction industry. Therefore, there were research and industrial gaps in the knowledge and awareness of the application of the LCC concept. Due to time constrain the scope of the research was limited to identifying the gaps between required and acquired knowledge on building life cycle costing in the Sri Lankan context.

1.1.1 LIFE CYCLE COSTING (LCC)

LCC is *"The present value of the total cost of that asset over its operational life. This includes initial capital costs, finance costs, operational costs, maintenance costs, and the eventual disposal costs of the asset at the end of its life. All future costs and benefits are reduced to present-day values using discounting techniques"* (Goh & Sun, 2015) . Hyrkas, Pasanen, and Castro (2018) argued that LCC could be considered a tool that may optimize different building solutions at the start. Further, there are two main drives, (1) LCC can be used to choose the most cost-effective design solution for designers, and (2) Adopting LCC methodology can be helped to reduce building costs over the entire life span (Hyrkas, Pasanen, & Castro, 2018).

1.1.2 CALCULATION OF LCC

Haram, Marenjak, and Horner (2002) stated that analysis of LCC is the method of calculating all the direct and indirect costs of designing, constructing, and facility management (operating, maintenance, and replacement) of buildings within the entire building service life include the disposal process. Basically, when quantity surveyors involve with LCC calculation for building construction capital cost (design and construction cost), maintenance cost, replacement cost, operation cost, and end life cycle cost have been calculated as the main components for LCC (Haram, Marenjak, & Horner, 2002).

1.1.3 LCC Calculating Methods

As per Goh and Sun (2016), discounted cash flow is the most common method that is used for LCC calculation. Further, other suitable calculation approaches are Net Present Value (NVP), and the Equivalent Annual Cost (EAC) for assessing the life cycle cost of building construction (Goh & Sun, 2015).

1.1.4 Risk and Uncertainty of LCC Calculation

Gluch and Baumann (2004 stated that LCC calculation comprises with a high degree of uncertainty because LCC forecasts future consequences. While using algorithms for calculating LCC impacts of the risk factors occur on the value of the LCC (Plebankiewicz, Zima, & Wieczorek, 2016). That uncertainty generates from the parameters based on the assumptions, and time horizon, price increase, and discounted rate are identified as those parameters (Kovacic & Zoller, 2015). Kishk, et al, (2003) have identified that dealing with the uncertainty of the information and data is crucial thing for the successful outcome of LCC. Sensitivity analysis, probability-based techniques, and the fuzzy approach are identified as various risk assessment techniques relevant to the LCC (Kishk, et al, 2003).

1.1.5 Utilising Technology Using For LCC Calculation

Langdon (2007) has completed a basic assessment of the LCC calculation software and several software are based on spreadsheets. Bourke, et al (2005) stated that although LCC has a simple calculation process, it consumes a high amount of time and data so LCC calculation can be considered a tedious thing. Further, some software has been developed for facilitating the cost quantification and decision-making processes namely Bid-Builder, BLCC 5.3, Kostenreferentiemodel, LCCID, LCProfit, LCCWare 3.0, PARAP, RealCost 2.1, Relex LCC are (Bourke, et al., 2005).

2. Methodology

According to Grossoehme (2014), the qualitative approach is based on the collection, organization, and interpretation of textual data. The subject of this study was knowledge, beliefs, attitudes, and opinions towards LCC. These things can be easily captured in textual a manner and interpreted them. Therefore, the qualitative approach could be considered the most suitable approach for this study.

A literature survey was undertaken to identify the theoretical knowledge required to perform the LCC of a building project. An interview guideline was developed with the use of literature findings. This study is also based on the "what" types of questions to identify the knowledge gap of LCC among the QS. Especially, it was an exploratory and descriptive study. Therefore, the survey strategy was used for this research.

Meanwhile, this study was sometimes focused on capturing interviewee responses related to LCC implementation. Structured interviews cannot be used to capture interviewees' opinions freely. Therefore, fully structured interviews cannot be used. There were occasionally some topics that had to be covered in close-ended questions. As a result, fully unstructured interviews also will not be effective. Therefore, this study was planned to conduct via semi-structured interviews. Respondents were chosen using the snowball sampling technique because awareness of LCC of other responses was identified based on existing research participants. This interview guideline was developed in four sections. Section one presents the general

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information about the research, such as the research title, research aim, and research objectives. Section two is for the collect background information of the interviewees. Then section three is to capture the interviewee's opinion towards the LCC and their approach towards the LCC. Section four focuses on the calculation part of the LCC. This section addresses the current practice in the industry.

Furthermore, Gibbs (2007) has emphasized that Content Analysis as the commonly accepted data analysis method relates to the qualitative approach. Further, the author has identified Content Analysis as a widely used data analysis method under a qualitative approach. This study was also done a content analysis. This was done using the MS word macro, which was based on the fully structured codebook. Based on the analysis finding were identified the knowledge acquired by quantity surveyors relate to LCC in building construction.

3. RESULTS AND DISCUSSION

The semi-structured interviews were conducted with twenty (20) Quantity Surveyors who have experience in the construction sector of Sri Lanka. Respondents were selected using the snowball sampling technique. Table 1 summarised the working experience of the respondents contacted in data collection.

Table 1: Working Experience of the Respondents

		0-5 Years	10- 20 Years	20- 30 Years	30- 40 Years
Proportion of respondents		8	5	5	2
(%)		40%	25%	25%	10%

3.1 AWARENESS OF THE BUILDING LIFE CYCLE COSTING CONCEPT

Table 2 summarised the result of analytical data regarding the awareness of the different stages of the life cycle of building construction and LCC concept.

Table.2: Awareness of The Different Stages of The Life Cycle of Building Construction and LCC Concept

	Stages of the building construction	LCC Concept
Number of respondents having awareness	20 (100%)	17 (85%)
Number of respondents with a lack of awareness	-	3 (15%)
Total number of awareness	20 (100%)	20 (100%)

As per the analytical data, 100% of respondents were aware of the different stages of the life cycle in building construction. 85% of respondents are aware of the LCC concept and 15% of respondents have some understanding despite a lack of experience regarding LCC concept.

3.2 AWARENESS OF CALCULATION OF MAIN COMPONENTS IN LCC

Awareness of the LCC calculation was assessed through the different aspects which are used to calculate LCC. Table 3 summarised the result of analytical data regarding the awareness of the calculation of main components in LCC.

Table 3: Awareness of Calculation of Main Components in LCC

Main components in LCC	Number of respondents having awareness	Number of respondents with lack of awareness	Number of respondents without awareness
Capital cost Calculation (Design and Construction Cost)	20 (100%)	-	-
Maintenance cost Calculation	12 (60%)	8 (40%)	
Replacement cost calculation	6 (30%)	2 (10%)	12 (60%)
Operation cost calculation	6 (30%)	2 (10%)	12 (60%)
End life cost calculation	5 (25%)	5 (25%)	10 (50%)

As per the analytical data, respondents have considerable awareness for the calculation of capital cost and maintenance costs. Further, a limited number of respondents only have experience regarding the calculation of replacement cost, operation cost, and end-life cost.

3.3 AWARENESS OF VARIOUS RISK ASSESSMENT TECHNIQUES RELEVANT TO THE LCC

As per the literature synthesis Serval techniques have been described that can be used to deal with risk and uncertainty. Table 4 summarised the result of analytical data regarding the awareness of various risk assessment techniques relevant to the LCC.

Table.4: Awareness of Various Risk Assessment Techniques Relevant to the LCC

	Technique	Number of respondents having awareness	Number of respondents without awareness
Knowledge	Sensitivity analysis	12 (60%)	8 (40%)
Extracted	Monte Carlo simulation	8 (40%)	12 (60%)
Areas from	Confidence index approach	7 (35%)	13 (65%)

In a summary, an average number of respondents has considerable awareness of all three (03) techniques relevant to the LCC calculation.

3.4 AWARENESS OF UTILISING TECHNOLOGY USED FOR LCC CALCULATION

As per the literature synthesis serval, technologies have been described that can be used for LCC calculation. Table 5 summarised the result of analytical data regarding the awareness of utilising technology used for LCC calculation.

Table 5:Awareness of Utilising Technology Using for LCC Calculation

Technology	Number of respondents having awareness	Number of respondents without awareness
Spreadsheets	20 (100%)	-
Bid-Builder	02 (10%)	18 (90%)
BLCC 5.3	01 (05%)	19 (95%)
Kostenreferentiemodel	-	20 (100%)
LCCID	-	20 (100%)
LCProfit	-	20 (100%)
LCCWare 3.0	01 (05%)	19 (95%)
PARAP	-	20 (100%)
RealCost 2.1	01 (05%)	19 (95%)
Relex LCC	01 (05%)	19 (95%)

As a summary, all the respondents have experience in using a spreadsheet to calculate LCC. When considering new IT software which has been used to calculate LCC, respondents have rare knowledge.

3.5 APPLICATION OF LCC CONCEPT INTO SRI LANKAN BUILDING CONSTRUCTION

Rather than the factor that has been identified from literature synthesis, there was the requirement for identifying the application of the LCC concept in Sri Lankan Building Construction. As per the opinion of the respondents, the LCC concept has been applied for areas such as, evaluating design, measuring of suitability, facility management work, procurement and tendering, cost planning, and making decisions with the building design development.

3.6 ISSUES GENERATED AREAS DUE TO LACK OF KNOWLEDGE

As per respondent opinion, lack of awareness and application of the global and local standard for LCC in construction projects, data scarcity, minimum exposure to the functional stage, lack of knowledge regarding relevant cost elements related to a functional stage, and limited technological application which is used in industry were identified as the issue generated area due to lack of knowledge of resource persons.

3.7 REVIEW THE GAPS BETWEEN REQUIRED AND ACQUIRED KNOWLEDGE ON BUILDING LCC

Based on the analysis part, when considering the Sri Lankan context, QSs lack awareness and knowledge related to the LCC concept. Qs have focused on capital cost expenditure when involved in building construction. Further, the building construction industry also has narrowed the role of QS within the initial phase of building construction. Research findings show that most of the time QS has to consider capital expenditure. Usually, QS has limited chances to touch other building phases' cost implications. As a result of that, they had to drag their silent knowledge areas within their entire professional carrier. Research findings show that QS can cover some knowledge areas related to LCC but are not very structured

4. CONCLUSION(S)/ IMPLICATIONS/ RECOMMENDATIONS & LIMITATIONS

This research mainly focuses on the building LCC and this provides a basic understanding of the LCC. When considering the Sri Lankan context still concepts like LCC were in the very initial stage. Meanwhile, there was a scarcity of the use of LCC within the building construction sector. If the LCC concept is optimally utilised within the building construction, it may lead to a high amount of cost conservation. The advantages and applications of the LCC have been expressed within this study. This research's outcomes are more relevant to the QS who have an interest in building LCC. This can be used to identify the LCC implementation barriers which may have to face by QS. The research was limited to the Sri Lankan context. Because research findings were focused only on the Sri Lankan QS practice. The study was done within the QS perspective; therefore, this cannot be recommended for other professionals.

REFERENCES

Bourke, K., Ramdas, V., Singh, S., Green, A., Crudgington, A., & Mootanah, D. (2005). Achieving whole life value in infrastructure and buildings. *BRE Electronic Publication.*

Deore, S., & Ambre, H. (2019). Life cycle cost analysis of residential building. *International Research Journal of Engineering and Technology*.

Fuller, S. (2006). Life-Cycle Cost Analysis. *Whole building design guide*.

Fung, P. W., Salleh, H., & Rahim, F. M. (2014). Capability of Building Information Modeling Application in Quantity Surveying Practice. *Journal of Surveying, Construction and Property*.

Gibbs, G. R. (2007). Analysing Qualitative Data. *SAGE publications. 5*(1), pp.1-13.

Gluch, P., & Baumann, H. (2004). The life cycle costing (LCC) approach: a conceptual discussion of its usefulness for environmental decision-making. *Building and Environment*, 571 – 580.

Goh, B. H., & Sun, Y. (2015). The development of life-cycle costing for buildings. *Building Research &* Informa *44*(3), pp.319-333.tion. doi:10.1080/09613218.2014.993566

Grossoehme, D. H. (2014). Overview of Qualitative Research. *Journal of Health Care Chaplaincy*, pp 109-122. doi:0.1080/08854726.2014.925660

Han , G., Srebric, J., & Pommer, E. E. (2014). Variability of optimal solutions for building components based on comprehensive life cycle cost analysis. *Energy and Buildings. 9*, pp.223-231.

Haram, M. A., Marenjak, S., & Horner, M. W. (2002). Development of a generic framework for collecting whole life cost data for the building industry. *Journal of Quality in Maintenance Engineering*, pp 144-151. doi:0.1108/13552510210430017.

Kishk, M., Hajj, A. A., Pollock, R., Aouad, G., & Bakis, N. (2003). Whole Life Costing In Construction. *The Open Access Institutional Repository.*

Kovacic, I., & Zoller, V. (2015). Building life cycle optimization tools for early design phases. *Energy*, pp 409-419. doi:10.1016/j.energy.2015.03.027

Langdon, D. (2007). Life Cycle Costing as a contribution to sustainable design: a common methodology. *Davis Langdon Management Consulting. 196*, pp.565-570

Langdon, D. (2007). *Life Cycle Costing as a contribution to sustainable design: a common methodology.*

Lim, B. T., Zhan, W., & Lan, B. (2018). Sustainable Procurement in Australia: Quantity Surveyors' Perception on Life Cycle Costing. *International Journal of Integrated Engineering*.

Liu, H., & Lin, B. (2016). Ecological indicators for green building construction. *Ecological Indicators, 67*, pp 68-77. doi:10.1016/j.ecolind.2016.02.024

Oduyemi, O., & Okoroh, M. (2014). Barriers to Life Cycle Costing Usage. *Portsmouth: 30th Annual ARCOM Conference.*

Oduyemi, O., Okoroh, M., & Dean, A. (2014). Barriers to Life Cycle Costing Usage. Paper presented at the 30th Annual ARCOM Conference. Portsmouth.

Plebankiewicz, E., Zima, K., & Wieczorek, D. (2016). Life cycle cost modelling of buildings with consideration of the risk. *Archives of Civil Engineering*, 150-166. doi:0.1515/ace-2015-0071

Managing Risk In The Construction Industry In Response To The Economic Crisis In Sri Lanka

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Abstract

Sri Lanka is currently experiencing its greatest economic crisis since gaining independence and as a result, this year is expected to see a decline in the country's construction industry. Although risk management in construction projects in Sri Lanka has been the focus of a few past studies, it is not specifically addressed risk management in the economic crisis in Sri Lanka. This study aims to identify the methods for managing the risk in the construction industry which arose due to the economic crisis in Sri Lanka in 2022. The required empirical data were collected by conducting a literature review and a questionnaire survey. The collected data were analysed using content and descriptive statistics. The results revealed the fundamental areas in which the economic crisis affected how construction projects are handled: the adoption of more uniform project governance, more strict risk management procedures, and a more thorough project portfolio management. According to the research, the creation of an early warning system, the creation of crisis scenarios, and the establishment of a crisis management team should be prioritized when it comes to Risk management during an economic crisis.

Keywords: Construction Industry, Economic Crisis, Risk Management, Sri Lanka.

1. Introduction

The construction sector is an investment-led sector where the government shows high interest and government contracts with the construction industry to develop infrastructure related to health, transport as well as the educational sector most importantly construction industry is quintessential for the property of any nation (Manoharan, et al., 2021). Therefore, the construction industry is identified as the cannonading industry of the Present day that has a great impact on the economy of any nation (HHI, 2018). When risk comes as an economic crisis, that can negatively affect both developed and developing economies, the Sustenance of the construction industry is very important for the national economy (Weerasinghe, 2020) All the financial or economic down-towns have impacted the country's construction industry (Edmund, Yang, & Eric, 2018).

The construction industry is a high-risk industry, with regard to the economic crisis, complex and dynamic project environments creating an atmosphere of high uncertainty and risk (Eshan, et al., 2010). Potts and Ankrah (2013) stated that the proper process is essential to mitigate risk in the construction industry and that process must have the aim of identifying and assessing the risk by using risk management. Risk management can be used as a tool to mitigate risks that occurred during an economic crisis (Scheytt & Huber, 2013).

Wijerathne (2022) stated that the Sri Lanka construction industry, which is one of the biggest GDP contributors and used to contribute an average of 8%-10% to the GDP, considering the negative impact in

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2019 and 2020 the contribution decrees to 7.4% and 6.2% respectively. In addition, this sector has provided employment to 650,000 direct and 325,000 indirect and economic crisis impact, (Wijerathne, 2022). The government decided to halt large construction projects after realising that since the beginning of the economic crisis this year, around 500,000 workers in the construction sector had lost their employment. Sri Lanka's real GDP is expected to fall by 9.2 percent in 2022 and a further 4.2 percent in 2023. Nonetheless, Sri Lanka is facing the worst-ever economic crisis in the year 2022 since its independence and it has created vast risk for the construction industry (Wijerathne, daily news, 2022).

Since the importance of risk management has been recognized, many research studies on risk management and related theories have been conducted on an international basis. Only less number of studies have discussed risk management in the construction industry during the economic crisis. When considering the Sri Lankan context, there is a research respite in this area hence the Sri Lankans faced a vast economic crisis for a time.

Therefore, the aforementioned study aims to identify the methods for managing the risk in the construction industry which arouse due to the economic crisis in Sri Lanka in 2022. The objectives encompassing this study are to, (1) Review the impact of the economic crisis on the construction industry, (2) Investigate the impact of the economic crisis on the Sri Lankan construction industry, and (3) Identify the measures to manage the risk arouse by reason of economic crisis in Sri Lankan construction industry.

1.1. REVIEW OF LITERATURE

The economic crisis in Sri Lanka caused a vast impact on the construction industry. The study mainly focuses on identifying how the economic crisis in Si Lanka affects the Sri Lankan construction industry and by what method to manage that risk. As a result of time constrain the scope of the research was limited to identifying the measures to manage the financial risk which occurs due to the economic crisis in the Sri Lankan construction sector.

1.1.1. *ECONOMIC CRISIS IN SRI LANKA IN 2022*

The term "economic crisis" refers to a circumstance in which a country's economy experiences a sharp drop in output, usually as a result of a financial crisis (Edmund, Yang, & Eric, 2018). A drop in a state's or country's economic growth has an impact on construction activity, resulting in widespread hardship and joblessness in the industry (Hicks, 1981). Sovereign debt crises occur when a government takes on too many debts and is unable to meet its obligations, this leads to an economic crisis (Gunasekara, 2021). A global currency crisis occurs when the US dollar depreciates in value due to a loss of investor confidence (Lukmanova & Yaskova, 2016).

Sri Lanka has never experienced a serious financial or economic crisis in its history (Gunasekara, 2021). The Sri Lankan government announced a soft default on April 12, 2022, and will default on its US$51 billion ($70.09 billion) debt in the interim (Tohfeek, 2022). Official reserves dropped from US$7.6 billion

in 2019 to less than US$400 million in June 2022 (CBSL, 2022). Net foreign assets in the banking system also fell to US$ -5.9 billion in June 2022. This severe for liquidity constraint has been felt across the economy, particularly from the second quarter of 2022, with shortages of fuel, medicines, cooking gas, and inputs needed for economic activity (Weddikkara & Devapriya, 2022).Year-on-year inflation reached an unprecedented 64.3 percent in August 2022, and CCPI-based headline inflation was recorded at 69.8% on year-on-year basis in September 2022 (CBSL, 2022). Sri Lanka's central bank floated the rupee in March after the currency depreciated by about 78 percent since the floating. Poorer households are hardest hit owing to food inflation, job losses, limited fertilizer supply and a drop in remittances (Ihalavithana, Bandara, & Jayasoriya, 2022). To raise more revenue, the government increased the Value Added Tax rate from 8 to 15 percent and proposed additional tax measures in May, and through the Interim Budget in August (Tohfeek, 2022).

The Chamber of Construction Industry of Sri Lanka cannot be certain of the future because authorities have paid insufficient attention to the difficulties confronting the construction industry (Razeek, 2022). As a result of Global Data's sharp downward revision of its growth projection for the Sri Lankan construction industry for 2022, which was previously expected to grow by 9.2%, the industry is now expected to contract by 4.6% in real terms this year. This is down from the previous projection of growth of 9.2% (Gunatillake, 2022).Sri Lanka's construction sector has crashed with 90 per cent of their work countrywide coming to standstill. Over 1000 building material suppliers had to close down owing to non-availability of items like cement, iron and other essential items for the construction industry (Jayalath & Gunawardhana, 2022). The whole construction industry is in a severe financial crisis, despite the fact that many large projects were started under the prior administration due to their failure to finish payments. The government has also halted practically all major infrastructure projects, which has made the situation worse. Contractors are thought to owe the banking industry a staggering Rs. 200 billion (Gunatillake, 2022).

Table 1: Risk Factors that Affected to the Construction Industry During Economic Crisis

Risk Factors	Sources
Pandemic risk	(Lukmanova & Yaskova, 2016) (Edmund, Yang, & Eric, 2018)
Delayed Payments to contractors	(Cao, Zhu, Han, & Zhu, 2018)
Design change	(Razeek, 2022) (Scheytt & Huber, 2013)
Inflation of construction materials price	(Razeek, 2022)
Fluctuation of the currency	(Mhetre, Konnur, & Landage, 2016)
Lack of solvency	(Choudhry & Iqbal, 2013)
Interest rates fluctuation	(Patel, et al., 2020)
Lack of clarification in taxes liabilities	(Tohfeek, 2022)
Unavailability of foreign currency exchange	(Cao, Zhu, Han, & Zhu, 2018)
Unmanaged cash flow	(Gunasekara, 2021)
The reduction of public procurement and investment programmers.	(Wijesekera, Abeyaratna, Hemacandra, Shantha, & Indika, 2020)
The decrease in the private construction industry	(Tohfeek, 2022)
The tightening of bank lending	(Wijesekera, Abeyaratna, Hemacandra, Shantha, & Indika, 2020)

Risk Factors	Sources
The past incorrect administration/ management of construction companies.	(Tohfeek, 2022)
Profit margin decrease	(Gunasekara, 2021)
Competition increase	(Gunasekara, 2021)

Table 2 presents the negative factors affecting the construction industry in the wake of the economic crisis.

Table 2: Negative Factors Affecting the Construction Industry in the Wake of the Economic Crisis

Effects of the Economic crisis	Sources
Competition increase	(Nafday, 2010)
Profit margin decrease	(Babu & Sudhakar, 2016)
The cutting of public investment programmers.	(Babu & Sudhakar, 2016)
The decrease of private construction industry	(Hicks, 1981)
The past incorrect administration/ management of construction companies.	(Babu & Sudhakar, 2016)
The tightening of bank lending	(López & Coto, 2015)

Table 3 presents the risk in the construction industry due to the economic crisis.

Table 3: The Risk in the Construction Industry Due to the Economic Crisis

Risks	Sources
Postponement of project	(Choudhry & Iqbal, 2013)
Reduction of the number of new projects	(Choudhry & Iqbal, 2013)
Limiting the scope of the project already initiated	(Choudhry & Iqbal, 2013)
Budget cutting while maintaining project scope	(Thomson, 1984)
Redefine the objective of the project	(Razeek, 2022)
Reassessment of project risk	(Lukmanova & Yaskova, 2016)
Staff reduction in project already initiated	(Gunasekara, 2021)
Cancellation of project already initiated	(Lukmanova & Yaskova, 2016)
Undertaken of smaller projects.	(Hicks, 1981)
Redefine of project portfolio	(Nafday, 2010)
Merging of project	(Nafday, 2010)
Less priority to project quality	(Razeek, 2022)

Table 4 presents the measures to mitigate risk in economic crisis.

Table 4: Measures to Mitigate Risk in Economic Crisis

Measures	Sources
Emphasis on project planning and control	(Choudhry & Iqbal, 2013)
Develop risk and crisis control procedure	(López & Coto, 2015)
From a competitive crisis management team	(Wells, 1984)
Cut down unnecessary cost and reduce unnecessary activities	(Tohfeek, 2022)
Search for other field with growth potential	(Tohfeek, 2022)
Carefully select project that better fit the company	(Zafiu & Saracu, 2013)
From and test crisis plan and scenarios	(Zafiu & Saracu, 2013)
Develop an early warning system	(Patel, et al., 2020)

2. METHODOLOGY

The major objective of this study is to find out the current threats affecting Sri Lankan construction industry and how economic crisis affects the construction industry in Sri Lanka and to identify the methods

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to manage the risks arouse due to economic crisis. The questionnaire has consisted of Three sections include questions about general information, current risk for construction industry and solutions. The questionnaire is directed mainly to all professional bodies currently working in construction industry. The data used for data collection were mainly from a comprehensive literature review. The qualitative and quantitative both research approaches were selected as the best method to collect data due to the Due to the limited time and the possibility of reaching the professionals. There were thirty five (35) professional bodies who are currently working in construction industry respond for the questionnaire survey. They were selected through random sampling technique. Questionnaire surveys were transcribed and analyzed using Microsoft Office Excel Rapid analysis and clear graph. Based on the 'Mean Weighted Rating' formula (Equation 01), quantitative data were analysed.

$$\text{Mean value} \quad = \sum \frac{f(x)}{N} \quad (1)$$

Where, $f(x)$ -Rating given by the respondent and N- Total number of responses.

3. RESULT AND DISCUSSION

The questionnaire Survey were conducted with thirty-five (35) professionals who have experience in the construction industry at Sri Lanka. Respondents were selected using random sampling technique. Tables 5 and 6 provide the summary of respondents contacted in data collection.

Table 5: Summary of the Respondent Profile

	Quantity Surveyors	Engineers	Contractors	Total Number of Respondents
Proportion of respondents	15	14	6	35
(%)	43%	40%	17%	100%

Table 6: Working Experience of the Respondents

	0-5 Years	5- 10 Years	10-15 Years	15- 20 Years	More than 20 Years	Total Number of Respondents
Proportion of respondents	10	13	04	05	03	35
(%)	28.57%	37.14%	11.43%	14.29%	8.57%	100%

3.1 RESEARCH FINDINGS

3.1.1 CURRENT RISKS FACTORS AFFECTING SRI LANKAN CONSTRUCTION INDUSTRY

Table 7 summarised the result of analytical data regarding the main current risk factors which are affecting the Sri Lankan Construction industry due to the economic crisis.

Table 7: Risk Factors which Affect Construction Sector

Risk factor	Mean Value	Rank
Inflation of construction materials price	3.17	1
Fluctuation of the currency	3.17	1
Unavailability of foreign currency exchange	3	2
Lack of solvency	2.97	3
Interest rates fluctuation	2.97	3
Delayed Payments to contractors	2.94	4
Lack of clarification in taxes liabilities	2.83	5
Unmanaged cash flow	2.77	6
Design change	2.63	7
Pandemic risk	2.6	8

Fluctuations in the value of currencies and increases in the cost of construction materials are two of the most frequently cited risk factors. Lack of access to foreign exchange resulted in a shortage of materials in the sector, as well as fuel shortages and power outages, both of which have a negative impact on the construction business*.*

3.1.2 EFFECTS OF THE ECONOMIC CRISIS ON THE CONSTRUCTION INDUSTRY IN SRI LANKA

Table 8 summarised the result of analytical data regarding the effects of the economic crisis on the construction industry in Sri Lanka.

Table 8: Effects of the Economic Crisis on the Construction Industry in Sri Lanka

EFFECTS OF THE ECONOMIC CRISIS	Mean Value	Rank
Competition increase	2.97	1
Profit margin decrease	2.94	2
The cutting of public investment programmers.	2.91	3
The decrease of private construction industry	2.89	4
The past incorrect administration/ management of construction companies.	2.71	5
The tighten of bank lending	2.69	6

The economic crisis resulted in a significant drop in public and private project spending. Many construction companies went bankrupt due to the confluence of ongoing unproductive projects, a shortage of capital, and improper management. The increase in competition led to a run of failing projects for many organizations.

3.1.3 THE RISK IN THE CONSTRUCTION INDUSTRY DUE TO THE ECONOMIC CRISIS

Table 9 summarised the result of analytical data regarding the risk in the construction industry due to the economic crisis in Sri Lanka.

Table 9: The Risk in the Construction Industry Due to the Economic Crisis

Risk	Mean Value	Rank
Postponement of project	2.03	1
Reduction of the number of new projects	2	2
Limiting the scope of project already initiated	1.91	3
Budget cutting while maintaining project scope	1.89	4
Redefine the objective of the project	1.89	4
Reassessment of project risk	1.86	5
Staff reduction in project already initiated	1.8	6

Cancellation of project already initiated	1.77	7
Undertaken of smaller projects.	1.77	7
Redefine of project portfolio	1.77	7
Merging of project	1.71	8
Less priority to project quality	1.69	9

The majority of construction companies did not halt work on projects that had already begun. However, the start of the crisis undoubtedly caused delays in the schedule of construction activities. Construction firms are said to be able to utilize their limited resources more effectively during an economic downturn.

3.1.4 *MEASURES TO MANAGE THE RISKS AROUSE DUE TO ECONOMIC CRISIS*

Table 10 summarised the result of analytical data regarding the Measures that can be used to manage the risks arouse due to economic crisis in Sri Lanka.

Table 10: Measures Manage the Risk

Measures to Manage the Risk	Mean Value	Rank
Emphasis on project planning and control	2.14	1
Develop risk and crisis control procedure	2.09	2
From a competitive crisis management team	2.06	3
Cut down unnecessary cost and reduce unnecessary activities	2.06	3
Search for other field with growth potential	1.91	4
Carefully select project that better fit the company	1.97	5
From and test crisis plan and scenarios	1.97	5
Develop an early warning system	1.97	5

Construction companies in Sri Lanka concur that enterprises should give project planning more attention. The overwhelming majority of survey participants believe that there should be a stronger emphasis on accountability. Despite the difficulties brought on by the crisis, firms have shown responsibility by giving careful consideration to project quality.

3.2 DISCUSSION

The construction industry was one of the most severely hit industries by the economic crisis, according to a survey of over 35 construction workers in Sri Lanka. The most popular answers among all the mentioned risk factors are Fluctuation of the currency and Inflation of construction materials price. Lack of clarification in taxes liabilities, Design change, and unmanaged cash flow can identify as risk factors that affect the construction industry. The survey shows that only a small percentage of respondents were led to unemployment, according to the results of the survey.

Sri Lankan construction firms have revised their project profit to address the problems posed by the economic crisis. Many construction enterprises went bankrupt during the crisis years due to the combination of ongoing unprofitable projects and a lack of funding. The majority of construction companies did not choose to cancel already initiated projects, however, the outbreak of the crisis caused disruptions to the timetable of construction activities.

Research highlights the importance of project prioritization as a component of project profit management. The majority of respondents think that better staff training is a crucial lesson from the economic crisis. Sri

Lankan construction firms also believe that businesses need to place more focus on project planning. The majority of Sri Lankan respondents support the creation of a crisis team, although weakly. According to the respondents, the best option is Emphasis on project planning and control. Developing risk and crisis control procedures are the most important tools for managing an economic crisis.

4. CONCLUSION

The Sri Lankan construction companies did not halt already started projects in terms of the construction process, but there were some interruptions to the regular construction activity. Main conclusion is that the economic crisis altered how construction companies saw project management and helped them realize the value of having project management. The project quality was handled with seriousness, and it will be maintained throughout the years of the crisis. They have elevated the position of project managers inside their organization and placed greater emphasis on Risk management. The initial stages toward an effective Risk management response to an economic crisis include the creation of a crisis team and the creation of an early warning system. All employees of a corporation should display a heightened feeling of responsibility during the entire construction process due to the gravity of the issue.

REFERENCES

Agumba, J. N., & Renault, B. Y. (2016). Risk management in the construction industry: a new literature review. *MATEC Web of Conferences* (p. 66). Johannesburg: EDP Sciences.
Cao, J., Zhu, L., Han, H., & Zhu, X. (2018). *Modern Emergency Management.*
CBSL. (2022). *Annual Report.*
Choudhry, R. M., & Iqbal, K. (2013). Identification of Risk Management System in Construction Industry in Pakistan. *Journal Of Management In Engineering, 29*(1), pp 42-49.
Edmund, B.-T., Yang, H., & Eric, A. (2018). A General Overview of the Impact of Global Financial Crisis on Construction Industries. *Ontari: scelibrary.org* by University of Western Ontari.
Eshan, N., Alam, M., Mirza, E., & Ishaque, A. (2010). Risk management in construction industry. 20.
Fromentin, V., 2016. The global economic crisis and migrant workers: The case of the construction sector in Europe. *International Economic Journal*, *30*(1), pp.147-163.
Gunasekara, V. (2021). Crises in the Sri Lankan Economy: Need for National Planning and Political Stability". *Institute of South Asian Studies (ISAS) Working Paper*, pp 14-19.
Gunatillake, R. (2022). Urgent measures vital - Construction Industry Chamber. *Sustaining construction sector*.
HHI. (2018). Importance of construction industry in the economy and use of construction equipment. (Holloway houston). *Holloway houston,inc:* https://www.hhilifting.com/importance-of-construction-industry-in-the-economy-and-use-of-construction-equipments/
Hicks, A. (1981). The Economic Crisis and American Society by Manuel Castells. *The American Political Science Review, 75*(2), 489-490.
Ihalavithana, N., Bandara, S., & Jayasoriya, s. (2022). Impact of Covid-19 pandamic to construction industry in sri lanka. *Build environment and spetial sciences sessions*, pp. 161-166.
López, L. X., & Coto, P. (2015). From the Boom to the Collapse: a Technical Efficiency Analysisal of the spanish construction industry duribg the financial crisis. *Construction Economics and Building, 15*(1), 104-117.
Lukmanova, I., & Yaskova, N. (2016). Hidden reserves of post-crisis development of construction industry. *Underground Urbanisation as a Prerequisite for Sustainable Development*, *165*, pp. 1293 – 1299.
Mauliana, M. (2016). Risk management. *The task of the padjadjaran University Pharmacy Study Program*.
Patel, S., Patel, P., Sarkar, D., & Ranganath, N. (2020). Application of fuzzy TOPSIS method for risk evaluation in development and implementation of solar park in India. *International Journal of Construction Management.*
Potts, K., & Ankrah, N. (2013). *Construction cost management* (second edition ed.). Abingdon, Oxon, Canada: Routledge.

Razeek, T. (2022). Construction industry on the verge of collapse. *Ceylontoday:* https://ceylontoday.lk/2022/04/30/construction-industry-on-the-verge-of-collapse/

Scheytt, T., & Huber, C. (2013). The dispositif of risk management: Reconstructing risk. *Management Accounting Research, 24*(2), pp.88-99.

Thomson, H. P. (1984). For Construction Industry: Issues and Strategies in Developing Countries. *International Bank for Reconstruction and Development. Washington:* The World Bank.

Tohfeek, R. (2022). Correcting the Course of Sri Lanka's Economy. *South Asian Voices:* https://southasianvoices.org/correcting-the-course-of-sri-lankas-economy/

Weddikkara, C., & Devapriya, K. (2022). Demand and supply trends and construction industry development. *The Australian jurnal of cnstruction ecnmics & building*, pp 91-105.

Weerasinghe, M. C. (2020). Co-existing with COVID-19: Engaging the community to strengthen the public health response in Sri Lanka. *Journal of the Ceylon College of Physicians, 51*(1), pp 8-13.

Wells, J. (1984). The construction industry in the context of development: *A new perspective. 8*(3-4), 9-28.

Wijesekera, N. T., Abeyaratna, U. S., Hemacandra, M. G., Shantha, U., & Indika, M. H. (2020). Developmet of Sri lanka<s construction industry The way forward after COVID-19. *Constuction Industry Development Autority. Colombo: Constuction Industry Development Autority.*

Zafiu, D. C., & Saracu, A. F. (2013). The Economic Crisis – Meanings and Significations Causes and Solutions. *Economics and Applied Informatics, 2*(2), pp 21 – 24.

Zou, P. X., Zhang, G., & Wang, J. (2007). Understanding the key risks in construction projects. *International journal of projets management*, pp 601- 614.

Mhetre, K., Konnur, B. A., & Landage, A. B. (2016, jan 8 & 9). Risk Management in Construction Industry. *International Journal of Engineering Research, 5*(Special 1), pp153-155.

Babu, S. S., & Sudhakar, B. (2016, November–December). Construction project mangement during economic crisis. *International Journal of Management (IJM), 7*(7),pp 370–381.

Jayalath, A., & Gunawardhana, T. (2022, 10). Towards Sustainable Constructions: Trends in Sri Lankan Construction Industry - A Review. *International Conference on Real Estate Management and Valuation*, 143.

Nafday, A. M. (2010, 11 10). Strategies for Professional Engineering Firms during Economic Recession. *Journal of Professional Issues in Engineering Education and Practice, 137*(1).

APPLICATION OF THE ADOPTABILITY OF CARBON ACCOUNTING CONCEPT IN THE DESIGN AND CONSTRUCTION STAGES BY THE CONSTRUCTION RELATED PROFESSIONALS IN SRI LANKA

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ABSTRACT

Carbon Accounting Concept is granted with a role in calculating the Carbon Foot Print. This paper aimed to develop recommendations to improve adoptability of Carbon Accounting (CA) practice at key professionals: Civil, Structural Engineers, Architects, Project Managers MEP Engineers and Quantity Surveyors at construction industry in Sri Lanka, at various Design/Project stages. A questionnaire survey and a structured interview was conducted among sample key building professionals, identifying CA adoptability. Results indicated as awareness of key professionals at basic concepts of Carbon emission is considerably low. Specially at material selection at construction stages the application of CA concept is not highly applied with lower awareness of micro-level basic concepts of CA ideologies. Yet, a considerable application green building codes of Sri Lanka is further noticed in practice, but it was found out that because of the minimal application of fundamentals of CA concepts in these codes, the CA fundamentals were not reveled in the specific jobs. Therefore, as recommendations it was suggested that, their needs a major revision in the Green Building codes, with special reference to CA concepts as a fundamental application, to impose as a central governmental enactment. An utter need of filling fundamentals of Carbon Accounting knowledge gap at key professionals is also highly recommended, as per the study.

Keywords: *Embodied Carbon, Carbon Accounting, Construction Stages, Quantity Surveyor's Role, Professional's Role*

1. INTRODUCTION AND BACKGROUND

Construction Industry is a dynamic diligence in the journey of economic development of any economy. (Polèse, 2005). As per the rapid development of global economy, its impact to the natural environment also has been increased correspondingly (Sayma et al, 2021). Since the construction sector is the largest material and energy consumption sector in the world, impact to the environment due to the construction industry is very high, overcoming the negative impact to the environment. (Kucukvar & Tatari, 2013). Carbon Footprint is considered as a sustainable development indicator and the Carbon Accounting Concept, that will undertake an excessive role when calculating the Carbon Foot Print. (Laurent, Olsen & Hauschild, 2012)

Carbon Accounting is identified as a process of quantifying, monitoring, recording and reporting the amount of embodied Greenhouse gas emissions of a product or service, throughout the defined production process, based on reported data from internal and external systems. (Hogne, Edgar, & Hertwich, 2009)

"Carbon Accounting" (CA) is a process undertaken to measure the amount of Carbon Dioxide and equivalent Greenhouse gases emitted by an entity and the primary objective of measuring the Carbon emission is to improve the environmental performance (Jayalath, 2017). But according to the "r2r.com" web site, the Carbon Accounting is a process of measuring, monitoring, benchmarking and reporting the

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Greenhouse gas emissions, in a defined reporting period. Qingliang Tang (2016), in the "The Role of Carbon Accounting in Corporate Carbon Management Systems: A Holistic Approach", argue that the Carbon Accounting has referred to a set of accounting methods and procedures that can be used to quantify the amount of embodied Carbon and account for Carbon related assets, liabilities and disclosures. Yet, generally CO_2 emissions have become established as an indicator for Greenhouse Gases, but they should have expanded by further Greenhouse gases (GHG), stated as CO_2 equivalents (Schmidt, 2009). Subsequently, not only the CO_2 emissions of fossil origin, but also the emissions of Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorocarbons, Perfluorocarbons or Sulphur Hexafluoride (SF_6), have to be taken into account (Schmidt, 2009).

Although the world begun to change as a better living place due to the application of CA concepts, the Sri Lankan construction industry is still found to be in an infantile age in CA, when compared with the international context. (Nawarathna, Siriwardana, Alwan, 2021). As per several researches, it was found out that the awareness of construction professionals in Sri Lanka have poor wakefulness about carbon emission strategies. Construction professionals in Sri Lanka are basically aware of some basic/conventional mitigation strategies, yet their awareness of micro-level strategies is considerably poor. (Abeydeera, Mesthrige, Samarasinghalage, 2019)

Further, research conducted to find out the extent considered emission of carbon at material selection criterion at building professionals in Sri Lanka indicated as consideration of carbon emissions as a material selection criterion is very minimally considered among construction professionals of Sri Lankan architects, engineers, sustainability managers, even if they primarily follow green building rating systems and basic level green strategies (Nawarathna, Siriwardana, Alwan, 2021)

Hence, to face the challenge of improving the application micro-level mitigation strategies at carbon emission concept application at Sri Lankan construction sector, recommendations have to be implemented immediately. This is vital as from traditional practices need to change in to suitably regulation level enactment to improve. Therefore, this research will be identifying the recommendations to improve the carbon emission consideration practices at construction stages, will initially foster the growing carbon accounting adoptability in the construction industry, to an awareness level towards an application of micro-level strategies in application mode.

Several researches were identified with discussions of application of CA concepts of the construction sector in Sri Lanka. Yet, as there are not much studies found as followed with need of improving the adoptability of carbon accounting practices at stages of design and construction, especially with lack of evidences in the Sri Lankan context to adopt the practice with the related roles of professionals. Therefore, there is a specified need to identify recommendations at CA application, related to Sri Lankan context with related key professional activities. The objectives of this study are a.) to find out the knowledge and application of adoptability of CA concept in the design and construction stages by the construction related professionals in Sri Lanka, b) to find out the role of construction professionals in the CA of Sri Lankan construction

industry and c) to make recommendations and to improve the AA concept in the construction projects in Sri Lanka.

2. METHODOLOGY

In this research, the concept of CA and the design stages of a construction project will be identified/investigated through a Literature Review.

Further, in order to find the opinion of the research area, a questionnaire survey and a Structured interview at the sample of key professionals was conducted. The respondents are selected at a sample among the key professionals of the construction industry as Civil Engineers, Structural Engineers, Architects, Project Managers MEP Engineers and Quantity Surveyors.

Adoptability of the CA concept by all related professionals, for different stages of a construction project such as: inception, feasibility, briefing, concept, outline design, scheme design, detail design, construction at site stages, are to be investigated through a detailed questionnaire survey.

A detailed role of a quantity surveyor in the construction field identified through a literature review was validated via a questionnaire survey. An in-depth-interview is to be carried out for validating each role separately and also for identifying the key professionals and Quantity Surveyors' adoptability for the CA practice as per construction stages.

3. RESULTS AND DISCUSSION

3.1. CONCEPT OF CARBON ACCOUNTING FOR CONSTRUCTION PROJECTS

With the beginning of the 21st century, the world order has begun to talk about the environmental performance accounting systems, as a new way of Corporate Social Responsibility (CSR) strategies, to assist the global warming issue and those environmental accounting programs were very attractive and accountable, because it allows companies to account their environmental performance as much as possible, to minimize the impact of climate change (Tiphaine, 2017). The negative impact of climate change on economy, social activities and peoples' health, has already been emerging and the trend towards a low Carbon economy has been beginning (Qingliang, 2016).

The fundamental objective of the Carbon Accounting, is the mitigation of the impact of Greenhouse gases in the built environment (RICS 2018).

3.2 CONSTRUCTION PROJECT STAGES OF CONSTRUCTION INDUSTRY

Construction project stages are identified as strategic definition, preparation and briefing, concept design, spatial coordination, technical design, manufacturing and construction, handover and use of building stages (Plan of Work, RIBA 2020).

3.3 ADOPTABILITY OF CARBON ACCOUNTING CONCEPT, IN THE PROJECT STAGES OF CONSTRUCTION INDUSTRY IN SRI LANKA

To conduct the study on finding out the adoptability of CA concept in project stages of the Sri Lankan construction industry, the respondents were subjected to a questionnaire.

At a preliminary survey, awareness among the industry professionals about the adoptability of CA concept for construction projects in Sri Lanka, was investigated.

Figure 1: General Awareness about Carbon Accounting Concept
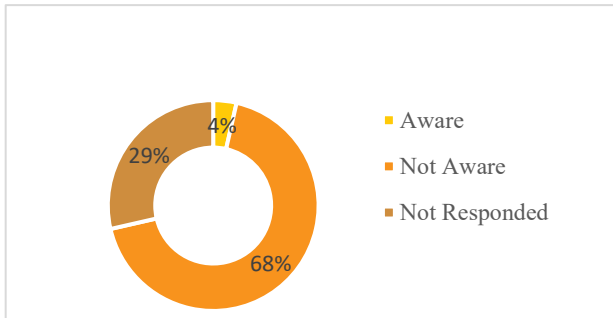
As shown in Figure 1, only 4% of the professionals were aware of this concept, while 68% were not aware of it and 29% did not respond at all.

Figure 2: Professions of respondents
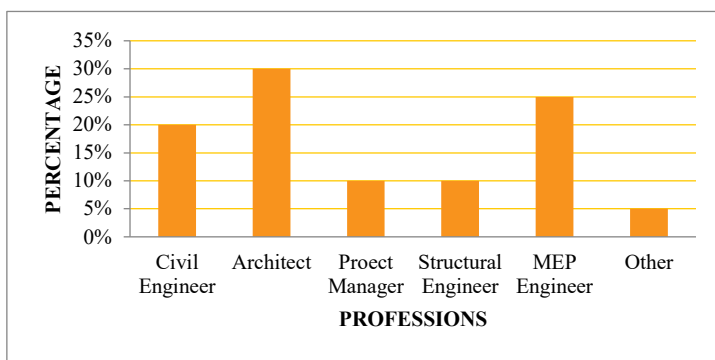
As given in Figure 2, among the respondents, 20% were Civil Engineers, 30% were Architects, 10% were Project Managers, 10% were Structural Engineers, 25% were MEP Engineers and 5% were other professionals. Among them, one respondent had only less than 1-year experience in the construction industry, 1-5-year experience, 7 of them had 6-11-year majority had over 11 years of experience.

Figure 3: Carbon accountability applied at concept design stage

Figure 3 shows the Carbon accountability applied at the concept design stage. 5% of the professionals have always applied the CA at the concept design stage (least response), 20% have applied it highly, 35% have applied it only sometimes (most response), 15% have not applied it frequently, 10% have never applied it and 15% have not responded.

Figure 4: CA applied at brief design stage

Figure 4 depicts CA applied at brief design stage. 5% of the professionals have always applied the CA at the brief design stage (least response), 20% have applied it highly, 50% have applied it sometimes, 15% have not applied it frequently and 10% have never applied it.
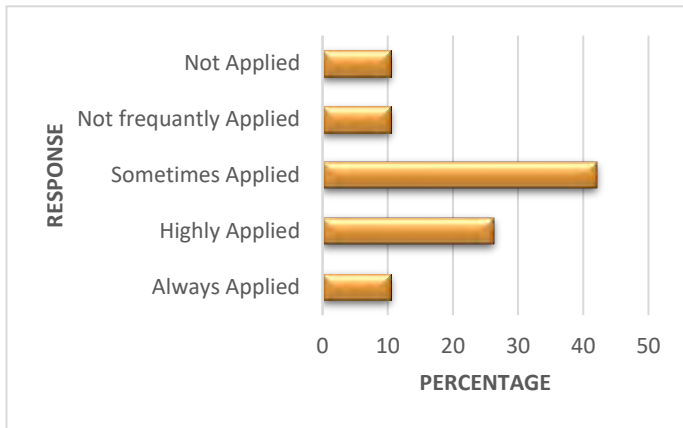
Figure 5: CA applied at outline design stage

CA applied at outline designed stage is shown in Figure 5. 11% of the professionals have always applied the CA at the outline design stage, 26% have applied it highly, 42% have applied it only sometimes (most response), 11% have not applied it frequently and 11% have never applied it.
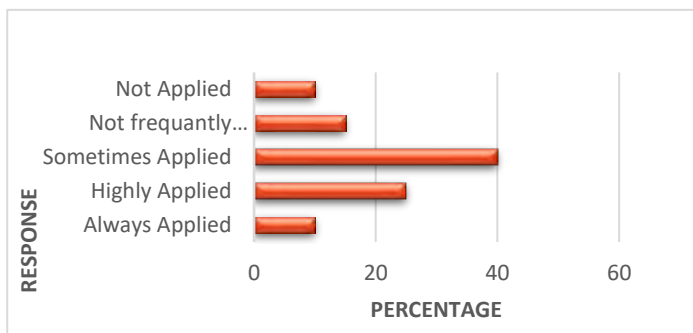
Figure **6**: Carbon Accounting applied at scheme design stage

Figure 6 shows the CA applied at scheme design stage. 10% of the professionals have always applied the Carbon Accounting at the Scheme Design Stage, 25% have applied it highly, 40% have applied it only sometimes (most response), 15% have not applied it frequently and 10% have never applied it.
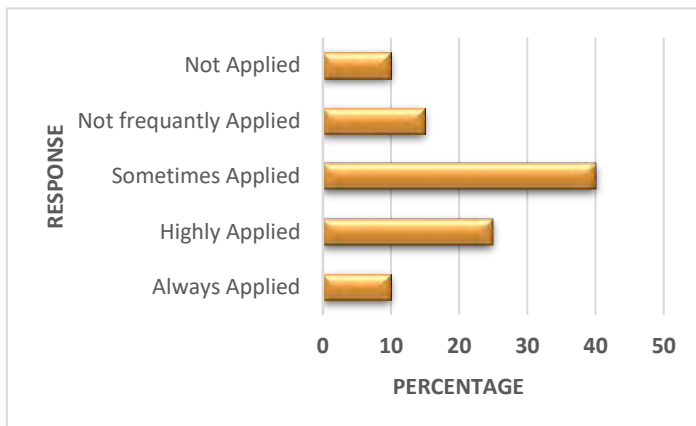
Figure 7: Carbon Accounting applied at detail design stage

As shown in Figure 7, 10% of the professionals have always applied the Carbon Accounting at the Detail Design Stage, 25% have applied it highly, 40% have applied it sometimes, 15% have not applied it frequently and 10% have never applied it.
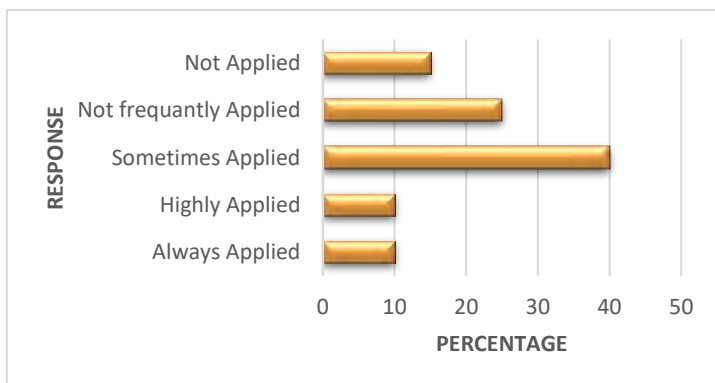
Figure 8: Carbon Accounting applied at construction at site stage

Figure 8 shows the CA applied at the construction at site stage. 10% of the professionals have always applied the Carbon Accounting at the Construction at Site Stage, 10% have applied it highly, 40% have applied it sometimes, 25% have not applied it frequently and 15% have never applied it.
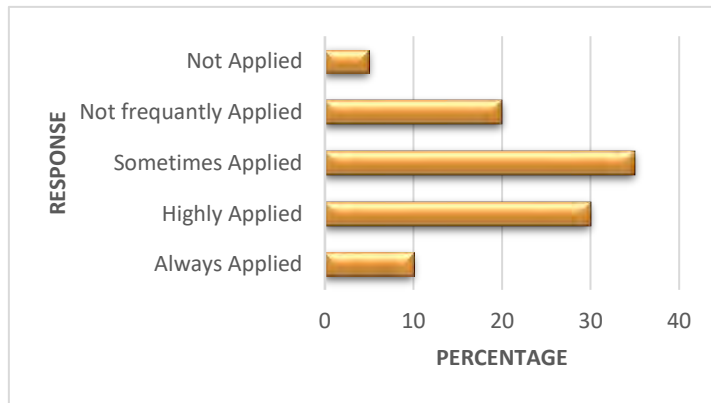
Figure 9 shows CA applied at the maintenance stage. 10% of the professionals have always applied the Carbon Accounting at the After Construction/Maintenance Stage, 30% have applied it highly, 35% have applied it only sometimes (most response), 20% have not applied it frequently and 5% have never applied it.

Figure 9: Carbon Accounting applied at construction at site stage

3.4 QUANTITY SURVEYOR'S ROLE IN THE CARBON ACCOUNTING OF SRI LANKAN CONSTRUCTION INDUSTRY AND HIS POTENTIALS

3.4.1 LITERATURE REVIEW ON QUANTITY SURVEYORS' ROLE IN THE IDENTIFICATION OF CARBON ACCOUNTING

Quantity Surveying is a profession, that guarantees the assets of the construction business are used to the best point of interest of Society, by suggesting to obtain the optimum value for money, by monetary administration (Reddy, 2018).

The total amount of embodied Carbon of a material or structure, is directly proportional to the quantity of the material used in the building (Akbarnezhad and Xiao, 2017).

Quantity Surveyors are the professionally qualified group, typically involved in measuring the quantities of materials for the preparation of cost plans, since they are the most ideal professionals in the industry to quantify the embodied Carbon dimensions for their reports and to calculate and manage this environmental impact of the built environment, as a part of the cost planning. (RICS, 2012)

Further, RICS (2012) described, that Carbon emissions released from the entire activities through the lifecycle of a building, could be measured by a Quantity Surveyor, since he is well armed with a good vision about quantities and specifications. The Quantity Surveyor can perform an initial assessment of embodied Carbon at the initial stages of a construction project. The RICS (2012) further recommends the quantity surveyors, for Carbon critical elements to be included in embodied Carbon calculations, highlighting that the Quantity Surveyor is one of the best professionals to help the sustainability by identifying Carbon values.

Affori (2012), also has pointed out the importance of Carbon indexing of buildings, by Quantity Surveyors. Although, the Carbon accounting must not only consider the quantification of GHG emitted, but also the emission cost or Carbon price, which is the financial impact of emissions. For example, Carbon allowances could be used to determine financial risks (Tang, 2014).

Table 1 summarizes the responsibilities of modern quantity surveyors.

Table 1: Responsibilities of Modern Quantity Surveyors

Involvement Area	Authors
Value Management	(Reddy, 2018), (Cartlidge, 2018)
Provision and Accessibility to Wide Range of Procurement Services	(Reddy, 2018), (Cartlidge, 2018)
Cost Management and Controlling Concepts	(Reddy, 2018), (Cartlidge, 2018)
Conception of Innovative Developmental Approaches	(Reddy, 2018), (Cartlidge, 2018)
Life Cycle Costing	(Reddy, 2018), (Cartlidge, 2018)
Working Ability with BIM	(Reddy, 2018), (Cartlidge, 2018)
Sustainability Assessment	(Reddy, 2018), (Cartlidge, 2018)
Analysis of Embodied Carbon Values	(Cartlidge, 2018), ((RICS), 2012)

Ultimately, the value management skills, provision and accessibility to a wide range of procurement services skills, cost management and controlling skills, conception of innovative developmental approaches skills, etc., are concluded as quantity surveying competencies.

3.4.2   RESULTS OF INTERVIEWS: OPINION SURVEY ON QUANTITY SURVEYORS

Basically, the interviews were carried out as an opinion survey, to verify the awareness of the CA concept. The survey was carried out among 10 quantity surveyors, who had more than 10 years of experience in the industry.
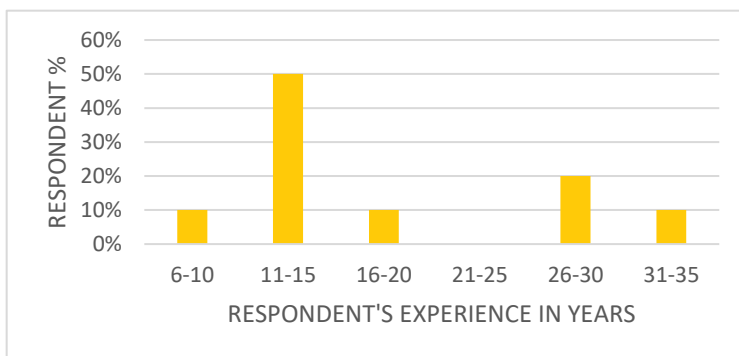
As shown in Figure 10, 10% of the respondents had 6-10 years of experience, 50% had 11-15 years, 10% had 16-20 years, 20% had 26-30 years and 10% had 31-35 years of experience.

Figure 10: Industry Experience

Accordingly, an in-depth-study was planned to be conducted through an Interview Survey among the quantity surveyors, to identify the applications of CA at each stage of the expertise areas, such as the provision and accessibility not limited to cost management and cost controlling, procurement services management, value management, developmental approaches of life cycle costing, etc.

Before going through this in-depth-study, an assessment was made to evaluate the initial awareness of quantity surveyors on the CA in the Sri Lankan construction industry.

Figure 11: Evaluating the Quantity Surveyors' awareness, in the Carbon Accounting of Sri Lankan Construction Industry
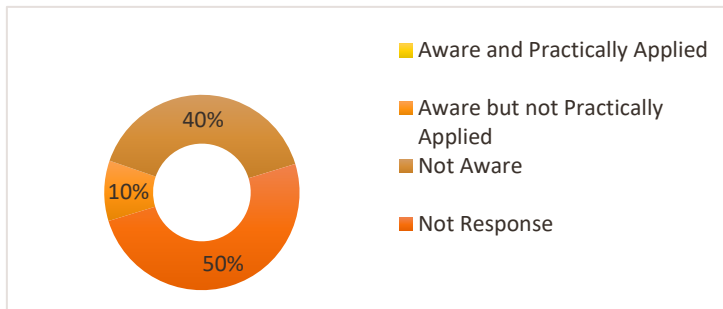
According to Figure 11, 40% of the respondents were not aware of the CA concept. 50% of respondents had not responded. 10% of the participants were aware of it but had not practically applied.

As a conclusion, even though the CA is not a novel concept to the construction industry, 90% of the interviewees had no idea about it.

As such, the in-depth-study, originally planned to be conducted through an Interview Survey, was found to be not feasible technically, as the basic knowledge of the quantity surveying practitioners on the application of CA concept in the construction industry, was found to be not up to the required standard.

3.5 RECOMMENDATIONS TO IMPROVE THE ADOPTABILITY OF CARBON ACCOUNTING CONCEPT IN THE CONSTRUCTION PROJECTS OF SRI LANKA

According to the results the key construction professionals in Sri Lanka: civil, structural engineers, architects, project managers, MEP Engineers and quantity surveyors shown with a significantly lower awareness about carbon emission strategies and Carbon Accountability concepts at built material. However, the professionals of the construction industry such as civil engineers, architects, project managers, structural engineers, etc., after being explained the benefits of the concept have responded favorably in the application of it, in future construction projects.

Special focus was made at consideration of Carbon emissions as a material selection criterion, as per CA concepts, and it was identified key professionals were identified with very minimally considerations of CA concepts when selecting material at construction.

As per the interviews, it was further identified with comments of some minimal application of fundamentals of CA concepts in green building codes of the country. Therefore, as recommendations it was suggested that, the needs of major revision at Green Building enactments, Green Building codes, to be done with special reference/consideration with CA concepts fundamental applications. It is specially recommending to a central governmental enactment, making the CA concept-based codes while selecting the Building Material, to be implemented as mandatory to apply construction jobs of Sri Lanka. Suitable regulation level enactment to improve is also proposed.

Knowledge and application of CA concepts by the professionals in construction projects is not found to be at a very satisfactory level, according to this study. Therefore, a lot of improvements in the filling of the knowledge gap on this subject, among the Quantity Surveying professional would be essential. Interviewees have expressed their willingness to learn more about CA concept and also to get involved positively in the application of it in future projects, if they were given the opportunity. need of

filling fundamentals of CA knowledge gap at key professionals is also highly recommended, as per the study.

4. CONCLUSIONS

The particpants of the survey have responded, that they have *"practically applied"* or *"sometimes applied"* the CA at the construction stages overall. This shows conflicting findings that: their awareness level, and application level of CA. Therefore, it can be concluded that participants of the study are not aware of the real meaning of "Carbon Accounting", and the related fundamentals. but they identify it as per the ideologies of "Green concepts in overall sense".

Results indicate that interviewees, as key professionals: Civil and Structural Engineering, Architectural, Project Managing and MEP Engineering disciplines*),* were in lack of satisfactory knowledge level (4%), about the application of CA concept for construction industry projects.

40% of the sample were not aware of the CA concept and only 10% have responded that they are aware of the said concept, yet they do not practically apply the knowledge in construction projects.

Moreover, it is recommended to conduct awareness programs on the CA concept, among the key professionals involved in the Sri Lankan Construction Industry. Further, even if application green building codes of Sri Lanka is considerably noticed among the key professionals in construction practice, as per the interviews it was identified with minimal essential applications of CA fundamental concepts in these codes as a basis. Also, it is recommended to impose enactments regarding green building code application as mandatory to apply at construction work, which to be developed in special focus to applications of CA fundamental in green building codes

REFERENCES

Abeydeera L.H.U.W., Mesthrige J.W.,(2019). Samarasinghalage T.I., Perception of Embodied Carbon Mitigation Strategies: The Case of Sri Lankan Construction Industr, *Sustainability. 11(11),* p.30; https://doi.org/10.3390/su11113030

Alexis Laurent, A., Olsen S.L., Hauschild M.Z., (2012). Limitations of Carbon Footprint as Indicator of Environmental Sustainability, Environ. Sci. Technol. *46,* (*7),* pp.4100–4108, https://doi.org/10.1021/es204163f

Ali Akbarnezhad and Jianzhuang Xiao, (2017). Estimation and Minimization of Embodied Carbon of Buildings. *s.l.: Tongji University*

Cartlidge, D., (2009). Quantity Surveyor's Pocket Book. First ed. Burlington: Elsevier Ltd.

Cartlidge, D., (2018). New Aspects of Quantity Surveying Practice. 4 ed. Oxon (2 Park Square, Milton Park): Routledge

Hogne N., Edgar L., Hertwich G., (2009). The case for consumption-based accounting of greenhouse gas emissions to promote local climate action, *Environmental Science & Policy, 2, (7),* pp 791-798 https://doi.org/10.1080/00420980500150839

Jayalath, C., (2017). Carbon Accounting; a New Dimension of Quantity Surveying. Construction Review.

Kucukvar M., Tatari O., (2013). Towards a triple bottom-line sustainability assessment of the U.S. construction industry, *The International Journal of Life Cycle Assessment.18*, 958–972

Nawarathna A., Siriwardana M.,Alwan Z.,(2021). Embodied Carbon as a Material Selection Criterion: Insights from Sri Lankan Construction Sector, *Sustainability* , *13*(4), 2202; https://doi.org/10.3390/su13042202, 2021

Polèse M., (2018).Cities and National Economic Growth: *A Reappraisal*, *42, (8)*

Reddy, Y. B., (2018). The Changing Face of Quantity Surveying Practices in Construction Industry.

RICS, R. I.O C. S., (2012). Methodology to calculate embodied carbon of materials. First ed. London: Royal Institution of Chartered Surveyors (RICS).

Sayma Zia, S., et al(2021) , Environmental Science and Pollution Research. (28), pp 52499–52513

Schmidt, M., (2009). Carbon accounting and carbon footprint - More than just diced results? *International Journal of Climate Change Strategies and Management*.

Tang, Q., (2014). The Role of Carbon Accounting in Corporate Carbon Management Systems*: a Holistic Approach. Australia, Western Sydney University*

EVALUATION OF ACCURACY OF NATURAL LIGHTING SIMULATION; A CASE STUDY

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ABSTRACT

Daylighting or natural lighting is the freely available natural lighting source which can be utilized for internal lighting of buildings specifically in tropical countries like Sri where the sunlight is available throughout the year. However since the daylighting levels generally vary over the year and during the day, designing a lighting system with natural lighting is a complex process and simulation software are used to predict the amount of daylight levels available at a given point at a given time. Hence accuracy of the software is crucial. This study looks at a typical room in a building in Sri Lanka and compares the results produced by two such simulation software with actual measurement and also compares the results obtained by the two software in order to verify how realistic the simulated values are.

Keywords: *Daylighting, Simulation, Sri Lanka.*

1. INTRODUCTION

Natural light or daylight as it is also commonly known is a freely available lighting source. Sri Lanka is a tropical country where sunlight is available all throughout the year. Therefore it is widely discussed that it is possible to incorporate daylighting to Sri Lankan buildings as an alternative to artificial lighting. However in most of the commercial buildings in the country, very low attention is given for effectively incorporating daylighting to the building. Most of the buildings are installed with a full system of artificial lighting to cater to all lighting requirements. While artificial lighting is a mandatory requirement when the building is used during the night time or in the daytime when daylighting levels are low, during the daytime artificial lighting usage can be minimized by incorporating daylighting to the building.

1.1 BACKGROUND STUDY AND REVIEW OF LITERATURE

The main problem for not integrating daylighting as a regular lighting source in buildings is due to the unpredictable nature of natural lighting. Natural lighting that penetrates the building will change during the time of the day, over the year and also it will be changing with the climatic condition of the day. Therefore designers sometimes see natural lighting as unreliable source and do not consider the building design. The most common practice is to think that if daylight is there it will be an additional bonus, and users will switch off artificial lighting when natural lighting is available. This approach however does not work since users will very rarely be concerned about whether they should switch off the artificial lighting. Therefore proper planning of daylighting is essential if the advantages of daylighting is to be utilized for a building. This is specifically important for a country like Sri Lanka where we see that daylighting is available throughout the year. Due to the unpredictability and dynamic nature of natural lighting, prediction of

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availability of daylighting at a particular site at a given time is important to make decisions regarding incorporating daylighting for a building at the design stage. There are several software tools available, which can simulate and predict natural light; however the accuracy of the software with the actual condition has to be evaluated. Further, although it is presumed that natural lighting is available in Sri Lanka all throughout the year its variation and other dynamic behaviors have to be determined.

Many research work have been carried out to evaluate the advantages and effectiveness of incorporating daylighting, According to (Chien & Tseng, 2013) "to achieve a higher level of energy efficiency and sustainability in the buildings sector, the consideration of natural daylight utilization during the daytime is crucial. Towards this end, the electric lighting would then be supplemental, such that significant reduction of electric lighting demands can be achieved. That can result in significant impacts on building performance, energy efficiency, productivity, as well as occupants' comfort and satisfaction" . Research work has been carried out in relation to capabilities and accuracy of daylight simulation software. "Despite computer simulation programs being frequently used during the design development stage, the complexity of the programs and insufficient program documentation have been identified as weaknesses of the existing computer simulation programs. Such level of complexity increases the amount of time required for calculations and only those with reasonable skills and knowledge would be able to perform the calculations." (Wong, 2017)

According to Wong (2017) minimum accuracy between measurements and simulation was reported as around 20% and one of the main difficulties is how to acquire reliable measurements of reflectivity from surroundings. Chien & Tseng (2013) discusses a possible reason for the accuracy of the simulation results. "The most used daylight metric is based on a simplified daylight performance model at one time step under the standardized overcast sky. There have been concerns that the results obtained from such a metric may not reflect intermediate daylight performance conditions over an extended period of time with variable sky conditions." In Sri Lankan context, (Korale, 2013) has carried out a simulation modelling on daylight implementation for a commercial building using Dialux 4.11 software.

After reviewing previous work, the research objectives of this study are:

   i.   To evaluate the accuracy of the simulation results produced by daylighting software with actual readings in Sri Lankan conditions.
   ii. To determine the variations of natural lighting in Sri Lanka over the day and also over the year.

2. METHODOLOGY

In order to achieve the two specified objectives experimental measurement and software simulation was used.

2.1. EXPERIMENTAL MEASUREMENT

One of the objectives is to compare the experimental data with the simulation data produced from the software. In order to evaluate the accuracy of the results, a set of experimental data were obtained. For the measurement an office building in the old building of University of Vocational Technology was selected. The location of the selected room is illustrated in figure 1. The room selected is an office room and it has windows facing approximately the south east.
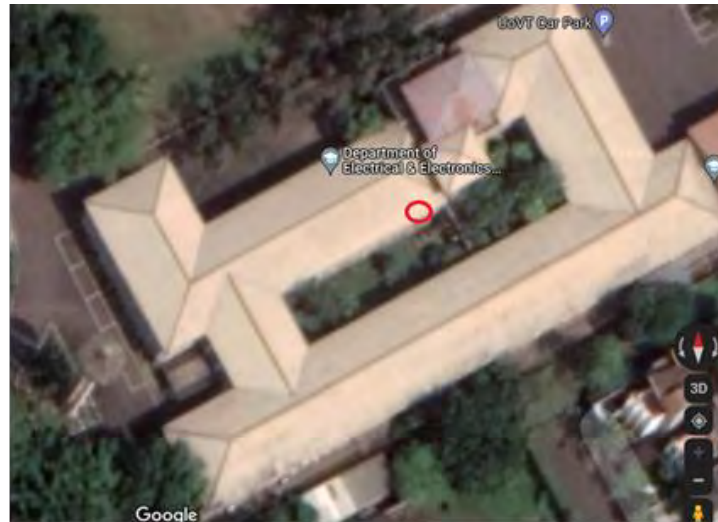
Figure 1: Location of the Selected Room for Experimental Measurement

2.2. SIMULATING THE SCENARIO WITH SOFTWARE

In order to compare the experimental data and the results given by the simulation software, the same scenario where the experimental data were measured must be simulated using a software that is suitable for daylight simulating. Dialux and Design Builder software were selected for this purpose since the software were readily available and both software had several settings that can be configured so that the actual scenario can be simulated as close as possible to the actual case. The results of daylighting calculation may depend on many factors. Some of these factors are location of the building , building orientation, size, material of the window or other opening through which the daylight enters the building, day and time of the year the simulation is done, condition of the sky and calculation of surface height, size etc.

Most of these factors were customizable in both software and the relevant details are presented below.

2.2.1 SIMULATING WITH DESIGN BUILDER SOFTWARE

Design Builder software enables setting parameters such as building shape, size and material of the window and calculation surface. However weather data (location of the site) for Sri Lanka was only available for Katunayake and therefore the location of the building had to be set as Katunayake. However the orientation of the building with respect to north could be adjusted accurately. The software presents seven sky models defined by CIE are CIE Sunny Clear Day, CIE Clear Day, CIE Sunny Intermediate Day, CIE Intermediate Day, CIE Overcast Day, and Uniform Cloudy Sky. Therefore a

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suitable sky condition can be selected that is applied to the scenario and in most of these options the date of the year and time of the day could be also selected.

2.2.2 SIMULATING WITH DIALUX EVO SOFTWARE

Dialux Evo 9.2 was used for the simulation. The software enables setting parameters such as building shape, size and material of the window and calculation surface. The location of the site could be given accurately with longitude and latitude and the orientation of the building with respect to the north also could be given accurately. In that aspect Dialux is more flexible than Design Builder. The time of the day and day of the year can also be given. However there are only three sky models described in CIE 110-1994 which can be selected in the Dialux Evo software. They are Clear Sky, Average Sky and Overcast Sky.

2.3 SIMULATION SCENARIOS CONSIDERED

The simulations were carried out for a few cases. For the scenarios the experimental data were measured, the simulation was carried out from both software. The illuminance levels were calculated for the same working plane that was considered for the experimental measurement. The sky condition that was prevailing at the time of the measurement was taken for the simulation as well. Another set of simulations was carried out for every 1st and 15th of each month of the year at 10am, 12 noon and 2pm. This simulation was done from both software with the intention of analyzing the variation of natural lighting conditions over the year and also over the time of the day.

3. RESULTS AND DISCUSSION

3.1 COMPARISON OF EXPERIMENTAL AND SIMULATED DATA

The comparison between the results obtained through experimental measurement and simulation for different days of the year is tabulated in Table 1. From Table 1, it can be observed that in some cases there are significant differences between simulated value and experimental value. The Pearson correlation coefficient was calculated for the two series of data. Correlation coefficient between measured and simulated data of Design builder software is 0.948 and correlation coefficient between measured and simulated data of Dialux Evo software is 0.67. Hence the simulated data by design builder is closer to the actual measured data. However in order to verify this further the analysis must be done for a higher number of points.

3.2 VARIATION OF EXPERIMENTAL DATA OVER THE YEAR

The experimental data was measured from the month of July to December. Using this data, analysis was done on the variation of natural lighting. Most of these measurements were made at 1 pm however there are some points that were taken at different timing. Since timing also has an effect on the illuminance, these points were not considered for the analysis. The variation of the natural lighting of the measured working plane from July to December is illustrated in Figure 2.

Table 1: Experimental Data vs Simulated Data

Date	Measured Average Illuminance Value (Lux)	Simulated Average Illuminance Value (Lux)- Design Builder	Simulated Average Illuminance Value (Lux)- Dialux Evo	Error % Design Builder
7/14/2021	759.25	750.6	918	1%
7/26/2021	254.5	331	735	-23%
8/02/2021	975.75	819	958	19%
8/10/2021	982.75	847.8	984	16%
10/21/2021	734	801.4	712	-8%
10/21/2021	881.75	789	616	12%
11/05/2021	738	825	638	-11%
11/16/2021	926	912.6	903	1%
12/02/2021	637.75	720	575	-11%
12/10/2021	1281.25	1244.8	1243	3%

Figure 2: Experimental Data Variation of the Measured Average Illuminance from July to December
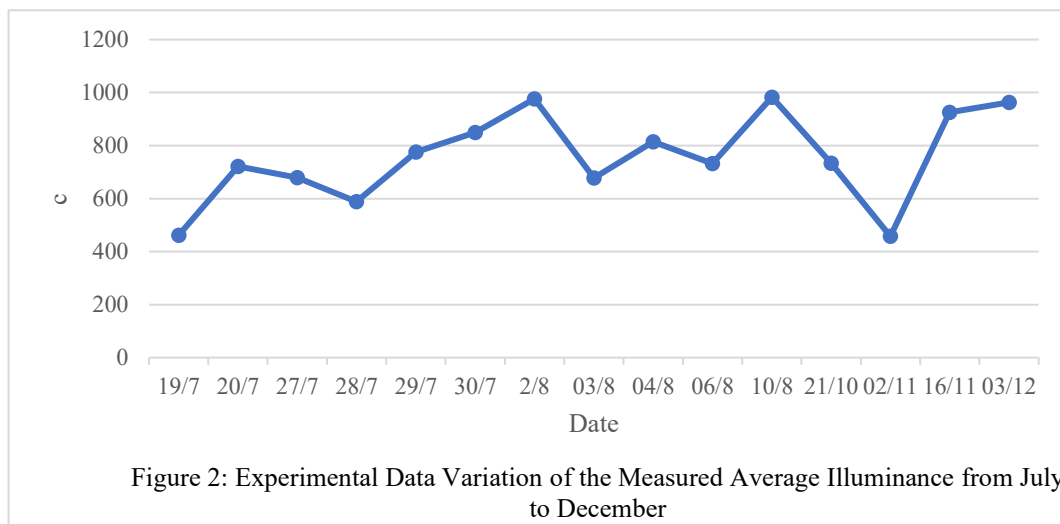
3.3 VARIATION OF SIMULATED DATA OVER THE YEAR

As explained in the research methodology simulations were carried out over the year at three selected times (three cases) under clear sky conditions. The simulation was carried out using both software. For this calculation the whole room was considered as the working plane (except for the wall boundary). The analysis was done for three cases, that is at 10 am, 12 noon and 2 pm. The results are illustrated in Figure 3. When the three graphs were analyzed it was observed that there is a difference between the values simulated by the two software. This can be due to various reasons such as the approximations made in location, variations of the data used in the two software etc. However if the variation of the illuminance over the year is considered the same type of pattern can be observed in all three cases. During the first months (January, February) the illuminance levels are high and then the illuminance gradually decreases and comes to the minimum values in the months of June, July and August and then the illuminance values gradually increase and come to the maximum in December.

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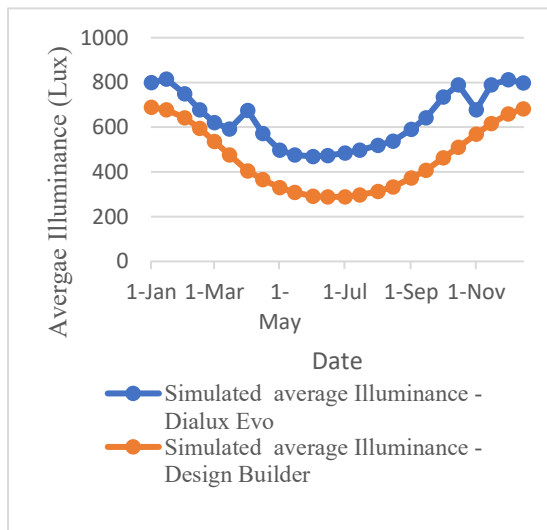
Figure 3 a: Variation of Simulated Illuminance Values Over the Year – 10 am
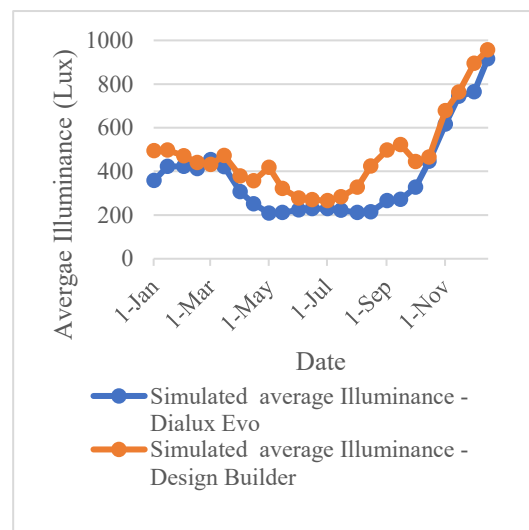
Figure 3 b: Variation of Simulated Illuminance Values Over the Year – 12
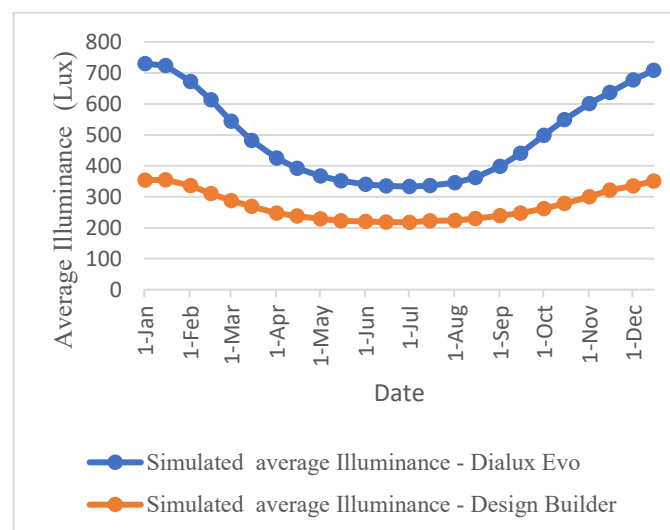
Figure 3 c: Variation of Simulated Illuminance Values Over the Year – 2 pm

Figure 3 a, b, c: Simulated Illuminance Variation over the Year- 10 am,12 noon and 2 pm

4. CONCLUSIONS AND LIMITATIONS

From the data and the analysis several conclusions can be made. There is a significant difference between the values simulated by Design Builder and Dialux Evo software. This variation may be because of the various approximations made in the software in respect of location of the site, weather data, internal and external reflections from obstacles and the material properties. Specially the definition of the sky model in each software is different and this could make a considerable difference in the results given. Further by comparing the Pearson correlation coefficients it can be concluded that the experimental data are closer to the Design Builder therefore we can conclude that Design Builder

software gives more realistic results for the case considered. However this should be further verified with more experimental data. Regarding the variations of the daylighting over the year from experimental and simulation data it can be concluded that the daylighting levels are higher in the months of December, January and February and lowest in the months of June, July and August. However whether this variation is common for rooms facing all directions must be verified further by a more detailed study.

REFERENCES

Chien, S.-c. & Tseng, K. J., (2013). Simulation-assisted daylight performance analysis in a high-rise office building in Singapore. *Beijing, China, 30th CIB W78 International Conference.*

Korale, C., (2013). Daylight utilisation in commercial buildings and potential energy savings, *s.l.: s.n.*

Wong, L., (2017). A review of daylighting design and implementation in buildings. *Renewable and Sustainable Energy Reviews*, pp. 959-968.

USE OF AGRO-WASTE FOR MASONRY UNIT CONSTRUCTION IN SRI LANKA: A MINI-REVIEW

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ABSTRACT

Emerging research on green building materials focuses excessively on utilizing agro-waste to ensure sustainable practices. In this regard, there has been appreciable work done in Sri Lankan masonry unit construction industry using agro-waste such as rice husk, rice husk ash, coconut shells, coconut shell ash, cow dung ash, ground nut shells, and fruit resin. However, to date, no critical analysis in this arena has been presented and thus the study was conducted. We reviewed the literature from 2000 to 2022, and 19 key works were chosen to compare the performances. According to study outcomes, rice husk ash is the most commonly used agro-waste among the others. The masonry units made from coconut shells, rice husk ash/alkali activated fly ash, groundnut ash, cow dung ash and bamboo leave ash possess higher compressive strengths, while fruit resins and sugarcane bagasse yield low compressive strengths. Only a few masonry units meet both ASTM C90 and ASTM C129 standards and usually an optimum agro-waste dosage exists to ensure the best performance.

Keywords: *Agro-waste, Masonry units, Compressive strength, Review, Sri Lanka.*

1. INTRODUCTION

More than 40% of the world's population still resides in building made of earth (Jannat et al., 2020). Although fired clay bricks have been a traditional choice in most Asian countries for buildings, the processing technique involves significant CO_2 gas emission and energy demand (i.e. a fired clay brick results in approximately 0.43 kg of CO_2 production (Abdel-Gawwad et al., 2021)). Therefore, green building materials recently emerge as an excellent choice to ensure sustainable development (Jannat et al., 2020). Agro wastes (denoted as AW hereafter), which are generated during the processing and consumption of agricultural products, play a key role in developing such materials for the construction industry. In fact, the annual consumption of agro waste exceeds 4.4 billion MT in the Asia region alone and thus an excellent resource to develop greener products by completely or partially replacing the ingredient in traditional products. In this context, research have been progressing in several sectors in the construction industry to achieve the sustainability goals and the published literature encompasses the progress in the development of earth blocks, cement blocks, bricks, binder materials, aggregates, reinforcement materials and particle boards from AWs (Madurwar et al., 2013).

As an agricultural country, Sri Lanka produces a significant amount of AW annually. For example, the annual production of rice husk, rice straw, and bagasse ash account for 6.5 million MT, 9.3 million MT and 2.1 million MT, respectively (Arachchige and Sakuna, 2019, Fernando et al., 2022b). These

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materials can be used in construction industries as masonry materials. There has been a significant portion of published works that focus on using AWs in the Sri Lankan construction industry (Sathiparan and De Zoysa, 2018, Yatawara and Athukorala, 2021, Fernando et al., 2017, Fernando et al., 2018a, Fernando et al., 2022b, Udawattha et al., 2018, Perera et al., 2015). Even though the outcomes are promising, they have not been critically analyzed nor aligned well in a single document. In addition, some recently published review papers (Jannat et al., 2020, Madurwar et al., 2013) have not considered the recent improvements in the Sri Lankan context. No study has been conducted to date to address the research gaps mentioned. Thus, this review aims to critically analyze the relent research work and we restrict the scope to masonry units considering the length of the article. The research objectives include (i) compilation of relevant literature, (ii) comparison of the performances of masonry units made of different AWs, and (iii) analyze the effect of the amount of AW added on the performance. The outcomes of this study are significant in comparing the benchmarking the performances of reported agro-waste-based products and engineering agro-waste-based products in future. In this article, we first outline the methodology of selecting the relevant article and the resulting key investigations are then summarized based on different agro-waste varieties. The properties mentioned above of these masonry units are critically analyzed next, followed by conclusions and recommendations for future work.

2.   METHODOLOGY

During the research design, the relevant set of literature was first screened from an appropriate database by using appropriate keywords. We selected the Google Scholar database based on its accessibility and availability of the most published works, including books, journal articles, theses and conference proceedings. For the search, the time period ranging from 2000 to 2022 was chosen considering the emergence of relevant works in Sri Lanka. During the screening phase of relevant literature, the keywords "Agro waste", "Sri Lanka", "Earth blocks", "Blocks" and "Bricks" were used to initially screen all the relevant works. This search was further refined by specifying the AW type, for example, "Rice husk", "Rice husk ash", "Wood ash" etc. and by using the Booleans such as "and" "or". Accordingly, the study screened and analyzed 19 key works.

3. RESULTS AND DISCUSSION

3.1 TYPES OF AWS USED FOR THE CONSTRUCTION OF MASONRY UNITS

The most common AW varieties considered in masonry unit construction include rice husks, rice straws, shells (e.g., groundnut, coconut etc.), and the ashes of respective husks and shells. In addition, recent attention has been on certain abundant materials such as resins of fruits (i.e., bael, wood apple), leaves (i.e., bamboo leaves) tea waste, cow dung ash and eggshell ash (Udawattha et al., 2018, Fernando et al., 2018b, Madhushani and Yatawara, 2019, Fernando et al., 2019b). Among AWs, rice husk ash has been highly used agro-waste and around 45% of examined works focus on it. Furthermore, fruit

resins, sawdust, leave ash and animal-waste-ash have been minimally experimented and recently introduced. During the production of masonry units, AWs are mixed with (i) clay (Perera et al., 2015, Fernando, 2017, Fernando et al., 2019a, Fernando et al., 2018b, Fernando et al., 2019b) or (ii) clay/cement (Yatawara and Athukorala, 2021) or clay/lime (Fernando, 2020) or (iii) cement/sand (Sathiparan and De Zoysa, 2018, Fernando et al., 2017, Fernando et al., 2018a, Prabagar et al., 2015, Nilantha et al., 2010, Dolage et al., 2015) or (iv) cement/sand/lime (Pushpakumara and De Silva, 2012) or (v) cement/clay brick waste (Rajapaksha and Wijerathne, 2021) or (vi) NaOH or Na_2SiO_3 (Fernando et al., 2022a, Poorveekan et al., 2021) or (vii) soil (Udawattha et al., 2018) or (viii) soil/cement (Madhushani and Yatawara, 2019). Apart from providing a greener solution, by using AWs, it is usually expected to enhance the quality of the masonry unit based on several properties such as binding activity, stabilizing activity, hydraulic activity and pozzolanic activity (Prabagar et al., 2015, Rajapaksha and Wijerathne, 2021, Madhushani and Yatawara, 2019, Udawattha et al., 2018). The following section outlines how the masonry units discussed so far perform in terms of popular physical properties such as compressive strength and water absorption.

3.2 PERFORMANCE COMPARISON OF MASONRY UNITS

The performance of a masonry unit is usually assessed by its compressive strength, flexural strength, water absorption, -thermal conductivity and acoustic properties (De Silva and Perera, 2018, Sathiparan and De Zoysa, 2018). Out of these, compressive strength and water absorption were chosen for the performance comparison as they directly impact the strength of the building made by using the brick and construction quality standards usually focus on them. Figure compares the compressive strengths of different masonry units, which are either 21-day or 28-day values depending on the data available. The compressive strength data are compared against the ASTM C90 and ASTM C129 standards, which have been developed to assess the suitability of masonry units under load-bearing and non-load-bearing scenarios. The minimum recommended compressive strengths are 4.14 MPa for ASTM C129 and 13.79 MPa for ASTM C90, respectively (Sitton et al., 2018, Dolores et al., 2020).

In Figure, each bar's bottom and top values represent the minimum and maximum compressive strengths achieved in the study by differing the dosage of AW. In this way, the whole range of compressive strength obtained through the masonry unit is presented. However, for some studies, only one compressive strength value is provided in the relevant article and in such cases, a solid line is used to show the corresponding value (see for example, (Rajapaksha and Wijerathne, 2021), (Fernando et al., 2022a) and (Madhushani and Yatawara, 2019)). As per Figure, coconut shell ash-clay, cow dung ash-clay, ground nut ash-clay and rice husk ash-fly ash-Na_2SiO_3-cement masonry units can achieve larger compressive strength values while achieving the ASTM C90 standard. Apart from these, six masonry units, which are made from rice husk-sand-cement, coconut shell-sand-cement, rice husk ash-clay-lime, rice husk ash -cement-lime, peanut ash-cement-sand and saw dust-cement-sand achieve ASTM C129

standard even though they fail to reach the ASTM C90 standard. The remaining set of masonry units does not meet these standards. Out of these masonry units, when a combination of resin and soil is used, the compressive strength yields significantly low values. Furthermore, the compressive strength can be varied in a comparatively broader range when coconut shell ash, groundnut ash and bamboo leave ash are used as the AW.

Figure 1: Compressive Strengths of Different Masonry Units (RH – Rice Husk, RHA – Rice Husk Ash, CSA – Coconut Shell Ash, CS – Coconut Shell, PS – Peanut Ash, GNA – Ground Nut Ash, GNS – Ground Nut Shell, BLA – Bamboo Leaves Ash, SD – Saw Dust, SCR – Sugarcane Resin, BR – Bael Resin, WR – Wood apple Resin, RS – Rice Straw, PTW – Processed Tea Waste, CDA – Cow Dung Ash)

Figure 2 compares the water absorption rendered by different masonry units and the data representation is the same as Figure. Similar to compressive strength, water absorption can also be altered based on AW dosage. In this regard, masonry units made from ground nut ash-clay, rice husk ash -sand-cement, rice husk ash-clay and bamboo leave ash-clay demonstrate comparatively high variations of water absorption with the AW content. Lower water absorption is preferred to a masonry unit and the ASTM standards recommend a maximum of 12% water absorption (Holmes et al., 2016). Considering the products examined, the lowest water absorption is shown by rice husk ash-fly ash-Na_2SiO_3-cement unit, which has been investigated very recently (Fernando et al., 2022a). Furthermore, only four masonry units, namely, rice husk ash-fly ash-Na_2SiO_3-cement, ground nut ash-cement-sand, sugar cane resin-soil and wood ash-cement-sand masonry units, exhibit water absorption within the recommended value for the range of AW dosage tested. The coconut shell ash-sand-cement and rice husk ash-sand-cement masonry unit agree with the ASTM standards only for some values of AW dosage.
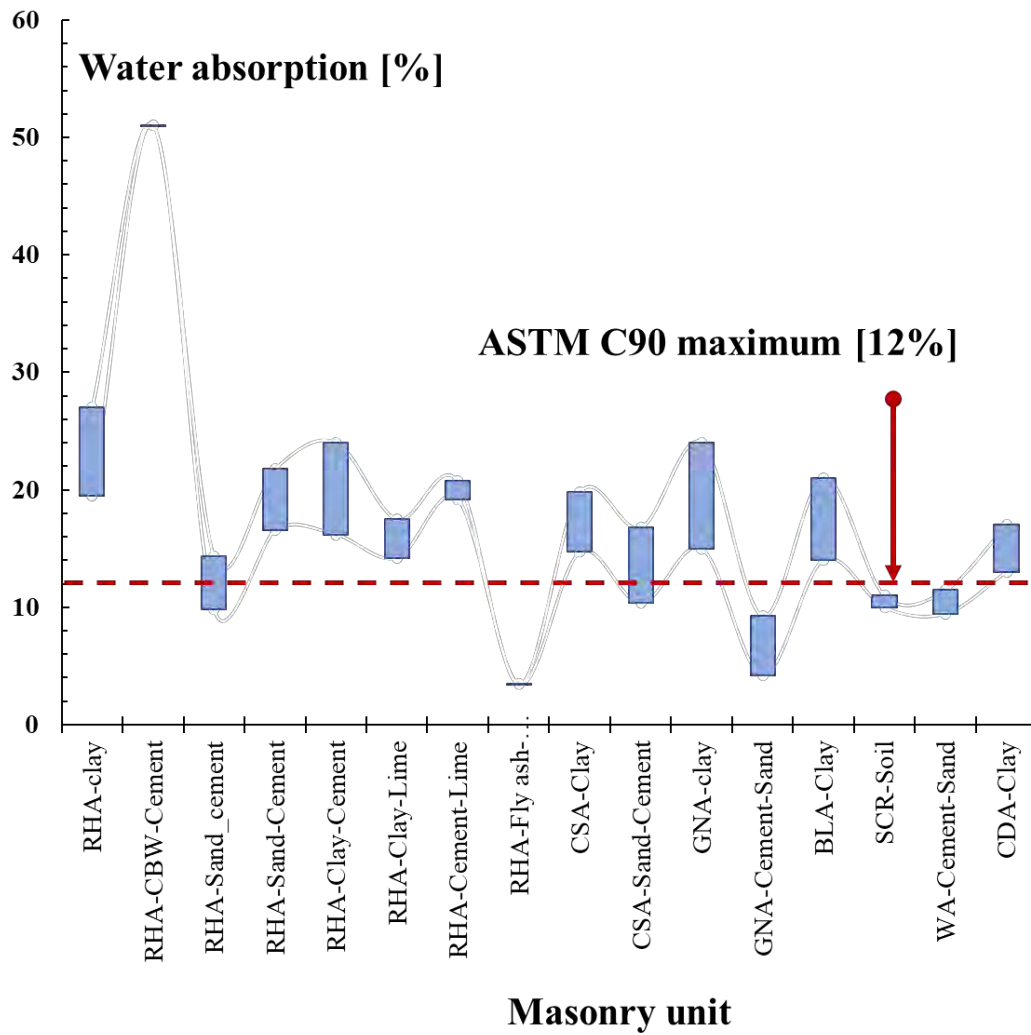
Figure 2: Percentage of Water Absorption of Different Masonry Units (RHA – Rice Husk Ash, CSA – Coconut Shell Ash, GNA – Ground Nut Ash, BLA – Bamboo Leaves Ash, SCR – Sugarcane Resin, WR – Wood apple Resin, CDA – Cow Dung Ash, WA – Wood Ash)

Some studies present water absorption as the mass of water absorbed per unit of the dry mass of the masonry unit. Figure 3 shows such data while comparing with the ASTM C90 standard. Accordingly, all the examined masonry units can achieve the standard provided that the masonry units made from rice husk-sand-cement, saw dust-sand-cement and rice straw-sand-cement can satisfy the requirement for specific values of AW dosage only.
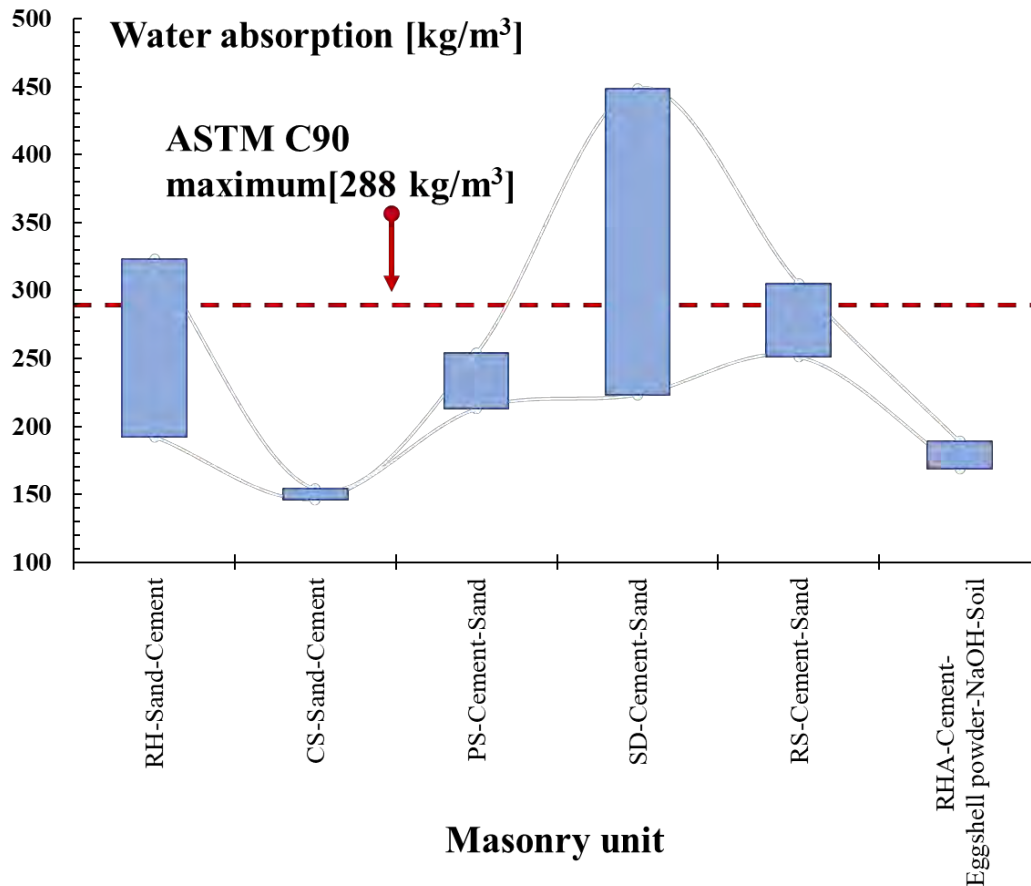
Figure 3: Amount of Water Absorbed by Unit Dry Mass of Different Brick Types (RH – Rice Husk, RHA – Rice Husk Ash, CS – Coconut Shell, PS – Peanut Ash, RS – Rice Straw)

Table 1 provides a comparison among different masonry units that individually meet compressive strength and water absorption requirements recommended by ASTM C90 and ASTM C129 standards. Accordingly, coconut shell ash-sand-cement and rice husk ash-fly ash-Na_2SiO_3-cement masonry units satisfy both standards. Thus, they may be considered to construct both load-bearing and non-load-bearing structures. Furthermore, masonry units that only satisfy the ASTM C90 requirement may be recommended for non-load-bearing structures. However, these results have been derived entirely based on ASTM standards and different results may be expected when a different standard is considered (i.e., SLS 855).

Table 1: Agreement of Different Masonry Units on ASTM Compressive Strength and Water Absorption Criteria (Acronyms: RH – Rice Husk, RHA – Rice Husk Ash, CSA – Coconut Shell Ash, CS – Coconut Shell, PS – Peanut Ash, GNA – Ground Nut Ash, BLA – Bamboo Leaves Ash, SD – Saw Dust, SCR – Sugarcane Resin, CDA – Cow Dung Ash, Symbols: √ Satisfy, *X* Does Not Satisfy)

Masonry unit	Compressive strength criterion		Water absorption criterion
	ASTM C129	ASTM C90	
RH- sand-cement	√	X	√
RHA- sand-cement	X	X	√
RHA- clay-lime	√	X	X

RHA-cement-lime	√	X	X
PS-cement-sand	√	X	√
SD-cement-Sand	√	X	√
BLA-clay	√	X	X
CSA-clay	√	√	X
CSA-sand-cement	√	√	√
CS- sand-cement	√	X	√
GNA-clay	√	√	X
RHA-fly ash-Na$_2$SiO$_3$-cement	√	√	√
CDA-clay	√	√	X
GNA- sand-cement	X	X	√
RS-cement-sand	X	X	√
SCR-soil	X	X	√
WA- sand-cement	X	X	√
RHA-cement-eggshell powder – NaOH-soil	X	X	√

3.3 EFFECT OF THE AMOUNT OF AW ADDED

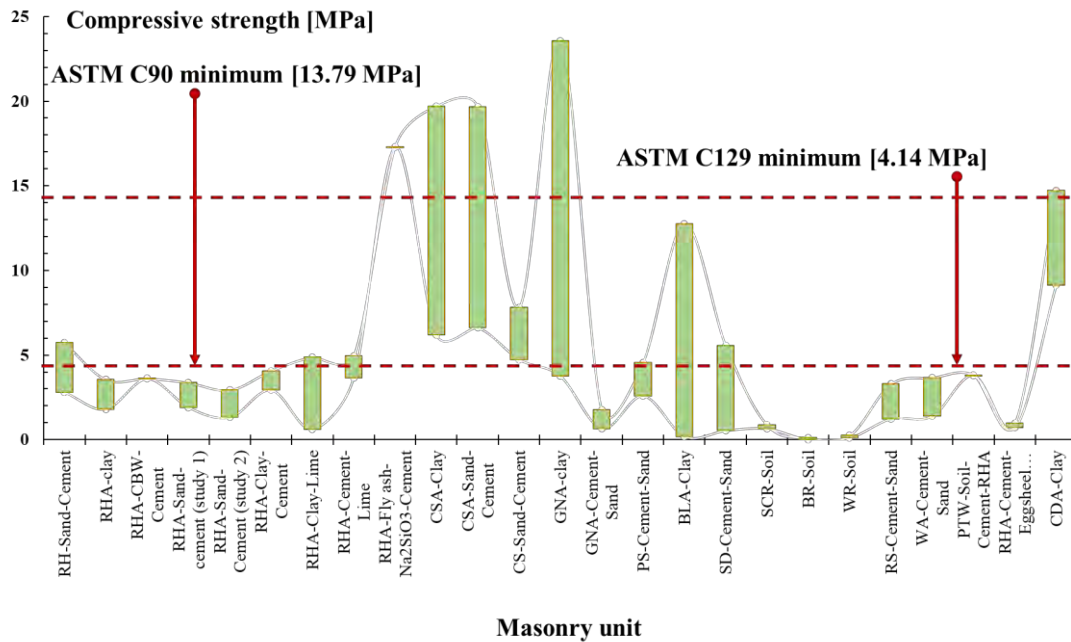Table 2: Effect Of The Amount Of AW On Compressive Strength And Water Absorbance Of Different Masonry Units (RH – Rice Husk, RHA – Rice Husk Ash, CSA – Coconut Shell Ash, CS – Coconut Shell, PS – Peanut Ash, GNA – Ground Nut Ash, GNS – Ground Nut Shell, BLA – Bamboo Leaves Ash, SD – Saw Dust, SCR – Sugarcane Resin, BR – Bael Resin, WR – Wood apple Resin, RS – Rice Straw, PTW – Processed Tea Waste, CDA – Cow Dung Ash)

Brick type	Range of AW added	Optimum composition	Compressive strength beyond optimum composition	Water absorbance beyond optimum composition	Work
RHA-clay	2-10% (w/w%)	4%	Decreases	Increases and decreases	(Perera et al., 2015)
RHA-clay-cement	5-20% (clay replacement)	7.5%	Decreases	Increases	(Yatawara and Athukorala, 2021)
RHA-clay-lime	2-14% (w/w)	12%	Decreases	Increases	(Fernando, 2020)
RHA-cement-lime	5-20% (w/w%)	10%	Decreases	Increases	(Pushpakumara and De Silva, 2012)
CSA-clay	2-10% (w/w%)	2%	Decreases	Increases	(Fernando, 2017)
CSA-sand-cement	5-50% (w/w%)	10%	Decreases	Increases and decreases	(Fernando et al., 2017)
GNA-clay	2-12% (w/w%)	8%	Decreases and increases	Decreases	(Fernando et al., 2019a)
GNA-sand-cement	5-25% (w/w%)	10%	Decreases	Increases	(Fernando et al., 2018a)
BLA-clay	2-10% (w/w%)	8%	Decreases	Increases (a little)	(Fernando et al., 2018b)
WA-sand-cement	10-25% (cement replacement)	15%	Decreases	Increases	(Prabagar et al., 2015)
CDA-sand-cement	5-20% (w/w)	10%	Decreases	Increases	(Fernando et al., 2019b)
RHA-cement-eggshell powder-NaOH-soil	10-20% (RHA + eggshell powder) Within each mixture, eggshell powder: RHA ratio was also varied (10:90, 20:80, 30:70, 40:60)	30:70 (eggshell powder: RHA)	Decreases	Decreases	(Poorveekan et al., 2021)

According to the outcomes in the examined literature, the dosage of AW governs the properties of the masonry unit. Table presents information on AW dosage and the effect of AW dosage on compressive strength and water absorption of selected studies. These studies were selected based on the availability

of compressive strength and water absorption with a varying AW dosage. Based on that, for most masonry units developed, an optimum amount of AW (usually less than 10% w/w) can assure the maximum compressive strength and minimum water absorption. Beyond this limit, usually, the compressive strength tends to decrease, and water absorption increases while making the product undesirable as per construction protocols. However, some studies present the optimum AW dosage based on the workability and surface finish of the masonry unit (Rajapaksha and Wijerathne, 2021).

4. CONCLUSIONS

The current study was carried out to critically evaluate the agro-waste (AW) use in the Sri Lankan masonry unit construction industry. Accordingly, rice husk ash is identified as the most used AW. The masonry units made from coconut shells, coconut shell ash, groundnut ash, bamboo leave ash and cow dung ash possess larger compressive strengths, while fruit resins and sugarcane bagasse result in significantly low compressive strengths. The water absorption is significantly low in the masonry units made from rice husk ash-fly ash-Na_2SiO_3-cement, ground nut ash-cement-sand and coconut shell-sand-cement. Out of the products examined, coconut shell ash-sand-cement and rice husk ash-fly ash-Na_2SiO_3-cement masonry units satisfy ASTM C90, C129 standards in both compressive strength and water absorption. Thus, they can be recommended for both load-bearing and non-load-bearing scenarios. The AW dosage can finetune the compressive strength and water absorption in masonry units and an optimum agro waste dosage usually exists to ensure the best performance. This study can be further extended by analyzing other reported properties, such as dry density, thermal conductivity etc. to further elaborate on the use of various agro waste in controlling the properties of masonry units.

5. ACKNOWLEDGEMENT

REFERENCES

Abdel-Gawwad, H. A., Rashad, A. M., Mohammed, M. S. & Tawfik, T. A. (2021). The potential application of cement kiln dust-red clay brick waste-silica fume composites as unfired building bricks with outstanding properties and high ability to CO2-capture. *Journal of Building Engineering,* 42**,** pp 102479.

Arachchige, U. & Sakuna, S. (2019). Alternative fuel for biomass boilers in Sri Lanka. *International Journal of Chemical Studies, 7***,** pp 729-733.

De Silva, G. S. & Perera, B. (2018). Effect of waste rice husk ash (RHA) on structural, thermal and acoustic properties of fired clay bricks. *Journal of building engineering, 18***,** pp 252-259.

Dolage, D., Alirajay, A. & Parvathakeethan, A. (2015). Use of rice husk ash blended cement to manufacture cellualr masonry blocks. *Construction Materials and Systems***,** pp 148.

Dolores, A. J. S., Lasco, J. D., Bertiz, T. M. & Lamar, K. M. (2020). Compressive strength and bulk density of concrete hollow blocks (CHB) infused with low-density polyethylene (LDPE) pellets. *Civil Engineering Journal, 6***,** pp 1932-1943.

Fernando, P. (2020). Compressive strength, density and water absorpation of clay bricks with partial replacement of lime and rice husk ash. *GSJ,* pp 8.

Fernando, P., Hatangala, H., Karunagaran, S. & Dissanayake, D. (2018). Evaluates some engineering properties of innovative sustainable cement blocks as a partial replacement of groundnut shell ash (GSA). *Acta Scientific Agriculture (ISSN: 2581-365X),* pp 2.

Fernando P., Madhushani, L. D., Prarthana, M. & Nanayakkara, H. (2019). Synthesis and characterization of clay brick using waste groundnut shell ash. *Journal of Waste Resources and Recycling,* p 1.

Fernando, P. R. (2017). Mechanical and physical properties of fired clay brick partial doped with coconut shell ash. *J Energy Nat Resour, 6,* pp 58-63.

Fernando, P. R., AAZIR, S. M., Pushpalatha, N., Puvanakanthan, N. & Nishantha, V. H. T. (2017). The performance of the low cost masonry cement blocks as a partial substitution of coconut shell ash. *American Journal of Mechanical and Industrial Engineering, 2,* pp 212-220.

Fernando, P. R., Kannangara, G. L., Buddhika, G. P. & Urushiya, A. (2018). Synthesis and characterization of sustainable man-made low cost clay bricks with bamboo leaf ash. *Engineering Physics, 2,* pp 15-22.

Fernando, P. R., Krishanth S., Rathnayake, N. B. & Welarathne, S. A. (2019). Manufacturing, Physical and Chemical Characterization of Fire Clay Brick Value Added with Cow Dung Ash. *American Journal of Materials Synthesis and Processing, 4,* pp 32-36.

Fernando, S., Gunasekara, C., Law, D. W., Nasvi, M. C. M., Setunge, S., Dissanayake, R (2022). Engineering properties of waste-based alkali activated concrete brick containing low calcium fly ash and rice husk ash: A comparison with traditional Portland cement concrete brick. *Journal of Building Engineering, 46,* p 103810.

Fernando, S., Gunasekara, C., Law, D. W., Nasvi, M. C. M., Setunge, S., Dissanayake, R. & Robert, D. (2022). Environmental evaluation and economic analysis of fly ash-rice husk ash blended alkali-activated bricks. *Environmental Impact Assessment Review, 95,* p 106784.

Holmes, N., O'malley, H., Cribbin, P., Mullen, H. & Keane, G. (2016). Performance of masonry blocks containing different proportions of incinerator bottom ash. *Sustainable Materials and Technologies, 8,* pp 14-19.

Jannat, N., Hussien, A., Abdullah, B. & Corgrave, A. (2020). Application of agro and non-agro waste materials for unfired earth blocks construction: A review. *Construction and Building Materials, 254,* p 119346.

Madhushani, K. & Yatawara M. (2019) Use of Processed Tea Waste Powder and Fiber in Improving the Properties of Rice Husk Ash Filled Compressed Stabilized Earth Blocks. (2019). *4th International Conference on Advances in Computing and Technology (ICACT – 2019)*, Faculty of Computing and Technology, University of Kelaniya, Sri Lanka. pp 24.

Madurwar, M. V., Ralegaonkar, R. V. & Mandavgane, S. A. (2013). Application of agro-waste for sustainable construction materials: A review. *Construction and Building materials, 38,* pp 872-878.

Nilantha, B., Jiffry, I., Kumara, Y. & Subashi, G. (2010). Structural and thermal performances of rice husk ash (RHA) based sand cement block. I*nternational Conference on Sustainable Built Environment (ICSBE-2010),* pp 138-144.

Perera, B., Madhushanka, K., De Silva, G. & De Silva, G. (2015). Effect of rice husk ash (RHA) on structural properties of fired clay bricks. *6th International Conference on Structural Eng. and Construction Management,.* pp 131-136.

Poorveekan, K., Ath, K., Anburuvel, A. & Sathiparan, N. (2021). Investigation of the engineering properties of cementless stabilized earth blocks with alkali-activated eggshell and rice husk ash as a binder. *Construction and Building Materials, 277,* pp. 122-371.

Prabagar, S., Subasinghe, K. & Fonseka, W. (2015). Wood ash as an effective raw material for concrete blocks. *Int J Res Eng Technol,* 4, pp 1-6.

Pushpakumara, B. & De Silva, G. (2012). Characteristics of masonry blocks manufactured with rice husk ash (RAH) and lime.

Rajapaksha, R.P.T.N. & Wijerathne, W.D.C.C. (2021). Investigating the potential of clay brick waste to be used as a raw material for rice husk ash-based bricks. *5th International Research Conference Uva Wellassa University (IRCUWU) 2021,* pp 311.

Sathiparan, N. & De Zoysa, H. (2018). The effects of using agricultural waste as partial substitute for sand in cement blocks. *Journal of Building Engineering, 19,* pp 216-227.

Sitton, J. D., Zeinali, Y., Heidarian, W. H. & Story, B. A. (2018). Effect of mix design on compressed earth block strength. *Construction and Building materials, 158,* pp 124-131.

Udawaththa, C., De Silva, D. E., Galkanda, H. & Halwathura, R. (2018). Performance of natural polymers for stabilizing earth blocks. *Materialia, 2,* pp 23-32.

Yatawara, M. & Athukorala, S. (2021). Potential of replacing clay soil by rice husk ash (RHA) in enhancing the properties of compressed earth blocks (CEBs). *Environment, Development and Sustainability,* 23, pp 3474-3486.

EFFECTIVE TOOLS OF COST CONTROL PREFERRED BY CONTRACTORS OF SRI LANKA: A CASE STUDY

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ABSTRACT

Effective tools of cost control are important to achieve project success in the construction industry, as various tools of cost control help to minimize cost overruns. The aim of the research is to gauge the effectiveness of various tools of cost control preferred by contractors in Sri Lankan building construction projects and minimize cost overruns. This research identifies ways to gauge the effectiveness of various tools of cost control preferred by contractors and to identify the most effective tools of cost control. Estimating, planning, earning value, project budget, site inspection, work program, meetings, record keeping, monitoring work and cost performance, evaluation using bills of quantities, and software were identified as the twelve cost control tools used in the literature review. This research depended on both qualitative and quantitative information obtain through a questionnaire survey conducted among a questionnaire survey considering C1 to C2 grade contractors. Accordingly, a sample of 30 quantity surveyors and project managers were selected (from the contractor's perspective) as a sample for a detailed questionnaire survey. They were ranked as traditional cost control tools and validated in the survey questionnaire. Collected data is analyzed using a relative importance index (RII), and factors are ranked based on their percentage. According to the findings, project budget control, site meetings, estimation, and planning were all done at a high level and were thus recommended for broad use in construction projects. Furthermore, respondents' software programs and other approaches were among the least preferred cost control tools; therefore, it was suggested to identify ways to improve in practice for construction projects.

Keywords: Tools of Cost Control, Cost Overrun, Effectiveness, Versatile.

1. INTRODUCTION

In construction industry almost, all clients are interested in obtaining fully functional facilities completed in time, cost, quality and scope (Harris and McCaffer, 2002). A builder who is able to construct within the estimated time and budget, to the right standards and scope is an excellent builder (Harris and McCaffer, 2002). Cost control is a process where the construction cost of the project is managed through the best methods and techniques so that the contractor does not suffer losses when carrying out the activities of the project (Harris and McCaffer, 2002). Cost control is to ensure that scarce and limited resources are used to best advantage (Harvey, 2004). Cost control is about ensuring that clients receive the best value for money for the projects that they construct. Ultimately the decision of the manager that something should be done differently and the translation of that decision into practice are the actions to achieve control (Harris and McCaffer, 2002). Cost control in construction is the process by which managers keep expenses under control by managing labor, material, and overhead costs to ensure that the project finishes on budget. Cost control relies on sound estimates and constant monitoring over the course of a project. Without cost control, a project quickly burns through its budget

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and leaves the construction firm with very little profit or even a loss. As a result, good cost control is a must for any construction business that wants to be successful The (Motley Fool. 2022).

Most Project managers, Quantity Surveyors and Contractors find difficulty in controlling costs on their construction sites due to a number of problems which include poor project preparation, lapse in management and control, over budgeting, poor materials, labour shortages, increased cost of materials, delays in deliveries, wastage of materials, unexpected weather changes, loss of materials, insecurity and poor communication. This results into cost overruns, conflicts and sometimes abandoning projects (Otim *at al*, 2011).

This report identifies the tools of cost control preferred by contractors of Sri Lanka and their effectiveness to minimize cost overruns. It specifically looked at problems faced by the contractors in controlling the costs on site studied the tools of cost control commonly used by the contractors during the construction stage and proposed remedies to be used by contractors on site to control their costs.

1.1 THE PROBLEM STATEMENT

Project control includes both progress control and cost control aspects altogether. Project managers, quantity surveyors, and contractors mostly find it difficult to control costs on their construction sites due to a multitude of problems. Thus, there are various tools of cost control applied to controlling costs by these groups. Therefore, there is a need to identify the most frequently used tools of cost control in the construction industry and their effectiveness to minimize cost overruns to find the most recommended types of cost control tools.

1.2 AIM & OBJECTIVES

The aim of the research is to gauge the effectiveness of various tools of cost control preferred by contractors in Sri Lankan building construction projects and minimize cost overruns.

This research identifies ways to gauge the effectiveness of various tools of cost control preferred by contractors and to identify the most effective tools of cost control.

The aim of this research is achieved through the following objectives:

1) To find out the tools of cost control preferred by contractors of building construction projects,

2) To examine the user perception as to the efficacy criteria (usage, reliability, accuracy, and versatility) of cost control tools.

3) To identify the most effective tools of cost control among the frequently applied practices.

4) To recommend the most effective tools of cost control to minimize cost overruns of construction projects in Sri Lanka.

1.3 REVIEW OF LITERATURE

The construction industry is an economic investment and its relationship with economic development is well posited. Many studies have highlighted the significant contribution of the construction industry

to national economic development (Myers 2013). The construction industry of a country was basically linked to its economy (Willis, Ashworth & Hogg, 2007). Sri Lankan industry sector provided 30% of the annual GDP for year 2014, while construction accounted for 10% of it, and is claimed to be growing at a rate of 10% (Central Bank of Sri Lanka, 2014). Construction is the process of planning, designing, and manufacturing buildings and building systems. Construction organizations manage the construction, alteration, and/or repair of large structures. Construction is a high hazard industry that produces residential properties, bridge erections, roadway paving, excavations, demolitions, and even large scale painting jobs (Awsweldlink.org.,2018). In order to successfully operate in construction industry, the output of the industry which are known as construction projects need to be managed effectively and efficiently to achieve the desired results of the stakeholders. One of the major components and stakeholder concern is project cost. Cost is the bottom line factor for any project to determine its success. Therefore, it is extremely vital to plan and control cost to achieve of the project for different stakeholders.

The cost control techniques help to keep the project within the budget. Poor cost control often results in the cost overrun of a project. The overall planning process in a project budget plays an important role, it evaluates the financial consequences of the plan and provides financial feedback so that plans can be monitored and revised (Marsh C, 2009). Companies must complete projects on budget to achieve financial objectives. Project managers applying cost control techniques effectively can ensure that projects stay within projected budgets or are allowed to exceed budgets in a controlled way for specific reasons. When company implements appropriate project cost controls, it reduces risk and receives the full benefits anticipated from project completion (Source: Smallbusiness.chron.com, 2018). Control costs can be as mostly applying techniques as using the estimating, planning, earned value, budget, inspection of work, work programme, meetings, records keeping, monitoring works and cost performance, evaluation of the works, by software applications and others. (Source: Small Business - Chron.com. n.d.).

The calculation of total amount of cost overrun of a project is established by the difference between the final contract cost of completion and the bid amount in the tender document (Bordat, McCullouch, Labi, & Sinha, 2004). The terms of "cost escalation", "Cost increase" or "budget overrun" are usually used instead of the word cost overrun Zhu and Lin. The degree of cost overrun can be compared by measuring the change in contract amount divided by the original contract award amount. This calculation can be altered to a percentage for simplicity of comparison Jackson (as cited in Enshassi, Al-Najjar, & Kumaraswamy, 2009).

$$\text{Cost overrun} = \frac{\text{Final contract amount} - \text{Original contract amount}}{\text{Original contract amount}}$$

Cost overrun is a frequent phenomenon and is associated with most of the projects in the Sri Lankan construction industry (Roachanakanan, 2005). Possible causes of cost overruns from the beginning of

projects include omission of some items and out of-date cost estimates (Roachanakanan, 2005). The cost information such as labour rates, equipment rates and material costs used in estimating should be accurate (Roachanakanan, 2005). These can be obtained from historical data, past projects, a proprietary database, or current material costs (Roachanakanan, 2005).

2. METHODOLOGY

To identify the tools of cost control in Sri Lankan construction projects, it is essential to observe the applications of the construction industry regarding the practice. Furthermore, in order to determine the efficacy of various cost control tools in Sri Lankan construction projects, information about the cost control tools must be gathered from the Sri Lankan construction industry. To attain the above goals, it is necessary to select a qualitative approach to carry out the research. The quantitative approach is used mostly to identify effective cost control tools to minimize cost overruns in the construction industry. Therefore, within the mixed approach, combining both quantitative and qualitative approaches, the research is advanced.

The triangulation of quantitative and qualitative methods was highly useful for this study as both methods complemented each other, yielded a comprehensive picture and provided a range of perspectives to enhance the study. Further a simple random sampling was carried out for each sub group. This ensures representation of not only the overall population, but also key subgroups of the population; especially small minority groups. This gives higher statistical efficiency than simple random sampling (Krishnaswami and Sathyaprasad, 2010, p.62).

The data collected from the survey was analyzed using Likert scale and relative Relative Importance Index. Likert Scale as bipolar ranging from two extreme ends provides series of statement within those ends. In this research five points Likert scale was used to understand the perception of Practitioners as 1 for very low, 2 for low, 3 for medium, 4 high and 5 for very high (Likert, 1932). The contractor's frequently used Cost Control Techniques was calculated by using Relative Importance Index (RII).

A total of twelve numbers of questions out of fifteen questionnaires presentations were in the form of graphs, bar charts, and tables. RII was calculated with the following expression: Where:

$$RII = \sum_{i=1}^{5} \frac{w_i x_i}{AN}$$

RII = Relative importance index

w = weighting given to each factor by respondents and it ranges from 1 to 5

x = frequency of its response given for each cause

A = highest weight (i.e., 5 in this case)

N = total number of respondents

3. RESULTS AND DISCUSSION

3.1 Tools of Cost Control frequently used by contractors in construction projects
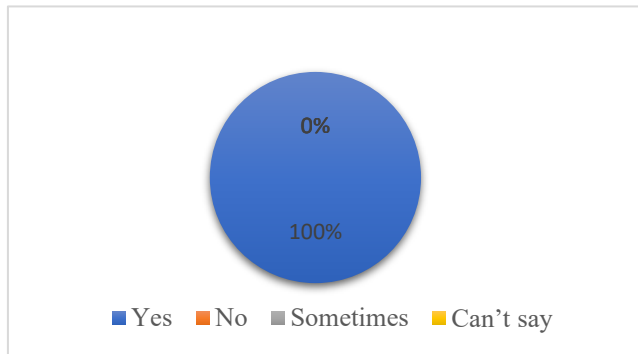
Figure 1: Usage of tools for cost control by professionals

According to the response of professionals, Figure 1 illustrates that 100% of respondents mentioned the usage of cost control tools on building construction projects in Sri Lanka. Thus, in considering the use of cost control tools, professionals in the construction industry frequently use cost control tools in construction projects.
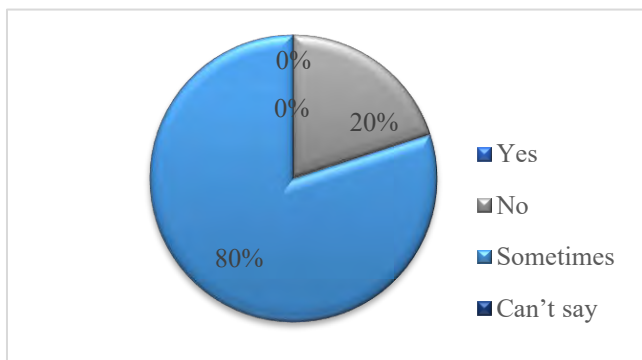
Figure 2: Resource sufficiency in the orgnization

Figure 2 illustrates the sufficiency of resources in the organization. Accordingly, 80% of respondents reacted positively when the resources were sometimes low-usage or medium-usage for effective construction practice. 20% of respondents mentioned that resources are not sufficient.
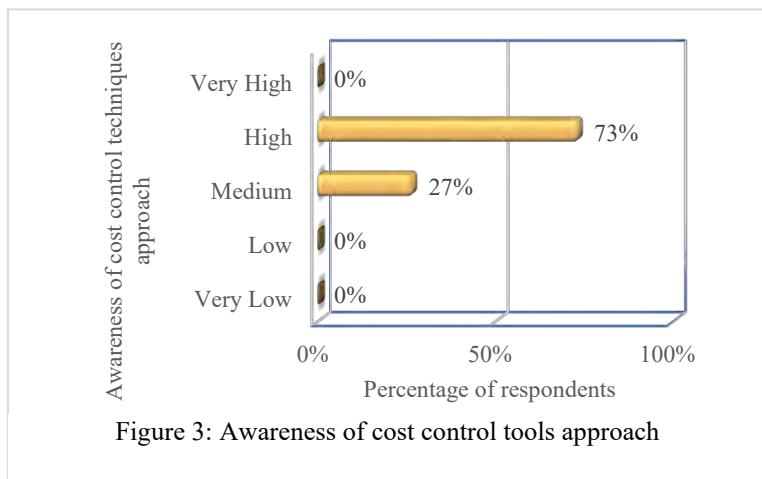
Figure 3: Awareness of cost control tools approach

As illustrated in Figure 3, 27% of respondents mentioned the awareness of tools of the cost control approach as medium, and 73% of respondents mentioned the awareness of tools of the cost control approach as high. It can be identified that the awareness of tools of the cost control approach is high.

3.2 To Examine The User Perception As To Effectiveness Criteria (Usage, Reliability, Accuracy, And Versatility Of Tools Of Cost Control).

Figure 4: Management: the tools of cost control in construction projects
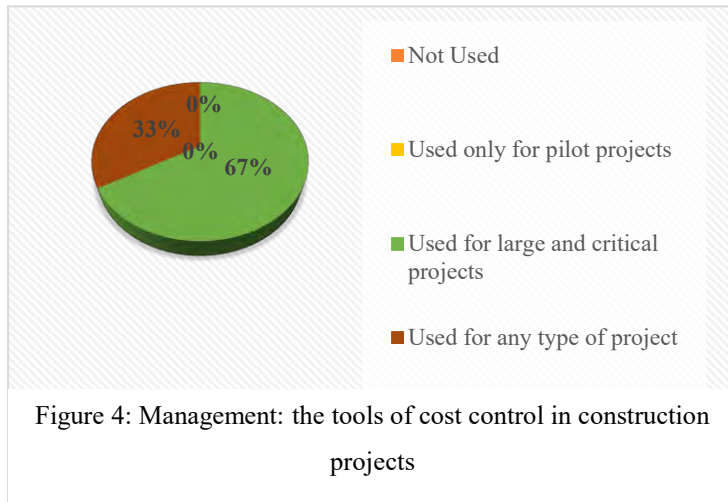
Figure 4 illustrates the management of the tools of cost control in construction projects. 67% of respondents manage the use of large and critical projects. 33% of respondents mentioned it as being used for any type of project. C1 and C2 contractors are mostly tools of cost control used for large and critical projects.

Moreover, 100% of respondents claim that they maintain documents for records for controlling the cost.

Figure 5: Level of documents maintained in records for controlling the cost
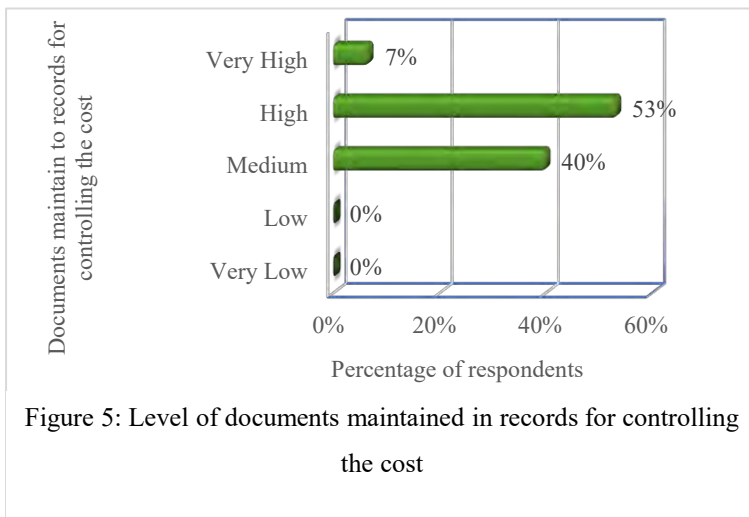
As illustrated in Figure 5, 40% of respondents mentioned the level of documents maintained for records for controlling the cost as medium; 53% of respondents mentioned the level of documents maintained for records for controlling the cost as high; and 7% of respondents mentioned the level of documents maintained for records for controlling the cost as very high.

Figure 6: Using osoftware to control the cost
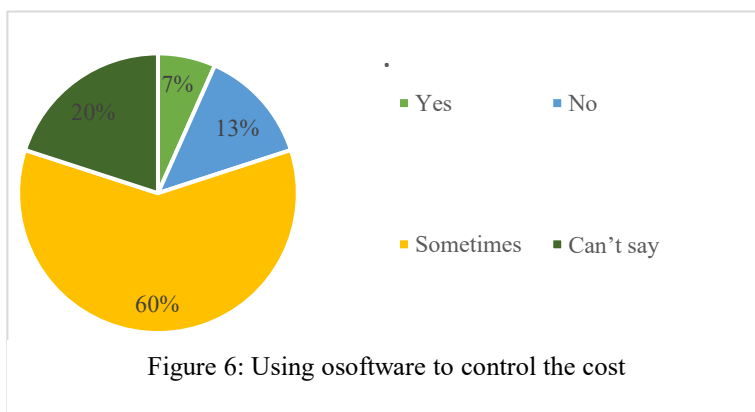
Figure 6 illustrates the use of software for controlling the cost. 7% of respondents were using software for controlling the cost; 13% of respondents were not using software for controlling the cost; 60% of respondents were using software for controlling the cost sometimes; and 20% of

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respondents couldn't say whether they were using software for controlling the cost in construction projects.
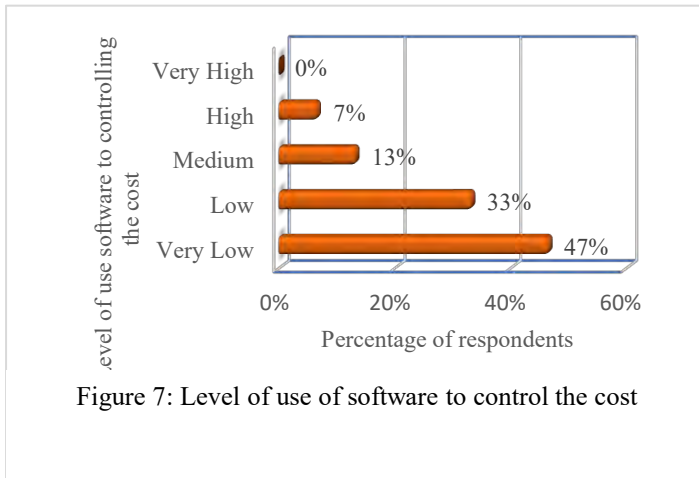
Figure 7: Level of use of software to control the cost

As illustrated in Figure 7, 47% of respondents mentioned the level of use software to control the cost as very low, 33% of respondents mentioned the level of use software to control the cost as low, 13% of respondents mentioned the level of use software to control the cost as medium, and 7% of respondents mentioned the level of use software to control the cost as high.

Once the data has been collected and the format has been established for a report, there then comes the need to ensure that the report is accurate and understandable. For example, a summary report can provide accurate WBS or cost details while also providing a level of clarity on the project.
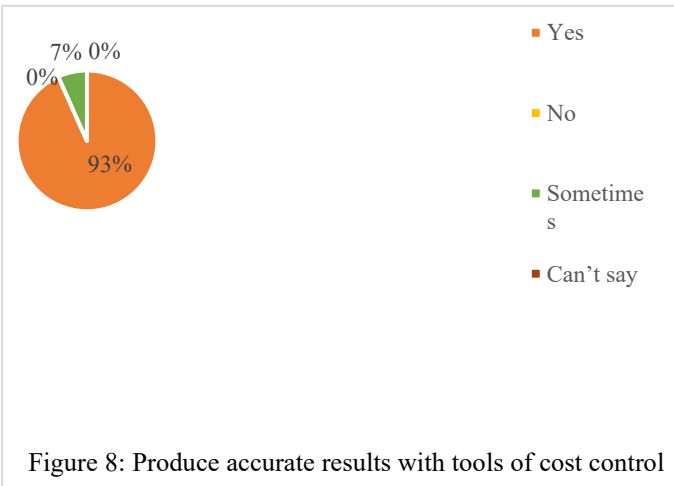
Figure 8: Produce accurate results with tools of cost control

As Figure 8 shows that 93% of respondents mentioned producing accurate results by tools of cost control as yes, while 7% of respondents mentioned producing accurate results by tools of cost control as sometimes. As a result, it can be concluded that the majority of respondents believed these cost-control tools produced accurate results in construction projects in Sri Lanka.
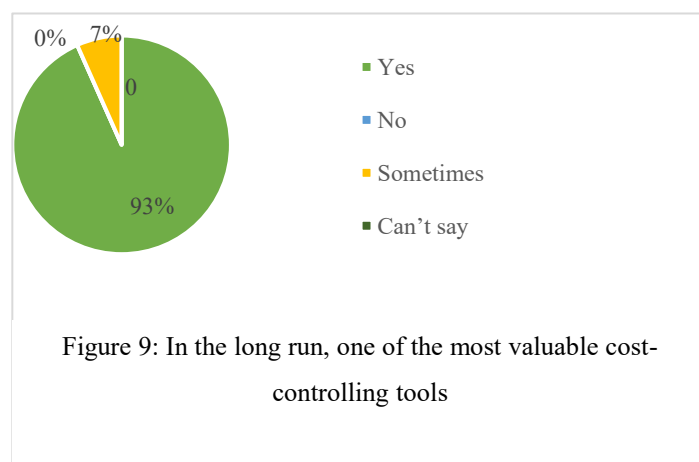
Figure 9: In the long run, one of the most valuable cost-controlling tools

Figure 9 illustrated the valuable tools of cost control in the long run. According to that, 93% of respondents indicated that cost-controlling tools are valuable in the long run, while 7% indicated that cost-controlling tools are valuable in the long run only occasionally. Therefore, it can be concluded that most respondents believed these control tools were valuable in the long run in the construction projects which cost more than 100 million rupees in Sri Lanka.

3.3 IDENTIFY THE MOST VERSATILE COST-CONTROLLING TOOLS AMONG THE FREQUENTLY USED PRACTICES.

This objective is achieved by a detailed questionnaire survey. The questionnaire survey used a five-point scale to rank the various cost control tools based on the professionals' responses.

Table 1 illustrates tools of cost control frequently used by contractors. Twelve tools of cost control frequently used by contractors on sites are identified in the literature survey as: estimating, planning, earning value, project budget, site inspection, work program meetings, record keeping, monitoring work and cost performance and evaluation using bills of quantities, software applications, and other tools.

In the results, 83% of respondents used the project budget and 81% of respondents used the site meetings. 80% of respondents used the estimating and 79% of respondents used the planning, with higher responses for tools used for cost control. Furthermore, 77% of respondents used earned value; 77% of respondents used record keeping; 76% of respondents used the work program; 76% of respondents used the monitoring of work and cost performance; 73% of respondents used work inspection; 68% of respondents used work evaluation; 31% of respondents used software; and 25% of respondents used other tools.

Table 1: Tools of Cost Control in percentage and rank based on RII

No.	Cost Control Techniques	1 Very Low	2 Low	3 Medium	4 High	5 Very High	Total	% of RII	Rank
a	Estimating	0	0	12	88	20	120	80%	3
b	Planning	0	0	12	96	10	118	79%	4
c	Earned Value	0	0	12	104	0	116	77%	5
d	Project Budget	0	0	0	104	20	124	83%	1
e	Inspection of Work	0	0	30	80	0	110	73%	9
f	Work Programme	0	0	18	96	0	114	76%	7
g	Site Meetings	0	0	0	112	10	122	81%	2
h	Records Keeping	0	0	18	88	10	116	77%	5
i	Monitoring Works and Cost Performance	0	0	18	96	0	114	76%	7
j	Evaluation of Works Carried Out	0	4	42	56	0	102	68%	10
k	Software	16	24	6	0	0	46	31%	11
l	Others	22	16	0	0	0	38	25%	12

3.4 RECOMMEND THE MOST EFFECTIVE COST-CONTROL TOOLS FOR REDUCING COST OVERRUNS ON CONSTRUCTION PROJECTS IN SRI LANKA.

This study has been entirely focused on gauging the efficacy of various tools of cost control for projects costing above 100 million rupees in Sri Lanka (Colombo suburbs). Findings from the literature review and questionnaire survey confirm the necessity of implementing a proper framework in attaining a successful project. It is recommended the need to keep an eye on all appropriate tools and cost control practices in Sri Lanka.

After analyzing the questionnaire survey data, it was found that the frequently used and most versatile tools for cost control are as follows: project budget control, site meetings, estimating, and planning. Therefore, it is recommended to implement these cost control techniques in construction projects in a wide application and arena. Furthermore, software applications and work evaluation are found to be the least preferred cost control tools, which require more attention to develop as tools of cost control in the Sri Lankan construction industry.

4. CONCLUSION(S)/ IMPLICATIONS/ RECOMMENDATIONS & LIMITATIONS

The proper tools of cost control will help to minimize the cost overruns of construction projects. The aim of this research gauge the effectiveness of various tools of cost control preferred by contractors in Sri Lankan building construction projects and minimize cost overruns by identifying the preferred tools of cost control used by contractors on Sri Lankan construction projects to complete projects as budgeted. The findings of this study elaborate precisely on the effective tools of cost control preferred by contractors. The twelve tools of cost control used by contractors on their sites in Sri Lanka are identified in the literature survey, including use of: estimating, planning, earned value, project budget, site inspection, work programme, meetings, record keeping, monitoring work and cost performance, evaluation using bills of quantities, software usage, and other tools, further validated in the questioner survey to identify the most frequently applied tools in the industry.

The research results indicate project budget control as the most preferred technique, with 83% of respondents having an RII value. 81% of respondents used site meetings. 80% of respondents used estimating and 79% of respondents used planning with RII values, found with considerably higher responses for techniques used for cost control. These highly preferred tools are highly recommended for widespread implementation in construction projects, as proposed measures allow projects to be completed within budget.

Furthermore, 31% of respondents found for the software applications and another 25% found for the other tools with RII values, which were identified as the least preferred methods as cost-controlling tools in the findings and are proposed to be improved for applications.

This research suggests implementing the most preferred cost control tools to improve the effectiveness of cost control in Sri Lankan construction industry. It is recommended that the least used cost-control

tools be critically examined from a technical standpoint for further research that will be beneficial to improving cost control events in the Sri Lankan construction industry.

REFERENCES

Arditi, D., Akan, G. T., & Gurdamar, S. (1985), 'Cost overruns in public projects', *International Journal of Project Management*, *3(4),* 218-224.

Ashworth, A., and Hogg, K. (2007), 'Willis's practice and procedure for the quantity surveyor', (12th ed.), *Blackwell publishing, Oxford*.

Ashworth, A., and Hogg, K. (2007), 'Willis's practice and procedure for the quantity surveyor', (12th ed.), Blackwell publishing, Oxford.

Awsweldlink.org. (2018), 'Construction Industry', Industry Overview (Harvey, 2004).

Basak, B.G. (2006), 'Cost Management in an Imperfect World: Bridging the Gap Between Theory and Practice', *ICEC Cost Management Journal.*

Bordat, C., McCullouch, B. G., Labi, S., & Sinha, K. C. (2004), 'An analysis of cost overruns and time delays of INDOT projects', Publication no. FHWA/IN/JTRP-2004/7, SPR-2811. Washington, *DC: Transportation Research Board.*

Central Bank of Sri Lanka. (2014), 'Annual report 2014', Colombo: Central Bank of Sri Lanka.

Central Bank of Sri Lanka. (2014), 'Annual report 2014', Colombo: Central Bank of Sri Lanka.

Harris and McCaffer, (2002), 'Modern Construction Management'.

Hyung, K.P. (2005), 'Cash Flow Forecasting Model for General Contractors Using Moving Weights of Cost Categories', *Journal of Management in Engineering*, *21*, No.4, 64-172.

Latham, M. (1994), 'Constructing the team'. UK: HMSO.

Likert, R. (1932), 'A Technique for Measuring Attitudes Archives of Psychology', *140,* pp.1 – 55.

Marsh, C. (2009), 'Mastering Financial Management', Pearson Education Limited, Britain.

Myers, M.D. (2013), 'Qualitative Research in Business & Management', 2nd Edition, Sage Publications, London.

Myers, M.D. (2013), 'Qualitative Research in Business & Management', 2nd Edition, Sage Publications, London.

Potts, K. (2008), 'Construction Cost Management: Learning from case studies', 1st Edition ed. London: Taylor & Francis.

Potts, K., & Ankrah, N. (2013), 'Construction Cost Management: Learning from Case Studies', 2nd Edition ed. Abingdon, United Kingdom: Routledge.

Roachanakanan, K. (2005), 'A case study of cost overruns in a Thai condominium project', (Doctoral dissertation, Texas A&M University).

Small Business - Chron.com. (n.d.). Construction Cost Control Procedures. [online] Available at: https://smallbusiness.chron.com/construction-cost-control-procedures-80517.html.

The Motley Fool. (2022). Construction Management: Understanding Cost Control. [online] Available at: https://www.fool.com/the-ascent/small-business/construction-management/articles/cost-control-in-construction/.

INNOVATIVE TECHNOLOGIES IN ICT AND MEDIA TOWARDS RESILIENCE

PIRIVENA TEACHERS ATTITUDES TOWARDS INTRODUCTION OF INFORMATION TECHNOLOGY AS A SUBJECT FOR PRIMARY PIRIVENAS IN RATNAPURA EDUCATION ZONE, SRI LANKA

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ABSTRACT

The study explored issues affecting the introduction of information technology to the Primary (Mulika) Pirivenas (Buddist monastic colleges). The study is focused on three objectives identify attitudes toward the introduction of IT subject among the teachers, finding out the current situation of available and to explore the issues related introduction of IT subject. Two samples are used, one consisted of 42 teachers and 07 Principals in Pirivenas in the Ratnapura Education Zone. Purposive sampling was used as the sampling method. A questionnaire was used for data collection. Findings revealed IT is increasingly contributing to the learning. increase the attention and interest of students in attending classes. Also, IT supports students in self-studies. As for the conclusions of the study, in introducing IT in Primary Pirivenas, lack of facilities and resources, was revealed. Furthermore, the fact that teachers who were assigned to teach IT should be given technical training and resources and recruitment of a separate teacher to teach IT was revealed. Updating the Pirevana Act is recommended to resolve most of the challenges in introducing IT for Primary Pirivenas.

Keywords: *pirivena, IT, teachers, attitudes, teaching learning process*

1. INTRODUCTION

Pirivenas were established in 2004 in Sri Lanka and the main types of Pirivenas in Sri Lanka are the Primary Pirivenas, Maha Prirvenas, Vidyathana, bilingual mission and Seela Matha Pirivena Institutions. Current Pirivena education applies to monks, nuns and lay students who wish to study in the Pirivenas. Pirivenas mainly offer Buddhist philosophy and culture studied with Pali Sanskrit and Sinhala subject and most Pirivenas not teach Information Technology (IT) at least as additional subject. IT has become an essential element of anything in the world. In terms of education, the integration of IT has made the teaching and learning process effective.

Therefore this study was conducted to identify the issues affecting the introduction of IT as a subject to primary Pirivenas and modern teaching learning methods and knowledge of online platforms, was specifically explored in the study.

The objectives of the study are;

1. To find the attitudes of Pirivena teachers regarding the facilities available in Primary Pirivenas to teach IT as a subject

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2. To find the attitudes of Pirivena teachers regarding the contribution of IT towards learning and teaching in Primary Pirivenas

3. To find the attitudes of Pirivena teachers regarding the challenges in introducing IT as a subject in Primary Pirivenas

2. METHODOLOGY

Total population of this study is all Primary Pirivena teachers in Ratnapura Education Zone. The target population of this study is 84 Pirivenas teachers and 14 Principals in 14 Pirivenas. Accessible population is 42 teachers and 07 Principals in 7 Pirivenas. Purposive sampling method was used as the sampling method. Data collection instrument was a questionnaire. Quantitative data was collected through the questionnaire and analyzed through charts and graphs based on the objectives.

3. RESULTS AND DISCUSSION

3.1 ATTITUDES OF PIRIVENA TEACHERS REGARDING THE FACILITIES AVAILABLE IN PRIMARY PIRIVENAS TO TEACH IT AS A SUBJECT
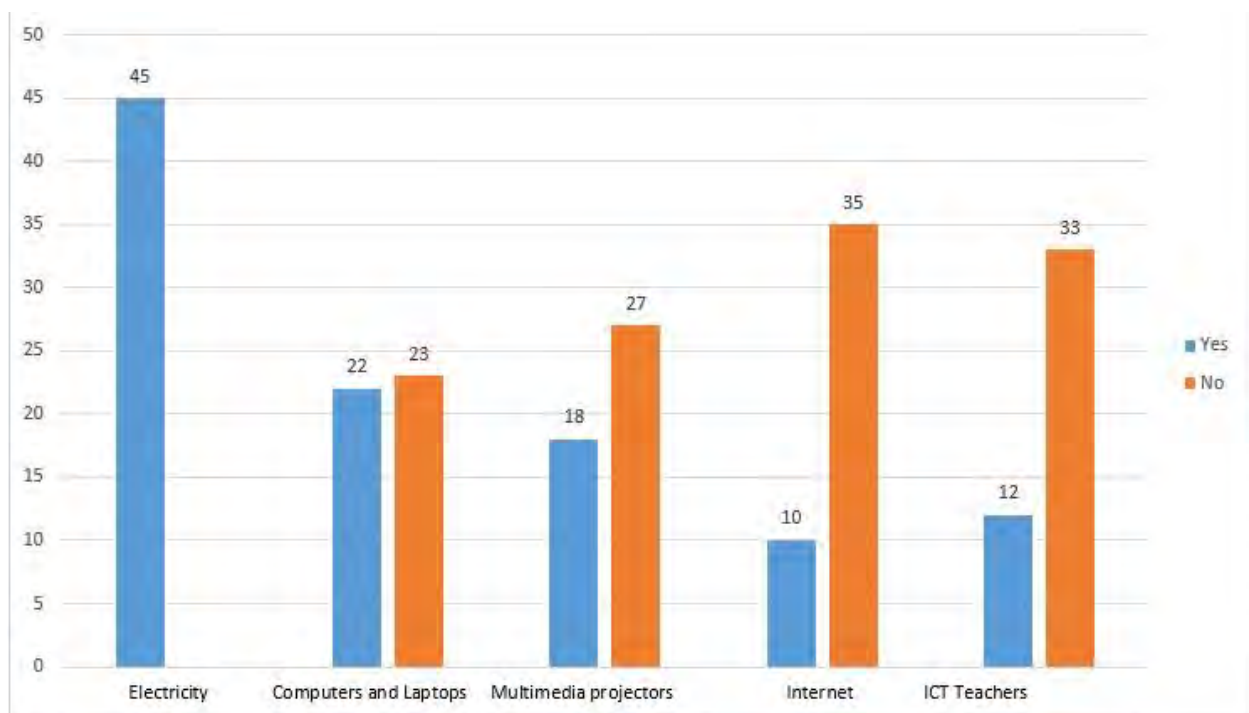
Figure 1: Available Facilities to Introduce IT in Primary Pirivenas

As shown in Figure 1, the study found that although all the Primary Pirivena institutes subjected to the study had electricity, but there was a dearth of other computers and laptops, multimedia projectors, internet and a teacher to teach IT, which is essential for the introduction of the subject of IT. Therefore,

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the practicality of introducing IT as a subject is questionable. Lack of facilities and lack of qualified teachers might lead to negative attitudes towards introducing IT for Primary Pirivenas among the teachers who teach in Primary Pirivenas.

3.2 ATTITUDES OF PIRIVENA TEACHERS REGARDING THE CONTRIBUTION OF IT TOWARDS LEARNING AND TEACHING IN PRIMARY PIRIVENAS

As given in Table 1, study revealed the attitudes of the teachers that information technology is increasingly contributing to the learning process. Also most of the teachers were in the attitude that, it help to study other traditional Pali, Sanskrit and Sinhala subjects. Further, many of the teachers believed that IT increasingly conducive to innovation and to improve attitudes and motivation in the classroom as well as outside the room.

Table 1: Attitudes towards introduction of IT towards learning and teaching

Attitudes	Strongly Agree %	Agree %	Neither Agree nor Disagree	Disagree %	Strongly Disagree %
IT based teaching is needed as a mode of delivery	7	16	22	00	00
Modernized delivery methods create more engaged environment in teaching	24	10	03	02	00
Introduction of IT will encourage active participation of learners	25	17	02	02	00
IT based teaching supports different learning styles	14	12	14	00	00
Improving IT related facilities will enhance the quality of teaching	20	24	01	00	00
Application of IT for other subjects helps improving English and the use of IT related technology	28	16	00	02	00
IT based teaching will support teaching the other subjects	19	11	15	01	00
IT encourages self-learning	29	14	03	04	00
It is easy to teach in a technology enhanced learning environment	21	20	03	00	00
Attention of authorities in including IT for Pirivena education	18	17	00	05	07

3.3 ATTITUDES OF PIRIVENA TEACHERS REGARDING THE CHALLENGES IN INTRODUCING IT AS A SUBJECT IN PRIMARY PIRIVENAS

Figure 2 shows the attitudes among the Pirivena teachers regarding the challenges in introducing IT as a subject in Primary Pirivenas.

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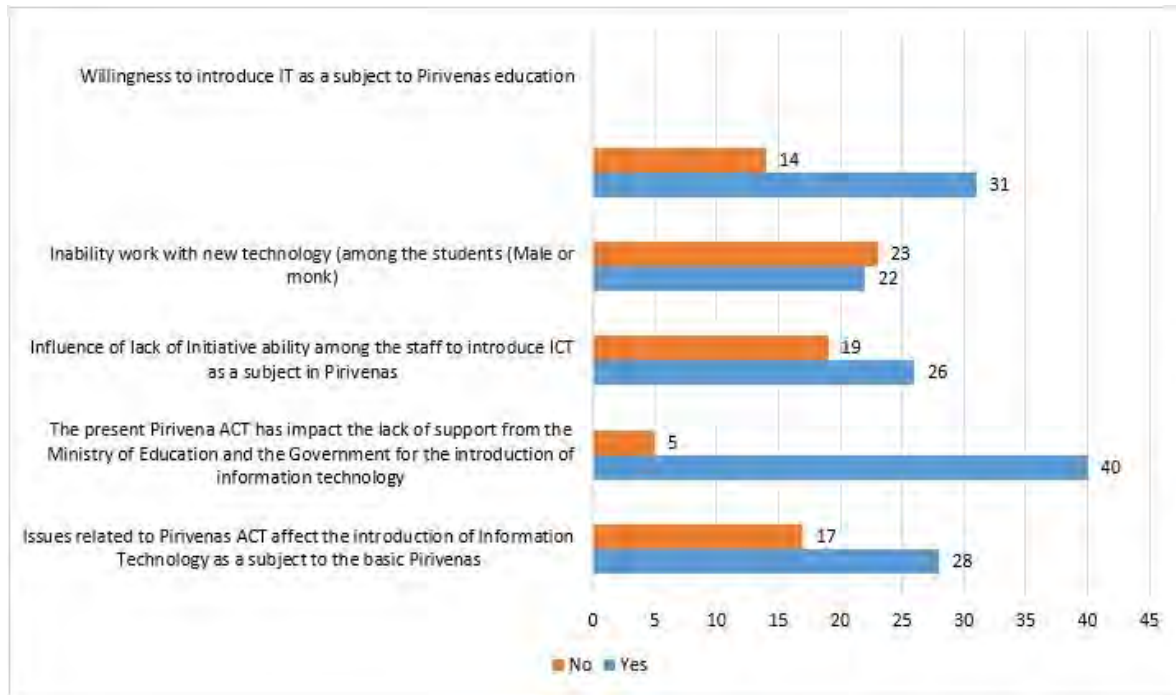
Figure 2: Attitudes of teachers regarding the challenges in introducing IT as a subject

Most of the teachers were in the view that they are willing to accept and agree that IT is introduced as a subject in Primary Pirivenas. They do not find that students are unable to work with new technology. As one of the major challenges they found the staff would find it challenging because they do not have adequate IT knowledge and IT skills to initiate teaching IT in Primary Pirivenas. Majority of the teachers were in the attitude that lack of support from the Ministry of Education in introducing IT as a subject in Primary Pirivenas as one of the major challenges. Most of the teachers were in the view that due to some of the restrictions in the Pirivena Act, the implementation of teaching IT is hindered and therefore the Pirivena Act should be revised to support teaching of IT as a subject.

4. CONCLUSIONS AND RECOMMENDATIONS

Pirivena teachers were in the attitudes that facilities including infrastructure facilities and human resources are not adequate to introduce IT as a subject in Primary Pirivenas. In considering the teachers attitudes related to introducing of IT towards learning and teaching, the teachers were very positive about the possible benefits of contribution of introducing IT in teaching and learning processes. Regarding the challenges in introducing IT as a subject in Primary Pirivenas, the study revealed that the current Pirvena Act hinders such implementations and lack of support from the government are the major challenges.

Therefore, it is recommended to provide basic facilities needed to provide to Primary Pirivenas and qualified IT teachers to be recruited while revising the Pirivena Act to support IT education in Primary Pirivenas.

REFERENCES

Aboobucker, I. (2019). Importance of information and communication technology (ICT) curriculum in government school of Sri Lanka: A critical review of educational challenges and opportunities. *SSRN Electronic Journal.* Available at;

https://doi.org/10.2139/ssrn.3344630

Arigatou International Geneva. (2015). Learning to live together facilitator training workshop in Mandalay, Myanmar. *Ethicseducationforchildren.Org*. Available at;

https://ethicseducationforchildren.org/en/news/latest-news/860-learning-to-live-together-facilitator-training-workshop-in-mandalay-myanmar

Baggaley, J., & Belawati, T. (Eds.). (2010). Distance Education Technologies in Asia. *IDRC (International Development Research Centre).* Available at;

https://www.idrc.ca/sites/default/files/openebooks/502-1/index.html

Bennett, J. (2017). Modern teaching in a traditional Burmese monastery | *British Council*. Available at; https://www.britishcouncil.org/voices-magazine/modern-teaching-traditional-burmese-monastery.

Gunalankara, G., & Wijithatissa, V. K. (2020). Study on the necessity of psychological intervention for pirivena students in Sri Lanka. Available at; (Unpublished.

http)s://doi.org/10.13140/RG.2.2.13230.54080

Miskiah, M., Suryono, Y., & Sudrajat, A. (2019). Integration of information and comunication technology into Islamic religious education teacher training. *Jurnal Cakrawala Pendidikan, 38*(1), 130–140.

W.K.D. Keerthirathne. (2020). A Study On Evolution Of Pirivena As An Educational Institute From Past To The Present In The History Of Traditional Education In Sri Lanka. *International Journal of Humanities and Social Science Invention* (IJHSSI).

https://www.ijhssi.org/papers/vol9(6)/Series-4/G0906044145.pdf

INFORMATION COMMUNICATION TECHNOLOGIES USED IN RESEARCH ACTIVITIES: PERSPECTIVES OF UNIVERSITY ACADEMICS IN SRI LANKA

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ABSTRACT

Information Communication Technologies (ICTs) have made a significant contribution to the advancement of higher education by providing free and remote assistance at all stages of the research process. Current research contributes to the understanding of ICT use and research efficiency in Sri Lankan academia. The main objective of this study was to look into employment of ICT tools in improving the efficiency of researchers in Sri Lankan universities. A questionnaire was administered to academics to collect quantitative data through a survey strategy. Majority of academics (85.7%) has agreed using ICTs for publishing their research outputs and the lowest (34.8%) agreed to use ICTs for data collecting. Most of the academics (87.4%) agreed use of online research networks to publish research outputs. Also a considerable percentage of academics (97.1%) have agreed using ICTs for Internet searching for literature and 94.8% agreed using Electronic collections/Electronic journals/Journal databases. Based on these findings it could be recommended to improve further the technological infrastructure to enhance the research culture of the Sri Lankan academia.

Keywords: Academic Research, ICT Adoption, ICT usage, Knowledge production.

1. INTRODUCTION

Over the last two decades, the Internet and related Information Communication Technologies (ICTs) have become increasingly central to scientific work. ICT is a process in which human data interaction occurs; through one or more networked telecommunication systems. The use of ICTs in research is one of the major shifts in processes of scientific research. Concurrently, ICT promoters argue that the ICT will improve and provide a great support on scholarly work, increase technology transfer, and widen information access. Moreover ICT has become an important source of innovation and improvement of efficiency for many sectors across the globe.

Applications of ICTs are particularly powerful and uncontroversial in higher education's research function. It has grown steadily in the past 10 to 15 years in both developing and developed countries, although there are wide variations in usage both within and between countries and regions. These variations reflect the vision and commitment of the leadership of Higher Education Institutions (HEIs) to deploying ICTs in research; the funds and people available to sustain investments in ICT infrastructure and support systems; and the existence of helpful national and institutional ICT policies. Adoption of ICT in teaching, learning and research has come a long way and so is the use of various ICT tools. Academic researchers use a diverse set of ICT tools to communicate, create, disseminate, store, and manage information for their research activities. The possibilities of conducting research with Internet and its virtual components by individuals and organizations are innumerable. While going

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through the research papers among others, several authors have mentioned that ICTs support: instantaneous information exchange despite geographical barriers.

1.1 BACKGROUND STUDY

ICTs have made a significant contribution to the advancement of higher education by providing free and remote assistance at all stages of the research process, including the collection of data and documents, improvements in the precision of knowledge reproduction, and innovative and more effective routines for designing new products and conducting problem-solving activities. Many technological tools, such as electronic bulletin boards, databases, forums, emails, blogs, and social networking sites, have been made available to aid researchers' work. As a result, researchers may find, gather, and arrange data in a highly accurate, successful, and timely manner. Despite the belief that ICT has influenced scientific research and contributed to enhanced efficiency, there is still a scarcity of data on the use of ICT in research activities in Sri Lankan academics. Therefore, the current research contributes to extend the understanding of ICT use in Sri Lankan academia. The main objective of this study was to look into employing ICT tools for research activities by the academics in Sri Lankan universities.

2. METHODOLOGY

Reviewing a larger number of technology adoption theories there are number of frameworks/models have been used in the literature to assess IS systems. Technology acceptance models discussed in the literature review are Diffusion of Innovation (DOI), Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB), Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT) and Task Technology Fit (TTF). All of the presented models seem to concentrate rather strongly on individual attributes of the users and of the technology, neglecting attributes of tasks which are highly important to understand IT adoption processes. TTF (Figure 2.1) is however important as it concerned with the notion of fit, explaining that it is not individual attributes which are important, but the quality of fit between task and technology.

The idea of fit is more comprehensively elaborated in the task-technology-fit model (TTF) of Goodhue and Thompson (1995). They take into account not only technology and user, but also considers the complexity of the tasks which have to be supported by an IT system. The TTF model measures the correspondence between task requirements, individual abilities, and the functionality of information systems. The essence of this model is the assertion that information systems will have a positive impact on individual performance if the system is used, and it has a good fit with the tasks it supports. Thus TTF model is suitable to investigate the use of ICT by academics in Sri Lanka on their research work activities.
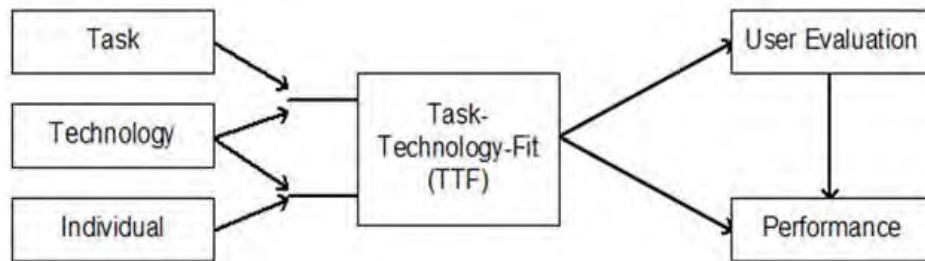
Figure 1: Task Technology Fit Model
Source: Goodhue and Thompson, 1995, p. 141

Goodhue and Thompson (1995, pp 141) indicated that individuals' interactions with an information system are often intertwined with their task-technology individual-adoption behaviors. TTF is measured by assessing how satisfactorily the system function meets the individual task needs; this is so in the current research. TTF is the relationship between task requirements, individual abilities, and the functionality of the ICT. Furthermore, TTF has been linked to the criterion of personal performance, which can be used in the larger context of considering the impact of IT on individual performance (D'Ambra et al., 2013; McGill, 2009; Migosi, 2009; Williams and Kotrlik, 2004; D'Ambra and Rice, 2001; Goodhue and Thompson, 1995). Previous research has identified varying approaches to conceptualize fit between available IT functionality and the functionality required to complete various tasks.

TTF relationships can inform the associations between tasks and technology use from a number of perspectives: improved performance (Goodhue et al., 2000; Carswell et al., 2000), altered user perceptions (Wenger and Carlson, 1995) or increased user utilization (Ngai, Poon and Chan, 2007; Kim and Malhotra, 2005; Venkatesh et al., 2000). Moreover, empirical results have suggested that TTF and technology usage together better explain the impact of IT on individual task performance than does usage alone (D'Ambra and Wilson; 2004, D'Ambra and Rice, 2001). Further studies have demonstrated the efficacy of the TTF construct to measure the value of an IT (Goodhue and Thompson, 1995).

The TTF model considers the importance of fitting the functionality and attributes of technology used to the demands imposed by individual needs. Researcher argues that if the tasks of academics in research process such as information retrieval, creating publications and dissemination of publications and technology used to complete the above tasks are fit with each other, the academics will use such technology in their research work. Therefore the researcher used TTF as a lens to see the technology context in the scientific research. Overall, TTF used to conceptualize the present research on use of ICT by academic in Sri Lankan academia for their research work.

2.1 POPULATION AND SAMPLE OF THE STUDY

Academics in the field of Arts, Engineering, Medicine, Science and Management from 6 universities out of 17 universities governed under University Grant Commission (UGC) are the population of the present study. Top six universities of the Webometrics ranking of universities in July/2021 were selected for the study. These universities are University of Colombo, University of Peradeniya, University of Sri Jayewardenepura, University of Kelaniya, University of Moratuwa and the University of Ruhuna. These six universities demonstrate a fair representation of all 17 universities in Sri Lanka as for specific subject streams selected: Arts, Science, Management, Medicine and Engineering. Professors, Associate professors and Senior Lecturers from all 6 universities are considered as the population of the study. Probationary Lecturers were not included in this study as they do not have much experience about research and their scholarly communication and their contribution would be minimal with respect to research productivity. The target population for the study is 2527 (UGC statistics, 2020) and the sample size is determined using the Morgan table under the 0.05 significance level (Krejcie & Morgan, 1970). The sample size was 335 and stratified sampling technique was employed to select the respondents considering universities as strata. Only 247 were responded. The response rate is 69.77%. Use of ICT for literature searching, collecting data, analysing, compiling, publishing and collaboration under the task technology fit theory was analysed using the SPSS 21.

3. RESULTS AND DISCUSSION

3.1 DISTRIBUTION OF THE SAMPLE

The highest percentage of respondents (32.8%) was from the University of Sri Jayewardenepura and the lowest (6.8%) was from the University of Moratuwa. Most of the respondents were from Science faculties (23.5%). There were 55.5% of males and 44.5% females in the sample. The age group of the most academics (40.1%) was 41-50 years. The sample comprised of 68% of senior lecturers and 32% professors. Majority (79.7%) of the respondents held PhD degrees and majority of them (72.1%) has been obtained their post graduate degrees from foreign universities.

3.2 PERCEPTIONS FOR FHE USE OF ICT BY THE UNIVERSITY ACADEMICS

Use of ICTs for identified 15 tasks including literature searching, collecting data, analysing, compiling, publishing and collaboration under the task technology fit theory by the academics in the fields of Arts/Humanities & Social Sciences, Engineering, Medicine, Science, and Management was analysed. Following Table 1 demonstrates the percentages for the agreement to use of technologies for 15 tasks under the 5 point Likert scale.

Table 1: Percentages for the agreement to use ICTs for research purposes under TTF theory

	Task	% Use		
		Agree	Strongly Agree	Total
Searching for Literature		**(76.8%)**		
1	Internet search engines for literature tracking	18.2	78.9	**97.1**
2	Library OPACs, Wikipedia, Encyclopedia to find literature	32.8	25.5	58.3
3	Websites, blogs and twitters to gather literature	31.2	25.9	57.1
4	Electronic collections/Electronic journals/Journal databases (Emerald, JSTOR, Hinari, Taylor and Francis, PubMed, Science direct) to find literature	23.1	71.7	94.8
Collecting data		**(34.8%)**		
5	Social networks to collect data	18.6	16.2	**34.8**
Analyzing research data		**(61%)**		
6	Analytical software (SPSS, Minitab) to analyse research data	23.3	37.7	61
Compiling the researches		**(79.4%)**		
7	Word processing software to prepare manuscript of research publications	13.4	82.2	95.6
8	Referencing software to compile the bibliography of publications	21.9	41.3	63.2
Publishing the research outputs		**(85.7%)**		
9	Online publishing services (online journals, open access journals) to publish research outputs	34.8	45.7	80.5
10	Online research networks (Google Scholar/ Research gate) to publish research outputs	26.7	60.7	87.4
11	Presenting software (Ms PPT) to present/publish findings	13.0	76.1	89.1
Collaboration with other researchers		**(67.6%)**		
12	E-groups (Listserve or e-mail alert, chat groups, BBS, News groups, Discussion groups) to collaborate with researchers	24.3	23.1	47.4
13	E-mail to communicate with supervisor/reviewer, scholars/professionals at other institutions, submit proposals)	12.1	83.0	95.1
14	Instant messaging/Video conferencing (Skype, Viber) communicate with scholars	32.4	43.7	76.1
15	Media sharing (You tube, Google drive) to share information	25.9	27.9	51.8

As shown in Table 1, if it considers the grand mean of agreeing percentages, the highest percentage of academics (85.7%) has agreed using ICTs for publishing their research outputs. Most of them (87.4%) agreed use of online research networks (Google Scholar/ Research gate) to publish research outputs. The lowest percentage (34.8%) agreed to use ICTs for data collecting. 79.4%, 76.8%, 67.6% and 61%

agreed using ICTs for compiling researches, literature searching, collaboration with other researchers and analyzing data respectively.

Though 79.4% have agreed using ICTs for compiling researches, 95.6% agreed to use Word Processing for compiling activities. Only 63.2% agreed using reference management software while compiling their researches. As highlighted in Table 1, among 76.8% who agreed using ICTs for literature searching, 97.1% has agreed using ICTs for Internet searching for literature. Furthermore, 94.8% agreed using Electronic collections/Electronic journals/Journal databases (Emerald, JSTOR, Hinari, Taylor and Francis, PubMed, Science Direct) for literature searching. Only 57.1% agreed use of websites and social media. 58.3% has agreed using Library OPACs.

Among 67.6% who agreed using ICTs collaboration with other researchers, 65.1% mostly agreed use of e-mail as the communication media to cooperate with each other collaborators. Only 61% agreed to use ICTs for analyzing data.

4. CONCLUSION & RECOMMENDATIONS

According to the findings of the study, the highest percentage of academics (85.7%) has agreed using ICTs for publishing their research outputs and lowest percentage (34.8%) agreed to use ICTs for data collecting. Most of the academics (87.4%) agreed use of online research networks to publish research outputs. Majority (95.6%) agreed to use Word Processing for compiling activities. Also a considerable percentage of academics (97.1%) has agreed using ICTs for Internet searching for literature and 94.8% agreed using Electronic collections/Electronic journals/Journal databases. As analysed here, it could be concluded that more than 50% of academics used to practice of ICTS for all their research activities except data collecting. However, for last 2-3 years with the Covid-19 pandemic almost all the academics only used technological ways to collect data for their research purposes. Based on these findings it could be recommended to improve further the technological infrastructure to enhance the research culture of the Sri Lankan academia.

REFERENCES

Carswell, L., Thomas, P., Petre, M., Price, B. & Richards, M., (2000), Distance education via the Internet: The student experience. *British Journal of Educational Technology, 31(1),* pp.29-46 Available at: http://onlinelibrary.wiley.com/doi/10.1111/1467-8535.00133/full (Accessed: 6 June 2019).

D'Ambra, J., Rice, R. E. (2001), Emerging factors in user evaluation of the world wide web. *Information and Management, 38,* pp.373–384. Available at: http://www.ugr.es/~focana/dclasif/artAFEvaW3.pdf (Accessed: 29 September 2020).

D'Ambra, J., Wilson, C. S. (2004), Use of the world wide web for international travel: Integrating the construct of uncertainty in information seeking and the task-technology fit model. *Journal of the American Society for Information Science and Technology, 55 (8),* pp. 731–742. Available at: http://onlinelibrary.wiley.com/doi/10.1002/
asi.20017/abstract (Accessed on: 8 October 2020).

D'Ambra, J., Wilson, C., Akter, S. (2013), Application of the task-technology fit model to structure and evaluate the adoption of e-books by academics. *Journal of the American Society for Information Science and Technology, 64(1),* pp. 48-64. DOI: 10.1002/asi.22757

Goodhue D. L., Thompson R. L. (1995), Task-Technology Fit and Individual Performance. *MIS Quarterly ,19(2),* pp. 213-236. Available at: DOI: 10.2307/249689

Goodhue, D. L., Klein, B. D., March, S. T., (2000), User evaluations of IS as surrogates for objective performance. *Information & Management, 38*, pp.87-101. DOI: 10.1016/S0378-7206(00)00057-4

Kim, S. S., Malhotra, N. K. (2005), A longitudinal model of ccontinued IS use: an integrative view of four mechanisms underlying post-adoption phenomena. *Management Science, 51(5)*, pp. 741-755. DOI: 10.1287/mnsc.1040.0326

Krejcie, R. V., Morgan, D. W. (1970), Determining sample size for research activities. *Educational and Psychological Measurement, 30(3),* pp.607–610. DOI:10.1177/001316447003000308

McGill, T. J.,Klobas, J. E. (2009), A task-technology fit view of learning management system impact. *Computers & Education, 52 (2),* p.496–508. Available at: http://wiki.learnstream.org/wiki/ref:mcgill2009task. (Accessed on: 3 May 2020)

Migoshi, J. A. (2009), Factors influencing research productivity among academic staff in selected universities in Kenya. PhD *Thesis submitted to the Catholic University of Eastern Africa*. Available at: http://repository.seku.ac.ke/bitstream/handle/123456789/ 370/Migosi_Factors%20influencing%20research%20productivity%20among%20academic%20staff.pdf;sequen ce=1. (Accessed on 30th 2021)

Ngai, E. W. T., Poon, J. K. L., Chan, Y. H. C. (2007), Empirical examination of the adoption of WebCT using TAM. *Computers & Education, 48(2),* pp. 250-267. Available at: http://cgit.nutn.edu.tw:8080/cgit/PaperDL/tkw_090926142352.pdf (Accessed on: 13 August 2021)

University Grant Commission (UGC) Statistics. (2021). Available from: http://www.ugc.ac.lk/en/university-statistics-2012.html (Accessed on: 13 May 2021)

Venkatesh, V., Morris, M. G., & Ackerman, P. L. (2000). A Longitudinal Field Investigation of Gender Differences in Individual Technology Adoption Decision Making Processes. Organizational Behavior and Human Decision *Processes, 83,* pp. 33-60. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.469.3591&rep =rep1&type=pdf (Accessed on: 6 January 2021)

Wenger, J. L. & Carlson, R. A. (1995). Learning and coordination of sequential information. *Journal of Experimental Psychology: Human Perception and Performance, 21(1),* pp.170–182. Available from: http://psycnet.apa.org/journals/xhp/21/1/170 . [Accessed on: 28th May 2020].

DEVELOPING A QR CODE BASED AUTOMATED VEHICLE DETECTION SYSTEM

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ABSTRACT

Object Detection Simulation is a system that will facilitate multiple features and functionality implementation to fulfill current challenges due to the pandemic situation and bring the advantage of better financial management for industries in Sri Lanka. This will aim to fill the gap between vehicle transformations and its behaviors. This project is to identify vehicles or any kind of moving objectives to collect unique data with specific criteria. This implementation will hope to fulfil gathering information regarding any kind of vehicle within this pandemic situation & also getting location details when the vehicle passes barriers that are implemented with this system. Sri Lanka Traffic Police will be well supported in providing essential services and it will be very easy for the Traffic Police to deal with such emergencies. They will also have the opportunity to provide their services to the people without wasting their time on essential services. It can also be used not only in emergencies but also in the future to track and analyses road traffic and their data. The system also helps to compute vehicle data related to crimes.

Keywords: emergencies, vehicle, QR code

1. INTRODUCTION

QR code is a type of matrix barcode or two-dimensional barcode. This technology is useful for our developing system. The main purpose of QR code is, uses in the system like vehicle identification. This technology is helpful in situations where the license plate number is missing or GPS tracking is not available due to geographical issues.

QR Codes are generally used to encode information. And people can scan QR Codes via their smartphones to decode the information. To enhance the verification process could be added important information to the QR Code. These may include the driver's contact details and their registration certificate.

Behalf of that, Object Detection Simulation is a system that will facilitate multiple features and functionality implementation to fulfill current challenges due to the pandemic situation and bring the advantage of better financial management for industries in Sri Lanka. and also this will aim to fill the gap between vehicle transformations and its behaviors. In addition to that this will provide solutions to store and analyses the records about vehicles and locations and generate automated reports to authorized parties. On this system, there are 3 levels of corresponding applications that synchronously work as one application.

Regarding the user level application functions that include at the system level will be fully

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automated with legible validations to manage data through the system. So the user can control the whole system with different permission of users through the permission matrix of this system. Apart from that this system is secured with JWT which will be helpful to secure network requests from unauthorized parties. For this, the system is functioning Single Sign On to access this system where the system is physically placed. This system is required only a device that is facilitated with an internet connection to access this system without any troubles due to Web Based System. That means, a user can manage data through internet browsing and the user can operate the whole system through the internet.

The vehicle detection application is only to implement on the physical location that will identify vehicles using camera/s. To monitor this detection part, this application will show the user real-time data reporting on the screen.

The service level application is storing data in the database level through the API that will function with CRUD operation. So, this application is the middle layer operator to make communication between user-level application and the detection model.

1.1 BACKGROUND STUDY/ REVIEW OF LITERATURE

Object detection is a fundamental, and practical, research branch in the field of computer vision, practicing border and category prediction of each instance object in an image by corresponding algorithms. Compared with earlier detectors, current mainstream real-time anchor-based detectors such as Faster R-CNN, SSD (Single Shot Multi-Box Detector), and YOLOv3 have achieved favorable detection results. Current object detectors identify each object through an axis-aligned bounding box that tightly encompasses the object, and reduces object detection to image classification of potential object bounding boxes. Specifically, the classifier would classify the image content in each bounding box into specific objects or backgrounds.

However, in this chaotic world situation caused by the SARS-CoV- 2 viruses (COVID-19 pandemic) has hampered many sectors of human activity, especially in activities that require physical interactions. Thus, requiring social restrictions for those sectors that are affected. To limit the people's interactions Sri Lanka police, give special permits to distribute emergency services to those affected areas. And also introduce a color code to identify service categories.

It is too difficult to track emergency service vehicles and keep records for future analysis. In this project, vehicles can detect using a QR code without stopping the vehicles on the road. When each vehicle registers as an emergency service vehicle QR code will be provided. QR code will keep the information about a vehicle no, service category, etc.

The detecting QR code system will track vehicle details and store them in the database. When Sri Lankan police need to analyse or find any information about emergency vehicles, using the system they can find the details easily.

In addition to that this project will provide data obtained using this system will be of great help to the

computations in dealing with the situation in which the information has been analyzed. Also, the Sri Lanka Traffic Police will be well supported in providing essential services and it will be very easy for the Traffic Police to deal with such emergencies. They will also have the opportunity to provide their services to the people without wasting their time on essential services. It can also be used not only in emergencies but also in the future to track and analyze road traffic and its data. The system also helps to compute vehicle data related to crimes.

1.2 AIM

This project aims to identify vehicles or any kind of moving objectives to collect unique data with specific criteria. This implementation will hope to fulfill gathering information regarding any kind of vehicle within this pandemic situation & also get location details when the vehicle passes barriers that are implemented with this system.

1.3 OBJECTIVES

To achieve the aim of this project, the following objectives are defined:

- Identify the Covid-19 permitted vehicles or the industry authorized vehicles using QR code.
- Generate Automatically QR code based on vehicle details.
- Alert authorized members about unauthorized vehicles.
- Keep records about vehicle details and locations.
- Keep record history & analyze the records.
- Record road details with vehicle movement time find all the vehicle details between specific time periods.
- Filter by specific emergency service type. Filter by locations.

2. METHODOLOGY

To identify the emergency service vehicles by introducing a QR code to each vehicle when register time. Every checkpoint will have a CCTV or HD Camera directed to the coming vehicles on the road. The illustration of the design is depicted in Figure 1 and the Checkpoint view (Detection) is depicted in Figure 2.

If a vehicle comes with the QR code system will detect the QR code and read its information. This mechanism is the type of validation and classification in regard image processing. The used technology of this system automates to identify moving objects with Line Region of Interest (ROI). For this detection model, there are two (2) different model that will facilitate to identify License Plate of vehicle and detect QR.

The detected vehicle by the detection model will process QR to get information about this object and send that data into the service layer to store data in the database through the API's.

The License Plate detection model is work as a unique model to identify vehicle registration numbers in the country.

The stored data in the database can fetch by the web-based system using service layer CRUD operation through the Model View Control (MVC) architecture that is based on separate applications.

Using a web browser users can access the system by facilitating Single Sign On with JWT authentication and users can filter or find the required information from the system easily. By the way, the application perform by the user will have multiple permission levels to manage users in the system.

Figure 1: Illustration of the design

The main system is divided into two sub-systems. First part is a Vehicle Detection System and the second part is the Web-based Management System.

Using Web-based Management System must register all vehicles in the company/special permitted with valid details (ex: - Register No., Type, Category, etc.). When registering successful system will give a unique QR Code to each vehicle. That QR Code must stick to vehicle side of the windscreen or side door. (QR Code must be 4"X4 or 5"X5" size)

Each Checkpoint/Entrance have a HD Camera or CCTV Camera to detect the parsing vehicles.

Detection system will detect and validate the vehicles using QR Code and License Plate and store its information to Cloud DB. Users can use Web based Management System to get necessary information and reports.

Figure 2: Checkpoint view (Detection)

3. RESULTS AND DISCUSSION

3.1 DETECTION SYSTEM (CHECKPOINT)
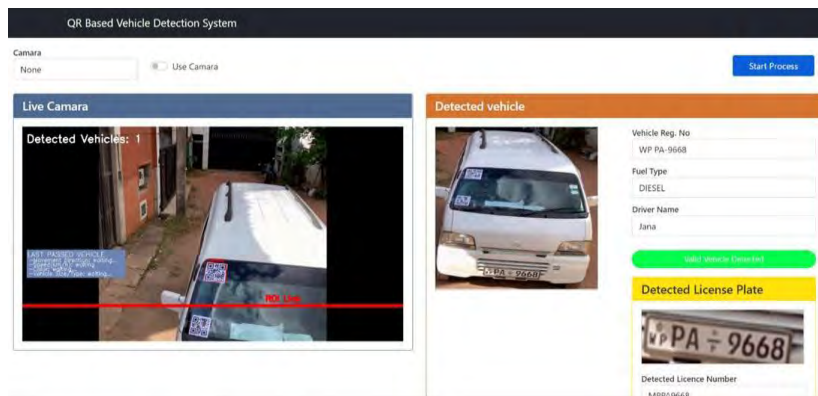
Figure 3: Detection System (Screenshot)

As given in Figure 3, the Detection System can successfully detect the passing vehicle's QR Code and License plate. Above screenshot is a taken from the Detected System. System shows live feed in left side and detection details on the right side. After detect the vehicle features system call the API and validate the vehicle.

3.2 WEB BASED MANAGEMENT SYSTEM

Figure 4: Frontend - Login Page (Screenshot)

Figure 4 shows the login page of the Web based Management System. Users can use their username and password to login to the system and this will act as a Single Sign on Login.

Apart from that, this is secured with JWT (JSON Web Token) and credentials stored in the database level. Also, this token is perform multilevel user types and there are main 3 user levels.

- SUPERADMIN
- ADMIN
- DATAENTRY

These three user levels supposed to control CRUD operation (Create, Read, Update, Delete) and features may restrict according to the logged on user type.

However, The SUPERADMIN have super permissions to manage all process without any dependencies.

Figure 5: Frontend – Vehicle Details Page (Screenshot)

Figure 5 shows the View of Vehicle Details. There are four main data about vehicles. Those are,

- Vehicle ID, Registration No
- Registration Date, Registration Address

The showing data can change according to the client or customer request and the data grid(table) is a fully customize grid to considering cognitive load and keep user's behavior in simple. Also, there are Buttons to manipulate operations for the vehicles
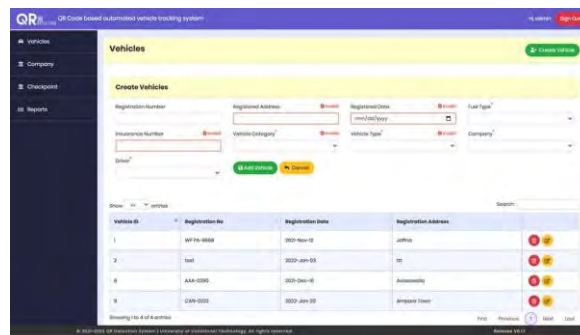
Figure 6: Frontend – Vehicle Registration Page (Screenshot)

Figure 6 shows a form on the top of the grid (table) that functions with two-way form controlling with its unique validations. This view is called Vehicle Registration.

The form is functioning with nine fields to describe the vehicle which is ready to register a new vehicle to this system.

Regarding the field validations, a user cannot bypass a field if it is mandatory to fill it before submitting. If any field has wrong data then the errors will appear logically according to the business logic.

A user can print the QR Code after completing the vehicle registration. The QR Code is automatically populated by the system and it will be supposed to print QR without any dependencies.

Figure 7: Frontend – QR Code view (Screenshot)

Figure 7 shows a QR Code that was automatically generated according to the registered vehicle details. This will become a popup view and cannot bypass without downloading this QR.
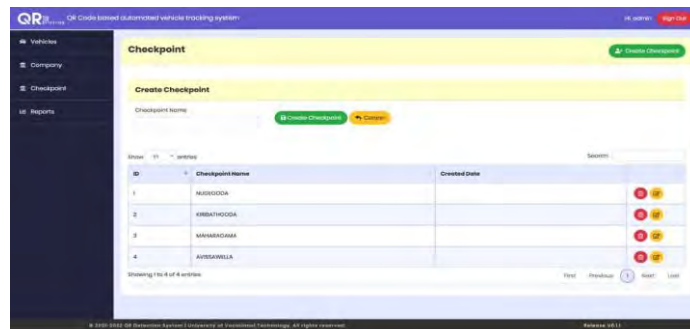
Figure 8: Frontend – Checkpoint Creation and Details Page (Screenshot)
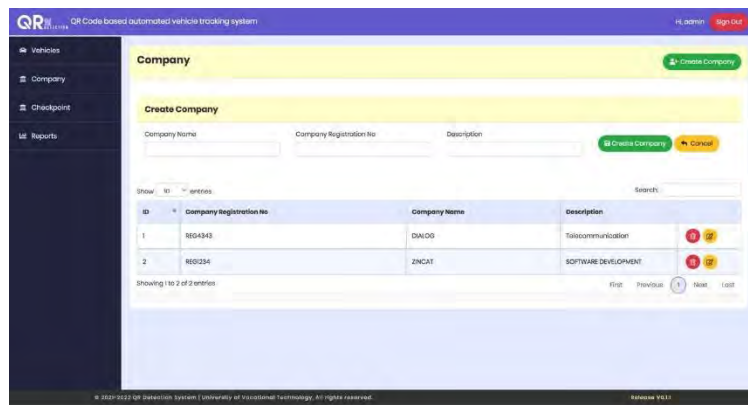
Figure 9: Frontend – Company Creation and Details Page (Screenshot)

Figures 8 and 9 show the Checkpoint and Company details view. These views are fully functioning with their data creation form with validations.

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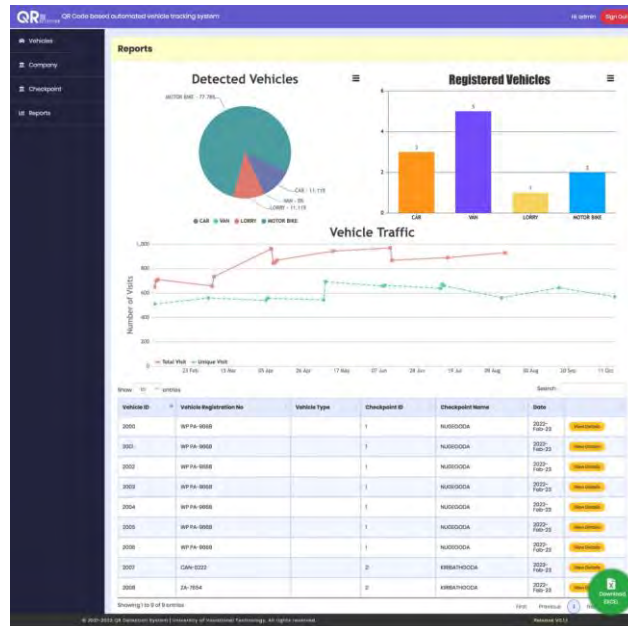
Figure 10: Frontend – Report/Analytic Page (Screenshot)

Figure 10 shows the Report view of this system. It shows all the analytical data of the detected vehicles. There are three (3) different graphs. The Pie chart will describe the percentage of detected vehicles that data separate by the vehicle categories.

The Graph chart will describe system-registered vehicle details according to the categories of vehicles.

The line chart will describe vehicle traffic at the checkpoints.

And also, these all charts will give the ability to download the graph option as an image format and the whole report can download as the EXCEL format as an example below in figure 11.

Figure 11: Downloaded Excel Report (Screenshot)

4. IMPLICATIONS / RECOMMENDATIONS & LIMITATIONS

By using this system drivers and authorities don't need to stop the vehicle and show all the documents to pass. Simply stick the valid QR Code on the windscreen or the side of the vehicle authorities can validate vehicle identification and the purpose of the moving vehicle. And also, if someone duplicates

the QR Code and try to pretend as a valid vehicle it can detect by the system.

However, there were few limitations and difficulties during identifying the QR Code on the moving vehicles. The first deficit was to identify the QR Code. When capturing the QR Code on a moving vehicle using Web Cam or CCTV camera has taken image can be blur.

The second problem was that using high-resolution captured images, requires very high processing power to process the images. When processing power is low detection process gets very slow.

REFERENCES

Artificial intelligence foundations: Machine learning (no date) LinkedIn. Available at: https://www.linkedin.com/learning/artificial-intelligence-foundations-machine-learning (Accessed: July 26, 2022).

Artificial intelligence foundations: Neural networks (no date) LinkedIn. Available at: https://www.linkedin.com/learning/artificial-intelligence-foundations-neural-networks (Accessed: July 26, 2022).

Artificial intelligence foundations: Thinking machines (no date) LinkedIn. Available at: https://www.linkedin.com/learning/artificial-intelligence-foundations-thinking-machines (Accessed: July 26, 2022).

Hemalatha, C., Muruganand, S. and Maheswaran, R. (2014), A survey on real-time object detection,

tracking and recognition in image processing, *International journal of computer applications*, 91(16), pp. 38–42. doi: 10.5120/15969-5407.

Piao, J.-C. et al. (2016), Improving performance on object recognition for real-time on mobile devices, *Multimedia tools and applications, 75(16),* pp. 9623–9640. doi: 10.1007/s11042-015-2999-1. (No date a) Udemy.com. Available at: https://www.udemy.com/course/computer-vision-a-z/ (Accessed: July 26, 2022).

PROPAGATION MODEL TUNING FOR SUB URBAN REGIONS IN SRI LANKA (LTE 2600)

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ABSTRACT

The global tends to use high rates of multimedia applications. High-speed data services through cellular networks are the major sector that facilitates data service. LTE is the one of cellular technology in the mobile industry that achieves the required data demand. Currently all of the mobile operators in Sri Lanka have been launched the 4G network and the number of LTE attached subscribers are rising rapidly and most of networks are ready for 5G also. The goal of model tuning is to calibrate the parameters of propagation model and improve the prediction model. Prediction simulation was the first action of the any mobile network and based on simulated model it can be taken rough coverage level which can be provided with on air. All the planning procedures are based on coverage simulation and total process will be depended with propagation model which used. There for fine tune the correct propagation model is important task.

Keywords: *LTE, Model, Model Tuning, Propagation, Simulation.*

1. INTRODUCTION

Propagation or path loss models are basically used to produce a coverage simulation to check the predicted coverage. By tentative coverage simulation which can be produced by planning tools will be said the feasibility of the site. Basically, coverage prediction is produced based on the antenna pattern and the propagation model with path loss calculation. The generalization of the propagation models to any environment can be either area (urban, suburbs, and rural) or a specific cell radius (macrocell, microcell, picocell). It is depending on the diversity of the environment.

1.1. BACKGROUND STUDY/ REVIEW OF LITERATURE

Propagation models are used extensively in network planning, particularly for conducting feasibility studies during initial deployment. They are also very useful for performing interference studies as the deployment proceeds. The generalization of these models is either particular areas (urban, suburbs, and rural) or specific cell radius (macrocell, microcell, picocell). That's depending on the diversity of environments where mobile communications occur. In general, there is a relationship between these models and the types of environments to which they are applicable.

These models can be broadly categorized into three types empirical, deterministic and stochastic. Empirical models are those based on observations and measurements alone. These models are mainly used to predict the path loss, but models that predict rain-fade and multipath have also been proposed. The deterministic models make use of the laws governing electromagnetic wave propagation to

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determine the received signal power at a location. Deterministic models often require a complete 3-D map of the propagation environment. Stochastic models, on the other hand, model the environment as a series of random variables. These models are the least accurate but require the least information about the environment and use much less processing power to generate predictions.

2. METHODOLOGY

Stage 1:

Collect the drive test data with enough field measurement. Log file collection by TEMS DT kit.

Stage 2:

With help of field test measurement (Drive test data) extract the basic radio frequency (RF) parameters reference signal received power (RSRP) and primary cell identity (PCI). RSRP measurement indicates the received signal reference power and PCI indicates the received signal dominant cell. Use the ACTIX post-processing tool to extract the required data.

Stage 3:

Extract the CW measurement points with help of ATOLL 9955 RNP tool by importing CSV formatted DT log information's.

Stage 4:

Tune up the individual propagation model for each selected site with help of extracted CW measurements. Follow the same process for each site.

Stage 5:

Considering the outcomes of initial parameter tuning and reference with the standard model (SPM model) for pathloss calculation identified the most affectable "K" variables for final model tuning.

Stage 6:

Based on the stage 5 analysis selected "K" factors which use for the final model. Tune up the final propagation model with K1, K2, K4 & K5 as variable factors and all other parameters as fixed with standard model values.

Stage 7:

Calculate the path loss for all sites referring with same standard (same height & distance).

- Ex: standard site H =40m and d =1000m
- Initial tuning excludes the clutter tuning
- Clutter tuning need to proceed after the K factor tuning.

SPM 2600 MHz propagation model is based on the following formula:

$$L_{model} = K_1 + K_2 \log(d) + K_3 \log(H_{Txeff}) + K_4 \times Diffraction\ loss + K_5 \log(d) \times \log(H_{Txeff})$$
$$+ K_6(H_{Rxeff}) + K_7 \log(H_{Rxeff}) K_{clutter} f(clutter) \qquad (Eq:01)$$

Table 1: Parameter Description

Factor	Description
L_{model}	total pathloss at the d distance
K_1	constant offset
K_2	multiplying factor for log(d)
K_3	multiplying factor for log(H_{Txeff})
K_4	multiplying factor for diffraction calculation
K_5	multiplying factor for log (H_{Txeff})log(d)
K_6	multiplying factor for H_{Rxeff}.
K_7	multiplying factor for log (H_{Rxeff})
d	distance between the receiver and the transmitter (m)
H_{Txeff}	effective height of the transmitter antenna (m)
H_{Rxeff}	effective mobile antenna height (m)
$K_{clutter}$	multiplying factor for f(clutter)
$f_{(clutter)}$	average of weighted losses due to clutter

3. RESULTS AND DISCUSSION

Based on the similarity overall analysis identified the site samples which can be taken for final model tuning for sub urban model region.

"K" Parameters of Tune-up Sub Urban model

Table 2: Tune-up "K" Parameters

Model Name	K1(los)	K2(los)	K1(nlos)	K2(nlos)	K3	K4	K5
Standard Model	**18.5**	**42**	**18.5**	**42**	**10**	**0.5**	**-6.93**
Sub Urban Model	22.89	39.93	18.5	42	5	0.5	-4.48

Sub Urban model applicable the sites which located in sub urban areas with less vegetation.

Selected sites for suburban model

1) Katharagama   2) Ambalantota   3) Thissamaharamaya   4) Angunukolapelessa

5) Embilipitiya   6) Polonnaruwa   7) Aranaganwila

8) Kaduruwela   9) Pulasthigama   10) Dehiattakandiya
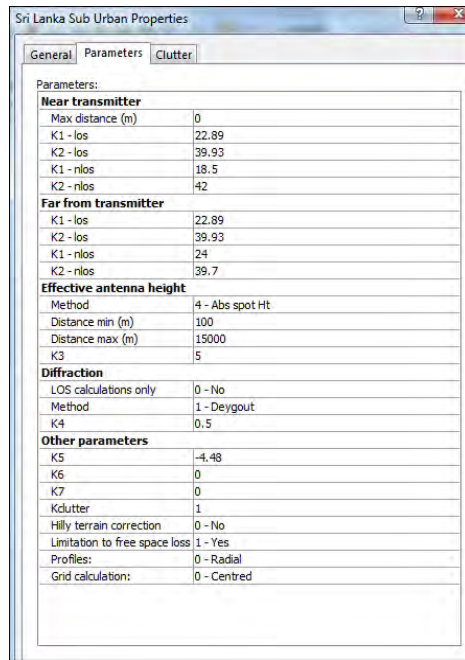
Figure 1: "k" and "Clutter" parameters of Sub urban model

Most of "K" Parameters and clutter parameters clearly shown the deviation with standard parameters. Initial coverage simulation was not accurate due to the parameter deviation. Based on tune-up results of "K" parameters final outcome produce the 70% accurate coverage simulation. Further tuning need to be done with clutter tuning for more accurate simulation.

Before Model Tuning	After Model Tuning
Figure 2-a: Actual & Coverage with standard model	Figure 2-b: Actual and coverage with sub urban model

Before Model Tuning	After Model Tuning
Figure 2-c: Actual & Coverage with standard model	Figure 2-d: Actual and coverage with sub urban model
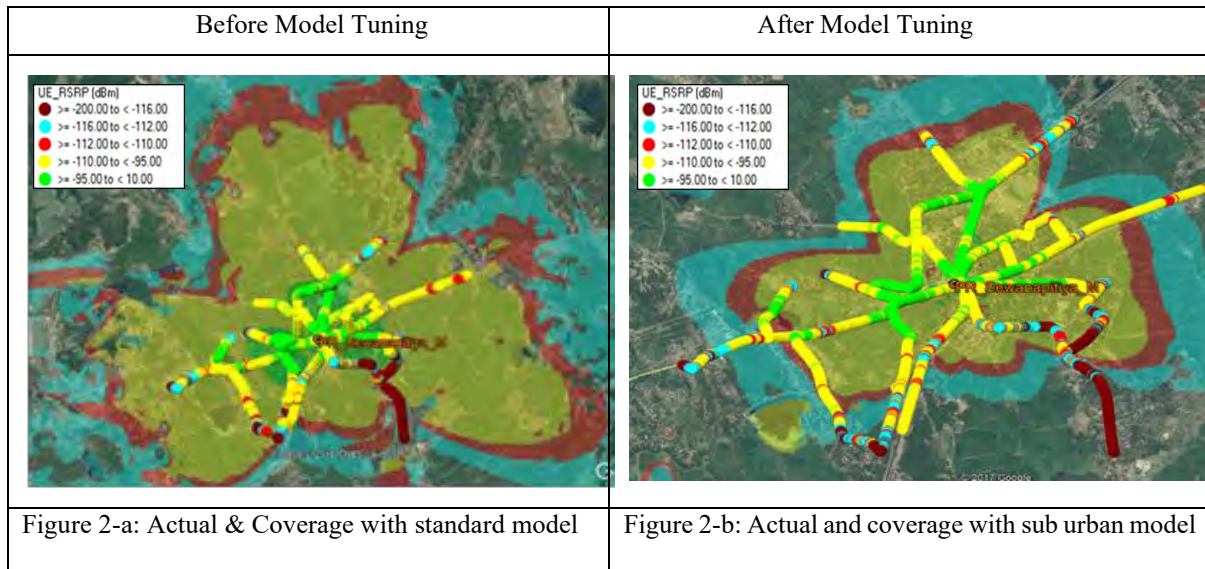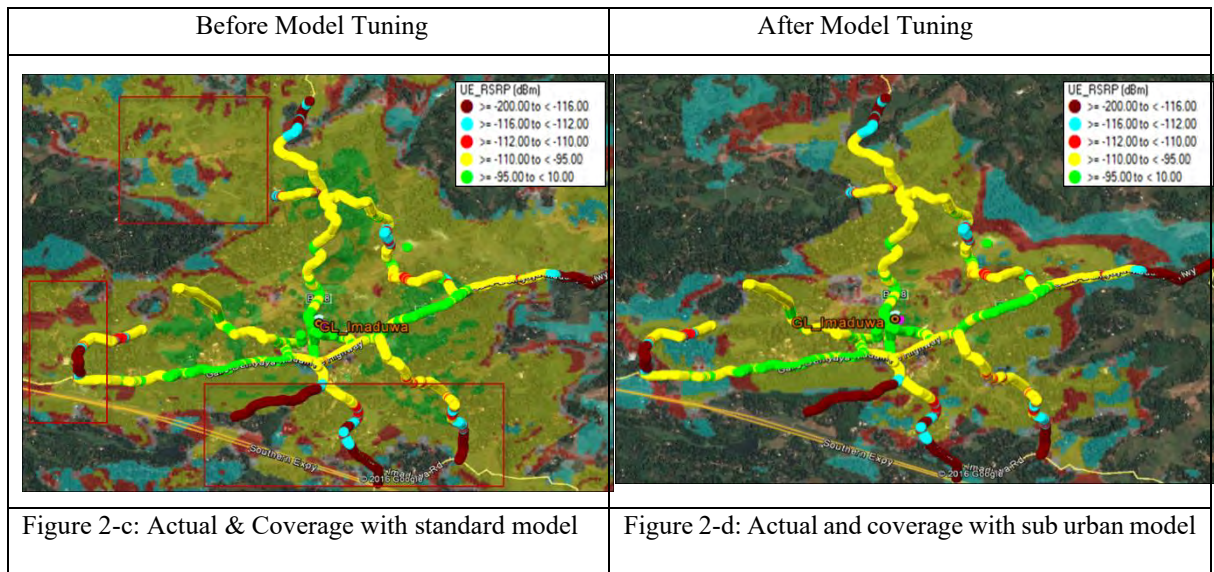
4. CONCLUSION(S)/ IMPLICATIONS/ RECOMMENDATIONS & LIMITATIONS

4.1 CONCLUSION

By using different sets of field measurements over the target regions and pre-and post-processing with measurements try to develop a set of propagation models which can be used for LTE 2600MHz TDD band in Sri Lanka. With developed regional models, most can be given predictions with expected accuracy. As a result, the accuracy of the radio-propagation predictions of the whole network was improved. Moreover, the improvement was significant when applying the presented approach to a network deployed island-wide. Basically, develop two models sub-urban and rural. But the suburban model extended through terrain and clutter variance. That would be a good decision I have taken at the developing stage. Because of regional models, I can get a well-accurate prediction with accurate clutter parameters.

4.2 RECOMMENDATION

Models need to be selected on a regional basis. An example of the southern region must be used suburban model for the southern region. Each model is identical for regional clutters. Their model selection is important. The rural model is only for sites that have less than 30m in height with heavy shadowing. Most of the shadowing happens due to the heavy vegetation. Digital maps need to be updated with 5m resolution. Currently use 20m clutter digital database. It will impact the accuracy of the prediction. Models may be NOT perfect. Optimization will always be required.

REFERENCES

LTE Network Throughput Estimation' by Alexander Babkin, Alexey Pylenok, Alexander Ryzhkov, Andrey Trofimov, The BonchBruevich Saint-Petersburg State University, Saint-Petersburg, Russia.

Atoll_3.1.0_Documentation\Atoll_3.1.0_Documentation.

Hormoz Parsian:Comparison of Asset and Atoll Cellular Planning Tools   for LTE Network Planning, AALTO UNIVERSITY-2012

Rohde & Schwarz: Application Note 1MA111 "UMTS Long Term Evolution (LTE) Technology Introduction

Rohde & Schwarz: White Paper 1MA232 "LTE-Advanced (3GPP Rel.11)   Technology Introduction"

A VEHICLE WARNING SYSTEM TO AVOID ACCIDENTS ON THE ROAD

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ABSTRACT

Road accidents have significantly increased in developing nations like Sri Lanka as a result of recent technological advances and rapid economic expansion. It is evident that by identifying accident hotspots and providing drivers with the necessary knowledge beforehand, these accidents can be significantly reduced. Accident hotspots are places with a high density of accidents, which are the main cause of injury-related death. With advance planning, both drivers and passengers may guarantee their own safety when traveling. These pre-awareness systems are uncommon, though, for a variety of financial, technological, and psychological reasons, including the fear of emerging technologies. These accident hotspots are frequently identified, examined, and treated through implemented awareness systems. Some excellent improvements have also been put into practice using the concepts of ubiquitous computing, which will have a significant impact on the field of road safety. We identify accident hotspots in our system using vehicle data, dashboard camera video analysis, object detection and analysis, and sending the driver the appropriate warning message when a warning circumstance is found along the way.

Keywords: *Accident Hotspots, Computer Vision, Data Science, Video Analysis.*

1. INTRODUCTION

Life is the greatest enterprise one could achieve in his or her lifetime. Due to numerous unfortunate factors, including the prevalence of traffic accidents in many developing nations, including Sri Lanka, life on the road has now devolved into such a pitiful scenario. There are many factors that contribute to high traffic accident rates, but the most common ones are driving while distracted, driving too fast, driving while intoxicated or under the influence of drugs, changing lanes suddenly, driving while lane-splitting, driving through an animal crossing, poor road management, infrastructure issues, and weather [1]. Researchers, engineers, and even governments have concentrated on developing rigid solutions to minimize these controllable road accidents due to the rapid increase in the number of fatal and non-fatal deaths and injuries caused by traffic accidents, which are also reported to go unreported in rural areas. In truth, cutting-edge developments in data science, machine learning, and image processing would provide fantastic solutions for making significant strides in avoiding these senseless fatalities. Authorities in the EU or the NHTSA in the USA have been continuously advising drivers [2], and numerous research groups have demonstrated the impact that using in-vehicle warnings of impending accident hotspots has on driver behavior. However, people favor technological solutions to these problems over straightforward verbal cautions. Programs like EuroRAP, RANKERS, and EURO TAP [2] that focus on enhancing the road infrastructure are another strategy to lower traffic accidents. Today, there are also a number of in-vehicle systems like automated braking systems, steering pattern detection

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systems, night vision assistance systems, EBD (Electronic Brake-Force Distribution), etc. that were built utilizing cutting-edge technology and would encourage good driving habits [3]. The majority of emerging nations have also implemented legislation involving traffic accidents, however despite rigorous regulations, severe penalties, and safety precautions to avoid corruption, the number of fatalities has not decreased globally. Methodologies for reducing fatal accidents by being aware of accident hotspots beforehand are already a developing research field. Road traffic accident hotspots are areas with a high probability of ongoing accidents occurring and where accidents have previously been reported and concentrated. In the next parts, the study at hand gives a review of the existing created systems born with assessing accident hotspots to answer traffic accidents problem. The essay is set up as follows. Section 3 highlights other's efforts with compliments and critiques in their techniques. Our intended model is provided in Section 4. Section 5 also discusses other tasks we should complete for the field research setup, such as the system activation and data gathering process. The document ends by providing a conclusion and a forecast for the project's launch on a solid foundation.

1.1. BACKGROUND STUDY/ REVIEW OF LITERATURE

Geographical information systems (GIS) have supplanted the principles, frameworks, and methods for identifying recurring hotspots with a wide range of mishaps. In order to locate regions with a high cluster of a particular behavior, a number of studies on road safety, accident minimization, traffic information mapping, and hotspot mapping have already presented their GIS-based approaches. For a variety of purposes, geographic information systems (GIS) are a computer-based technology and methodology for gathering, managing, analyzing, modeling, processing, and portraying geographic data. Kernel Density Estimation (KDE) based on both planer KDE and network KDE, the Empirical Bayesian Method, the Accident Frequency Method, the Accident Rate Methods, and Quality Control Methods are some hotspots identifying techniques in this subject that have been documented in the literature [4][5]. /Researchers have made great efforts to locate, map, and analyze the temporal and spatial patterns of traffic accidents, as well as to identify hotspots in these areas. Also, they have sought to determine the core causes of traffic fatalities while also searching for answers on how to control them by enhancing road safety measures. The suggested system would next concentrate on evaluating the vehicle data and other data parameters linked with the driver at hotspot locations once the hotspots have been correctly identified. The method for receiving CAN-Bus signals coupled with video clips, position data, and other extra sensor data from the phone is described in [1] and [2] studies. Signal name, frequency, wheel speed, wheel slip status, fuel level, brake pressure, etc. are some of the specified CAN-Bus data parameters. GPS altitude, GPS longitude, GPS latitude, GPS speed, GPS accuracy, etc., are among the smartphone data parameters that are being targeted. However, both of these studies used a tailored crowdsensing approach to categorize accident hotspots and risky driving behavior on the road. Here, a Bluetooth dongle will be linked to the vehicle via the OBD-II connection in order to retrieve and gather the vehicle and driving data from the CAN Bus of a vehicle. Their system consists

of three components: the vehicle and any accompanying sensors, the driver's smartphone that transfers data from the vehicle to the server, and the server that saves, analyses, and relays accident hotspot data to the driver's smartphone. Data was captured there and sent over Bluetooth to the smartphone before being forwarded to the server using a dongle put at the OBD-II port to access the CAN Bus. Nowadays, cell phones with On-Board Diagnostics (OBD) sensors can access crucial sensor data collected by in-vehicle computers that are considerably more capable of doing so. In-built sensors on smartphones and tablets include accelerometers, gyroscopes, GPS, and also potent cameras. Therefore, compared to old methods, current developments in smartphone technology have made it possible to detect automobile accidents in a more portable and affordable manner. Researchers have demonstrated a prototype that can gather real-time data from moving automobiles, including speed, engine RPM, fuel usage, and GPS locations, without jeopardizing the device's security in [8]. The majority of the research has used road-mounted detectors including cameras, microwave sensors, and Bluetooth scanners to gather data on the kind and quantity of cars that pass through an area as well as their speed, trip time, and other relevant information. The most popular OBU report car information to other vehicles directly or to a centralized server where researchers can gather measurement data to monitor traffic, detect traffic accidents, spread emergency alerts, and convey diagnostic information. An architecture for detecting automotive accidents based on Wreck Watch, a mobile client/server application that was created to automatically detect car accidents, is also shown in [9] research. The system was created using Java/MySQL with Jetty and the Spring framework on the server side and Android on the client side. The client applications will interface with the wreck watch server using bespoke XML and JSON, and the clients will send data to the server using regular HTTP post operations. Additionally, various cutting-edge approaches fusing the fields of AI have also been realized and utilized in several domains, including the automobile fault detection sector. Research has been done in [10] to utilize the expertise of expert systems that can offer fresh and efficient ways to diagnose automotive maintenance faults. The effectiveness and standardization of tests and maintenance for vehicle failures have increased [10]. The primary factor determining life on the road in the majority of traffic accidents is irresponsible driving. The most recent and cutting-edge research in the fields of wearable technology and mobile technology has made it possible to find novel and creative ways to identify and offer workable solutions to this reckless driving behavior. The dissemination of driver behavior has been done via C2C communication. Most frequently, basic errors can result in tragic incidents. According to their research findings, [18] it has been shown that driver inattentiveness and distraction are the two primary causes of traffic accidents. Some of the most frequent errors that result in road accidents include texting while driving, talking on the phone, eating or drinking, being sleepy or distracted. In [18], they made an effort to prevent traffic accidents brought on by driver behavior by using image processing and machine learning ideas to find the best solutions. The majority of the research has focused on the study of facial expressions, head movements, pupil movements, and eyelid movements. As a result, methodologies based on both visual and nonvisual aspects have been developed. For instance, techniques like Haar-like, SVM, LBP,

HOSVD, and Nave Baiyes have been used to analyze eye conditions, and SVM and Nave Baiyes have been used to analyze mouth and yawning conditions. Non-visual features can be divided into two categories: driver-based features and vehicle-based features. Driver-based features include the driver's pulse rate and brain activity, while vehicle-based features include brake pressure, speed fluctuations, and wheel angle. These can be investigated using EEG, ECG, and EOG. lane holding, acceleration pedal movement, braking, and vehicle movement analysis.

2. SYSTEM DESIGN

As shown in the following Fig.1, the proposed model is based on four distinct sections. Vehicle data will be collected through the Bluetooth dongle which connects the vehicle unit with the OBD II port. The smartphone will be collected the data over Bluetooth. The mobile phone will be transferred the collected data to the server through the cellular network. The server will process the data and warning messages will be sent by the system if a hazardous scenario is found through analysis by processing the vehicle data. In the second section, when the vehicle passes across the hotspot area, warning messages will be broadcast. Location will be monitored through the GPS, and it will compare with the hotspot database.
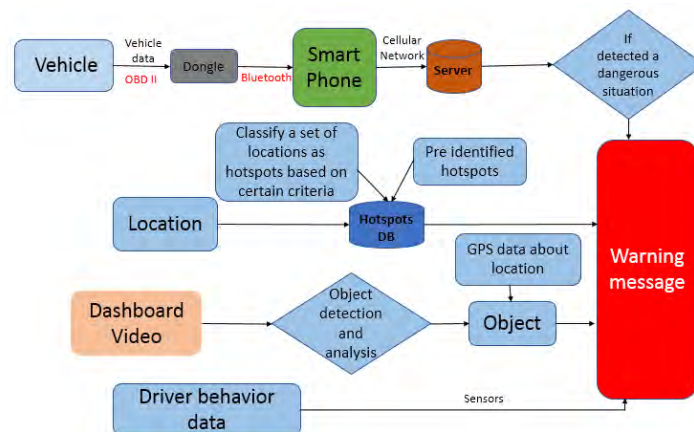
Figure 1: System Design

In the third section, will be analysis the video data through the vehicle's dashboard camera based on the image processing techniques, If the system captured any harmful effect that appropriate warning message will be produced. In the fourth section, focusing on information of driver behaviour and information and data will be collected through the sensors and other cutting-edge methods, such as wearable technology and mobile phones. If any inappropriate behavior was detected, warning messages will be generated.

3. RESULTS AND DISCUSSION

Up to now, circuit development was completed to carry out the fundamental stages used for data gathering using the OBD II port. The gadget which needs to be fixed to the vehicle is shown in Fig. 2. The GPS data can be obtained from the GPS sensor. Additionally added the Real Time Clock sensor

which can be used to determine the time zone. An accelerometer that is coupled to this device will be used to measure acceleration as well as its angle. Also, need to we obtained the hotspots' geographic coordinates from Sri Lanka's Ministry of Transport and Civil Aviation.

Figure 2: Device to collect Vehicle Data

4. CONCLUSION(S)/ IMPLICATIONS/ RECOMMENDATIONS AND LIMITATIONS

Using data analysis and image processing tools, we have compiled a study of the systems that have been put in place to pinpoint areas that are traffic accident hotspots and find ways to prevent possible accidents. The system was deployed in the field to gather a sizable dataset of hotspot locations that had already been discovered in order to determine the correct cause of a hotspot. With the solid information base gained from the review, a smart in-vehicle system for successfully minimizing and preventing road accidents would be constructed.

REFERENCES

Chen, P. and Min, Y. (2013). Research and Implementation of Vehicle Fault Diagnosis Expert System. *In: Advances in information Sciences and Service Sciences(AISS)*.

Gahr, B., Ryder, B., Dahlinger, A. and Wortmann, F., (2018), July. A crowd sensing approach to video classification of traffic accident hotspots. In *International conference on machine learning and data mining in pattern recognition*. pp. 183-197. Springer, Cham..

Mutya, K., and. Rudra, S., Road safety mechanism to prevent overtaking accidents*, International Journal of Engineering Trends and Technology*, *28(5),* 2015.

Nyoni, R. (2019). A GIS based approach to identify road traffic fatal accident hotspots in the greater Durban city from 2011-2015. *University of KwaZulu-Natal*

Reininger, M., Miller, S., Zhuang, Y. and Cappos, J. (2015). A First Look at Vehicle Data Collection via Smartphone Sensors. In: *2015 IEEE Sensors Applications Symposium (SAS)*. Zadar, Croatia.

Ryder, B., Gahr, B. and Dahlinger, A., (2016). An in-vehicle information system providing accident hotspot warnings. In *Proceedings of the 24th European Conference on Information Systems (ECIS), Istanbul, Turkey* (p. 3). AIS Electronic Library (AISeL)..

Thompson, C., White, J., Dougherty, B., Albright, A. and Schmidt, D. (2010). Using Smartphones to Detect Car Accidents and Provide Situational Awareness to Emergency Responders. In: *International Conference on Mobile Wireless Middleware, Operating Systems, and Applications*. Nashville, TN USA.

Truong, L. and Somenahalli, S. (2011). Using GIS to Identify Pedestrian-Vehicle Crash Hot Spots and Unsafe Bus Stops. *Journal of Public Transportation*, *14(1*), pp.99-114.

Zinebi, K., Souissi, N. And Tikito, K. (2018). Driver Behavior Analysis Methods: Applications oriented study. In: *The 3rd International Conference on Big Data, Cloud and Applications*. Morocco.

INFLUENCE OF SOCIAL MEDIA ON HEALTHINESS OF ADOLESCENTS IN SRI LANKA

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ABSTRACT

The use of social media has become a common practice among adolescents in Sri Lanka. Today, social media is highly responsible for various effects on adolescents' health. This paper investigates how social media affects adolescents' vision, attention, and overall physical and mental health, as well as how they spend their leisure time. Primary data were collected through a survey and in-depth interviews. The results demonstrate that the majority of adolescents faced physical and mental health problems as a result of their use of social media.

Keywords: Adolescents, Eye-Disorders, Face Book, Social Media, New Media.

1. INTRODUCTION

The use of social media in Sri Lanka is steadily increasing. With this increase, adolescents have been motivated to use social media irrespective of age. More than 8.20 million people in Sri Lanka use social media. Also, 11.34 million people use the internet. (*DIGITAL 2022: SRI LANKA*, 202 C.E.) Here social media like Facebook, YouTube, WhatsApp, and Instagram are the most popular social media among teenagers in Sri Lanka. The objective of the study is to investigate the physical and mental health problems due to the use social media for adolescents.

However, social media yield positive and negative influences on them.(*Positive and Negativ e and Negative Effects of Social Media on Adolescent W Ects of Social Media on Adolescent WellBeing.*, 2019) Adolescents use this social media for positive impacts such as education, information, communication, e-money and etc. Also, in recent times, it has been pointed out that adolescents have faced physical and mental health problems because of their addiction to social media. Adolescents faced depression, back pain, eye disorders, and anxiety due to the long time using social media.(*Social Media Use and Depression in Adolescents: A Scoping Review*, 2020) Since the use of social media, a lot throughout the day, from the morning until the time of going to bed at night, and because the use of social media without taking a break and taking exercise, here adolescents facing these kinds of health problems more. Thus, due to the continuous use of social media from childhood, greatly affects their minds. Here for example thinking power is decreasing, memory power is decreasing and the responsibility to continue as a generation has gradually decreased. (*Social Media Use and Depression in Adolescents: A Scoping Review*, 2020)

2. LITERATURE REVIEW

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Dr. Kavitha Karan has done research on the effects of social media on the health of college students. In this study, a survey has been done as a method of data collection. (VanOverbeke, 2008) A questionnaire consisting of 117 questions was used and 206 students participated from Midwest University, USA. The research investigates the high level of social media use among college students and their negative health and academic habits. The results show social media's downsides include cyber bullying, depression, and social media addiction. The findings show that issues have a large impact on their physical and lead to changes in their mental health.

The impact of social media on adolescent's general health research done by Dr. Saima Nisar, Dr. Safa Akmal, Hamza Hussain, Quart Ul Ain Ainy, and Syed Nawazish. (Nisar et al., 2020) The method used in this research is a survey method. There, a questionnaire collected data from Karachi schools in Pakistan. Random sampling technique has been used by school participants at lower-, middle- and upper-class levels at different social levels. There were 100 respondents and the data was obtained from teenagers between 12- 18. The research shows how social media changes adolescents or teenagers' physical health, and mental health (behavior changes, social anxiety, sleep disorders). The findings are that social media strongly negatively influenced for teenagers. However, this research shows there is a negative result with mental disturbance, and depressive anxiety because of addiction to social media. It also finds teenagers faced physical health problems such as migraine, vision, backache, and headaches. Anali Singh, Herendra Kumar, Sunita Kumari have done research about the impact of social media on adolescent's mental health. (Kumar & Singh, 2020) 100 students in Aligard district of India were selected and students who use social media mostly using mobile phones were used as a sample. The study served 100 students people aged 16 – 18 using for this survey and find when adolescent use social media for more than two hours, they have huge impact on their stress level, depression and anxiety. The research hypothesized "there will be a significant adolescent who use social media for less than two hours and who use social media more than two hours on depression, stress, anxiety ". The hypothesis was found to be true in the results of the research. Finally, in this research find adolescents who are using social media more than two hours have a poor mentality.

Rahman et al., (2020), researching on the effects of social media usage and how it impacts on health and academic performance among students at University of Sharjah, data collection was done through a questionnaire and an in – depth interview through a sample of 300, 18 years of age participants selected through random sampling technique. Results of Rahman et al., (2020), show the harm of the social media of the students' academic performance and health that; when students spend a lot time on social media, they easily get addicted to it and they got a lot of general health problems such as headache, neck pain, poor posture and fatigue, confronting a huge health risk. McNamee et al., (2019) had researched on social media extensive and emotional, and behavioral outcomes for adolescents in the age group of 10- 15 years in UK, showing high levels of usage of social media and how it effects the mental wellbeing also the behavioral problems.

3. METHODOLOGY

The study was conducted in the Western Province of Sri Lanka. This research use primary data was collect based through a questionnaire survey and in – depth interviews.

3.1. SURVEY

All the respondents belong to the age group of 14 – 19 in the Western Province in Sri Lanka. Total population of the teenagers is 450 278 in the Western Province. The accessible sample size is 384 which was decided thorugh sample size calculator. Thus, the number of sample particpants of the survey is 384 in the Western Province, Sri Lanka. Survey data was anlyzed using SPSS.

3.2. IN-DEPTH INTERVIEWS

In – depth interviews were conducted from 02 randomly selected physiologists and 06 randomly selected teenagers in the Western Province.

4. ANALYSIS

Among the adolescents who participated the questionnaire survey, 61.2% were females and 38.8% were males.

4.1. SOCIAL MEDIA USAGE
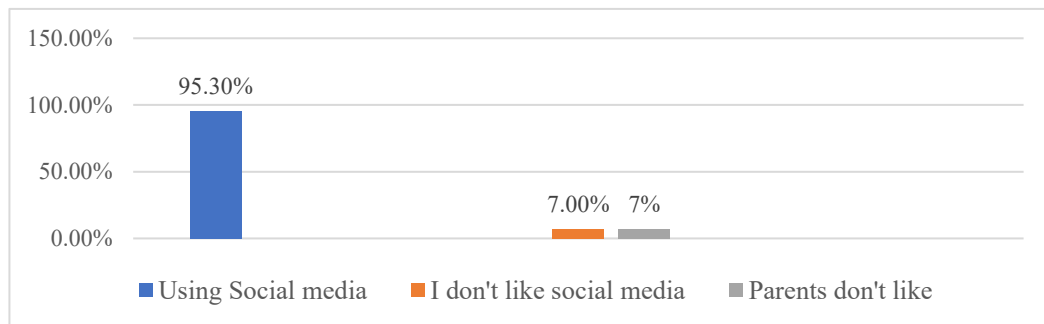
Figure 1: Social media usage

Figure 1 shows that, among the particpants 95.30% are using social media, 7% of the particpants do not like to use social media and7% of adolescents' parents do not like them using social media
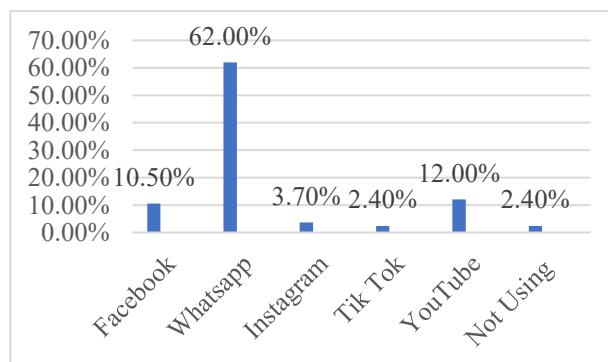
Figure 2: Types of social media platforms

Figure 2 shows the social media platforms that adolescents are using. WhatsApp 254 (66.7 %) is the most frequency used social media platform

and YouTube as the second most used social media type, with a frequency of 49, (12.9%). Facebook is the third most used social media platform and it is 43, (11.3%). Other platforms are Instagram 15, (3.9%) and TikTok 10, (2.6%). The participants do not use other types of social media.
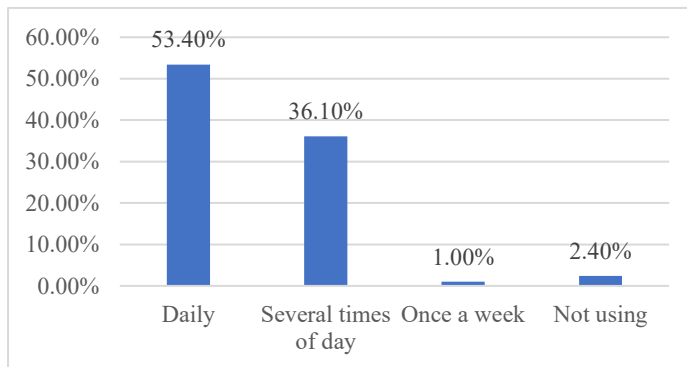
Figure 3: Frequency of social media usage

Figure 3 shows the frequency of adolescents' use social media. The most frequency of adolescent's using social media daily. 219, (53.4%) of the particpants claim that they are using social media daily. 148, (36.10%) of the particpants have mentioned that they are using social media several times a day. A number of 4, (1.0%) adolescents claim that they use social media once a week. 10 (2.6%) adolescentshave mentioned that they are not using social media. Among the particpants who claim that they are using social media daily, following information shown in Figure 4, 5 and 6 was revealed.
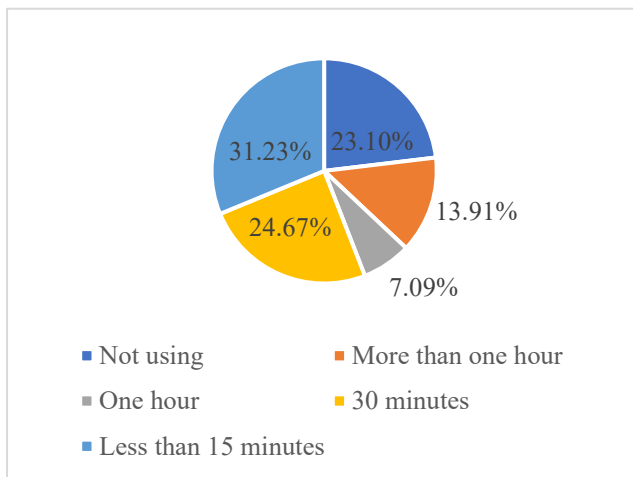
Figure 4: Time spent for social media when woke up in the morning
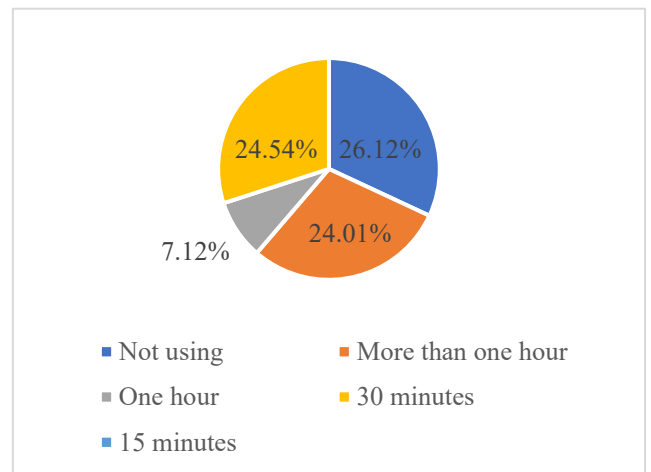
Figure 5: Time spent for social media when going to bed at night
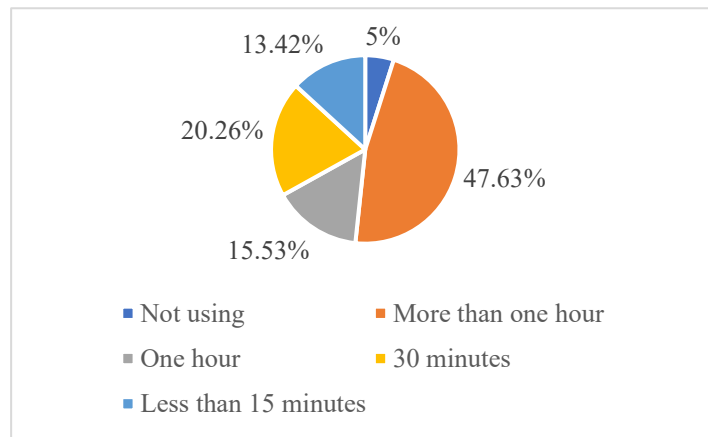
Figure 6: Time spent for social media per a day

Figure 6 shows the time spent for social media when the adolescents woke up in the morning. 31.23% of the participants claim that they are using social media for 15 minutes when they wake up in the morning 24.67% claim that they are using social media for half an hour when they wake up, whereas 13.91% of the participants claim that they are using social media more than one hour, when they wake up in the morning. As shown in Figure 5, before going to bed at night, 26/12% of the adolescents claim that they are using social media for 15 minutes, 24.54% are using social media for 30 minutes and 24.01% are using social media more than one hour. In considering the overall usage, as shown in Figure 6, 47.63% of adolescents claim that they are using social media more than one hour per day.

4.2. *PHYSICAL AND PSYCHOLOGICAL DIFFICULTIES*
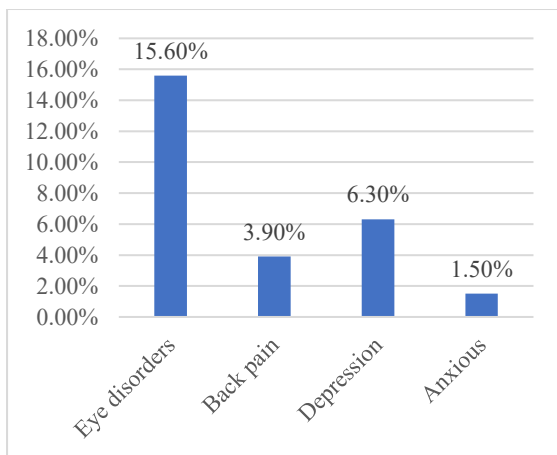
Figure 7: Physical and psychological difficulties
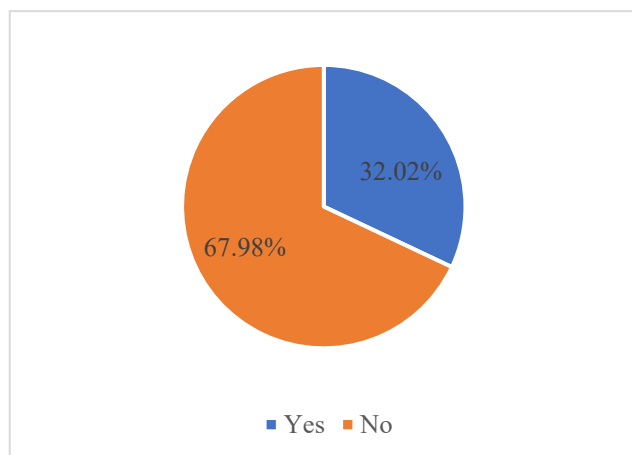
Figure 8: Physical and psychological difficulties may occur due to social media

Figure 7 shows the physical and mental difficulties adolescents get due to the use of social media while Figure 8 shows how the participants believe in whether physical and psychological factors may occur due to social media. Most of the participants claim that they have difficulties in eye sight, when some suffer from back pain. Psychologically the have felt depressed and anxious as well.
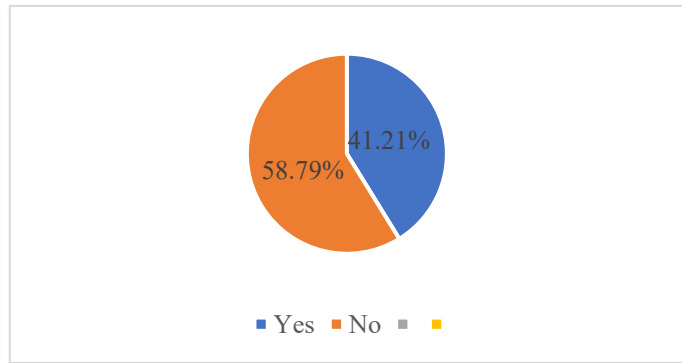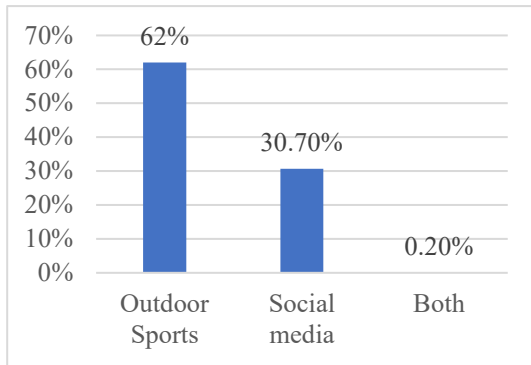
Figure 9: Interest for social media vs. outdoor sports   Figure 10: Whether they are addicted to social media

Figure 9 shows the adolescents' interest for social media vs outdoor sports. Here majority of 254, (62%) of the participants said that they prefer outdoor sports. Interview data revealed that "outdoor sports are healthy and mind relaxing, and it is good for entertainment". 126, (30.7%) of the adolescents said that they like social media. Interview data revealed that some adolescents said that; "social media is best" "social media is not boring".

Figure 10 shows the participants' viewpoint regarding their own addiction of social media. 58.79% of the particpants claimed that they are not addicted to social media when 41.21% of the particpants claimed that they are addicted to social media. Here, those who claim that they are addicted to social media without playing outdoor sports, it might have a great impact of their physical health. One interview participant claimed that "We like social media and we do not like to play outside".

4.3. ACADEMIC PERFORMANCE
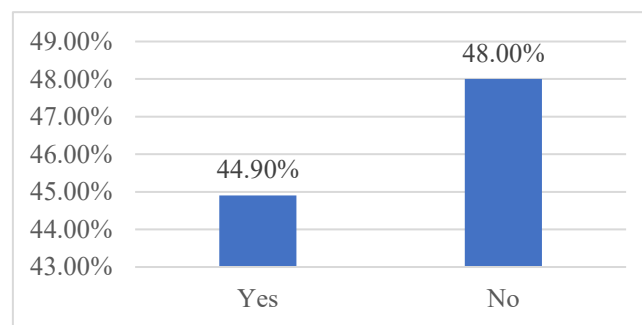
Figure 11: Academic Performance

Figure 11 shows the attitudes of adolescents regarding whether social media influences their academic performance. 44.90% of the participants claim that social media impact their education. Some interview participants claim that "If social media is used with moderation, it will not be a problem". In analyzing reasons for this the participants mentioned that they are fond of new technology. They are using it as a source of information, entertainment, e – money, and communication. Some of such participants have mentioned that "Social media is very good for mind relaxing". Among them, 37.8% are using social

media for education, 19.8% are using social media for information and 7.3% are using social media for communication.

5. CONCLUSION

In conclusion, the findings demonstrate that social media influenced adolescents' physical and psychological health. When the participants use mobile phones to access social media, it also greatly affects the physical and psychological health though such conditions as blue screen effect, which contributes to poor eye sight. Using social media for more than one hour every day can reduce the blinking rate of the eyes. Also, the screening time means how long the eyes are exposed to the screen. There is a possibility of eye redness, eye irritation, visual impairment and eye damage due to spending too much time on social media. Due to the decrease in the blinking rate, dry eyes can damage the vision. Another difficulty can be headaches. There, long – term headaches can come due to the excessive use of social media. It can lead to migraine as well. Moreover, when the postures are not positioned properly, it will create physical difficulties. There, lying on the bed or sitting in a chair and using social media for a long time can cause long – term physical problems.

The findings of this research show the adolescents have become increasingly accustomed to using social media before going to bed at night. This greatly disturbs sleep of adolescents. Lack of proper bed time can cause fatigue and physical discomfort. This can affect adolescents directly and indirectly. Social media greatly affects the minds of adolescents. Adolescents make various connections through social media, which can cause psychological problems. Although social media is used to build up relationships, social media gives a lot of pressure to the mind due to cyber bullying, etc.

REFERENCES

Digital 2022: SRI LANKA. (202 C.E.). https://datareportal.com/reports/digital-2022-sri-lanka
Kumar, H., & Singh, A. (2020). *Impact of Social Media on Adolescent's Mental Health*. https://www.researchgate.net/publication/343205479_Impact_of_Social_Media_on_Adolescent%27s_Mental_Health
McNamee, P., Mendolia, S., & Yerokhin, O. (2019). Social Media Extensive Use and Emotional and Behavioural Outcomes in Adolescence: *Evidence from British Longitudinal Data*. file:///C:/Users/sachi%20wijesundara/Desktop/Li/5.pdf
Nisar, S., Akma, S., Hussain, H., Ainy, Q. ul ain, & Ali, S. N. (2020). Impact Of Social Media On General Health Of Adolescent. https://doi.org/DOI: 10.29322/IJSRP.10.12.2020.p10866
Positive and Negativ e and Negative Effects of Social Media on Adolescent W ects of Social Media on Adolescent WellBeing. (2019). https://cornerstone.lib.mnsu.edu/cgi/viewcontent.cgi?article=1923&context=etds
Rahman, S. A., Rabbani, M., & Vriyath, S. (2020). Effects of Social Media Use On Health and Academic Performance Among Students at the University of Sharjah. file:///C:/Users/sachi%20wijesundara/Desktop/Li/4.pdf
Social media use and depression in adolescents: A scoping review. (2020). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7392374/
VanOverbeke, D. T. (2008). *The Effects of Social Media on the Health of College Students*. file:///C:/Users/sachi%20wijesundara/Desktop/Li/1.pdf

OPPORTUNITIES AND INNOVATIONS IN INDUSTRIAL TECHNOLOGIES

DEVELOPMENT OF AN ANTIBACTERIAL FABRIC EMBEDDED WITH GREEN SYNTHESIZED SILVER NANOPARTICLES

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ABSTRACT

Prevention of respiratory infectious diseases is indispensable as they adversely impact physical and mental health, economy, and child education in the world. Therefore, a biological protective respirator with an antimicrobial function would be a timely approach to keep the public safe from unforeseen diseases during this post covid era. In this study, antibacterial filtration material was developed by incorporating green synthesized silver nanoparticles (AgNPs) with stem extract of Coscinium fenestratum (Venivel) to woven cotton fabric. The solution of synthesized AgNPs was characterized using UV–visible (UV–vis) spectroscopy. The UV–vis absorption spectra showed the typical absorption peak at ∼430 nm corresponding to the surface plasmon resonance of AgNPs. The microstructural characteristics, surface morphology, and elemental composition of treated fabric were investigated by Scanning Electron Microscopy (SEM) with Energy Dispersive X-ray analysis (EDX) and Attenuated Total Reflectance- Fourier Transform Infrared spectroscopy (ATR-FTIR) analysis. SEM - EDX revealed that AgNPs having a diameter of ∼70 nm were present on the surface of the developed fabric material. X-ray Diffraction (XRD) analysis further revealed the formation of AgNPs. The developed cotton fabric showed good durable antibacterial activity against Pseudomonas aeruginosa and Staphylococcus aureus strains. The wash durability of antibacterial activity of developed fabric was found to withstand up to twenty wash cycles. The results of this study emphasize the significant antibacterial efficacy of AgNPs incorporated in woven cotton fabric material and its potential application as a filter material in an antibacterial face mask.

Keywords: Antibacterial, Green, Silver nanoparticles, Venivel, Cotton fabric.

1. INTRODUCTION

The respiratory tract infections can adversely affect the sinuses, throat, airways, or lungs of human beings. *Streptococcus pneumoniae, Haemophilus influenzae and Moraxella catarrhalis* are the most common bacterial pathogens in upper and lower respiratory tract infections (Fadlyana *et al.*, 2018). Recently whole world suffered from Covid - 19 which is an infectious disease caused by the SARS-CoV-2 virus. The main route of transmission of these diseases was found as inhalation of infectious aerosols. The transmission of disease varies according to several factors; including environmental conditions, availability and effectiveness of medical care in infection prevention and control, host factors, pathogenic characteristics, and density of microbial population.

Infection prevention and control are commonly based on early recognition and source control, administrative controls, environmental and engineering controls, and personal protective equipment (PPE). Examples of recommended PPE are face masks, impermeable gowns, gloves, goggles, face shields, surgical hoods or caps and fluid resistant shoe covers or boots. Among the PPE, the role of face mask, should be explored in the prevention of respiratory infections. At present, polypropylene melt-

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blown nonwoven fabric has been extensively employed as a filter material for Filtering Facepiece Respirators (FFR) type masks because it resists microparticles such as pathogenic microorganisms. However, there is a known possibility to retain microorganisms on filter materials which can survive and multiply under favorable conditions and result in secondary infections in human beings. Hence, an antibacterial facemask filter is urgently needed. Nowadays, there is a new revolution in the textile industry with the apparition of new technologies that could add special functions and properties to the fabrics.

For the time being in the current covid-19 pandemic situation, an antimicrobial filtration material is developed in this study using a woven cotton fabric embedded with green synthesized silver nanoparticles. Further, silver nanoparticles are first time synthesized using the stem extract of *Coscinium fenestratum* which is an efficient approach compared with other reported work; one study has used time consuming approach using *Azadirachta indica* aqueous leaf extract as a capping agent.(Ahmed *et al.*, 2016) Further, Venivel stems are readily available, inexpensive and with known medicinal properties. In addition, present study incorporates the synthesized AgNPs to cotton fabric and the antibacterial properties of the developed fabric are investigated against both Gram-positive and Gram-negative bacteria.

Cost-effective solutions are needed to control the transmission of respiratory tract infections in mass gatherings. In a recent study, a large-scale facemask trial has been carried out during the Hajj pilgrimage in Saudi Arabia. This trial concluded that the efficacy of facemask used in preventing respiratory tract infections at mass gatherings is significant. Bashir, Edward and Dominic, (2015) As the filter materials in face masks can retain microorganisms, the incorporation of antimicrobial properties to filter materials has been studied. The application of nanoparticles and metal oxides has been reported as surface modifiers of fabrics for imparting antimicrobial properties.

1.1 BACKGROUND OF THE STUDY/ REVIEW OF LITERATURE

It is found that silver is more toxic towards prokaryotic cells than towards mammalian cells, leading to a therapeutic window where mammalian tissue is not harmed but where bacterial cells are destroyed. Hence, these compounds were used as antimicrobial agents with biocide effects for sixteen types of bacteria (Aymonier *et al.*, 2002) In addition to silver salts, silver nanoparticles are increasingly used due to their slower dissolution rate, leading to a continuous release of silver ions and large surface area to volume ratio. Antibacterial efficiency of the silver nanoparticles has been investigated by introducing the particles into a media containing *E. coli* as test microorganism. The nanoparticles were found to be completely cytotoxic to *E. coli* for surface concentrations as low as 8 μg of Ag/cm^2 (Baker *et al.*, 2005). Green approaches to synthesize metal nanoparticles have recently gathered grounds, providing safer and cost-effective alternative procedures to conventional chemical methods. Green synthesis utilizes mild experimental conditions such as ambient temperature and pressure, and uses nontoxic, environmentally benign solvents, reducing agents and capping materials. Natural extracts obtained from

plant materials such as leaf, root, seed, and stem have been frequently applied for the green synthesis of nanoparticles. These natural extracts contain various polysaccharides, proteins, vitamins, alkaloids, which are generally nontoxic, and biodegradable, and can act both as reducing and capping agents to promote the formation and inhibit the agglomeration of nanoparticles (Kozma *et al.*, (2016).

Silver nanorods have been synthesized using the extract of *Coscinium fenestratum* leaves along with tender stem samples (Jacob *et al.*, 2012) The major and active constituent among the isoquinoline alkaloids found in wood and root of *C. fenestratum* is berberine. Oxidative biotransformation of berberine has been studied hence berberine can be used as both a reducing agent and the stabilizing agent in green synthesis procedures. Therefore *C. fenestratum* can be used as a bio-reductor for reducing silver to allow nanoparticle formation (Skopalová *et al.*, (2012) Three main approaches have been practiced in the incorporation of metal nanoparticles to fabrics. In the first method, colloid solution of metal nanoparticles is synthesized at first step and then, the fabrics are impregnated by dipping them in the colloid solution of metal nanoparticles for a certain time period. Secondly, the metal nanoparticles are synthesized in-situ the fabrics whereas the third method uses the spinning process to synthesis a polymer-nanoparticles composite.

Antibacterial activities of developed antibacterial textiles have been investigated against different strains of bacteria. In a recent study, methanol extracts of *Helichrysum arenarium* were used as natural sources in wool fabric dyeing and the dyed wool fabrics demonstrated significant antimicrobial activity against *Staphylococcus aureus* and *Escherichia coli* (Cuce *et al.*, 2020)

2. METHODOLOGY

This is only a laboratory scale concept that has been developed; there are no preclinical or clinical studies have been conducted as there was no intention to cover that aspect during the study period.

2.1. SYNTHESIS OF SILVER NANOPARTICLES

The stem of *C. fenestratum* was washed with distilled water and pared into small pieces and shade dried for one-month period. Then weight of crushed stem (2. 0000 g) was boiled in distilled water (100.0 mL) for 10 minutes at 100 ˚C. The boiled leaf extract was filtered through filter paper (Whatman No: 1) and the collected filtrate was centrifuged for 40 minutes at 3500 rpm using a table centrifugation machine (FlexiFuge-NU-C2000VR). The supernatant was stored at 4 ˚C for the synthesis of AgNPs.

A volume of 2 % (w/v) stem extract of *C. fenestratum* (25.0 mL) was mixed with a volume of 100 ppm silver nitrate (200.0 mL) and pH was adjusted to 8.0 by adding 0.1 M NaOH dropwise using the pH meter (Hanna pH 211, Rhode Island, United States). Then, the mixture was stirred at 1200 rpm at 60 ˚C for 20 minutes on magnetic stirrer machine (AREC.X, VELP SCIENTIFICA). The resulted rust orange color solution of nanoparticles was centrifuged at 3500 rpm for 40 minutes. The supernatant solution was discarded and the pellet of nanoparticles was dried at 70 ˚C until a constant weight was obtained.

2.2. INCORPORATION OF AGNPS TO WOVEN FABRIC MATERIAL

A cotton woven textile fabric (2" × 2") was impregnated with synthesized AgNPs by dipping in a colloid solution of AgNPs (25.0 mL) in a 250 mL conical flask for four hours at 25 ˚C while shaking at 1000 rpm. The treated fabric sample was vacuum dried for six hours and finally dried at 70 ˚C in an Oven (Sanyo MOV-112) until a constant weight was obtained. This method was followed to incorporate the AgNPs to fabric material as it is time efficient as well as requires no complex instrumentation.

2.3. CHARACTERIZATION OF SYNTHESIZED AGNPS AND THE DEVELOPED COTTON FABRIC MATERIAL

UV-absorption spectra of synthesized AgNPs solution were measured using UV-visible spectrometer (Shimadzu UV2700). Oven-dried AgNPs were analyzed by XRD Unit (Pan Analytical, X-pert pro, Netherland). The study of morphology and composition of synthesized AgNPs and AgNPs incorporated cotton fabric material was carried out by using electron microscope (Carl Zeiss EVO 18 research, Germany). FTIR spectrometer (PerkinElmer, Spectrum Two, USA) was used to study the chemical composition of the synthesized AgNPs and the AgNPs incorporated cotton fabric material.

Antibacterial activity of synthesized AgNPs and AgNPs incorporated cotton fabric material were analyzed by disk diffusion method against Gram - positive bacteria (*Staphylococcus aureus*) and Gram - negative bacteria (*Pseudomonas aeruginosa*). The analysis of the retaining of antibacterial activity against laundering was carried out using disk diffusion method.

3. RESULTS AND DISCUSSION

3.1. UV-VIS SPECTRAL ANALYSIS

In this study phytochemicals present in stem extract of *Coscinium fenestratum* (Venivel) were used for the reduction of Ag precursor salt and to produce AgNPs. The initial color of the mixture of 2 % (w/v) *C. fenestratum* extract (25.0 mL) and 100 ppm silver nitrate (200 mL) was pale yellow. When the mixture was stirred at 60 ˚C for 20 minutes after adjusting the pH of the mixture to 8.0, a color change was observed from pale yellow to rust orange {Figure 1(a) and (b)} indicating the formation of AgNPs. As given in Figure 1 (c), the presence of the characteristic plasmon resonance band, centered at λ_{max} of 420 nm for the AgNPs, confirmed the formation of the AgNPs.
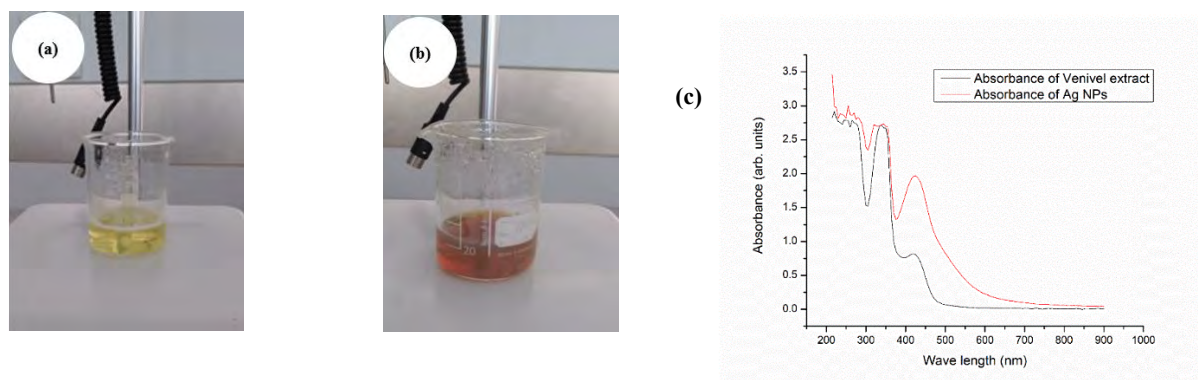
Figure 1: (a) 2 % (W/V) stem extract of *C. fenestratum* (b) The solution of AgNPs synthesized using the stem extract of *C. fenestratum (c)* UV/VIS spectrum of synthesized AgNPs and UV/VIS spectrum of *C. fenestratum* stem extract

3.2. MORPHOLOGICAL OBSERVATION OF AGNPS AND THE AGNPS INCORPORATED COTTON FABRIC THROUGH SEM ANALYSIS

According to Figure 2(a), AgNPs in solution phase can be observed as spherical structures attached to fibrils like particulate matter of the *C. fenestratum* stem extract with a mean diameter of 62.65 ± 21.49 nm with most of them falling in between 27 nm and 80 nm. Figure 3.2(b), indicates that AgNPs in solid phase have been aggregated and those are having the sizes between 140 and 270 nm. Figure 3.2(c), indicates that AgNPs of the developed cotton fabric sample were approximately smooth and having a mean diameter of 76.60 ± 22.34 nm, consistent with the sizes present in the solution phase.
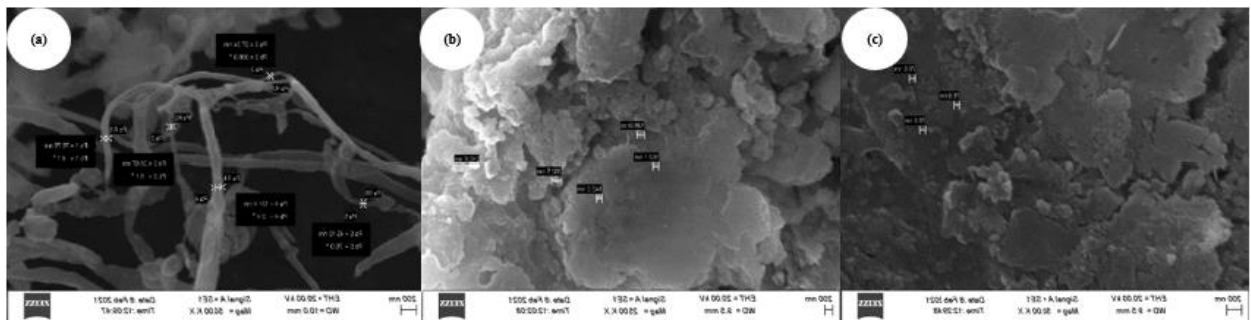
Figure 2: (a) SEM image of AgNPs in solution phase (b) SEM image of AgNPs in solid phase (c) SEM image of AgNPs incorporated cotton fabric material

3.3. EDX ANALYSIS OF AGNPS INCORPORATED COTTON FABRIC MATERIAL

The EDX pattern of AgNPs incorporated cotton fabric material (Table 1 and Figure 3) indicates the presence of element silver on the surface of the developed cotton fabric material.

Table 1: EDX weight ratio of AgNPs incorporated cotton fabric material

Element	Weight %	Atomic %
C	37.31	46.90
O	55.14	52.04
Ag	7.55	1.06
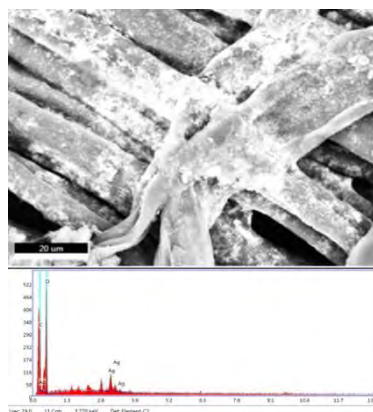
Figure 3: EDX pattern of AgNPs incorporated cotton fabric material

3.4. FTIR CHARACTERIZATION OF THE STEM EXTRACT OF C. FENESTRATUM, AGNPS AND AGNPS INCORPORATED COTTON FABRIC MATERIAL

The major alkaloid present in *C. fenestratum* is Berberine {Figure 4 (b)}. Berberine is responsible for N-H stretching appears in 3460 cm^{-1}, 3406 cm^{-1}, 3363 cm^{-1} and 3267 cm^{-1}. The C-H stretching peaks can be attributed to aromatic functional groups at 3176 cm^{-1}, alkanes at 2985 cm^{-1}, 2943 cm^{-1}, 2885 cm^{-1}, 2839 cm^{-1}, alkenes at 2731 cm^{-1}, alkynes at 2196 cm^{-1}, 2179 cm^{-1}. A saturated aliphatic aldehyde stretching at 1736 cm^{-1}, 1685 cm^{-1}, C-C stretching (in ring, aromatic) at 1606 cm^{-1}, 1450 cm^{-1}, C-H rocking (alkanes) at 1379 cm^{-1}, C-O stretching (esters) and C-N stretching (aromatic amines) at 1288 cm^{-1}, 1273 cm^{-1}, 1247 cm^{-1} are evidences for the presence of phenolic compounds in the extract of *C. fenestratum*. Lone electron pairs of Berberine may stabilize the Ag$^+$ ions and nucleation sites can be created avoiding the agglomeration of AgNPs. This observation highlights that AgNPs were capped with plant derived molecules, which might have reduced the Ag(I) precursors and provided a stabilization effect. Additionally, the slight reduction of –OH stretching intensity (3252 cm^{-1}) in coated AgNPs indicated the possible interaction of alcohols and phenols of plant extract with AgNPs.

When the AgNPs incorporated cotton fabric sample and untreated cotton fabric sample were compared, no additional peaks or considerable differences in the intensity of the transmission were observed.
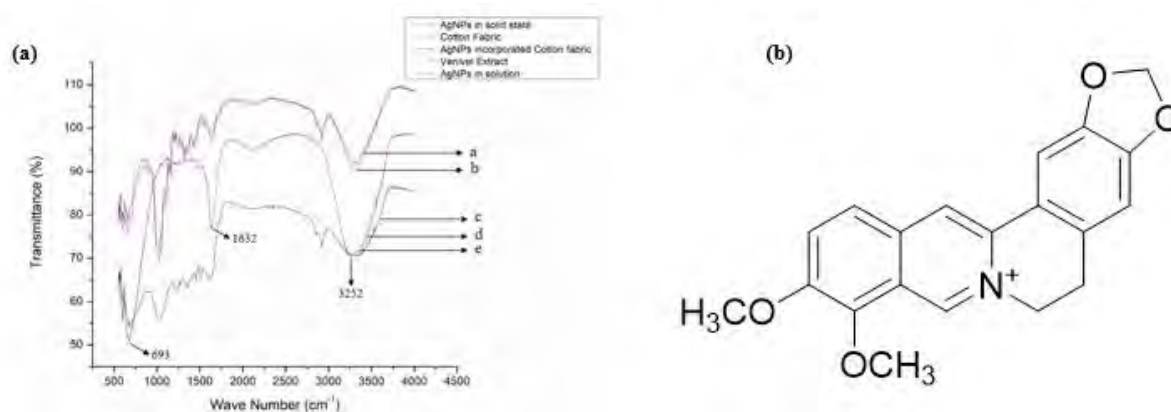
Figure 4: (a) FTIR spectra of a. AgNPs incorporated cotton fabric material b. Untreated cotton fabric material c. AgNPs in solid state d. AgNPs in solution e. stem extract of *C. fenestratum* (b) Structure of berberine

3.5. CRYSTALLOGRAPHIC CHARACTERIZATION USING XRD ANALYSIS

The Bragg reflections with 2θ values of 37.80 °, 45.96 °, 64.25 °and 76.66 ° indicate the [111], [200], [220] and [311] reflections of metallic silver, clearly indicating the cubic crystalline face-centered cubic structure of AgNPs (Figure 5). Increased intensity at the 45.96 ° peak of AgNPs is indicative of the predominance of [200] facet during the formation of AgNPs.
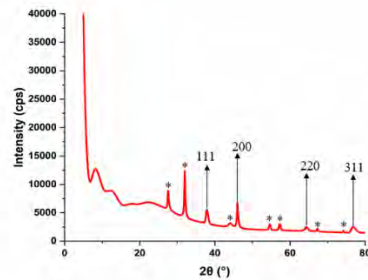
Figure 5: XRD patterns of synthesized AgNPs

3.6. ANTIBACTERIAL ACTIVITY OF AGNPS INCORPORATED COTTON FABRIC MATERIAL

AgNPs incorporated cotton fabric exhibited maximum bactericidal activity against *Pseudomonas aeruginosa* (inhibition zone of 4.5 mm) followed by *Staphylococcus aureus* (inhibition zone of 4.0 mm). This performance difference seems to result from the different cell structures between Gram-negative and Gram-positive bacteria. Gram-negative bacteria such as *Pseudomonas aeruginosa* have a layer of lipopolysaccharide at the outer cell wall, which is rich in negative charges. Thus, it is inclined to attract weak positive charges available on AgNPs. Once inside the cell, AgNPs would destroy the bacterial growth signaling pathway, thus inhibiting its viability and division.
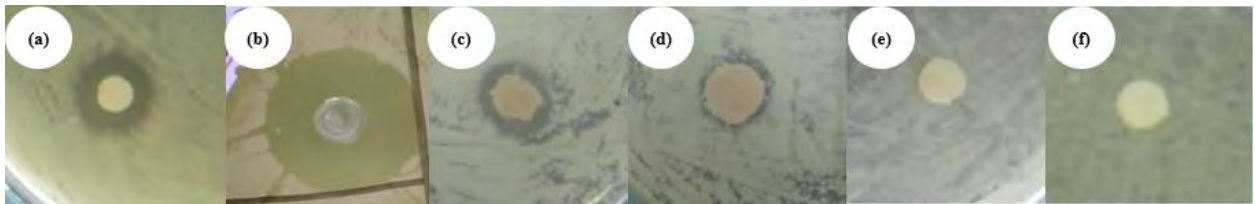
Figure 6: Disk diffusion test, zones of growth inhibition against *P. aeruginosa* (a) AgNPs incorporated cotton fabric (b) Positive control - cotton fabric saturated with Gentamycin (c) Negative control - cotton fabric saturated with 100 PPM AgNO₃ solution (d) Negative control - cotton fabric treated with stem extract of *C. fenestratum* (e) Negative control - untreated cotton fabric (f) Negative control - cotton fabric washed with the detergent followed by drying
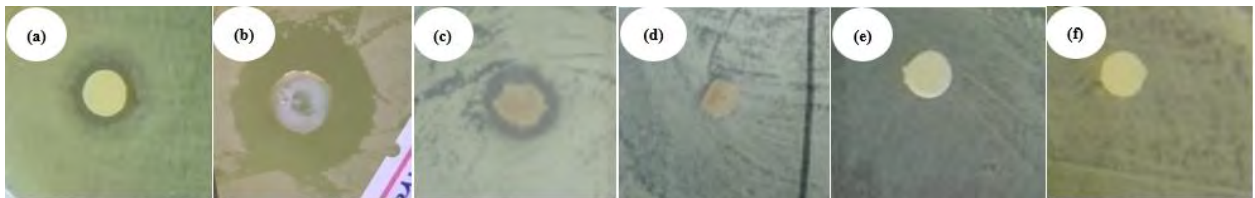
Figure 7: Disk diffusion test, zones of growth inhibition against *S. aureus* (a) AgNPs incorporated cotton fabric (b) Positive control - cotton fabric saturated with Gentamycin (c) Negative control - cotton fabric saturated with 100 PPM AgNPs solution (d) Negative control - cotton fabric treated with stem extract of *C. fenestratum* (e) Negative control - untreated cotton fabric (f) Negative control - cotton fabric washed with the detergent followed by drying

It is worthwhile mentioning that still considerable *P. aeruginosa* bacterial reduction and *S. aureus* bacterial reduction are maintained up to twenty cycles of laundering as shown in Figures 8 and 9. This durable antibacterial ability is significant compared with similar work.
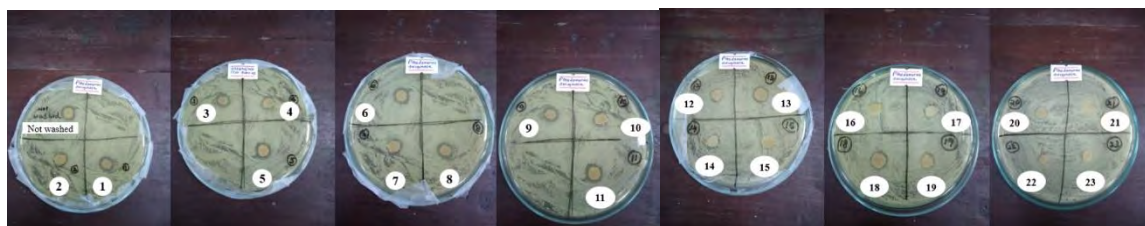
Figure 8: Antibacterial activity of AgNPs incorporated cotton fabric against *P. aeruginosa* with the effect of frequent laundering (23 washing cycles)
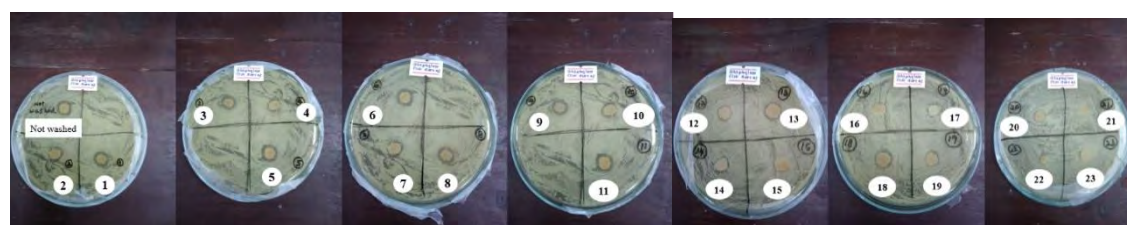
Figure 9: Antibacterial activity of AgNPs incorporated cotton fabric against *S. aureus* with the effect of frequent laundering (23 washing cycles)

4. CONCLUSION

The bioactive or phytochemical components of the plant extract are utilized as potential capping and reducing agents in green synthesis of nanoparticles. This study used the matured stem extract of *C. fenestratum* for the first time to synthesize AgNPs. The study confirmed the incorporation of AgNPs to the fabric material. The developed AgNPs incorporated fabric material exhibits significant antibacterial activity against both gram - negative bacterium of *P. aeruginosa* and gram - positive bacterium of *S. aureus*, especially prominent for *P. aeruginosa*. Further bacterial reduction has been maintained up to twenty cycles of consecutive laundering. Therefore, the developed fabric has great potential to be utilized in the fabrication of antibacterial textiles which can be used as the filter layer of a face mask.

REFERENCES

Ahmed, S. *et al.* (2016), Green synthesis of silver nanoparticles using Azadirachta indica aqueous leaf extract, *Journal of Radiation Research and Applied Sciences*, *9(1)*, pp. 1–7. Available at: https://doi.org/10.1016/j.jrras.2015.06.006.

Aymonier, C. *et al.* (2002) ,Hybrids of silver nanoparticles with amphiphilic hyperbranched macromolecules exhibiting antimicrobial properties, *Chemical Communications*, *24*, pp. 3018–3019. Available at: https://doi.org/10.1039/b208575e.

Baker, C. *et al.* (2005) , Synthesis and antibacterial properties of silver nanoparticles, *Journal of Nanoscience and Nanotechnology*, *5(2)*, pp. 244–249. Available at: https://doi.org/10.1166/jnn.2005.034.

Bashir, E., Edward, C. and Dominic, E. (2015), Tam , Jonathan and Memish , Ziad A . and Heron , Leon (2014)

A cluster-randomised controlled trial to test the efficacy of facemasks in preventing respiratory viral infection among Hajj pilgrims . Journal of Epidemiology.

Cuce, M. *et al.* (2020), Color, Fastness, and Antimicrobial Properties of Wool Fabrics Dyed with Helichrysum Arenarium Subsp. Aucheri Extract, *Journal of Natural Fibers*, 00(00), pp. 1–13. Available at: https://doi.org/10.1080/15440478.2020.1848706.

Fadlyana, E. *et al.* (2018), Risk factors associated with nasopharyngeal carriage and density of Streptococcus pneumoniae, Haemophilus influenzae, Moraxella catarrhalis, and Staphylococcus aureus in young children living in Indonesia, *Pneumonia*, 10(1), pp. 1–14. Available at: https://doi.org/10.1186/s41479-018-0058-1.

Jacob, S.J.P. *et al.* (2012), Synthesis of silver nanorods using Coscinium fenestratum extracts and its cytotoxic activity against Hep-2 cell line, *Colloids and Surfaces B: Biointerfaces*, *98*, pp. 7–11. Available at: https://doi.org/10.1016/j.colsurfb.2012.03.031.

Kozma, G. *et al.* (2016), Environmentally Benign Synthesis Methods of Zero-Valent Iron Nanoparticles, *ACS Sustainable Chemistry and Engineering*, *4(1)*, pp. 291–297. Available at: https://doi.org/10.1021/acssuschemeng.5b01185.

Skopalová, J. *et al.* (2012), Electrochemical oxidation of berberine and mass spectrometric identification of its oxidation products, *Bioelectrochemistry*, *87*, pp. 15–20. Available at: https://doi.org/10.1016/j.bioelechem.2011.09.002.

NANO-CELLULOSE APPLICATION IN TEXTILE PROCESSING FOR SUSTAINABLE PRODUCT DEVELOPMENT – A REVIEW

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ABSTRACT

The textile industry is regarded as one of the leading industries that contribute to polluting the environment. Several technological enhancements are extensively carried out by the researchers to introduce novel solutions and innovations to overcome the negative impact on the environment occurring due to the industrial activities during textile manufacturing. The key intention of this article is to do an analytical literature review on nanocellulose applications on textiles in its processing, investigated by the research community focusing on sustainable textile material development. Literature review was documented following research publications done during the period of 2016 -2022 found in two main databases, The Web of Science and the Science Direct. Types of nanocellulose and their properties, sources and extraction processes and application on sustainable textile manufacturing are discussed in the literature emphasizing the future directions of the utilization of nanocellulose in textile development. Altogether,about 35 research publications were found from several journals, which has led the focus on nanocellulose application in building advanced properties on textiles.

Keywords: Nanocellulose, Sustainable, Textiles, Coating.

1. INTRODUCTION

The textile industry has become a challenging industry for the sustainability of the environment due to the continuous use of non renewable fossil fuels in manufacturing synthetic textiles, catering the high demand that exists with fast fashion movement (Gapsari et al., 2021; Provin et al., 2021). The increase of the consumption of synthetic textiles ends up with its production waste and consumer waste in landfills or incineration causing several environmental issues (Barbero-Barrera, Pombo and Navacerrada, 2016; Sanchis-Sebastiá et al., 2021). Being ranked as the second largest environmental pollutant industry, one of the leading suppliers of greenhouse gas emissions to the environment, the textile industry is moving towards seeking solutions to reduce the impact of it productions for the air, water and lands to make a promising environment without pollutants (Salah, Vololonirina and Gidik, 2022; Subramanian et al., 2020). Several researchers have highlighted the impact of the environment occuring during all the stages of the product life cycle of textiles such as use of larger amounts of water, energy and chemicals in cotton textile processing. (Dissanayake et al. 2018; Shiwanthi, Lokupitiya and Peiris, 2018; Hu et al., 2018). As mantioned by Provin et al., (2021), the use of upcycling strategies supporting circular economy such as reuse and recycle of textile waste, use of living organisms and biotechnology for biodegradable materials are highlighted as sustainable approaches in the textile industry. As stated by Felgueiras et al., (2021); Pradhan, Jaiswal and Jaiswal, (2022); Phanthong et al., (2018); Choi, (2018); Spagnuolo, D'Orsi and Operamolla, (2022); Saremi et al., (2020) and Clemons, (2016) application of nanocellulose which is less than 100 nm in its diameter and length in several

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micrometers derived from the most abundant natural polymer cellulose has grabbed greater attention and its application in several industries including textile, automotive, food and medical due to its biodegradability, high strength, low cost processing and low density and larger surface area.

According to Pradhan, Jaiswal and Jaiswal, (2022); Pires, Souza and Fernando, (2019); Isogai, (2020); Phanthong et al., (2018) and Industrial Applications of Nanocellulose And Its Nanocomposites., (2022) biological wastes such as residues of food manufacturing, agriculture and forests are being used as the sources for nanocellulose.

The sustainable development goal number 12 of the policy brief of the United Nations 2030 agenda, it is focuses on ensuring sustainable consumption and production patterns being responsible to reduce waste and pollutants, utilizing cleaner and more resource efficient attempts (UNDP, n.d.; Provin et al., 2021).

Through this context, a review of unique properties of nanocellulose, its extraction processes and potential application on textiles to mitigate the sustainable issues being done in order to identify possible opportunities for musch greener industry in future aiming to meet the goals established by the United Nation in its 2030 Agenda.

1.1 BACKGROUND STUDY/ REVIEW OF LITERATURE

Lignocellulose biomass consists of three main polymers, cellulose, hemicelluloses and lignin (Pires, Souza and Fernando, 2019; Isikgor and Becer, 2015). Nanocellulose is derived from the most abundant and infinit natural polymer, cellulose, which is biodegradable, renewable and nontoxic through chemical, mechanical and chemo-mechanical processors in respect to its type of formations (Panchal, Ogunsona and Mekonnen, 2018).

Several research studies have emphasized the investigations of nanocellulose based compound applications during the textile processing, specially at the finishing processes such as dying and coating stages while enhancing their performances (Spagnuolo, D'Orsi and Operamolla, 2022; DP & BH, 2016; Saremi et al., 2020).

1.1.1 NANOCELLULOSE AND THEIR PROPERTIES

According to Saud, Saleem and Zaidi, (2022); Abdullah et al., (2021); Pradhan, Jaiswal and Jaiswal, (2022) and Panchal, Ogunsona and Mekonnen, (2018) nanocelluloses are varied due to the variations in the formation of cellulose nanoparticles (CNP) and those are identified as cellulose nanocrystals (CNC), cellulose nanofibrils (CNF), and bacterial nanocellulose (BNC) (Panchal, Ogunsona and Mekonnen, 2018; Thomas et al., 2020; Pires, Souza and Fernando, 2019). CNC are refered as nanocrystalline cellulose (NCC) or cellulose nanowhiskers (CNW) (Abitbol et al., 2016) and are having high modulus and strength, large surface area, greater thermal stability, 100-250 nm length and with 5-70 nm diameter (Thomas et al., 2020). CNF are found mentioned in several researches as nanofibrillated cellulose (NFC) or cellulose nanofibres (Nechyporchuk, Belgacem and Bras, 2016). CNF are flexible, 500-2000 nm length, 1-100 nm diameter and consist with high cristalinity index (>70%), low density,

high tensile strength (7500 MPa), renewable and biodegradable and with larger surface area (~150 m^2/g) which are identified as suitable cellulose nonoparticle for surface modification of materials (Phanthong et al., 2018; Lavoine et al., 2012; Nechyporchuk et al., 2016). BNC's are generated from several bacterias, such as bacterias belongs to the gene of *Gluconacetobacter* (Abdullah et al., 2021; Abdul Khalil et al., 2014), *Acetobacter xylinum* (Spagnuolo, D'Orsi and Operamolla, 2022) and algae through the fermentation of biomasses. (Panchal, Ogunsona and Mekonnen, 2018; Sharma and Bhardwaj, 2019).

1.1.2 SOURCES OF NANOCELLULOSE AND EXTRACTION PROCESSES

The preparation of the CNC and CNF is done through a top-down process while a bottom-up process is applied in the preparation of BNC (Pradhan, Jaiswal, and Jaiswal, 2022; Nechyporchuk et al., 2016; Teo & Wahab, 2020).

Extraction of CNC is done through a acid hydrolysis process which is considered a chemical process and CNF are derived from lignocellulosic biomass through the combination of mechanical and chemical process (Abdul Khalil et al., 2014; Abdullah et al., 2021; Panchal, Ogunsona and Mekonnen, 2018).

Figure1 presents the CNC and CNF production methods and its properties according to Pires, Souza, and Fernando, (2019).
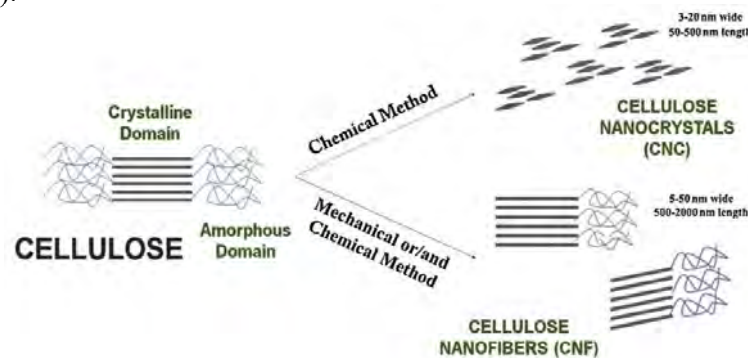
Figure1: Production method and properties of cellulose nanocrystals (CNC) and cellulose nanofibers (CNF)

Table 1: Comparison of physical properties and morphology associated with CNC, CNF, and BNC

Type of nanocellulose	Synonyms	Sources	Formation process	Average size
Cellulose nanocrystals (CNC)	Nanocrystalline cellulose (NCC) Cellulose nanowhiskers (CNW)	Cotton, wood, flax, wheat straw, hemp, rice straw, tunicin, BC mulberry bark, Avicel, ramie, MCC, algae	Acid hydrolysis	Length: 100–250 nm (from the plant) 100 nm to several micrometers Diameter: 5–70 nm
Cellulose nanofibrils (CNF)	Nanofibrillated cellulose (NFC)	Hemp, Wood, potato tuber, flax, sugar beet	Combination of mechanical and chemical process	Length: several micrometers Diameter: 5–60 nm

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| Bacterial nonocellulose (BNC) | Microbial cellulose, bio-cellulose bacterial cellulose (BC) | Bacterial synthesis | Bacterial synthesis | Length: several micrometers Diameter: 20–100 nm |

(Thomas et al., 2020)

2. METHODOLOGY

In this research review, literature findings through a deep research in two scientific databases, ScienceDirect and The Web of Science was done under key search terms "Nanocellulose", "textiles", "Crystalline nanocelluloses", "Nanofibrillated cellulose", "Bacterial nanocelluloses" and "sustainable material". Considerable number of research reviews and experimental research articles have been found under the titles of combination of certain search terms. Out of all the findings, it was selected the research papers which complements the objectives of the research title and conducted the review with the focus of finding nanocellulose applications on textiles.

Database:
Science Direct - *The Web of Science*

Key Search Terms:
Nanocellulose, Textile, Sustainable materials, Crystalline nanocelluloses, Nanofibrillated cellulose, Nanofibrillated cellulose, Bacterial nanocelluloses

Document type:
Research articles and Research reviews

Analysis:
Research Title, Abstract, Keywords, Conclusions
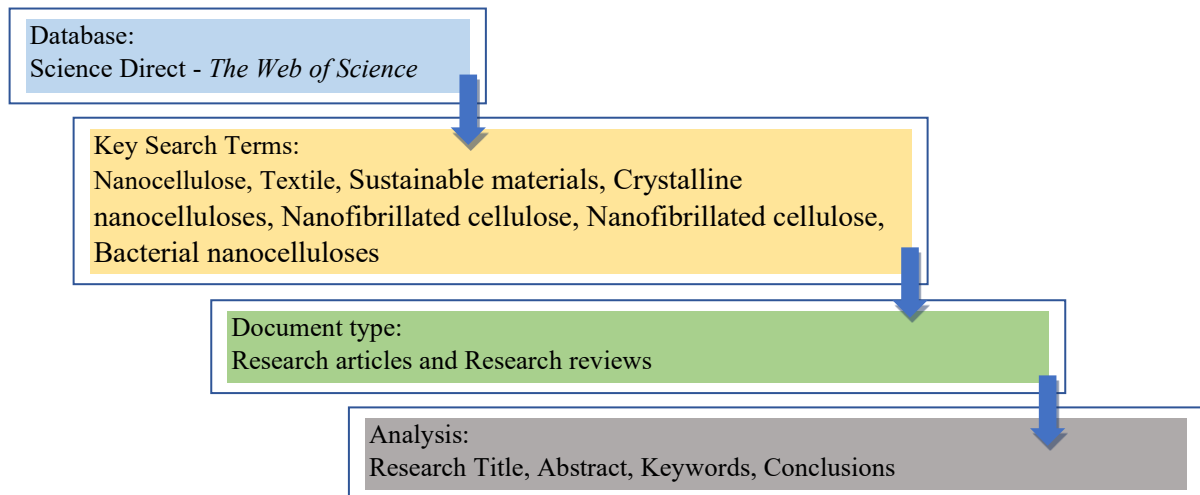
Figure2: Illustration of the method used for the selection of journal articles

3. RESULTS AND DISCUSSION

Due to the high demand of textile manufacturing and use of dyes which releases hazardous dye particles, salts and hydroxides and use of larger amounts of water which is not undergoing sometimes for recycling has become a huge issue to the environment. According to Liyanapathiranage et al.,(2020), nanocellulose hydrogels of NFC was utilized as an effective and efficient carrier of dyes instead direct dyeing of cotton fabric with reactive dyes under standard dyeing conditions and generate coloured NFC-dye pigment and further processing stepped to the deposition of the same on the textile using regular dye deposition methods with heat treatment application. In comparison of this method versus conventional dying process, NFC application has lessened one sixth the use of water, alkali, and salt making it a much greener production technology for textile dyeing. Further it is found through the patent information, NFC has the ability to act as dyes or other molecule carriers as well as gluing or binding

agents. Due to its high binding ability, it reduces the amount of dyes used and the same result in reducing the dye contamination in water resources at the end of the dyeing process (Minko, 2016).

It is found that the CNC has high Hydrophobicity which leads to the application on the surface of textiles developing less friction surface, water repellent properties with self cleaning ability (Panchal, Ogunsona and Mekonnen, 2018).

Nanocellulose has been investigated as coatings on textiles by very few researchers and understand that it is viable to use nanocellulose as coatings on both natural and synthetic fibre made textiles through chemical functionalization. It is observed that the nanocellulose coatings have deposited and adhesion has successfully happened on cellulose, nylon and cellophane surfaces. In comparison to CNC and CNF coatings, CNC coatings have shown higher adhesion than CNF. It tested the CNC coating application on polyester and observed that the coating improves the resistance to load and colour strength of the fabric withstanding against the colour fastening at soping. Further, it is mentioned that the CNF coatings are being used on the special textile used for lumbar belts which are considered as medical devices (Spagnuolo, D'Orsi and Operamolla, 2022).

It is found that the indigo dyes used in denim manufacturing are flammable and build corroding in wastewater pipelines. According to Spagnuolo, D'Orsi and Operamolla, (2022) indigo dyeing on cotton fabrics has been achieved by the utilization of CNF. Further BNC have been advanced to use as wound dressings and absorbent textiles.

Instead of modifying fabric surfaces with chemical substances and use of chemical solutions for fabric coatings, the use of nanocellulose modified with organosilane has resulted the improvement of antibacterial and water repellent properties of cotton fabrics (Hongrattanavichit & Aht-Ong, 2021).

According to the above research findings, the use of nanocellulose variations extracted from different biomasses are successfully applied mostly at the finishing processes of the textile manufacturing with advanced properties.

4. CONCLUSION(S)/ IMPLICATIONS/ RECOMMENDATIONS & LIMITATIONS

Coating of nanocelluloses and use of nanocellulose as dye carriers brings solutions for serious environmental issues occurring during textile manufacturing as of the biocompatible, biodegradable and easy functionalization characteristics on them. Nanocellulose properties should be further investigated to do greener surface development of textiles for sustainable textile industry. Emerging interest in research for the application of nanocelluloses in textile manufacturing is evident through the findings and a wider variety of opportunities are available. It is recommended to carryout further characterization of nanocelluloses derived from a variety of cellulosic sources such as ayurvedic lignocelluloses and continuous green technological advancements to replace with or to minimize the use of acids and other chemicals in textile processing for the development of sustainable textile materials for various.

REFERENCES

Abdul Khalil, H.P.S., Davoudpour, Y., Islam, Md.N., Mustapha, A., Sudesh, K., Dungani, R. and Jawaid, M. (2014). Production and modification of nanofibrillated cellulose using various mechanical processes: A review. *Carbohydrate Polymers*, [online] 99, pp.649–665. doi:10.1016/j.carbpol.2013.08.069.

Abdullah, N.A., Rani, M.S.A., Mohammad, M., Sainorudin, M.H., Asim, N., Yaakob, Z., Razali, H. and Emdadi, Z. (2021). Nanocellulose from agricultural waste as an emerging material for nanotechnology applications – an overview. *Polimery*, 66(3), pp.157–168. doi:10.14314/polimery.2021.3.1.

Abitbol, T., Rivkin, A., Cao, Y., Nevo, Y., Abraham, E., Ben-Shalom, T., Lapidot, S. and Shoseyov, O. (2016). Nanocellulose, a tiny fiber with huge applications. *Current Opinion in Biotechnology*, [online] 39, pp.76– 88. doi:10.1016/j.copbio.2016.01.002.

Barbero-Barrera, M. del M., Pombo, O. and Navacerrada, M. de los Á. (2016). Textile fibre waste bindered with natural hydraulic lime. *Composites Part B: Engineering*, 94, pp.26–33. doi:10.1016/j.compositesb.2016.03.013.

Choi, S. (2018). High Performance Fabrics Using Nanocellulose. *Trends in Textile Engineering & Fashion Technology*, 3(3). doi:10.31031/tteft.2018.03.000565.

Clemons, C. (2016). Nanocellulose in Spun Continuous Fibers: A Review and Future Outlook. *Journal of Renewable Materials*, 4(5), pp.327–339. doi:10.7569/jrm.2016.634112.

Dissanayake, DGK, Weerasinghe, DU, Wijesinghe, KAP & Kalpage, KMDMP 2018, 'Developing a compression moulded thermal insulation panel using postindustrial textile waste', *Waste Management*, vol. 79, pp. 356–361.

DP, C., & BH, P. (2016). Synthesis, characterization and application of nano cellulose for enhanced performance of textiles. Journal of Textile Science & Engineering, *06(02)*. https://doi.org/10.4172/2165-8064.1000248

Felgueiras, C., Azoia, N.G., Gonçalves, C., Gama, M. and Dourado, F. (2021). Trends on the Cellulose-Based Textiles: Raw Materials and Technologies. *Frontiers in Bioengineering and Biotechnology*, 9. doi:10.3389/fbioe.2021.608826.

Gapsari, F., Purnowidodo, A., Hidayatullah, S. and Suteja, S. (2021). Characterization of Timoho Fiber as reinforcement in green composite. *Journal of Materials Research and Technology*, 13, pp.1305–1315. doi:10.1016/j.jmrt.2021.05.049.

Hongrattanavichit, I., & Aht-Ong, D. (2021). Antibacterial and water-repellent cotton fabric coated with organosilane-modified cellulose nanofibers. Industrial Crops and Products, *171*, 113858. https://doi.org/10.1016/j.indcrop.2021.113858.

Hu, Y., Du, C., Pensupa, N. and Lin, C.S.K. (2018). Optimisation of fungal cellulase production from textile waste using experimental design. *Process Safety and Environmental Protection*, [online] *118*, pp.133– 142. doi:10.1016/j.psep.2018.06.009.

Industrial Applications of Nanocellulose And Its Nanocomposites. (2022). S.L.: Woodhead Publishing Uk

Isikgor, F.H. and Becer, C.R. (2015). Lignocellulosic biomass: a sustainable platform for the production of bio-based chemicals and polymers. *Polymer Chemistry*, 6(25), pp.4497–4559. doi:10.1039/c5py00263j.

Isogai, A. (2020). Emerging Nanocellulose Technologies: Recent Developments. *Advanced Materials*, p.2000630. doi:10.1002/adma.202000630.

Lavoine, N., Desloges, I., Dufresne, A. and Bras, J. (2012). Microfibrillated cellulose – Its barrier properties and applications in cellulosic materials: A review. *Carbohydrate Polymers*, 90(2), pp.735–764. doi:10.1016/j.carbpol.2012.05.026.

Liyanapathiranage, A., Peña, M.J., Sharma, S. and Minko, S. (2020). Nanocellulose-Based Sustainable Dyeing of Cotton Textiles with Minimized Water Pollution. *ACS Omega*, *5(16)*, pp.9196–9203. doi:10.1021/acsomega.9b04498.

Mhmt, R. (2020). Characterization of new natural cellulosic fibre from lasia spinosa (L.) thwaites rhizome for biodegradable textile material. *dl.lib.uom.lk*. [online] Available at: http://dl.lib.uom.lk/handle/123/16647 [Accessed 3 Sep. 2022].

Minko ed., (2016). Patent Application Publication.

Nechyporchuk, O., Belgacem, M. N., & Bras, J. (2016). Production of cellulose nanofibrils: A review of recent advances. *Industrial Crops and Products*, *93*, 2–25. https://doi.org/10.1016/j.indcrop.2016.02.016

Nechyporchuk, O., Belgacem, M.N. and Bras, J. (2016). Production of cellulose nanofibrils: A review of recent advances. *Industrial Crops and Products*, 93, pp.2–25. doi:10.1016/j.indcrop.2016.02.016.

Panchal, P., Ogunsona, E. and Mekonnen, T. (2018). Trends in Advanced Functional Material Applications of Nanocellulose. *Processes*, 7(1), p.10. doi:10.3390/pr7010010.

Pires, J.R.A., Souza, V.G.L. and Fernando, A.L. (2019). Valorization of energy crops as a source for nanocellulose production – Current knowledge and future prospects. *Industrial Crops and Products, 140*, p.111642. doi:10.1016/j.indcrop.2019.111642.

Pradhan, D., Jaiswal, A.K. and Jaiswal, S. (2022). Emerging technologies for the production of   nanocellulose from lignocellulosic biomass. *Carbohydrate Polymers*, 285, p.119258. doi:10.1016/j.carbpol.2022.119258.

Pradhan, D., Jaiswal, A.K. and Jaiswal, S. (2022). Emerging technologies for the production of   nanocellulose from lignocellulosic biomass. *Carbohydrate Polymers*, 285, p.119258. doi:10.1016/j.carbpol.2022.119258.

Provin, A.P., Regina de Aguiar Dutra, A., Machado, M.M. and Vieira Cubas, A.L. (2021). New materials for clothing: Rethinking possibilities through a sustainability approach - A review. *Journal of Cleaner Production*, 282, p.124444. doi:10.1016/j.jclepro.2020.124444.

Salah, F., Vololonirina, O. and Gidik, H. (2022). Development of fibrous materials applied in timber-framed construction using recycled fibers from textile waste. *Journal of Cleaner Production*, *347,*   p.131203. doi:10.1016/j.jclepro.2022.131203.

Sanchis-Sebastiá, M., Ruuth, E., Stigsson, L., Galbe, M. and Wallberg, O. (2021). Novel sustainable alternatives for the fashion industry: A method of chemically recycling waste textiles via acid   hydrolysis. *Waste Management*, 121, pp.248–254. doi:10.1016/j.wasman.2020.12.024.

Saremi, R., Borodinov, N., Laradji, A. M., Sharma, S., Luzinov, I., & Minko, S. (2020). Adhesion and stability   of   nanocellulose   coatings   on   flat   polymer   films   and   textiles. https://doi.org/10.20944/preprints202007.0213.v1

Saremi, R., Borodinov, N., Laradji, A.M., Sharma, S., Luzinov, I. and Minko, S. (2020). Adhesion and Stability of Nanocellulose Coatings on Flat Polymer Films and Textiles. *Molecules*, [online] 25(14),   p.3238. doi:10.3390/molecules25143238.

Saud, A., Saleem, H. and Zaidi, S.J. (2022). Progress and Prospects of Nanocellulose-Based Membranes for Desalination and Water Treatment. *Membranes*, 12(5), p.462. doi:10.3390/membranes12050462.

Sharma, C. and Bhardwaj, N.K. (2019). Bacterial nanocellulose: Present status, biomedical applications and future perspectives. *Materials Science and Engineering: C*, [online] 104, p.109963. doi:10.1016/j.msec.2019.109963.

Shiwanthi, S., Lokupitiya, E. and Peiris, S. (2018). Evaluation of the environmental and economic performances of three selected textile factories in Biyagama Export Processing Zone Sri   Lanka. *Environmental Development*, 27, pp.70–82. doi:10.1016/j.envdev.2018.07.006.

Spagnuolo, L., D'Orsi, R. and Operamolla, A. (2022). Nanocellulose for Paper and Textile Coating: The Importance of Surface Chemistry. *ChemPlusChem*, *87*(8). doi:10.1002/cplu.202200204.

Subramanian, K., Chopra, S.S., Cakin, E., Li, X. and Lin, C.S.K. (2020). Environmental life cycle assessment of textile bio-recycling – valorizing cotton-polyester textile waste to pet fiber and glucose   syrup. *Resources, Conservation and Recycling*, 161, p.104989. doi:10.1016/j.resconrec.2020.104989.

Thomas, P., Duolikun, T., Rumjit, N.P., Moosavi, S., Lai, C.W., Bin Johan, M.R. and Fen, L.B. (2020). Comprehensive review on nanocellulose: Recent developments, challenges and future prospects. *Journal of the Mechanical Behavior of Biomedical Materials*, 110, p.103884. doi:10.1016/j.jmbbm.2020.103884.

UNDP. (n.d.). *Biodiversity and the 2030 Agenda for Sustainable Development | United Nations Development Programme*. [online] Available at: https://www.undp.org/publications/biodiversity-and-2030-agenda-sustainable-development.

Determinants of Agro-tourists' Satisfaction in Sri Lanka with special reference to Destination Characteristics

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ABSTRACT

Tourism industry takes numerous shapes resulting variety in concepts and tourist attractions. This study is based on one such tourism concept which is promoted in agricultural societies. The agro-tourism in Sri Lanka is identified as an important aspect in gaining the benefits of tourism. The purpose of the study was to examine the factors determining the level of satisfaction in agro-tourists and define the possible ways and means to enhance their satisfaction levels in promoting agro-tourism in Sri Lanka. Research aim is to examines the factors determine level of satisfaction of agro-tourists in Sri Lanka. This research utilized both qualitative and quantitative data collection methods. The gathered data were analyzed using three instruments; reliability test, pearson correlation analysis, regression analysis.

Keywords: Agro-tourism, Tourist Satifaction, Destination characteristics.

1. INTRODUCTION

Guest satisfaction is important in determining the happiness of the customers who experience a product or a service. Consideration on guest satisfaction is essential for any industry in order to establish customer loyalty, brand credibility, profitability, and long run of a business. The service-based industries such as tourism and hospitality industry are also more focused on establishing guest satisfaction. This study has focused on analyzing the guest satisfaction of agro-tourists in Sri Lanka with reference to destination characteristics. Research aim is to examine the factors which determine the level of satisfaction of agro-tourists in Sri Lanka.

1.1 REVIEW OF LITERATURE

The destination characteristics that influence tourist satisfaction is addressed in tourism literature. Accommodation, activities, and attractions of destinations are identified as factors that satisfy the tourists who visit agro-tourism sites in Sri Lanka (Malkanthi and Routray, 2012). Accessibility and amenities were the other two destination characteristics influencing tourist satisfaction which were not in a satisfactory level for tourists who visited agro-tourist sites in Sri Lanka (Malkanthi and Routray, 2012). Further, the tourists destination characteristics were analyzed using the multiple regression model in order to identify its influence on tourist satisfaction in cultural tourism study (Kodithuwakku, 2018). A Poland based study titled "Mesuring tourist satisfaction with destination attributes", discussed the influence of destination characteristics in satisfying tourists. Study had been carried out through a questionnaire survey with the tourists who visit Poland during summer holiday. Sample consisted of 463 units. Five variables had been

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utilized in the study based on the services, activities and facilities offered at the destination (Ghose and Johann, 2019).
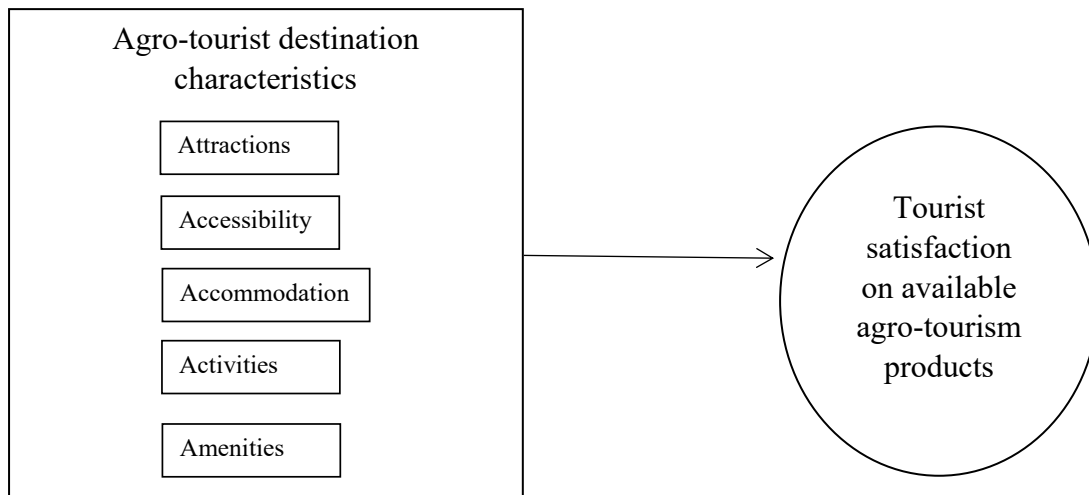
2. METHODOLOGY

The study utilized both qualitative and quantitative data collection methods. A field survey was carried out using a structured questionnaire to gather the primary data required. The survey was carried out among the tourists who visited agro-tourism sites in Sri Lanka. The literature survey supports to determine the destination characteristics of the agro-tourism destinations and their influence on tourist satisfaction. Both primary and secondary data collected were utilized to discuss the possible ways and means to enhance tourist satisfaction and positive experience for agro-tourists in Sri Lanka. The population of this study is unknown since there is no any proper means of calculating the agro-tourism service providers in Sri Lanka. Majority of the services are provided by unauthorized service providers. 260 tourists were selected as the sample for the questionnaire survey. Purposive sampling has been used as the sampling method. This is a type of nonprobability sampling. The sample was selected using tourists from social media groups who visited Sri Lanka. A pilot survey was carried out before the live survey. The responsive level was recorded above the level of acceptance. The questions with likert scale and drop down answers were used to collect data from the questionnaire.

3. RESULTS AND DISCUSSION

Descriptive Analysis

In the descriptive analysis mean, standard deviation, kurtosis and skewness were observed.

Table 1: Descriptive Analysis for Attractions

	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Clear display of agricultural function	3.92	.964	-.572	.343	.117	.674

Interpretation of functions in the site	4.06	.932	.622	.343	.582	.674
Places to see in the site	4.04	.988	-.776	.343	-.386	.674
Valid N (listwise)						

Source: Author's calculations

Table 2: Descriptive Analysis for Accessibility

	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
location is easily accessible	3.31	.888	-.088	.343	-.821	.674
Condition of the road	3.35	.263	.251	.343	-.959	.674
Signage available in the road	3.75	.694	.352	.343	-1.421	.674
Accommodations availability nearby	3.94	.954	-.484	.343	-.717	.674
Valid N (listwise)						

Source: Author's calculations

Table 3: Descriptive Analysis for Accommodation

	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Comfortable rooms	3.92	.942	-.946	.343	.995	.674
Hotel amenities	4.21	.824	-.412	.343	-1.406	.674
Physical environment in the	3.75	.158	-.429	.343	-.938	.674
Organic grown food	4.35	.812	-.998	.343	.081	.674
Taste of the food	4.02	.978	-1.181	.343	1.894	.674
Availability of dining	3.88	.937	-.552	.343	.311	.674
Valid N (listwise)						

Source: Author's calculations

Table 4: Descriptive Analysis for Amenities

	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Agricultural background	4.08	.846	-.822	.343	.383	.674
Cleanliness of the environment	3.10	1.134	.062	.343	-.816	.674

Financial facilities are provided at	3.58	1.007	-.238	.343	-.413	.674
Required information provided at	3.60	1.180	-.463	.343	-.760	.674
Sanitary facilities/ rest rooms at	3.63	1.265	-.360	.343	-1.123	.674
Drinking water facilities provided	3.15	1.203	.014	.343	-.848	.674
Emergency services and signage	3.17	1.078	.079	.343	-.702	.674
Valid N (listwise)						

Source: Author's calculations

Table 5: Descriptive Analysis for Activities

	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Activities designed utilising Agro	3.46	1.184	-.338	.343	-.681	.674
Appropriate time has given to each activity	3.54	1.091	-.522	.343	-.375	.674
Activities designed to provide	3.67	1.173	-.627	.343	-.576	.674
Activities are attractive	3.08	1.217	-.092	.343	-.719	.674
Shopping facilities located at the	3.54	1.110	-.742	.343	-.065	.674
The products are aligned with the	3.63	1.196	-.854	.343	-.065	.674
Product prices are appropriate	4.00	.989	-.825	.343	.382	.674
Valid N (listwise)						

Source: Author's calculations

In the descriptive analysis, values of all five elements are clused towards agree direction. Where the standard deviation indicates 1.1 which stays closer to mean value. The skewness of the questions of five variables were between -.05 to +.05 confirming the responses are symmetric. Standard error of kurtosis explains the normality. Therefore, in this data, it can be established that the dispersion is shorter based on kurtosis values. The Cronbach's Alpha test was used to analyse the reliability. It is generally accepted in research arena that a Cronbach's alpha of. 70 and above is good.

The summery of Cronbach's alpha are depicted in Table 7.

Table 7: Reliability Test

Variables	Cronbach's Alpha	Items
Attractions	.778	3
Accessibility	.839	4
Accommodation	.844	6
Amenities	.899	7
Activities	.946	7
Service Quality	.721	6
Satisfaction	.780	3

Source: Author's calculations

The CBA shows over .7 which is good.

Correlation Analysis

Correlation is a statistical measure that expresses the extent to which two variables are linearly related. It's a common tool for describing simple relationships without making a statement about cause and effect. The correlation coefficient values are ranging from -1 to+1. Where, Zero to +1 stands for a positive correlation while Zero to -1 stands for a negative correlation.

From the correlation test the hypothesis one developed was;

H1: There is a relationship between destination characteristics and tourist satisfaction on available agro-tourism products

Table 8: Correlations

		SATI	ATTR	ACCE	ACCOM	AME	ACTI
SATI	Pearson Correlation	1	.548	.479	.811*	.435**	.878**
	Sig. (2-tailed)		.040	.025	.032	.002	.008
	N	48	48	48	48	48	48
ATTR	Pearson Correlation	.548	1	.721**	.648**	.591**	.661**
	Sig. (2-tailed)	.040		.000	.000	.000	.000
	N	48	48	48	48	48	48
ACCE	Pearson Correlation	.479	.721**	1	.653**	.565**	.468**
	Sig. (2-tailed)	.025	.000		.000	.000	.001
	N	48	48	48	48	48	48
ACCOM	Pearson Correlation	.811*	.648**	.653**	1	.782**	.742**
	Sig. (2-tailed)	.032	.000	.000		.000	.000
	N	48	48	48	48	48	48
AME	Pearson Correlation	.435**	.591**	.565**	.782**	1	.818**
	Sig. (2-tailed)	.002	.000	.000	.000		.000
	N	48	48	48	48	48	48

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ACTI	Pearson Correlation	.878**	.661**	.468**	.742**	.818**	1
	Sig. (2-tailed)	.008	.000	.001	.000	.000	
	N	48	48	48	48	48	48

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Author's calculations

Accommodation and activities have a high positive correlation with the satisfaction of agro-tourists as well as attraction has a moderately high positive correlation with the satisfaction of agro-tourists. Accessibility and amenities have a low high positive correlation with the satisfaction of agro-tourists.

Hypothesis one, there is a relationship between destination characteristics and tourist satisfaction on available agro-tourism products, implied that hypothesis one is accepted.

Hypothesis testing

H1: There is a relationship between destination characteristics and tourist satisfaction on available agro-tourism products

There is a relationship between destination characteristics and tourist satisfaction on available agro-tourism products which implied that hypothesis one is accepted.

H2: Attractions impact on tourist satisfaction on available agro-tourism products

The attraction was regressed on tourist satisfaction. The tourist satisfaction explained significant amount of the variance in attractions, $F_{(5, 42)} = 2.147$, $p = .000$, $R^2 = .751$. The regression coefficient (B=.319, p=.000) indicated that there is a significant positive impact of attractions on tourist satisfaction.

H3: Accessibility impact on tourist satisfaction on available agro-tourism products

The accessibility was regressed on tourist satisfaction. Tourist satisfaction explained significant amount of the variance in accessibility, $F_{(5, 42)} = 2.147$, $p = .000$, $R^2 = .751$. The regression coefficient (B=.442, p=.000) indicated that there is significant positive impact of accessibility on tourist satisfaction.

H4: Accommodation has impact on tourist satisfaction on available agro-tourism products

The accommodation was regressed on tourist satisfaction. The tourist satisfaction explained significant amount of the variance in accommodation, $F_{(5, 42)} = 2.147$, $p = .000$, $R^2 = .751$. The regression coefficient (B=.582, p=.000) indicated that there is a significant positive impact of accommodation on tourist satisfaction.

H5: Activities have impact on tourist satisfaction on available agro-tourism products

The activities were regressed on tourist satisfaction. Tourist satisfaction explained significant amount of the variance in Activities, $F_{(5, 42)} = 2.147$, $p = .000$, $R^2 = .751$. The regression coefficient (B=.378, p=.000) indicated that there is a significant positive impact of Activities on tourist satisfaction.

H6: Amenities have an impact on tourist satisfaction on available agro-tourism products

The amenities were regressed on tourist satisfaction. Tourist satisfaction explained a significant amount of the variance in amenities, F (5, 42) = 2.147, p = .000, R^2 = .751. The regression coefficient (B=.674, p=.000) indicated that there is significant positive impact of amenities on tourist satisfaction.

4. CONCLUSION AND RECOMMENDATIONS

According to the correlation analysis, accommodation and activities have a high positive correlation with the satisfaction of agro-tourists as well as attractions have moderate high positive correlation with the satisfaction of agro-tourists. Accessibility and amenities have low high positive correlation with satisfaction of agro-tourists. The influence of destination characteristics on tourist satisfaction is addressed in the study. Accommodation, activities and attractions of destinations were known as the factors that satisfy the tourists who visit agro-tourism sites. Regression analysis revealed that one unit change in attraction would change guest satisfaction by .319 units; it can be concluded that agro tourism destinations must be attractive sites for tourists. Accessibility would change the guest satisfaction by .442 units which implies that accessibility impact agro tourists' satisfaction and amenities. One unit change in amenities would change the guest satisfaction by .378 units. Accessibility and amenities were the other two destination characteristics influencing tourist satisfaction which was not in a satisfactory level for tourists who visited agro tourism sites in Sri Lanka. Further, the tourists' destination characteristics were analyzed using the multiple regression model in order to identify its influence on tourists' satisfaction. Accommodation, activities, and attractions of destinations were identified as the factors that satisfy the tourists who visit agro-tourism sites in Sri Lanka. This research proves that one unit change in accommodation would change the guest satisfaction by .582 units. One unit change in activities would change guest satisfaction by .647 units. All effects are significant and positive.

The recommendations of the study were based on government corporations in tourism, private-sector collaboration and new product development in agro-tourism. Sri Lanka Tourism Development Authority, Department of Agriculture, Agrarian Services, Hotel Corporation, and Sri Lanka Tourism Promotion Bureau should establish a corporation in directing the agro-tourism businesses for sustainbale development. Information, education, guidelines, government funding support, and quality assurance should be promoted in these collaborations. Furthermore, agro-tourism destination promotion to be addressed by the National Tourism Organisation in order to increase the international market share of tourism. Managing and introducing Agro-tourism zones that are aligned with the traditional tourist routes is also recommended by the authors. Product diversification is suggested based on activities and packages. Travel and hotel sector operators are vital in performing this recommendation. The agro-tourism activities to be included in traditional packages via tour operators. In long run, the new agro-tourism package development is recommended.

To ensure the quality of service delivery measures to be taken to enhance the quality of the workforce. Short courses, workshops and education opportunities to be provided for the potential and existing workforce

targeting micro and macro level tourism establishments. Tourism entrepreneurship must be promoted in agri societies for the better utilization of the resources.

Apart from service standardization and quality assurance, healthy diet and organic farming practices should be promoted. The tourist experience has to be carefully determined by blending with the ecology of the farmlands. Environmemtal impacts to be analysed and provide solutions with the utilization of new technology. Monitoring and controlling of the tourism development could be established in agro-tourist destinations with use of technology and government and private sector collaborations.

REFERENCES

Bwana, M. A., W. H. A. Olima, D. Andika, Stephen G. Agong, and P. Hayombe. (2015). Agritourism: Potential Socio-Economic Impacts In Kisumu County. *IOSR Journal Of Humanities And Social Science (IOSR-JHSS* 20(3). doi: 10.9790/0837-20377888.

Camilleri, Mark Anthony. (2018). The Tourism Industry: An Overview.Pp. 3–27 in.

Della Corte, Valentina. (2015). Customer Satisfaction in Tourist Destination: The Case of Tourism Offer in the City of Naples. *Journal of Investment and Management 4(1)*:39. doi: 10.11648/j.jim.s.2015040101.16.

Ghose, Sanjoy, and Maria Johann. (2019). Measuring Tourist Satisfaction with Destination Attributes. *Journal of Management and Financial Sciences* (34):9–22. doi: 10.33119/jmfs.2018.34.1.

Jagtap, M.D., Nichit, M.B. and Benke, S.R., (2010). Agro-tourism: the performance, problems and prospects for the farmers in Maharastra. *International Journal of Commerce and Business Managaement*, *3*(1), pp.153-156..

Kniatt, N.L., (1995). *The effect of demographics on customer expectations for service quality in the lodging industry*. University of North Texas.

Kodithuwakku, Dilushi. (2018). Tourists' Satisfaction with Travel Destination Attributes: Special Reference to Galle Sri Lanka. *International Journal of Advanced Engineering and Management Research* 3(June 2018).

Lankton, Nancy K., and Harrison D. Mcknight. (2012). Examining Two Expectation Disconfirmation Theory *Models: Assimilation and Asymmetry Effects*. Vol. 13.

Ma, Anson T. H., Alice S. Y. Chow, Lewis T. O. Cheung, Karen M. Y. Lee, and Shuwen Liu. (2018). Impacts of Tourists' Sociodemographic Characteristics on the Travel Motivation and Satisfaction: The Case of Protected Areas in South China. *Sustainability (Switzerland)* 10(10). doi: 10.3390/su10103388.

Malkanthi, S. H. Pushpa, and Jayant K. Routray. (2012). Visitor Satisfaction in Agritourism and Its Implications for Agritourism Farmers in Sri Lanka., *International Journal of Agricultural Management 2(1)*:17. doi: 10.5836/ijam/2013-01-03.

Malkanthi, SHP, and JK Routry. (2011a). Potential for Agritourism Development: Evedance from Sri Lanka. *Journal of Agricultural Sciences 6(1)*:45. doi: 10.4038/jas.v6i1.3812.

Malkanthi, SHP, and JK Routry. (2011b). Potential for Agritourism Development: Evedance from Sri Lanka. *Journal of Agricultural Sciences* 6(1):45. doi: 10.4038/jas.v6i1.3812.

Marinao, Enrique. (2018). Determinants of Satisfaction with the Tourist Destination. *Mobilities, Tourism and Travel Behavior - Contexts and Boundaries*. doi: 10.5772/intechopen.70343.

Ramesh, S., and Management Studies. (2019). Impact of Five A ' s of Tourism on Tourist Loyalty in Tamil Nadu Tourism with Reference to Coimbatore City. XI(Xii):1048–55.

Salleh, Munir, Khatijah Omar, Azizul Yadi Yaakop, and Ahmad Ramli Mahmmod. (2013). Tourist Satisfaction in Malaysia. *International Journal of Business and Social Science 4(5)*:221–26.

Shahrivar, Rafat Beigpoor. (2012). Factors That Influence Tourist Satisfaction. *Journal of Travel and Tourism Research* (Special):61–79.

Wilson, Suzanne, Daniel R. Fesenmaier, Julie Fesenmaier, and John C. Van Es. (2001). Factors for Success in Rural Tourism Development. *Journal of Travel Research 40(2)*:132–38. doi: 10.1177/004728750104000203.

Zoto, S., Qirici, E. and Polena, E.S.M.E.R.A.L.D.A., (2013). Agrotourism-A sustainable development for rural area of Korca. *European Academic Research*, *1*(2), pp.209-223.

IMPACT OF NON-PAID AWARENESS CAMPAIGN ON SALES OF START-UP FOOD INDUSTRIAL BUSINESS IN SRI LANKA

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ABSTRACT

Recent research shows that as the global middle class' per capita income has grown, it has demanded larger quantities of higher quality and more diverse food. In this global change, local industry must increase their sales volumes, generate more income, and increase the export volume of our country. In this positive situation, startups in the food industry need to introduce their products to the market through the use of effective marketing strategies. Startups' initial investment and working capital get high value after calculating the total budget. Then the most effective method of marketing for startups is to use non-paid marketing tools like social media. The study was done by a startup dehydrated food manufacturing company. Secondary data is collected through research articles and competitor analysis. Primary data display by the existing customer questionnaire and complete marketing campaign use in social media, TV and radio programs, paper articles, and websites Finally, the results illustrate fluctuations in sales volume and product inquiries. As well as the result of this non-paid awareness campaign, it has had the most effect on increasing the sale of startup food and industrial businesses.

Keywords: Sales Volume, Marketing, Non-Paid advertising, Social Media

1 INTRODUCTION

The basics of marketing shifted to the aspects of modern marketing through the evolution of both traditional marketing and digital marketing. Many of traditional marketing's ground rules still apply to modern marketing, such as the purpose of marketing, how to define the target market, and the marketing mix. Recently, people tend to spend more time online, except for cutouts, handbills, leaflets, and magazines. These are replaced by social platforms such as Facebook, Instagram, Telegram, YouTube, Twitter, online publications, and online streaming series. Some are addicted to online ordering systems. Elderly persons engage with television and radio to spend their leisure time. Now that the company is able to identify how its target consumers are using the internet and understand the modern way of finding information about the products and comparing them, it can make the most of digital marketing. This understanding is the basis for creating a successful digital marketing plan in practice. (Narkiniemi, 2013)

Startup companies engage in developing a proper business plan in the initial stage, but most do not pay attention to developing a marketing plan. When developing the marketing plan, consider the budget for the marketing campaigns. In this point, it is most important to engage in a non-paid marketing campaign. When you use these tools, there is zero cost for the marketing at the initial stage. Common non-paid marketing tools are social media platforms, websites, media programs, paper articles, and online sales apps. Most start-

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ups don't have the digital literacy to use these platforms, but they can learn online, and these are user-friendly tools.

2 BACKGROUND STUDY

Most startup businesses haven't gradually increased sales because this is the introduction stage of the business life cycle. Yet, large-scale food industries spend more money advertising their new products. When startup companies use these methods, they are not effective because they do not have high sales output or high customer awareness for these products. They also invest more than $1 million in their marketing campaigns because they haven't recovered this cost in a short time period. Most of the startup company's management does not know what the benefits of these marketing tools are or how to use them in an effective way. They also have no idea about the non-paid campaign methods. Recently, most people have highlighted this digital marketing concept because people are engaging with the internet. Therefore, startups can use digital marketing strategies to promote their products without paying. Startups can apply the non-paid marketing strategies to increase sales. How and what are the non-pay marketing strategies used for in order to achieve the targets of marketing and sales?

A specially selected startup industry in the food manufacturing industry is a dehydrator manufacturer. Dehydrated foods have less demand in the local market because of the availability of fresh fruits and vegetables. Then marketing is the most powerful strategy to introduce the product to the customers and explain the convenience, benefits, and values.

Irem and Mesut (2012) in their article "The Impact of Social Media Marketing on Brand Loyalty" The aim of his study is to identify the effect of social media marketing on the brand loyalty of consumers, given that the concept is receiving increasing attention from marketing academia and practitioners. The scope of the study consists of customers who follow at least one brand on social media in Turkey. The results of the study showed that brand loyalty of the customers is positively affected when the brand (1) offers advantageous campaigns, (2) offers relevant content, (3) offers popular content, (4) appears on various platforms, and (5) offers applications on social media. Customers prefer to share music, technology-related, and funny contents on social media platforms.

Gail, Alan and Dave (2014) did a SWOT analysis of competitive knowledge from social media for a small start-up business. The analysis of data from social media sites can provide useful decision-making information for businesses; however, can small businesses with limited budgets and limited technical expertise compete in this new social media-driven market? This study provides a proof of concept for increasing a company's competitive knowledge through the use of the Strengths, Weaknesses, Opportunities, and Threats (SWOT) framework model by gathering qualitative data about the use of social media from employee interviews. By increasing their competitive knowledge through evaluating the results of the SWOT analysis, this small start-up company will have a strategic plan for increasing their competitive advantage. Several of the short- and long-term recommendations are substantiated through prior research studies. Future research could include a follow-up study of this company using a SWOT framework tool or

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other methodologies to indicate what social media tools and strategies provide the most beneficial competitive knowledge for a small business and why. Additionally, comparing the results from this study with a similar study of a different small start-up business could lead to the design of a model for other small businesses trying to increase their competitive knowledge through the effective use of social media.

Liis (2017) said his study, "Online marketing for start-up and small companies: getting the word out there," confirmed that before starting online marketing for a brand, the company needs to know the essence, concept, and goals of the company or brand. The study confirmed the importance of a strategic approach. The approach should derive from the character of the business and/or service. The interviewees confirmed the theory that an Instagram account for more personable visuals and a younger audience, Facebook for storytelling and a wider and more mature audience, and a website for driving sales and/or providing information The communication channels recommended by the participants and also chosen for the study were Facebook, Instagram, and a company's own website.

3   METHODOLOGY
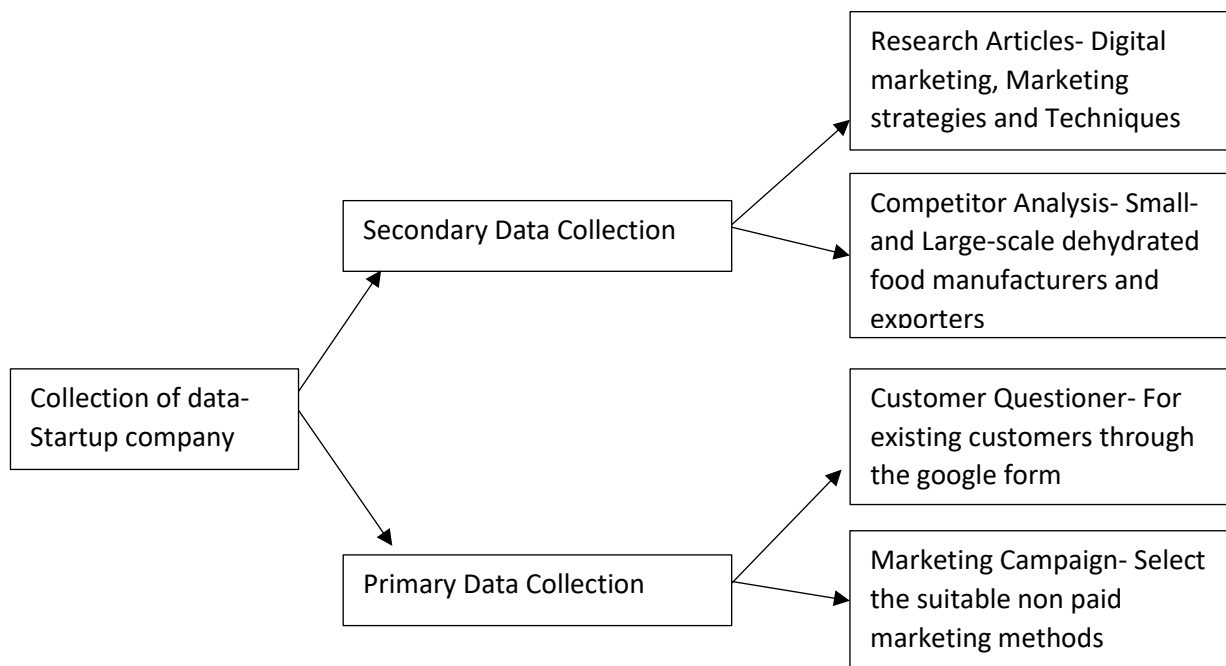
Figure 1: Type of collection of data to select best marketing strategies for start-up business
Source: Developed by the Author (2022)

In this research, we selected one startup dehydrated food manufacturing company, studied the company background and industry background, and got an idea about the current situation. In this case, it was identified that the company did not pay attention to its marketing strategies to catch more customers. Then we identified the requirements needed for the startup dehydrated food company.

One of the secondary data collection methods was reading the research articles related to our main key points: marketing strategies, techniques, and digital marketing. In the food industry, customers are mostly

aware of the manufacturing process, the quality of the products, a reasonable price, and attractive packaging. But to increase product awareness, companies must market their products. In their initial stages, startup companies are better off using non-paid advertising methods to promote their products and raise customer awareness. Sometimes, startup companies lack customer awareness because of a limited use of marketing strategies. reason for the low knowledge about initial investment in marketing and the lack of concern about non-paid advertisement methods like, for example, the use of social media.

After the studies and on-going studies, select the best solutions to apply to the business. Regarding the study, we selected a Facebook application and website to promote the products among the customers who were interested in buying the selected products. Then they used some other internet tools and applications to do the marketing promotions. They used other marketing tools like TV, radio, and newspaper articles to promote the brand among the customers. These methods can be used to identify the behavior of product sales and inquiries.

Basic, non-paid advertising methods include social media. In January 2021, reached 7,646,000 Facebook users in Sri Lanka. When we use Facebook, we can reach a large population of customers, but if we select a physical area, we can't reach the entire population with one advertisement. This is a high benefit for the startup company. Customers are more aware of the attractive photos, videos, and article with stories.

Initial-stage customers have no idea about the product or the manufacturing company. In the initial stages, it is difficult to satisfy customers. company creates a good image for other products and the company's background. After the customer shows interest in the company and products, In the dehydrated food industry, customers are most careful about the product and the background of the manufacturing company. In a normal marketing platform, the product is introduced with its package and name, and the company name and other small details can identify these methods. But social media or websites can display all the details in one post or on one platform. When using social media, you can publish public posts that anyone can see. These posts include all product details, history, nutritional value, company details, and the full story about the product and the company. But other paid methods want to physically accept the products to learn more details. Customers' interest is in knowing the details at one time. It is easy for customers to become interested in the product. Before 5 years, customers were physically able to reach the place and, after seeing these promotions, physically touch the product and purchase it. But now that social media platforms are free to use, they can display the marketing promotions. The customer can compare the products with the other products easily. The company can get feedback, comments, and suggestions online. The customer can ask the question and complete the clearance on time.

Primary data collection is done by studying the increase in post sharing on the business Facebook page and analyzing the data on how people engaged with the products through the Facebook posts. Facebook has an overview facility. On the other side, TV programs, radio programs, and newspaper articles help to increase marketing so customers can engage with the company with trust. It provides a digital outlook to the company free of charge. company website, another digital marketing platform that anyone can access at any time and from any place. Other data collection methods included doing a marketing survey to get

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customer feedback on existing customers, collecting the data, and analyzing it. It helps to make decisions based on the output of how you've applied some changes to ongoing company processes.

Then we identified the customer expectations and special requirements through these methods for existing products to fulfill the market demand gap. Finally, analyze the fluctuation of sales volume and product inquiries for a startup dehydrated food business.

4   ANALYSIS

According to the primary data collection, which selected around 50 competitors, they didn't plan the marketing strategies as non-paid advertising techniques. More than 80% of companies fail to develop their marketing strategies through paid-form advertisements, and they also can't recover this cost in a short time period. When the start-up food manufacturing company implemented the non-paid advertisement techniques, sales grew, and there were more customer inquiries and engagements in Sri Lanka and outside the country. When using the Facebook page to promote the products, any customer worldwide engages with the product and gets easy access to details about the product and the company. Recently, most customers engaged with internet platforms and used social media. Other methods used in the survey for existing customers screened around 50 customers, with more than 39% being highly satisfied with their overall experience with products and services and 0% being dissatisfied. 30% of customers are highly satisfied with the product price, and 5% are moderately satisfied. Most satisfied product range: 95% of customers. According to the question, customers also suggest sharing product details, company details, and product images for use on digital platforms, essentially developing the website.

When the Facebook post is shared, it gradually increases the reach of the people. By evaluating the data looking at the Facebook graphs showing how people engage with the post reactions, comments, and shares, the number of people who saw any content from the page, and the total reach from each day. It helped increase the number of inquiries in different countries and from local customers. Startups can use their Facebook pages very effectively to catch customers and attach their marketing strategies. TV programs, radio programs, and paper articles can be published on digital marketing platforms free of charge. Many TV, radio, and newspaper articles are done for entrepreneurs free of charge. These programs can be published on the internet, like YouTube and social media platforms. Then when published ,it indicates the post-reach count and engagement count; such as more than 1 million people reached these programs.

According to the results of the secondary data, Olonde (2017)'s study results indicated that email marketing and social media marketing had a significant impact on SMEs' sales growth and did so to a great extent. Mobile marketing, search engine optimization (SEO) marketing, pay-per-click (PPC), and online marketing all had a significant effect on SMEs' sales growth, albeit to a moderate extent. The study findings indicated that lack of digital media knowledge was the greatest challenge for SMEs in the adoption of digital marketing, followed by a lack of suitable digital marketing techniques and a lack of finances. The findings led to the conclusion that email marketing and social media marketing are important to improve SMEs' sales, while the other techniques (mobile marketing, SEO marketing, P.P.C., and online marketing) have

little or moderate effect on sales. The study recommended that SMEs be trained and sensitized on the available digital marketing techniques and how they are suitable for their businesses. The study also recommended that proper policies be made by the government to assist SMEs in adopting digital marketing. Finally, the study recommended that SMEs be provided with funds in order to improve their knowledge of digital marketing.

Finally, the startup food business increased its sales by more than 50% within 3 months, not only because product inquiries got more local customers but also because more international customers wanted to export the products. The purpose of the methods is to keep customers satisfied with the overall performance of the company, increase trust, and add digital value to the business.

5 DISCUSSION

Hansson, Wrangmo, and Silen (2013) said social media has increased as a marketing channel, and Facebook is the biggest social media company globally. Facebook contains both positive and negative information about companies; therefore, it is important for companies to manage their Facebook page to best serve their own interests. Although most users are familiar with business and marketing activities on Facebook, they use it primarily for fun and personal purposes. The most effective methods for companies to use Facebook have not been clear. The personal nature of Facebook presents unique challenges for companies by raising ethical and social responsibility issues that are important to users.

Guesalaga (2016), as his article shows There is recognition that social media can benefit personal selling and sales management, especially in the B2B context. This research draws on interactional psychology theory to propose and test a model of social media usage in sales, analyzing individual, organizational, and customer-related factors. We find that organizational competence and commitment with social media are key determinants of social media usage in sales, as well as individual commitment. Customer engagement with social media also predicts social media usage in sales, both directly and (mostly) through the individual and organizational factors analyzed, especially organizational competence and commitment.

Startup companies can use non-paid marketing methods to develop their business, engage with new customers, share product details, create attractive images, videos, and audios, create a digital value and image for the business, and, in return for all of these more customer inquiries, increase sales and generate profits.

REFERENCES

Bala, M. and Verma, D., 2018. A critical review of digital marketing. *M. Bala, D. Verma (2018). A Critical Review of Digital Marketing. International Journal of Management, IT & Engineering*, *8*(10), pp.321-339.

Brooks, G., Heffner, A. and Henderson, D., (2014). A SWOT analysis of competitive knowledge from social media for a small start-up business. *Review of Business Information Systems (RBIS)*, *18*(1), pp.23-34.

Erdoğmuş, İ.E. and Cicek, M., (2012). The impact of social media marketing on brand loyalty. *Procedia-Social and behavioral sciences*, *58*, pp.1353-1360.

Narkiniemi, J., (2013). Using Digital Marketing to Develop a Modern Marketing Strategy for a Startup.: Case study: *Design With Benefits*.

Usin, L., (2017). Online marketing for start-up and small companies: getting the Word out there. *Bakalaureusetöö. Estonian Business Shcool turunduse ja kommunikatsiooni instituut. Tallinn*, p.*55*.

Vinerean, S., Cetina, I., Dumitrescu, L. and Tichindelean, M., 2013. The effects of social media marketing on online consumer behavior. *International Journal of Business and Management*, *8*(14), p.66.

Basri, W.S. and Siam, M.R., (2017). Maximizing the social media potential for small businesses and startups: A conceptual study. *International Journal of Economic Perspectives*, *11*(2), pp.241-245.

Hassan, S., Nadzim, S.Z.A. and Shiratuddin, N., (2015). Strategic use of social media for small business based on the AIDA model. Procedia-Social and Behavioral Sciences, 172, pp.262-269.

Peña-García, N., Gil-Saura, I., Rodríguez-Orejuela, A. and Siqueira-Junior, J.R., (2020). Purchase intention and purchase behavior online: A cross-cultural approach. *Heliyon, 6(6),* p.e04284.

Olonde, J.O., (2017). Impact of digital marketing on sales growth of small and medium enterprises in Nairobi, Kenya (Doctoral dissertation, University of Nairobi).

Hansson, L., Wrangmo, A. and Søilen, K.S., (2013). Optimal ways for companies to use Facebook as a marketing channel. *Journal of Information, Communication and Ethics in Society*.

Guesalaga, R., (2016). The use of social media in sales: Individual and organizational antecedents, and the role of customer engagement in social media. Industrial Marketing Management, *54*, pp.71-79.

A Stakeholder Perspective on Career Opportunities in the Waste Management Industry: Evidence from Sri Lanka

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Abstract

Stakeholders' views on dealing with waste management are very important, as our sustainable existence could impede because of ineffective waste management practices. This study aims to explore career opportunities in the waste management system in Sri Lanka. In addition to collecting official documents, stakeholders in the waste management industry were interviewed to collect data for this study. There were four categories of stakeholders recognized as a result of a desk study namely Government, NGO, Private sector, and the community. Data were collected from eight (8) key informants, representing four stakeholder categories. Our findings reveal that a range of stakeholders could assume different roles and responsibilities in managing waste and considering the emerging career opportunities in the waste management industry, universities should offer educational and training programs to meet the expectation of stakeholders and to prepare graduates to take up emerging job opportunities, which are financially attractive. Findings further unveiled that career opportunities in the job categories of Researchers, Policy development officers, Directors, Waste centers controllers/officers, Environmental Consultants, Waste audit, and Environment design & Management Trainees produced by the waste management industry in Sri Lanka.
Keywords: Waste Management; Stakeholders; Career Opportunities

1. Introduction

Global warming and environmental pollution underscore the necessity of managing domestic and industrial waste effectively and efficiently. The United Nations' Sustainable Development Goal (SDG)-12/13 states that conserving natural resources is a basic requirement for improving the quality of human life (UN – Progress Report 2022). Similarly, the nascent literature envisages how waste management systems render financial and non-financial benefits to stakeholders (Kulkarni, 2000; Sharratt & Choong, 2002). In Europe, there were 0.8 million employees (Full-time equivalents) in waste management in 2000 (EPSU, 2017). In Sri Lanka, the local authorities, which consist of 15 Municipal Councils, 37 Urban Councils and 257 Pradeshiya Sabhas, are primarily bestowed with the task of managing waste. Based on the estimation by the Waste Management Authority of Western Province (WAM of WP), 7000 tons of Municipal Solid Waste (MSW) are generated daily and systematically collected by around 60% by the municipalities and the private sector waste management institutions, whilst only about 30% of such waste is systematically disposed of (WMA of WP report, 2019). All in all, such a scenario could contribute to triggering health issues and undermining the decent lifestyle of inhabitants and the ecological system's existence. Drawing on stakeholder theory, our study explores career opportunities in the waste management industry in Sri Lanka.

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2. BACKGROUND STUDY

The International Labour Organization (ILO) has identified the waste management sector as an intervention area for technical assistance to foster job creation and the promotion of decent work through enterprise development. As a result of the increased concerns on sustainable environment conservation and mitigating the risk caused to the environment due to human activity, most countries attempt to upgrade their waste management system. As such, the waste management sector is becoming a symbol of the green economy. Dumping of unsorted waste at landfills is gradually giving way to improving recycling and reusing of waste. As such, a large number of job roles emerge starting from segregating and collecting waste to the research and development level while the opportunities for entrepreneurs in the waste sector are open to taking up challenges in re-engineering to better respond to environmental concerns and incorporate innovations in recycling processes. Literature confirms that increasing the waste management plants will create opportunities of employment to several unemployed, skilled, semi-skilled and un-skilled manpower in society. Sharma1.S. et.al coined that the waste management industry produce job opportunities in HRM, Research & Development Person, Engineers, Executive Staff, Labours, Entrepreneurs and Sales & Marketing persons. Further, the municipal waste generation is expected to increase to 2.2 billion tons by 2025, accordingly each person generates approximately 0.65kg per day in Sri Lanka with an estimated 4.8 billion MT of waste collected per annum in the country (Dharmasiri, 2020). This increasingly articulates that the waste management sector has the potential to create jobs specifically in recycling. However, the recent literature is lacking evidence of empirical studies on employment opportunities in the emerging waste management sector. This paper attempts to examine the employment opportunities in the waste management industry in Sri Lanka from the stakeholders' perspective.

2.1. STAKEHOLDER THEORY

Stakeholder theory is frequently used in business management and sustainability research (Rambaree et al., 2021). States stakeholders are "all of those groups and individuals that can affect, or are affected by, the accomplishment of organizational purpose" (Freeman, 1984) and can be defined as anybody or any group, to some extent or through certain linkage, can be a stakeholder of a given organization. Stakeholder theory promotes a practical, efficient, effective, and ethical way to manage organizations in a highly complex and turbulent environment (Freeman, 1984; Freeman et al., 2007; Garvare & Johansson, 2010).

3. METHODOLOGY

We relied upon a qualitative research approach to collect data for this study. Semi-structured and focus group interviews were conducted with 16 key informants, representing 4 stakeholder groups, namely government, NGO, Private, and Community. These groups were identified through a desk study. The duration of each interview was 1 to 3 hours. Open-ended questions were posed in the order to obtain unbiased comments from respondents on the existing and potential employment categories in the waste management industry and the roles and responsibilities, incorporated with each category. The data was

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analyzed using the stakeholder analysis template adapted from the World Bank report (2010), which interprets the job opportunities available, attributes expected from graduates and roles and responsibilities incorporated. The secondary data were collected from the World Bank report, Waste Management Authority (WMA) reports of the Western Province, Data Collection Survey report on Solid Waste Management in the Democratic Socialist Republic of Sri Lanka and Road map for sustainable waste management and resource circulation in south Asia, 2019-2030.

4. EMPIRICAL FINDINGS

Stakeholders possess the means of pinpointing their needs and can adversely respond when their needs and concerns are not addressed (Garvare & Johansson, 2010). The identification of relevant stakeholders is a process that requires a substantial amount of work and care (Hemmati, 2002; Harrison (2003). Normally, the government is the main stakeholder in the waste management industry in Sri Lanka. Nevertheless, the private sector, NGOs and the community also appear to be powerful stakeholders, playing a vital role in disposing of waste in the country. Table 1 demonstrates the main groups of stakeholders, and their roles and responsibilities. Based on the stakeholder analysis, there are more opportunities for collaborating institutions and individuals to contribute to the sustainable waste management process.

Table 1: Role and responsibilities of stakeholders

Stakeholders	Roles and Responsibilities
Government	Representing government sectors: Waste Management Authority, Central Environmental Authority, Municipal Council, Universities. Policy making and activating rules and regulations are monitored towards sustainable waste management, according to the United Nations, The European Union, and the world bank, and encouraging public-private partnerships to waste management.
Private	Integrating with manufacturing industries and promoting reverse logistics and recycling, upcycle for sustainable industrial waste management, and providing environmental service towards a circular economy.
NGO	Consultation, Environmental Impact Assessment, Waste Reduction, Waste Management, Comply with Regulatory Requirements, Troubleshooting.
Community	Reduce waste generation, dispose of domestic waste as appropriately, follow 3R, and Properly segregate waste before dumping.

The UN particularly encourages establishing new partnerships in addressing issues and challenges that could undermine the sustainable existence of human beings. As envisaged in Table 2, a diverse group of individuals and institutions are involved in the process of collecting and disposing of waste.

Table 2: Career opportunities in the waste industry

Stakeholders	Career Opportunities
Government	Career Opportunities for graduates with sound knowledge and practical exposure in waste management as Researchers, Policy development officers, and Directors. Waste centers controllers – officers: there are many vacancies for Graduates with knowledge of sustainable holistic Waste management and Practical exposure as project managers of waste projects.
Private	There is a high demand for graduates with Hands-on experience and who specialized in waste treatment, and renewable energy. But the country is lacking graduates in those demanding areas. There are opportunities in all aspects of the career path from front supervisor to operation manager and quality manager etc., in the waste management industry. In the present context, graduates with the knowledge in handling contingencies, leadership and the existing inefficiencies in the waste management sector have financially attractive career opportunities.
NGO	There is no basic degree such as Environment Engineering in Sri Lanka. No qualified graduates for career opportunities at Environment related institutions Offices (Sustainability, Brand image, and CSR, Officers Environment, Labour and Health, and Safety), Environmental Consultant, Waste audit, and Environment design & Management Training
Community	Can promote entrepreneurial culture to introduce new products using waste as raw materials such as compost, toys and educational equipment, and colored coconut dust. Number and letter cubes, papers/fabric for Arts and handicrafts. Can generate extra income and provide more employment opportunities basically for women.

They mainly play the roles of resource recovery-based waste solution providers, waste collectors, reducing and recycling waste, and research and education amongst others. However, there are untapped opportunities, as there is no degree program that specifically aims at waste management education in the island.

5. CONCLUSIONS AND RECOMMENDATIONS

It is necessary to consider global sustainability, which is involving the interest of future generations and the natural habitat in addition to organizational sustainability (Garvare & Johansson, 2010). Every human activity creates waste and the amount of waste depends on the number of people, homes, institutions, and industries in the relevant area. Individuals, homes, and organizations are a source of waste. The different stakeholders have different roles and responsibilities which are ultimately linked to a better waste management system in Sri Lanka. Further, it revealed that highly demanding and financially attractive career opportunities are available for university graduates with specialized knowledge and hands-on experience in waste management and waste treatment areas. However, many organizations should contribute to managing waste with a well-established system from sewage treatment to MSW

collection. Based on emerging career opportunities in the waste management industry, universities should offer educational and training programs to meet the expectation of stakeholders and to prepare graduates to take up emerging job opportunities, which are financially attractive. Any organization must satisfy a range of stakeholders' needs and expectations to sustain its operational activities in a turbulent and uncertain context. We urge scholars to explore how various organizations cooperate and adopt sustainable waste management practices to minimize negative consequences on the ecological system and the interest of future generations from their operational activities.

6. ACKNOWLEDGMENT:

REFERENCES

Dharmasiri, L.M., (2021), Waste Management in Sri Lanka, Challenges and opportunities. *Progress towards the Sustainable Development Goals*, Report of the Secretary-General, 2022.

Edward, F.R.,(1984) Strategic Management: A Stakeholder Approach. *Boston: Pitman Publishing Inc*.

Garvare, R., & Johansson, P. (2010) Management for sustainability – A stakeholder theory. *Total Quality Management*, *21:7*, pp.737-744, DOI:10.1080/14783363.2010.483095.

OliverHeidricha, JoanHarvey, & NicolaTollin (2009) Stakeholder analysis for industrial waste management systems, *Waste Management. 29* (2) p 965–973.

Rambaree, K., Sundstrom, A., Wang, Z., & Wright, S.A.I. (2021) Qualitative Stakeholder Analysis for a Swedish Regional Biogas Development: A Thematic Network Approach. *Sustainability*, *13,* 8003. https://doi.org/10.3390/su13148003.

Menikpura, N., Bonnet, S., & Gheewala, S.H. (2012) Sustainability assessment of municipal solid waste management in Sri Lanka. *Journal of Material Cycles and Waste Management*.

WMA of WP Report the Role of Waste Management Authority (W.P).(2019).

A Cross Sectional Survey Of Consumer Awareness, Consumption And Purchasing Behaviour Of Functional Beverages In The Asgiriya Area In Gampaha District, Sri Lanka

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ABSTRACT

There is a strong trend to market products that promise improved health in Sri Lanka. Functional Beverages are rather a new concept promoting the healthfulness of beverages. This cross-sectional survey investigates the awareness, consumption, and purchasing behavior of functional beverages among aged 20 – 49 consumers in the Asgiriya area in Gampaha District, Sri Lanka. Google form questionnaire containing 14 questions relevant to awareness, consumption, and purchasing behavior of functional beverages was prepared with particular reference to Drinking Yoghurt, Soy Milk, Black Tea, Green Tea, Coffee, Herbal Infusion and Fresh Fruit Juices (Ready to drink). The survey link of the Google form was circulated via e-mail and social media. The study adopted the snowball-sampling technique where participants were asked to roll out the online questionnaire to their acquanties and relatives, under the Non-Probability sampling method. Data was collected from 200 consumers who are residing in the Asgiriya area. The survey was conducted within a week from 16 March 2022 to 23 March 2022. The survey results were downloaded for analysis in SPSS 26 (Statistics Package for Social Sciences). Descriptive statistics (percentages, frequencies) were measured to identify the awareness, consumption and purchasing behavior of the functional beverages among consumers. The chi-square ((χ2) test was used to analyze the relationship between separate variables and the respondents' socio-demographic features. Statistical significance for all tests was set at a p-value of 0.05. According to the survey results, it was identified that the daily consumed functional beverage was Black Tea (41.5%). Sixty percent (60%) of the respondents purchased functional beverages to stay healthy as per the purchasing intentions. Respondents gave the priority as the basics and stimulus when purchasing functional beverages as (very important) to the health benefits (62.0 %) , brand (41.0%),price (40.0%) ,sensory properties (37.0%) ,packaging and quantity (31.5%) and availability (29.5%) respectively.It was identified that there is a significant difference between age and the consumption of Fermented Milk Beverages(Drinking yoghurt), age and consumption of Fresh Fruit Juices, the highest E/L and consumption of Fermented Milk Beverages(Drinking yoghurt), and highest E/L and consumption of coffee. Also, there is a significant difference between purchasing Fermented Milk Beverages(Drinking yoghurt) and age, purchasing Fermented Milk Beverages(Drinking yoghurt) and the highest E/L, and purchasing coffee and the highest E/L.

Keywords: *Awareness, Beverages, Consumption, Functional, Purchasing.*

1. INTRODUCTION

Functional beverages have beneficial effects on one or more functions of the human body in addition to their basic nutritional values. Fermented milk beverages, Plant-based milk beverages, Caffeinated beverages, Herbal Beverages and Fruit Beverages are the most popular categories in Sri Lankan functional beverage market. Under these categories Drinking Yogurt, Soy Milk, Black Tea, Green Tea, Coffee, Herbal Infusion, and Fresh Fruit Juices (Ready to drink) are the most popular beverages among consumers respectively.

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In that sense, these product categories can be considered as the best carriers that can be developed into functional beverages.

Even though the global market for functional beverages is remarkably at a high level with expanding trend, the market share for healthy drinks including functional beverages in Sri Lanka is existing yet in infancy. A better understanding of consumers' awareness, consumption, and purchasing behavior are key factors for the market success of functional beverages in Sri Lanka.

This research is aiming at finding the knowledge and awareness, consumption and purchasing behavior, among consumers in the Asgiriya area in Gampaha District, Sri Lanka between the age span from 20 to 49 on healthy functional beverages with particular reference to Drinking Yoghurt, Soy Milk, Black Tea, Green Tea, Coffee, Herbal Infusion and Fresh Fruit Juices (Ready to drink). These indications may contribute to innovative product development and marketing decisions to maximize the satisfaction of health-conscious consumers. As specific objectives of this research is aiming to identify the most popular functional beverage among Sri Lankan consumers and the intentions of consumption of functional beverages, as well the basics and stimulus for purchasing functional beverages, and the relationship between socio-demographic factors which affect for consumption and purchasing behavior of functional beverages.

1.1 BACKGROUND STUDY/ REVIEW OF LITERATURE

1.1.1 FUNCTIONAL FOODS AND BEVERAGES

Functional food (FF) influences specific functions of the organism, may provide (beyond basic nutrition) additional health benefits or remedy some diseases following the addition/concentration of a beneficial ingredient, or removal substitution of an ineffective or harmful ingredient (Gautam et al., 2018). FF is also defined as food products possessing the appearance of traditional food and included in the daily diet. These products provide physiological benefits and or can reduce the risk of noncommunicable diseases. According to EU documents if it can be proven that a food product affects one or more target functions in the body in a positive way, this food product is regarded as a functional food, (Çakiroğlu and Uçar,2018)

Functional beverages are a segment in the functional food industry that is comparatively easier to process, handle, and incorporate bioactive compounds. Beverages are a "go and grab product" and attractconsumers'demand.

1.1.2 FUNCTIONAL FOOD AWARENESS AND PERCEPTION

Urala et al. (2011) stated that the concept of functional foods is vague for U.S. consumers in the United States. They are not familiar with the term, do not know what products can be considered functional foods and health benefits do not seem to affect their food choices. In addition, consumers do not trust manufacturers, food retailers, or the media in functional food-related information. Clear and understandable communication from independent authorities and nutrition specialists may be the best way to make the term familiar and reliable.

Vella et al, (2014) study invested that consumers, the awareness and perceptions of older adults concerning functional foods are of particular interest, as this population could greatly benefit from the incorporation of functional foods into their diets.

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1.1.3 FUNCTIONAL FOOD CONSUMPTION AND PURCHASING BEHAVIOR

Studies in the literature showed that demand for consumption of functional foods is affected by demographic variables such as age, gender and education can be classified as micro factors. Moreover, traditions, cultural heritage, and economic factors which affect the consumption rate of functional foods can be grouped as macro factors. Macro and micro factors emerged as potential determinants for consumer acceptance of functional foods (Verbeke, 2005).

1.1.4 INTENTIONS OF PURCHASING FUNCTIONAL BEVERAGES/FOOD

Consumers may consume functional food if such food is perceived as healthy. For example, Rezai et al. (2014) found that consumers who perceived greater benefits from functional foods (e.g. reducing the risk of health problems, improving skin conditions, providing daily nutrition) were more accepting of functional foods.

1.1.5 BASICS AND STIMULUS OF FUNCTIONAL BEVERAGES

The reviewed studies indicated that product characteristics (e.g. the combination of carriers and ingredients, price, taste, brand, and health information) can influence consumer acceptance of functional foods.

2. METHODOLOGY

Asgiriya area in Gampaha District which including four Grama Niladhari Devisions (Asgiriya, Agiriya West, Asgiriya South, Asgiriya North) was selected as the study area. The target population was males and females, in the span of age between the age of 20 to 49, who are consumers of functional beverages. The total population (2720) was obtained from the Department of Census and Statistics. 200 people were selected as per the sample size at the confidence level of 85%, Margin of Error of 5%, and Population Proportion of 50%.

2.1 QUESTIONNAIRE PREPARATION AND SAMPLING METHOD

Google form questionnaire was pre tested using 15 people. It was developed with fourteen questions to evaluate consumers' awareness, consumption and purchasing behavior of functional beverages. The study adopted the snowball-sampling technique which included in the Non probability sampling method.

2.2 DATA COLLECTION AND DATA ANALYSIS

The online survey was conducted within a week (16 of March 2022 to 23 of March 2022). The survey link was circulated via email and social media e.g., Whatsapp, Facebook, Viber, Gmail. The survey results were downloaded for analysis in SPSS 26 (Statistics Package for Social Sciences). Descriptive statistics (percentages, frequencies) were measured.

The chi-square (($\chi 2$) test was used to analyze the relationship between separate variables and the respondents' socio-demographic features. Statistical significance for all tests was set at a p-value of 0.05.

3. RESULTS AND DISCUSSION

The cross-sectional survey results related to socio-demographic characteristics of the survey participants, consumer awareness, consumption, purchasing behavior, opinions related to functional beverages, and the relationship between socio-demographic factors and functional beverages consumption behavior and purchasing behavior were evaluated respectively.

3.1 SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE SURVEY PARTICIPANTS

Table 1: Socio-Deographic Characteristics of the Participants

Variable	Answer Options	Frequency	Valid Percent (%)
Gender	Male	52	26
	Female	148	74
Age	20-29	114	57
	30-39	72	36
	40-49	14	7
Martial Status	Married	102	51
	Unmarried	98	49
Highest Education	GCE O/L Passed	1	0.5
	GCE A/L Passed	30	15
	Undergraduate	42	21
	Graduate or above	126	63
	Other	1	0.5
Household income	Below 30 000	8	4.0
	30 000 – 50 000	50	25
	50 000 – 75 000	44	22
	75 000 – 100 000	33	16.5
	Above 100 000	65	32.5
Household composition	Single person household	7	3.5
	Living with parents	105	52.5
	Married with children	36	18.0
	Married without children	42	21.0
	Extended family	10	5.0
Employment status	Government Sector	92	46.0
	Private Sector	80	40.0
	Student	14	7.0
	Unemployed	12	6.0
	Other	2	1.0

3.2 AWARENESS OF FUNCTIONAL BEVERAGES
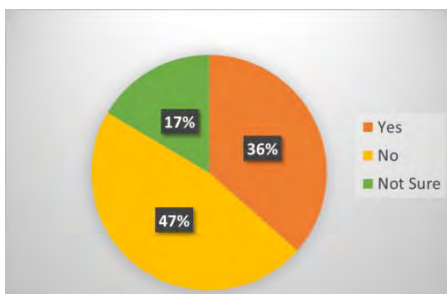
Figure 1: Percentages of the respondents who have heard the term "functional"
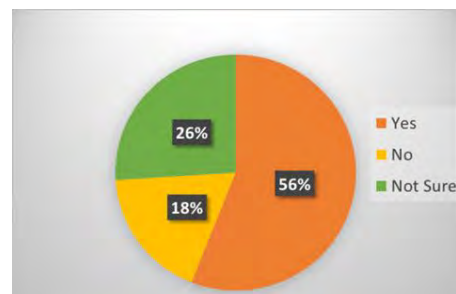
Figure 2: Percentages of the respondents who have thought that consuming of beverages has any medicinal properties other than nutritional properties

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3.3 CONSUMPTION OF FUNCTIONAL BEVERAGES

Table 2: Percentages of Respondents Regarding Awareness of Functional Beverages

Functional Beverages Question no 03 & 04		Fermented Milk Beverages (Drinking Yogurt)	Soy Milk	Black Tea	Green Tea	Herbal Infusion	Coffee	Fresh Fruit Juice (RTD)
Considered as being a functional food %	Yes	72.5	50.0	78.5	80.5	58.0	67.5	67.5
	No	10	17.0	9.0	7.5	18.0	15.0	15.0
	Not Sure	17.5	33.0	12.5	12.0	24.0	27.5	17.5
Awareness of its benefits	Correct answers %	55.0	24	40	46	40	34.5	45.5

Table 3: Percentages of Respondents Regarding Consumption of Functional Beverages

Functional Beverages Frequency of Consumption	Fermented Milk Beverages (Drinking Yogurt)	Soy Milk	Black Tea	Green Tea	Herbal Infusion	Coffee	Fresh Fruit Juice (RTD)
Daily	18.5	1.5	41.5	17.5	8.0	14.5	14.5
Weekly	28.0	9.5	11.0	12.0	25.0	30.5	34.0
Monthly	8.5	15.0	5.0	8.5	17.5	10.0	11.5
Frequently	12.5	15.0	12.5	8.5	14.5	12.5	20.5
Occasionally	29.0	16.0	9.0	17.5	16.5	18.5	15.0
Rarely	10.0	28.5	10.5	22.5	14.0	12.5	3.5
Never	7	14.5	10.5	13.5	4.5	1.5	1.0
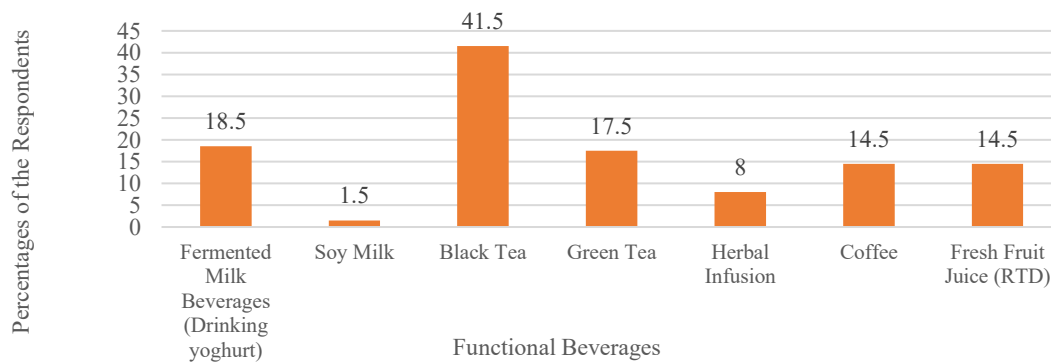
Figure 3: Percentages of Respondents of Daily Functional Beverage Consumers

3.4 PURCHASING BEHAVIOR OF FUNCTIONAL BEVERAGES

Table 4: Percentages of the Respondents Regarding the Frequency of Purchasing Functional Beverages

Functional Beverages Frequency of Purchasing	Fermented Milk Beverages (Drinking Yoghurt)	Soy Milk	Black Tea	Green Tea	Herbal Infusion	Coffee	Fresh Fruit Juice (RTD)
Every Week	28.0	3.5	16.0	9.0	11.0	12.5	24.5
Every Two Weeks	17.5	8.0	17.0	7.5	11.0	13.0	25.5
Once a month	17.0	14.0	29.5	23.0	25.5	30.0	14.0
Less than once a month	5.0	16.0	10.5	7.0	10.5	15.5	9.5
Occasionally	20.5	14.0	7.0	15.0	20.0	15.5	19.5
Rarely	9.5	25.5	8.5	20.5	17.5	11.5	6.5
Never	2.5	19.0	11.5	18.0	4.5	2.0	0.5

3.5 PURCHASING INTENTIONS OF THE FUNCTIONAL BEVERAGES
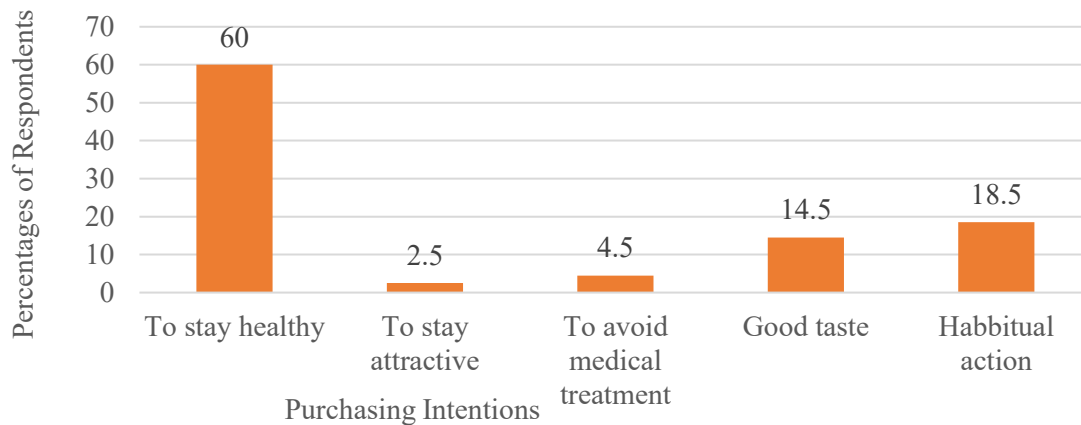
Figure 4: Percentages of Respondents Regarding Purchasing Intentions of Functional Beverages

3.6 FUNCTIONAL BEVERAGES BUYING PLACES

Figure 5: Percentages of Respondents of Purchasing Functional Beverages from Different Marketplaces

3.7 BASICS AND STIMULUS FOR PURCHASING FUNCTIONAL BEVERAGES

Table 5: Percentages of Respondents Regarding the Importance of the Stimulus for Purchasing Functional Beverages

Stimulus Importance	Price	Brand	Sensory Properties	Packaging/ Quantity	Availability	Health Benefits
Very Important	40.0	41.0	37.0	31.5	29.5	62.0
Important	46.0	45.5	45.5	48.0	54.5	31.5
Neutral	10.0	7.0	12.5	19.0	15.5	6.0
Less Important	2.5	5.5	4.5	1.5	0.5	0.5
Not Important	1.5	1.0	0.5	0.0	0.0	0.0

3.8 PRECONDITIONS OF PURCHASING FUNCTIONAL BEVERAGES
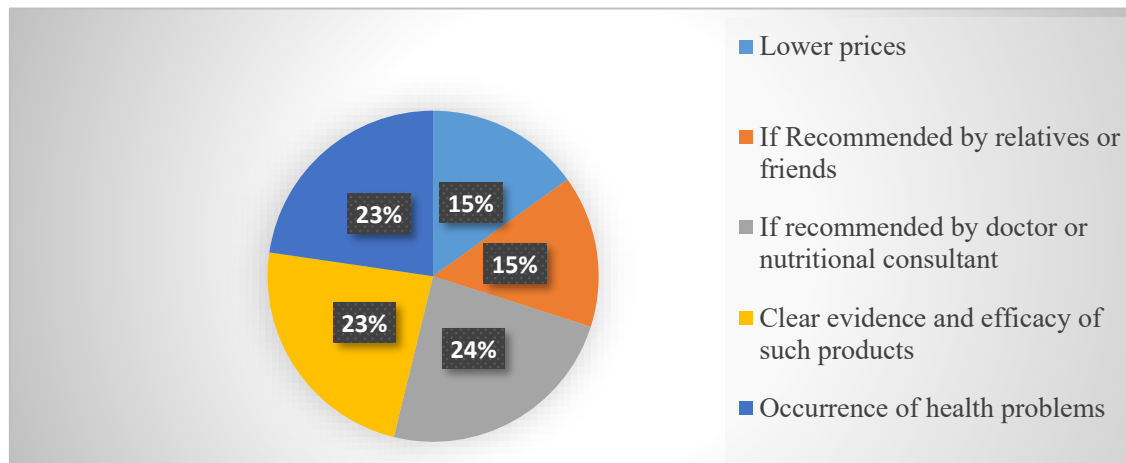
Figure **6**: Percentages of Respondents Regarding Preconditions of Purchasing Functional Beverages

3.9 OPINIONS REGARDING THE STIMULUS AND BASICS OF THE FUNCTIONAL BEVERAGES

It was identified that 63% of respondents were satisfied with the present market prices of functional beverages and the other 37 % were not satisfied with it. It was identified that 92.5% of respondents were thinking that consuming functional beverages give health benefits to the body

3.10 NEW FUNCTIONAL BEVERAGES TRENDS FOR SRI LANKAN MARKET

According to the present survey as new functional beverages, some respondents have indicated that meal replacement drinks (Porridges, Soups, Fruits and Vegetable drinks, etc) King coconut water drinks, Natural and healthy indigenous beverages, and Smart water drinks products with adding minerals.

3.11 RELATIONSHIP BETWEEN SOCIO-DEMOGRAPHIC FACTORS AND CONSUMPTION OF FUNCTIONAL BEVERAGES

It was identified that there was a significant difference between Age and Consumption of FMB, Age and Consumption of FFJuice, Highest E/L and Consumption of FMB, and Highest E/L and Consumption of coffee.

3.12 Relationship Between Socio-Demographic Factors And Purchasing Behavior Of Functional Beverages

It was identified that there was a significant difference between Purchasing FMB and Age**,** Purchasing FMB and the Highest E/L, and Purchasing coffee and the Highest E/L.

4. Conclusion(s)/ Implications/ Recommendations & Limitations

A lack of knowledge regarding functional food concept was noticed. From this point of view, it is important to educate consumers about the health benefits of functional products or functional ingredients and to encourage the consumption of functional foods through ethical and informative marketing. According to the present survey considering the daily consumption black tea was the most frequently consumed functional beverage by the respondents. The frequency of purchasing of short shelf life beverages (Drinking Yoghurt , Fresh Fruit Juices) are high among the respondents compared with long shelf life products such as Black Tea ,Green Tea , Herbal Infusion and Coffee.Most of the respondents purchased functional beverages to stay healthy and purchased from Supermarkets.Respondents were giving the priority as the basics and stimulus when purchasing functional beverages (Very Important) to the health benefits .According to the present study has shown that sociodemographic characteristics such as age, level of education and also health benefits, brand , prices are important factors which influence consumers decision to buy and/or consume functional beverages. The present survey indicated that consumers have been positive attitude reagrding the functional beverages. Respondents have recommended that meal replacement drinks (Porridges, Soups, Fruits and Vegetable drinks, etc) King coconut water drinks, Natural and healthy indigenous beverages, and Smart water drinks products with adding minerals have potential demand as new functional beverages among Sri Lankan consumers. These findings disclosed that functional foods/beverages generate one of the most promising and rapidly developing segments of the future food industry in Sri Lanka, requiring at the same time scientifically sound evidences of their health promoting benefits. As limitations of this study was valid for the urban consumers because the selected location belongs to the urban area. Therefore this scenario may be differ comparatively sub urban and rural areas.

References

Agriculture Innovations and Research, *7(1).*

Ares, G., Giménez, A. and Deliza, R., 2010. Influence of three non-sensory factors on consumer choice of functional yogurts over regular ones. *Food Quality and Preference, 21(4),* pp.361-367.

Bahorun, T., Luximon-Ramma, A., Neergheen-Bhujun, V., Gunness, T., Googoolye, K., Auger, C., Crozier, A. and Aruoma, O., 2012. The effect of black tea on risk factors of cardiovascular disease in a normal population. *Preventive Medicine*, *54*, pp. S98-S102.

Çakiroğlu, F. P. and Uçar, A. (2018) "Consumer attitudes towards purchasing functional products", *Progress in Nutrition*, *20(2)*, pp. 257–262. doi: 10.23751/pn.v20i2.5859.

Dagevos, H., 2005. Consumers as four-faced creatures. Looking at food consumption from the perspective of contemporary consumers. *Appetite, 45(1),* pp.32-39.

Functional food products. EurAsia J. BioSci, pp.6365–6369

Gardner, E., Ruxton, C. and Leeds, A., 2006. Black tea – helpful or harmful? A review of the evidence.

European Journal of Clinical Nutrition, *61(1),* pp.3-18.

Gautam, R., Maurya, K., Raj, M., Singh, R., Maurya, R., Mehetha, R., Kumar, S., Kumar, S. and Verma, S., (2018). Consumer Behavior Towards Functional Food in Eastern UP - A Study of Market Drivers & Challenges.

Küster-Boluda, I. and Vidal-Capilla, I., 2017. Consumer attitudes in the election of functional foods. *Spanish Journal of Marketing - ESIC, 21*, pp.65-79.

Markosyan, A., McCluskey, J. and Wahl, T., 2009. Consumer Response to Information about a Functional Food Product: Apples Enriched with Antioxidants. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie, 57(3),* pp.325-341.

Nayga, R. and Capps, O., 1999. US consumers' perceptions of the importance of following the US dietary guidelines. *Food Policy, 24(5),* pp.553-564.

Niva, M. and Mäkelä, J., 2007. Finns and functional foods: socio-demographics, health efforts, notions of technology and the acceptability of health-promoting foods. *International Journal of Consumer Studies, 31(1).*

Rezai, G., Kit Teng, P., Mohamed, Z. and Shamsudin, M., 2014. Structural Equation Modeling of Consumer Purchase Intention Toward Synthetic Functional Foods. *Journal of Food Products Marketing, 20(1),* pp.13-34.

Siegrist, M., Stampfli, N. and Kastenholz, H., 2008. Consumers' willingness to buy functional foods. The influence of carrier, benefit and trust. *Appetite, 51(3),* pp.526-529.

The Food Institute. 2022. *The Food Institute.* [online] Available at: <http://www.foodinstitute.com> [Accessed 25 April 2022].

Urala, N., Schutz, H. and Spinks, J., 2011. Consumer Perceptions of "Functional Food" in the United States. *Journal of Food Products Marketing, 17(4),* pp.407-419.

Verbeke, W., 2005. Consumer acceptance of functional foods: socio-demographic, cognitive and attitudinal determinants. *Food Quality and Preference, 16(1),* pp.45-57.

Xin, L. and Seo, S., 2019. The role of consumer ethnocentrism, country image, and subjective knowledge in predicting intention to purchase imported functional foods. *British Food Journal, 122(2*), pp.448-464.

INNOVATIONS IN MANUFACTURING TECHNOLOGY AND ENERGY EFFICIENCY

CHANGE OF METALLURGICAL AND MECHANICAL PROPERTIES OF CARBON STEEL WITH HOLDING TIME AND HOLDING TEMPERATURE OF THE TEMPERING PROCESS

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ABSTRACT

Plain carbon steel (PCS) is a highly consumed universal engineering metal, and it is mainly used in sectors that require mainly strength characteristics. It is easily amenable to heat treatments while displaying superior mechanical and fabrication properties. Properties of PCS can be altered with heat treatments, and hardening followed by tempering is the main heat treatment applied for PCS. The objectives were to analyse the pattern of change of mechanical and metallurgical properties of 0.45C medium carbon steel with the change of holding time at different tempering temperatures. Four sets of specimens of the given steel were used, and each set was assigned a particular tempering temperature. Similar holding times assigned for all sets were 1.00, 1.25, 1.50, 1.45, and 2.00 hours. Selected heating temperatures were 250 ^0C, 350 ^0C, 450 ^0C, and 550 ^0C. Change in grain size was also observed for a few specimens, tempered at different holding times, and for different tempering temperatures. Almost similar-shaped four plots of hardness versus holding time were developed for different temperatures. However, the determination of the actual curvature needs precise analysis, with more test cases. The observed average grain size variation also agrees with the hardness versus holding time plots.

Keywords: Grain Size; Hardness; HoldingTtime; Plain Carbon Steel; Tempering Temperature.

1. INTRODUCTION

Plain carbon steel is the most widely used category of engineering metals, universally. Iron carbon alloys containing up to 2% carbon are called carbon steels. In addition to carbon, carbon steels generally contain small amounts of sulphur, phosperous, silicon, and manganese. However, their role is insignificant in determining the properties of plain carbon steels.

Although the number of steel specifications runs into thousand, plain carbon steel accounts for more than 90% of the total steel output. The main reason for its importance is its strength, toughness, ductility, and cheapness. It is a material with reasonable casting, forming, and machining characteristics, and it is amenable to heat treatments to produce a wide range of properties.

The amount of carbon in steels has a profound effect on the structure, and thus properties of steels. With the increase of carbon content, carbon steel increases strength and hardness and decreases ductility and impact strength. Based on carbon content, plain carbon steels can be classified as low carbon steels with carbon in between 0.08% and 0.35%, medium carbon steels with carbon in between 0.35% and 0.6%, and high carbon steels with carbon in between 0.6% and 1.5% (Pakirappa, 2004, pp. 132-157).

Among the main heat treatments carried out for carbon steels, hardening is the main heat treatment applied for medium and high carbon steels. Hardening is applied to cutting tools and machine parts, where high hardness and wear resistance are important. Hardened steels are highly brittle so a slight impact will cause

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them to fracture. Toughness of such steel is improved by secondary heat treatment of tempering. However, with this treatment, there can be a slight reduction in strength and hardness. The main purposes of hardening followed by tempering are to reduce extreme brittleness, improve toughness and remove internal induced stresses (Pakirappa, 2004, pp. 132-157).

Tempering consists of reheating hardened steel to a temperature below the lower critical temperature, holding it at that temperature for a period of time, and then slowly cooling it in the air to room temperature. At the tempering temperature, carbon atoms diffuse out and form fine cementite and soft ferrite structure. Thus, the structure of tempered steel consists of ferrite and cementite (Pakirappa, 2004, pp. 132-157). Several studies are found in the literature based on hardening followed by tempering heat treatments. The found studies indicate that the rise of holding time and tempering temperature generally causes a reduction in the hardness of carbon steel. However, non of them describes the pattern of variation of the property.

The objectives of the study are focused on demarcating the pattern of variation of the hardness with the change of holding time, and developing a set of data for scheduling the tempering procedure, for obtaining the required hardness of the given medium carbon (0.45%C) steel, and also comparing approximate grain sizes as change with holding time and tempering temperatures.

1.1 REVIEW OF LITERATURE

One study (Tukur et al, 2014) explains that hardness, yield strength, and tensile strength decrease with the increase in temperature of tempering. However, ductility initially decreases until 450 ^{0}C, and then increases, while the temperature of tempering increases. To get well-balanced mechanical properties, the best temperature of tempering was observed to be 250^{0}C.

Cai (2018) has made a few observations based on his study on the tempering process of AISI4140 steels. It was noted that with the increase of tempering temperature, peaks of tempered martensite (ferrite) are sharpened and the carbon content in tempered martensite decreases with the precipitation of the carbides. It was also observed that carbide size increases when the tempering temperature increases and carbide size decreases as the heating rate increases. Further, he observed carbides with two different shapes; needle shape carbides which are precipitated along low-angle boundaries, and disc-shaped carbides which are precipitated along high-angle boundaries.

Another similar study was conducted (Purwanto et al, 2019) to analyse the effects of varying the tempering temperature on the mechanical properties of steel plates, which had been surface hardened by induction heating and quenched in oil. The utilised tempering temperatures were 100°C, 200°C, 300°C and 400°C. The hardness of the tempered samples was observed to be decreased with increasing the tempering temperature. However, the tensile strength was increased at lower temperatures.

A previous similar study (Mohamed et al, 2013, pp. 81-85) had also revealed that the increase of tempering temperature of medium and high carbon steel causes a gradual decrease in both, the ultimate tensile strength and the hardness and an improvement of ductility.

Orhorhoro et al (2018) conducted a study by varying the cooling rates of the tempering process of a low-carbon steel. The cooling rate was changed by putting the test specimens heated to 700^0C, into different cooling mediums of water, oil and brine. The study findings revealed that the brine-tempered specimen shows the lowest corrosion behavior and the least weight loss, followed by the untreated reference specimen, oil –tempered and water-tempered specimens.

2. METHODOLOGY

The used material was a 0.45 % carbon steel. When bought, it was a bar with a 01.00" diameter. Its spectrometric analysis indicated the composition mentioned in Table 1.

Table 1: Composition of the Steel

Element	Percentage by weight
Carbon (C)	0.45
Manganese (Mn)	0.71
Silicon (Si)	0.30
Ferrous (Fe)	Balance

The steel bar was cut into 22 number of specimens, with 01.00 cm thickness in each, using a lathe machine.

2.1 HEAT TREATMENT

Except for one specimen, others were subjected to a hardening heat treatment, under the same conditions. Heat treatments were conducted using a programmable furnace. Heating temperature was 850^0C, and the heating rate was approximately 6.83^0C. Soaking time of the hardening treatment was set to 35 minutes. Cooling medium was water, maintained at 70^0C. After cooling to room temperature, except for one hardened specimen, the other 20 specimens were divided into four different sets, specifying a tempering temperature for each set. Each specimen in each set was assigned a specific holding time. The assigned tempering temperature and the holding time for each specimen are indicated in Table 2.

Table 2: Specified Tempering Temperatures and Tempering/Holding Time Periods

Sample set number	Tempering temperature (^{0}C)	Specimen number	Holding time (hrs) in the selected temperature
1	250	1	1.00
		2	1.25
		3	1.50
		4	1.75
		5	2.00
2	350	1	1.00
		2	1.25
		3	1.50
		4	1.75
		5	2.00

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3	450	1	1.00
		2	1.25
		3	1.50
		4	1.75
		5	2.00
4	550	1	1.00
		2	1.25
		3	1.50
		4	1.75
		5	2.00

2.2 *HARDNESS MEASUREMENT*

After heat treatments, the hardness of all test specimens was measured using a Vickers hardness tester. Hardness test results were recorded by averaging three test readings of each test piece.

2.3 *MICROSTRUCTURE OBSERVATION*

After hardness measurement, five specimens were prepared for microstructure observation. Surface preparation was done for two test specimens with two different holding times of one hour and two hours, from each tempering temperature of 250^0C and 450^0C, and for the untreated specimen. One flat end of each test specimen was ground with a set of successively finer-grade emery papers. Nest, the five test specimens were polished with a rotary polisher having a diamond lapping compound (3 microns) on it. The polished surfaces were etched with Nital (10 % HNO_3) etchant. Microstructure of the all five polished specimens was observed under 500 magnification, using a metallurgical microscope.

3. RESULTS

3.1. *HARDNESS MEASUREMENT*

The average hardness for different holding time periods at different tempering temperatures are shown in Figure 1.
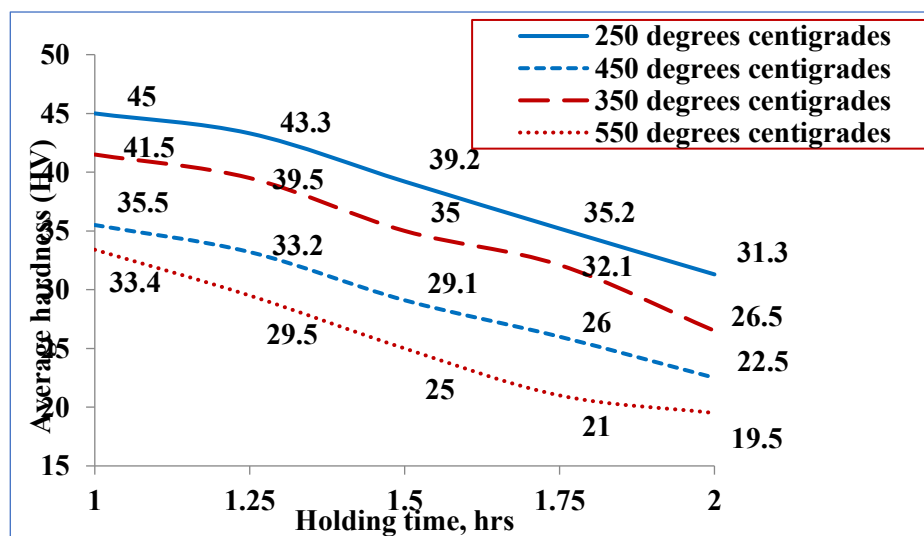
Figure 1: Average Hardness (HV) Versus Holding Time (Hours) for Different Tempering Temperatures

3.2 MICROSTRUCTURE OBSERVATION

The obtained microstructures of the heat treated and the non-treated specimens are shown in the Figure 2 and Figure 3, respectively.

(a)1	(a) 2
(b) 1	(b)2
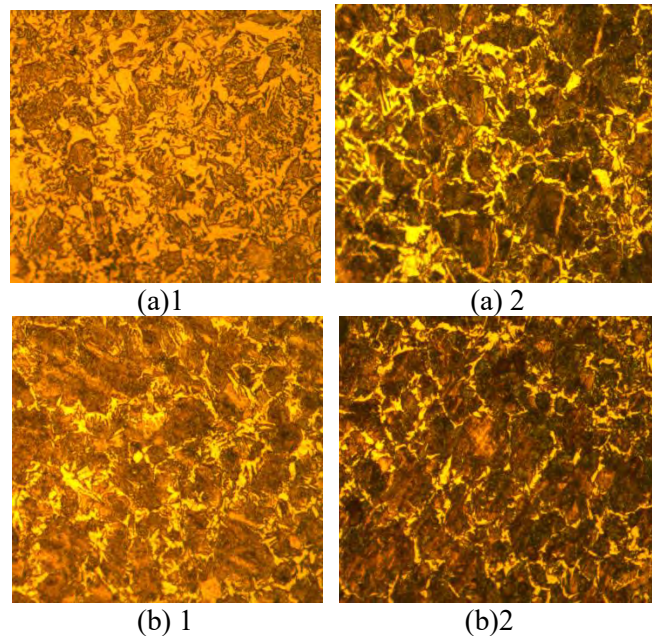
Figure 2: Microstructure of the Hardened and Tempered PCS Test Specimens (X500), by Changing the Holding Time: (a) For One Hour: (1) At 250^{0}C (2) At 450^{0}C (b) For Two Hours: (1) At 250^{0}C (2) At 450^{0}C
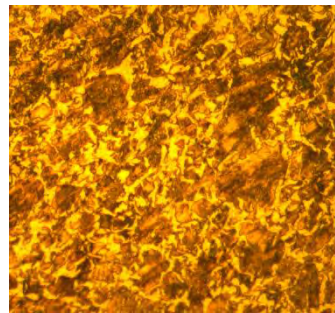
Figure 3: Microstructure of the Non-Heat-Treated Specimen (X500)

4. DISCUSSION

According to both, the test results and the review of the literature, the following assumptions can be made. A decrease in hardness is observed with the increase in the holding time (at all test temperatures). Additionally, average grain size is observed to be increased, as with both, tempering temperature and holding time.

According to the correlations found in the literature, strength and hardness are directly proportional to each other, while strength and ductility are inversely proportional. This relationship enables to plan of the heat treatments as per the required strength and plasticity properties also.

Additionally, according to another correlation, as grain size increases, hardness and strength (both yield strength and ultimate tensile strength) decrease, and vice versa. Thus, the observed microstructure details emphasise the results shown with the hardness.

When specimens are heated to a temperature of 850^0C and held for 35 minutes at that temperature, and then quenched rapidly in water, phase transformation of steel is taken place. Then the crystal structure of the steel changes immediately from face-centered cubic (FCC) (γ phase) to body-centered tetragonal (BCT) martensite. In martensite, the carbon dependence of hardness is attributed to carbon atoms, trapped in the octahedral interstitial sites of martensite crystal structure. Thus, high hardness correlates with high resistance to dislocation and slip formation.

As the temperature of hardened steel is raised for tempering, the mobility of atoms is increased and the phase tends to pass into a stable and equilibrium state. When this transformation takes place, both temperature and time are variables. During tempering, martensite decomposes into a mixture of ferrite and cementite, with a decrease in the volume of martensite platelets. As tempering temperature or holding time increases, the structure changes its physical and mechanical properties.

When the specimens are tempered at a lower temperature around $250\,^0$C, precipitation of hexagonal closed-packed (HCP) carbide (epsilon carbide) occurs due to a decrease of the tetragonality of martensite. The crystal structure of martensite transforms finally to body-centered cubic (BCC) of ferrite, from body-centered tetragonal (BCT) structure. With the increase of tempering time, dendritic carbide (orthorhombic Fe_3C) also forms at 250^0C.

Further increase in tempering temperature and tempering time causes to form sorbite structure, with finely divided cementite and ferrite structure, which brings lower hardness and strength with higher ductility.

The developed plots of hardness versus holding time at different tempering temperatures generally predict the reduction of the hardness property as with the increase of holding time, though the apparently observed shape of each curve is somewhat different to others, corresponding to different test temperatures.

Since the sample preparation for microstructure observation consumes more time, this examination was limited to few specimens, at two different tempering temperatures for two different holding time periods of one hour and two hours. The observed microstructures (at 500 magnification) clearly compares the average grain size, as with the change of the tempering temperature. Comparison of average grain size with regard to the change of holding time is sufficient for the observations made at 250^0C; however the developed structures are not much comparable for the observations made at 450^0C.

5. Conclusions and Recommendations

5. 1 Conclusions

For plain carbon steels, for a particular tempering temperature, as the holding time increases, hardness decreases. The developed plots of hardness versus holding time indicate approximately similar shapes, However, more data with more test cases are necessary to predict the real shape of the curves.

The obtained hardness versus holding time plots can be used to decide a preferable tempering schedule, for obtaining the required hardness of the given steel.

Microstructure observation agrees with the observed variation of hardness, as per the change of holding time and tempering temperature.

5.2 RECOMMENDATIONS

To get more precise results, more samples need to be tested repeatedly, in each tempering temperature, keeping the holding time gap between any two consecutive samples smaller (approximately five minutes). This will be more helpful to decide the pattern of change of the property (hardness), while holding time increases, at a given tempering temperature.

Also, the approximate grain size of these cases may be tabulated at different magnifications, enabling us to easily predict the approximate grain size, at different tempering temperatures, and for different holding times.

REFERENCES

Purwanto, H., Muhammad, D., Mohammad, T., Rifky, I., Nyoto, L. (2019), The effect of tempering temperature on medium carbon steel plate of surface hardening result using induction heating as ballistic resistant material study, *IOP Conf. Series: Materials Science and Engineering,* p. 694. Available from: Doi:10.1088/1757-899X/694/1/012041. [Accessed: 20 July 2022].

Orhorhoro, E.K., Erameh, A.A., Adingwupu, A.C., (2018), Evaluation of the effect of tempering on the corrosion susceptibility of low carbon steel in sea water, *Nigerian Research Journal of Engineering and Environmental Sciences,* 3(1), pp. 409-415.

Cai, X. (2018), Mechanical properties development in AISI 4140 steels during furnace and induction tempering, PhD thesis proposal, Worcester Polytechnic Institute.

Tukur, S.A., Usman, M.M., Muhammad, I., (2014), Effect of tempering temperature on mechanical properties of medium carbon steel, *International Journal of Engineering Trends and Technology, 9(15).*

Mohamed, A.G., Aldlemey, M.S., Abdessalam, F.K. (2013), Effect of tempering on mechanical properties and corrosion rate of medium and high carbon steel, *Advanced Materials Research, 685* pp. 81-85. Available from: Doi:10.4028/www.scientific.net/AMR.685.81. [Accessed: 22 August 2022].

Pakirappa: Heat treatment, in Metallurgy and Material Science. *Premier Publishing House, 2004, 2nd edn.*, pp. 132-157.

OPTIMISING TECHNICAL PROPERTIES OF CONCRETE BRICKS WITH RAW PADDY HUSK AS A REINFORCEMENT MATERIAL

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ABSTRACT

Concrete bricks are an integral part of the buildings and construction industry. However, nowadays, the fast increase in their prices has been an issue for consumers to survive. The main objective of the study was to produce lightweight concrete bricks with raw paddy husk (RPH) as a reinforcing material, according to the Sri Lankan concrete mix design. Production of low-cost concrete bricks is another objective. Furthermore, the environmental threats due to industrial wastes have now been greatly exacerbated. This study was designed considering solutions for this factor also. Seven sets of concrete bricks, with five bricks in each set were produced. In the study, visual appearance, density, percentage of water absorption, and compressive strength were tested for the bricks prepared by replacing concrete-brick mixture with 0, 10, 20, 30, 40, 50, and 60 by volume of RPH, in each set. The maximum percentage of RPH was revealed to be 30% by volume of RPH, by optimizing all concerned Properties and the cost.

Keywords: *Compressive Strength, Concrete Bricks, Density, Paddy Husk, Water Absorption.*

1. INTRODUCTION

Concrete brick is a hardened mixture of Portland cement, stone aggregate, sand, and water, according to the Sri Lankan context. Today, most of these concrete bricks are used in the construction industry. However, these concrete bricks are highly expensive. Also, the high demand for these bricks in the construction industry has reduced natural resources, such as stone, sand, and apatite deposits. Because of this, environmental damages such as the decay of riversides also occur. This creates an environmental imbalance. Aiming to reduce all these problems, it was decided to make concrete bricks using RPH as additional reinforcing material. This facilitates the production of lightweight bricks, making construction work easy. Additionally, this saves the cost of raw materials, also. Furthermore, this will be an environmentally friendly project, since the additionally involved material is biodegradable, agricultural waste.

The silicious content of paddy husk is resistant to the natural degradation of the constituent, which may lead to a large environmental load, emphasizing the requirement for alternative disposal methods. Due to interconnected porosity, concrete bricks produced by mixing concrete-brick mixture and agricultural wastes would be superior bricks, in terms of their lightweight.

Several studies have been conducted using RPH as a reinforcing material in concrete bricks. Each study has been planned according to the mixing schedules available in each region/country. Further, specific mix designs have been displayed in each study; replacing RPH with the filler, using specific ratios of certain ingredients, replacing RPH with a portion of the main concrete-brick mixture, and measuring added ingredients according to weight percentage or volume percentage are some of the variations that have been observed. Certain studies have used different sizes of RPH (ground RPH) while some others have used

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unground RPH. However, studies designed according to the Sri Lankan context of concrete bricks, with the unground RPH as a partial replacement of a normal concrete-brick mixture are rarely found in the literature.

The main objective of the study is to produce lightweight concrete bricks, while improving/preserving the essential physical and mechanical properties, using unground RPH as an added reinforcing material, according to the Sri Lankan concrete-brick mix design. Producing low-cost bricks, and reducing solid waste management issues together with the related carbon footprint values are the other objectives. The study employed partial replacement of the entire brick – mixture with RPH.

1.1 REVIEW OF LITERATURE

The literature describes several studies with RPH as additional material in concrete bricks. A summary of their findings is given below. In one recent study conducted in Indonesia by Winarno (2021), RPH has been used as a natural reinforcement for making lightweight concrete bricks. Portland cement and sand were used as the base ingredients and RPH was the only reinforcement. The mix contents were in a fixed volumetric ratio of cement 1.25 and sand 2.75 while changing the RPH dose from 8.5 to 10. It has been shown that, the higher the percentage of RPH, the lower the compressive strength and density. The study seeks improvements with increased cement and RPH contents and reduced sand contents, aiming to keep both density and compressive strength values within acceptable levels.

Winarno (2019) had previously conducted another study also, to check the possibility of RPH being used in concrete bricks. The study had planned to replace filler (sand) with RPH. A fixed ratio of ordinary Portland cement (OPC) to filler had been used by varying the ratio of OPC to RPH. The used sand has been a very fine aggregate, generated as a waste material from cutting stone blocks. According to this previous study, the optimum ratios of materials had been decided as OPC: Sand: RH to be 1: .63: 6, by volume. Compressive strength and percentage of water absorption were the concerned properties of this study.

Another recent study (Bassam A. et al., 2021) has presented the improved properties of paddy husk ash-added concrete. Density, workability, tensile strength, flexural strength, compressive strength, modulus of elasticity, and durability were the concerned properties of concrete. Technical results were verified with the microstructural analysis of test samples. Additionally, paddy husk ash has shown increased resistance to sulfate and acid attack.

According to a study conducted in Africa (Abdul et al., 2019), unburnt ground paddy husk has been used as an additive material in concrete made with water and cement only. OPC percentages of 0, 1.5, 2.5, 5.00, 7.5, and 10 in the original composition were replaced with a mixture of water and ground rice husk at a 0.5 volumetric ratio. According to test results, cement can be reduced up to 15% with unburnt ground paddy husk, without scarifying compressive strength requirements. However, an increase in paddy husk carries negative results, since increased water absorption results in durability issues of concretes.

Another recent study conducted by Eduardo et al. (2021) has sought to improve the mechanical, thermal, durability, and acoustic properties of concrete with the combined incorporation of paddy husk and straw.

2. METHODOLOGY

2.1 MATERIAL SELECTION

RPH, as in obtained form in dumping yards was used as a reinforcing material of concrete bricks. Ordinary Portland Cement (OPC) and river sand were used as the base raw materials.

Certain physical properties of used raw materials of OPC, river sand and RPH are given in Table 1, and a sample of used RPH is shown in Figure 1.

Table 1: Properties of Added Constituents

Constituent	Concerned Property	
RPH	Size	0.212-0.850 mm
	Bulk density	90–150 kg/m3
	Specific gravity	3.12
OPC	Grade	OPC – 43
	Specific gravity	3.05
	Fineness modulus	0.16
Sand	Size	Pan to 4.75 mm
	Specific gravity	2.67
	Fineness modulus	3.28

Figure 1: Raw Paddy Husk (RPH)

2.2 PREPARATION OF BRICKS FOR TESTING

The raw material was measured in percentage by volume. The percentage volume of each material used in different sets, for making bricks is given in Table 2.

Table 2: Percentage (by Volume) of Materials Used for Bricks

Set number	Percentage of cement	Percentage of sand	Percentage of RPH
1	20	80	0
2	18	72	10
3	16	64	20
4	14	56	30
5	12	48	40
6	10	40	50
7	08	32	60

The raw materials of cement and sand were mixed in 1:4 ratio, and water was added until a homogeneous mixture with sufficient plasticity was obtained. Then the allocated percentage volume of RPH was added and mixed. The wet mixture was filled into the mould and compacted with a flat end of a wooden bar. When the mould was compacted well and filled, the excess mixture was wiped off. The concrete bricks were then removed from the mould and placed in a shady area, allowing them to harden naturally. Water spraying was done twice per day, in the morning and evening, for seven days. Next, the concrete bricks were left to dry in the shade for another 21 days, before using for testing.

2.2.1 MOULD DESIGN

A combined wooden mould with five similar chambers (moulds) was fabricated to get the shape of the bricks. The dimensions of each chamber are 7.5 cm X 4.1 cm X 4.75 cm. The external dimensions of the wooden block are 43.5 cm X 6.1 cm X 4.75 cm. The design of the block was made using Solidworks software.

2.3 TESTING OF CONCRETE BRICKS FOR PHYSICAL PROPERTIES

2.3.1 VISUAL APPEARANCE

All of the prepared dried bricks were tested visually, to report any change in color and shape, in each brick.

2.3.2 DENSITY MEASUREMENT

The density of dried bricks was calculated, using the dimensions of the mould and the average weight of bricks of each composition. The following formula was used to calculate the density of concrete bricks.

$$P = \frac{M}{L \ X \ W \ X \ H}$$

(Eq:01)

Where,

P = Density of brick

M = Weight of brick, g

L = Length of brick, cm

W = Width of brick, cm

H = Height of brick, cm

2.3.3 WATER ABSORPTION TEST

Two bricks from each composition were used for the water absorption test. Since both, visual appearance inspection and density measurement are non-destructive tests, the same bricks used for the above two tests also could be used for this test.

First, the initial dry weight of each brick was measured. Next, each brick was completely immersed in water for 24 hours. Individual weight was measured immediately after each brick was taken out of the water. The following formula was used to calculate the percentage of water absorbed into bricks.

$$WA = \frac{W2 - W1}{W1} \times 100\% \tag{Eq:02}$$

Where,

WA = Percentage of water absorption

W1 = Weight of initial dried brick, g

W2 = Weight of brick with absorbed water, g

2.3.4 COMPRESSIVE STRENGTH MEASUREMENT

Three bricks from each composition were tested for compressive strength, using compressive strength testing machine (Model no. CT7comTest).

The following formula was used to calculate the compressive strength of bricks.

$$CS = \frac{W}{A} \tag{Eq:03}$$

Where,

CS = Compressive strength of brick, kN/m^2

W = Compressive load applied on brick, kN

A = Load applied surface area of brick, m^2

3. RESULTS AND DISCUSSION

3.1 RESULTS

3.1.1 VISUAL APPEARANCE

Compared to ordinary concrete bricks, almost all prepared bricks showed the same ash color. However, as the content of RPH increases, especially with 40% and higher contents of RPH, visual surface porosity increases, and surface evenness reduces. Additionally, surface covers with higher contents of RPH.

3.1.2 DENSITY MEASUREMENT

The density of the bricks prepared with different contents of RPH is given in Figure 2.
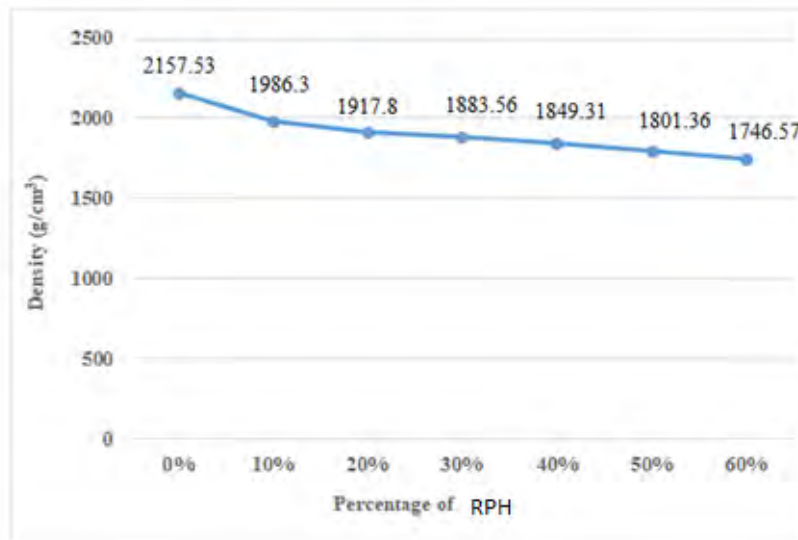
Figure 2: Density of the Bricks Prepared with Different Contents of RPH

3.1.3 WATER ABSORPTION TEST

Figure 3 shows the percentage of water absorption of the bricks prepared by varying RPH.
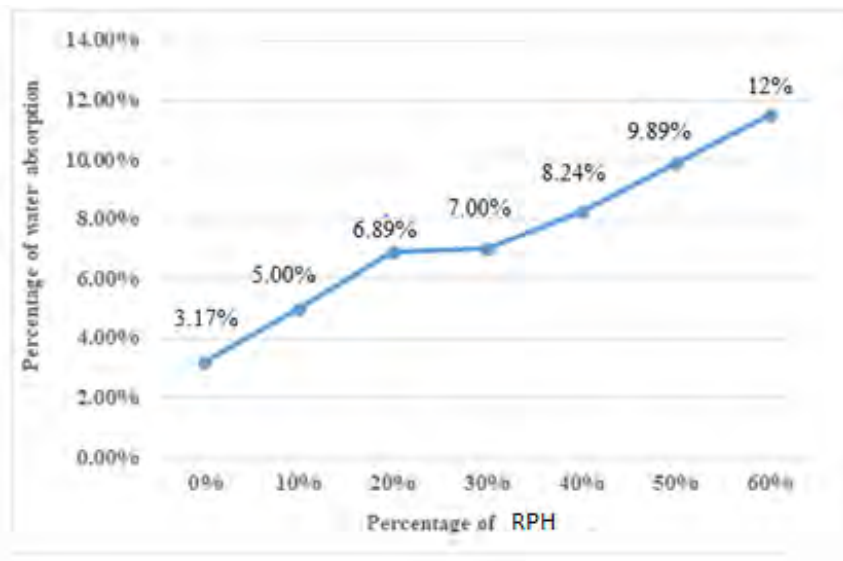
Figure 3: Percentage of Water Absorption for the Bricks Prepared with Different Contents of RPH

3.1.4 COMPRESSIVE STRENGTH MEASUREMENT

Figure 4 shows the compressive strength of the concrete bricks prepared by RPH.
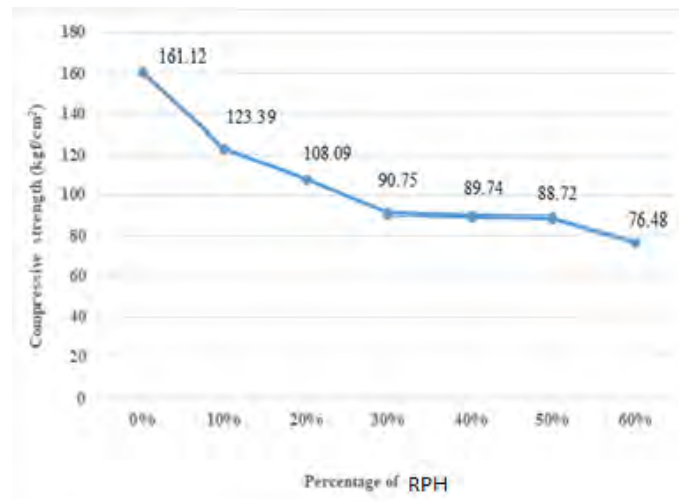
Figure 4: Compressive Strength of the Bricks Prepared with Different Contents of RPH

3.2 DISCUSSION

Concrete bricks were made by replacing RPH up to 60 % by volume. However, the composition of 70 % volume of RPH failed to prepare the bricks with stable dimensions. Due to lower cement content, the mixture was unable to form a hardened structure.

The test results indicate that, as the percentage of RPH increases, the density of bricks decreases, and the density value varies from, 2157.53 g/cm^3 for 0% of RPH to 1746.57 g/cm^3 for 60% of RPH. Water absorption of concrete bricks varies from 3.17% for 0% of RPH to 11.53% for 60% of RPH. Compressive strength varies from 161.12 kgf/cm^2 for 0% of RPH to 76.48 kgf/cm^2 for 60% of RPH.

According to the ISO (International Organisation for Standardisation) and other international standards, construction concrete bricks used for load-bearing work should have a density value above 1700 g/cm^3 (Alonso et al., 1990, p. 40). More international standards accept a higher value of percentage of water absorption, such as 40%, as the maximum allowable water content for concrete bricks (Alonso et al., 1990, p. 40). Generally, acceptable minimum compressive strength is above 35-40 kgf/cm^2 , only if the concrete brick is to be used for load bearing walls (Alonso et al., 1990, p.45).

With respect to the all concerned properties, RPH added concrete bricks can be used in all of the load-bearing structural work. However, none of the tested bricks may be recommended for light construction work, since the minimum average density obtained (1746.57 g/cm^3) is above the maximum allowable density of lightweight bricks (Alonso et al., 1990, p. 40).

Additionally, to verify the suitability of prolonged usage of these RPH-added concrete bricks, additional studies are needed, preferably to check the durability and thermal characteristics.

4. CONCLUSION

Aiming to reduce the weight and cost of construction, together with a positive contribution towards agricultural waste discarding issues, concrete bricks were made by replacing cement-sand concrete mixture with different percentages of RPH, as a reinforcement.

The physical properties of visual appearance, density, percentage of water absorption, and mechanical properties of compressive strength were tested during the study. The obtained test results are within the acceptable limits of ISO and more number of other international standards. With respect to the concerned properties, RPH up to 60% by volume can be used in concrete bricks, used in local structural construction work.

However, a more critical analysis has to be done to check the prolonged usage of the RPH-added concrete bricks, especially under critical environmental conditions.

REFERENCES

Winarno, S. (2021), Preliminary study on the hand-cast lightweight concrete block using raw rice husk as aggregate, *6th International Conference on Sustainable Built Environment*, p. 933. Available from: https://doi./10.1088/1755-1315/933/1/012005. [Accessed: 15 August 2022].

Bassam, A., Tayeha R.A., Hisham A., Abdulaziz A. (2021), Recycling of rice husk waste for a sustainable concrete: A critical review, *Journal of Cleaner Production*, p.312. Available from: https://doi.org/10.1016/j.jclepro.2021.127734. [Accessed: 15 June 2022].

Eduardo, C.P., Debora, B.S., Kassio, J.S., Ederli, M., Wang, C. (2021), Construction and Building Materials, Available from: https://doi.org/10.1016/j.conbuildmat.2021.122770. [Accessed: 20 August 2022].

Winarno, S. (2021), Comparative strength and cost of rice husk concrete block, *MATEC Web Conferences*, p. 280 . Available from: https://doi.org/10.1051/matecconf /20192800 4002. [Accessed: 28 August 2022].

Abdul, Q.T. L., Emmanuel, N., Oluwasegun, S. O., Abdurrahman, S.H., Ismail, A. O., Peter O. (2019), Effect of Unburnt Rice Husk on the Properties of Concrete. *2nd International Conference on Sustainable Materials Processing and Manufacturing*, *35*, pp. 635-640.

Alonso, M.A., Suarez, O.R., Rodriguez., P., Cantarel., M., Sanchez, J.M.B. (1990). Concrete Blocks. Analysis of UNE, ISO en Standards and Comparison with Other International Standards. *Materials De Construction, 40 (220)*, pp.764 Available from: DOI:http://doi.org/10.3989/mc.1990.v40.i220.764.   [Accessed: 30 August 2022].

ELECTRICITY GENERATION FROM ENERGY WASTED AT ROAD SPEED BREAKERS

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ABSTRACT

The global rate of energy use is increasing. As a result, researching alternate energy generation methods, even on a small scale, is critical to combating the looming energy crisis. Finding alternate means of electricity generation is very important in the current Sri Lankan power crisis. The goal of this project is to create a mechanical speed breaker electricity generator that runs on a rack and pinion mechanism. It is expected that the rotational action of the generator will transform the kinetic energy of the cars moving on the speed breaker into useable electrical energy. The designed prototype's output power is 2-3 W, and it can be improved further based on the necessity.

Keywords: *Kinetic energy, Rack and pinion mechanism, Speed breaker power generation.*

1. INTRODUCTION

The use of automobiles has become the number one mode of transportation used by general population of Sri Lanka. To decrease road accidents, mechanisms known as speed breakers/speed bumpers have been installed at strategic locations along roads. Every time a vehicle travels over a speed breaker, however, a significant quantity of energy is wasted due to heat loss and friction. Speed breakers can be built to capture energy from passing vehicles and transform it into usable energy. Another issue that comes up while discussing power generation is the environmental impact of electricity generation. The environmental implications of power production and energy use are inextricably linked. Electricity created from renewable energy sources has a lower environmental impact than power generated from fossil fuels. Finding alternate power producing technologies so contributes to a greener environment.

1.1 BACKGROUND STUDY

1.1.1. PROBLEM STATEMENT

In today's civilization, the demand for electricity is increasing. The sources of power in Sri Lanka are depicted in Figure 1. Despite the fact that the overall cost of this system is considerable, the country continues to use a large percentage of petroleum.

Therefore, alternative methods of electricity generating methods must be discovered.

In Sri Lanka, there are thousands of automobiles on the highways every day. To further ensure pedestrian safety, many speed breakers have been erected on the road. Devices called speed breakers use vertical deflection to slow down motor vehicle traffic.

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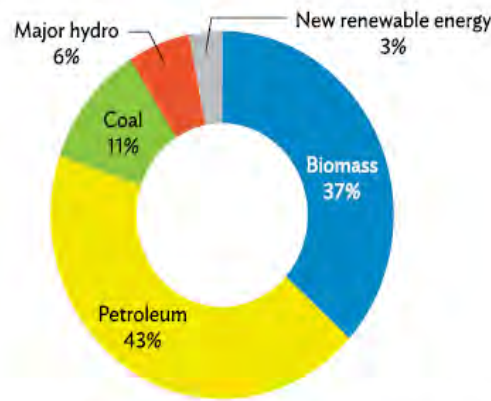
Source: Sri Lanka Sustainable Energy Authority. 2019. *Sri Lanka Energy Balance 2017.*

Figure 111: Sources of Electricity in Sri Lanka

Vehicles spend a significant amount of energy every time they cross a speed breaker. In order to use the speed breaker as a power generating device, a technique must be developed to capture the energy created. The objective of this project is to design a mechanical "speed breaker power generator" that uses a rack and pinion mechanism to transform kinetic energy into mechanical energy. The energy can then be transformed into active electrical energy that can be used. An LED light bulb and a multimeter will be used to display the electrical energy output.

1.2. REVIEW OF LITERATURE

The energy can be made by speed breakers through various mechanisms like roller, the crank-shaft, the magnetic and the rack and pinion mechanisms. Ramadan *et al.,* (2014) has discussed about various mechanisms that can be used for speed breakers and their corresponding governing equations. Sinha *et al.,* (2021) used a crank and slider mechanism for designing a speed breaker. Aswathaman and Priyadharshani, (2011) designed a speed breaker system consisting of Rack, pinion and Chain, sprocket arrangement. It reported an output of 4.0875 Watts for a one pushing force of a 250 Kg Load. But the design did not harness the energy stored in the springs during compression.

Ahmad and Masood, (2014) has also designed a speed breaker system consisting of rack and pinion and chain and sprocket arrangement with two parallel connected generators to charge the batteries earlier. According to their calculations 11.445 watts of power are generated when one vehicle passes over the speed breaker. Ramadan *et al.,* (2014) introduced a prototype containing rack and pinion mechanism. When masses of 73 kg and 85 kg are applied, it was demonstrated that the bumps can create powers ranging from almost 43 to 65 W. This is an average of 0.68 W/kg. But the design of the prototype is practically not suitable for the vehicles because of the 3 bumps. Ramadan *et al.,* (2015) has discussed about a prototype where 26.2 to 44.7W can be generated from the speed-breaker with rack, pinion and belt connected to generator system when masses of 65 kg and 80 kg are applied. Hence, an average of 0.37 W/kg. Extrapolations to a real physical system indicated that In that case, an average power of 0.56 kW, in minimum, can be produced.

Todaria *et al.,* (2015) have done an expensive energy harvesting by a system of Mechanical Motion Rectifier (MMRTo generate electrical power, the MMR translates both down and up pulse motions of the speed

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bump into a single direction rotation of the electrical generator. They used a rack pinion clutch mechanism. High power of up to 200 W was created in one phase of a three-phase generator. Ullah *et al.,* (2016) developed idea about a speed breaker system where, the hydraulic press converts the vehicle pressure on the speed breaker into rotary energy via rack and pinion. Younas *et al.,* (2017) has developed a rack pinion and chain sprocket system. The efficiency of the system was low.

Emovon (2018) conducted a comparative examination of many mechanisms (Roller, Rack and pinion, and Air Piston mechanism) in order to establish the most effective technique of power generation in a speed bumper. In this paper, the most appropriate mechanism for power generation was determined using an integrated Analytic Hierarchy Process (AHP) and WASPAS technique (which is a mix of the Weighted Sum Model (WSM) and the Weighted Product Model (WPM). According to their findings, even if the roller mechanism is inexpensive and simple to construct, its efficiency is only 50%. On the other hand, the cost of the Rack and Pinion mechanism is moderate, and the design is dependent on weight bearing capacity. But the efficiency is 70% which is higher than roller mechanism. And the Air Piston mechanism is very costly and is very difficult to setup. Das *et al.,* (2013) created a system in which a roller is fitted between a speed breaker and some form of grip is supplied on the speed breaker such that when a vehicle passes over the speed breaker, the roller turns. The spinning of the roller converts the vehicle's kinetic energy to the roller's rotational energy. Olugboji (2016) created a speed breaker system to generate electrical energy using air compression. However, the system is complex to build and expensive.

2. METHODOLOGY

A prototype was designed to convert inactive energy into active usable energy. A downward force is applied to the speed bumper plate as a vehicle passes over the bumper region. The spring compresses as a result of the downward force. After then, the rack begins to move vertically downward and upward. The pinion gear rotates in a circular motion because it is meshing with the rack gear. The engaged segment pinion teeth move a length equal to the rack length during one compression cycle. The engaged segment pinion disengages, followed by the engaged segment pinion. This is a spring tension reaction. The bumper then returns to its original position, completing a full cycle. The pulleys connected to the gear wheels transfer rotational energy to the generator via belt, which provides electrical energy.

Figure 2 shows the full working process of the proposed system.
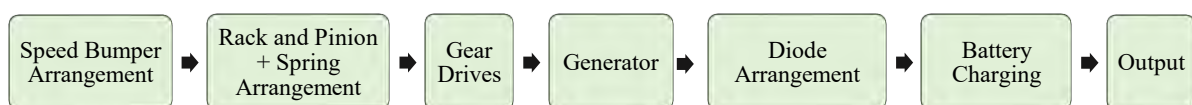
Figure 212: Block Diagram

2.1. DESIGNING THE PROTOTYPE

2.1.1. COMPONENTS USED AND THEIR DRAWINGS

Solid works software was used to design the following components of the prototype.

- Rack and pinion

- Two spur gears
- Pulleys
- Springs
- Spring guide, Guide pin and Linear guide brush
- Speed bumper plate

2.1.1.1. PINION DESIGN PARAMETERS

Module (m) = 02, No. of. Teeth (t) = 16 , Pressure angle (Q) = 20˚, Pinion angle =115

2.1.1.2. RACK DESIGN PARAMETERS

Module (m)	= 02	No. of. Teeth (t) = 16	Pressure angle (Q)	= 20˚
Pinion angle	= 115˚	Rack length	= 100mm	No. of. Teeth (t) = 16

2.1.2. DESIGN CALCULATION

Table 1 : Design Calculation

For 50 – teeth spur gear	*For 20 – teeth spur gear connected with dynamo*
• Module (m) = 02	• Module (m) = 2
• No. of. Teeth (t) = 50	• No. of. Teeth (t) = 20
• Pressure angle (Q) = 20˚	• Pressure angle (Q) = 20˚
• Pitch circle diameter (PCD) =Module × No. of .teeth = 100 mm	• Pitch circle diameter (PCD) =Module × No. of teeth = 40 mm
• Base circle diameter =Pitch circle diameter (PCD)×$\cos\emptyset$ = 93.97mm	• Base circle diameter =Pitch circle diameter (PCD) ×$\cos\emptyset$ = 37.59 mm
• Addendum(a)= Module (m)= 02 mm	• Addendum(a)= Module (m) = 2mm
• Dedendum(d)=1.25 × Module = 2.5 mm	• Dedendum(d)=1.25 × Module = 2.5 mm
• Clearance =Dedendum(d)-Addendum(a) = 0.5 mm	• Clearance =Dedendum(d)-Addendum(a) = 0.5 mm
• Tip circle diameter = Pitch circle diameter (PCD)+(2 × Addendum(a)= 104 mm	• Tip circle diameter = Pitch circle diameter (PCD)+(2 × Addendum(a)) = 44 mm
• Root circle diameter = Pitch circle diameter (PCD)-2 × Dedendum(d) = 95mm	• Root circle diameter = Pitch circle diameter (PCD)-(2 × Dedendum(d)) =35mm
• Circle pitch (p)=π × Module(m) = 6.3 mm	• Circle pitch (p)=π × Module(m) =6.3mm

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Table 1 shows the design calculation for the prototype.

2.1.3. COMPONENTS AND SPECIFICATIONS

Table 2 shows the components used and their specifications.

Table 2 : Materials and Componets

	Components	No.s	Specification
1	Speed bumper	01	MS Steel was used
2	Segment Pinions	02	No of teeth – 16
3	Gear wheels – 20 teeth	01	Module – 02
4	Gear teeth – 50 teeth	02	Module – 02
5	Driven Pulley	01	Diameter-35mm
6	Drive Pulley	01	Diameter-200mm
7	Belt	01	750mm
8	Dynamo	01	6V, 20mA
9	Block Bearing	06	UCP type
10	Linear guide	04	Ball type linear bearings
11	Spring	05	length140mm,D-100mm

For power generation, the device requires a configuration that can convert the linear motion of the speed breaker to rotating motion. The rack and pinion system is a good example of this. A rack and pinion linear actuator are made up of two gears that transform rotational motion to linear motion. The "pinion" circular gear engages teeth on the "rack" linear gear bar. When rotational motion is provided to the pinion, the rack travels relative to it, turning the pinion's rotating motion into linear motion. The spur gear is a tooth component with a cylindrical shape that can be used to convey mechanical movements as well as govern speed, power, and torque. It is a device for positive power transmission with a fixed velocity ratio. These gears can be combined to increase the speed and torque. Spur gears can be manufactured of metals like steel or brass, or polymers like nylon or polycarbonate. Plastic gears may have inferior strength and loading capacity. Spur gears, unlike other gear types, do not suffer from substantial losses due to slippage, hence they have a high transmission efficiency.

Pulleys are used to transfer power from one source of energy to another in the It uses a belt and pulley mechanism here. To impart a rotational motion to the application, this power is obtained from either an electrical or mechanical generator. Pulleys are always located on the rotational section of the energy source, allowing power to be delivered to the device via a belt. In our device, power is transmitted between the two pulleys by a belt. One pulley drives the belt (driving pulley) and the other pulley is driven by the belt (driven pulley). Drive Pulley which is attached to the 20 teeth Spur Gear wheel, the "source of power" for the drive pulley in the device. A driven pulley is one that is not connected to a power source but is connected to the drive pulley via a belt.

The rack when pressed down has to be reset for the next incoming force. So, to do this task the rack has to retrace its downward motion in upward direction. Therefor springs can be used. A spring is an elastic body that distorts when loaded and returns to its original shape when the force is removed. It absorbs, cushions,

or controls energy caused by shocks or vibrations. Springing devices must strike a balance between flexibility and rigidity. If it is more rigid, it will not absorb road shocks as well, and if it is more flexible, it will continue to vibrate even after it has been repaired. When choosing springs for the prototype, they have to be selected carefully. The downward motion of the force due to weight applied should transferred to the pinion and when doing that spring should deform easily. At the same time the springs should not give unnecessary shocks to the rack and the whole assembly of components. When the weight applied on the rack is removed the spring should reset the rack to its initial position. Therefore through trial and error of the device we have decided that the spring we have select should be of less stiffness, while having enough compressive strength to withstand the applied pressure.Spring guide pins provide support to the springs and helps in creating a smooth motion on the spring without bending to various sides. We have used four spring guides. The four linear provide support to the four spring guide pins. The dynamo used was 6V and 30 mA. Perspex material was used to laser cut and design the segment Pinions, Gear wheels and Pulleys of the Prototype.

2.1.4. CONSTRUCTION AND OPERATIONS OF THE DEVICE

2.1.4.1 .ASSEMBLY OF THE PROTOTYPE

Figure 3 : Prototype Front View   Figure 4 : Prototype Side View

The prototype was constructed to reproduce a "speed breaker on a road with vehicles" Scenario. Figure 3 shows the front view of the prototype made for the project after assembling all the components. It shows how the rack is in contact with the pinion wheels. Figure 4 shows the side view of the prototype.

3. RESULTS AND DISCUSSION

Following the design and construction of the mechanical speed breaker for electricity generation, the machine was tested to determine its performance.

3.1. WORKING PROCEDURE

When a force is applied on the speed breaker plate on top of the prototype the bumper plate is displaced vertically downward. The rack also moves downward along with it. The rack meshed with the pinions causes the gear wheels to move in a circular motion and the pulley attached give that energy through belts to the dynamo. The electrical energy generated was used to light a 2.5 W LED bulb.

3.2. CALCULATIONS

3.2.1. PROPOSED OUTPUT POWER CALCULATION

If the prototype can be developed further in future as an actual device capable of withstanding the weight of an average weighted car, the following output power can be made. Let us consider,

The mass of a body = 1500 Kg (Approximate weight of a car)

Height of speed brake = 10 cm ∴ Work done = Force x Distance

Here, Force = Weight of the Body = 1500 Kg x 9.81 = 14,715 N

Distance traveled by the body = Height of the speed brake = 10 cm = 0.10 m

∴Output power = Work done/Sec = (14,715 x 0.10)/60 =24.52Watts (For one pushing force**)**

If the speed-breaker power generation systems can be implemented on roads, the expected power corresponding to this mass can be estimated to be about 24.52 Watts per car. Therefore we may generate power that will be sufficient to satisfy the desired electrical demand to lighten roads during night-time, and deliver power to other electrical devices put on roads.

4. CONCLUSION(S)

The objective of the project was to construct a working prototype to demonstrate the idea introduced in our project. Solid work software was used in designing, modeling, and analyzing the components before manufacturing. The components were manufactured from Perspex material for the prototype by using laser cutting. And the output power generated by the prototype was between 2 – 3 Watts.

Finding alternative methods of power generation is an important task due to the current power crisis, and the environment impact traditional fossil fuel soured power generation is having.

Therefore in this project, a prototype model was proposed, which generated power by the operation of a rack and pinion mechanism underneath a speed breaker. Our project work gives a way of electric power generation without polluting the environment. Also this method is a promising technology that can provide a solution to the current power crisis. The proposed prototype can be installed near public car parks to generate electricity. This work can be improved by adding four or more DC generators used in combination to increase the current.

REFERENCES

Phillips R. (2009). Speed bumps to get new role as a source of green energy.*The Guardian*, Available at : https://www.theguardian.com/environment/2009/feb/08/alternative-energy-speed-bumps (Accessed: 20 August 2022)

Asian Development Bank (2019). *Sri Lanka energy sector assessment, strategy, and road map.* Available at : http://dx.doi.org/10.22617/TCS190557-2 (Accessed: 20 August 2022)

Sinha, A., Mittal, S., Jakhmola, A., Mishra,S. (2021) 'Green energy generation from road traffic using speed breakers', *Materials Today*. 3*8(1)*,(ISSN 2214-7853), pp. 160-168, Available at :https://doi.org/10.1016/j.matpr.2020.06.248.

Aswathaman, V. and Priyadharshini, M., (2011), Every Speed Breaker Is Now A Source of Power, *International Conference on Biology, Environment and Chemistry (IPCBEE),* pp. 234 - 236.

Ahmad, S. and Masood, B., (2014), Power Scavenging from Moving Vehicles on Road, *International Journal of Innovation and Applied Studies* (*ISSN)2028-9324 9(4)*, pp. 1428-1433.

Ramadan, M., Khaled, M., El Kady, M., & El Hage, H. (2014), Generating power from Speed-Bump. Prototype developement and experimental study, *17th Mediterranean Electrotechnical Conference(IEEE),* pp. 13 – 16.

Ramadan, M., Khaled, M., & El Hage, H. (2015), Using speed bump for power generation –Experimental study, *7th International Conference on Applied Energy (ICAE2015),* pp. 867 – 872.

Todaria, P., Wang, L., Pandey, A., O'Connor, J., McAvoy, D., Harrigan, T., Chernow, B., & Zuo, L. (2015), Design, modeling and test of a novel speed bump energy harvester, *Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems 2015,* Available at: doi: 10.1117/12.2084371

Ullah, K., Uz-Zaman, A., Hosen, S., Khan, H.R., Parvin, S. (2016), Electrical Power Generation Through Speed Breaker, *9th International Conference on Electrical and Computer Engineering.*

Younas, T., Saadat, M., Hussain, I., & Rashied, Z. (2017), Energy Recovery Using Ratchet Mechanism: An Experimental Study, *2nd International Conference on Advances on Clean Energy Research (ICACER 2017),* pp. 104 – 109.

Emovon, I. (2018), Model for Determining Appropriate Speed Breaker Mechanism for Power Generation, *Journal of Applied Science & Process Engineering, 5,(1), 2018.*

Olugboji, O. A., Abolarin, M. S., Ohiemi, I. E., & Ajani, K. C. (2016), Development Of A Speed Breaker Mechanism For Generating Electrical Energy By Compression Method', *Proceedings of the 2016 Annual Conference of the School of Engineering & Engineering Technology.*

RESILIENCE THROUGH EDUCATION

Factors Affecting Low Attendance To Zoom Teaching Sessions: A Case Study Based On Grade Seven Students In Type 02 Schools In Ibbagamuwa Educational Division, Sri Lanka

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ABSTRACT

The implementation of online teaching and learning during the Covid 19 pandemic in Sri Lanka was a big challenge for both teachers and students. With the lockdowns, schools were partially shut down. Therefore teachers had to shift from physical face-to-face classrooms to online classrooms in continuing the teaching and learning process by using different kinds of online platforms. Out of the several platforms, Zoom was the most used online platform by teachers and learners. The research objectives of this study are to find out the existing situation among grade seven provincial school children when using zoom applications and the reasons behind the low attendance to zoom classes. The existing situation and the reasons were gathered from the questions and the interviews conducted with students and teachers. This study includes a sample of 40 students and 8 teachers. In the methodology, data were gathered from questionnaires and semi-structured interviews. The collected quantitative data were presented using graphs and charts. Based on the analysis, the results showed that there is less attendance to zoom classes. The students do not switch on videos as a result of poor connections. It takes a time to hear the responses of the participants. The participants leave the session and rejoin the class because of the poor signal connections. The research found that there were a few reasons behind these problems. Lack of digital literacy, economical issues, and geographical issues can be considered as some of the reasons behind the low attendance.

Keywords*: Covid 19, Low Attendance, Online School Education, Zoom.*

1. INTRODUCTION

1.1 BACKGROUND TO THE STUDY: STRUCTURE OF THE GOVERNMENT SCHOOL SYSTEM AND THE TYPES OF SCHOOLSiIN SRI LANKA

In the year of 1945, Sri Lanka achieved success to have free education from the level of kindergarten to university which was associated with the British Education Act, of 1994. According to the annual census report published by the Department of Sri Lanka in 2020, currently, there are 10,155 schools and 4,063,685 children in Sri Lanka. The government schools were categorized into 5 types as follows, National schools, Type 1 AB, Type 1 C, Type 2, and Type 3. According to the "Ceylon Journal of Science", Type 1 AB schools have the Advanced Level science stream. These schools are considered the "best-equipped type of

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schools." (Dorabawila, 2002) Type 2 schools have classes from grade 01 to grade 11. The classes which have from grade 01 to grade 08 or 05 are called Type 3 schools. These Type 2 and Type 3 schools are regarded as "small schools" with fewer facilities and resources and are mostly situated in rural areas.

1.2 Rationale for The Study: Covid-19 Pandemic And Its Influence On School Education In Sri Lanka

The outbreak of Covid - 19 devastated the usual lifestyle of people all over the world. It was first recognized in a seafood market in Wuhan City, Hubei Province, China. Then it was primarily conveyed to the World Health Organization (WHO) on December 31, 2019. On 30th of January, 2020, the World Health Organization confirmed this as a Global Health Emergency. The first confirmed case of Covid 19 was reported on 20th January 2020 in Sri Lanka. As there was a risk of rapidly spreading the virus all over the country, the government of Sri Lanka declared to shut down all public events, gatherings, meetings, and all other social activities including attending schools.

Accordingly, the Ministry of Education in Sri Lanka announced to close of all academic institutions temporarily including government schools as a health safeguard to prevent this deadly disease. Therefore, teachers decided to shift from physical classrooms to online platforms to continue the teaching and learning process for their students. Yet, the Ministry of Education stated that out of the entire school children population only 40% of students engage in online classes. All the students do not get an equal opportunity to engage in online classes. The statics collected from the Ibbagamuwa Educational divisional office of the division in the month of June 2021 confirmed that between 5% to 81% of grade 07 provincial school children who study in Type 2 schools do not engage in zoom classes.

The ultimate target of this research is to find out the existing situation in zoom class attendance and whether the independent variables such as income, physical, geographical, and economic diversities, digital illiteracy, and attitudes are certainly influencing the dependent variable of low attendance rate to zoom online classes.

1.3 RESEARCH QUESTIONS:

i. What is the existing situation of students' participation in "zoom classes" (Grade 7 students of type   2 schools) in Ibbagamuwa Educational Division?

ii. What are the influencing factors behind this low attendance to zoom classes during Covid 19 pandemic?

1.4 RESEARCH OBJECTIVES:

i. To identify the existing situation of student participation in Zoom Sessions of grade seven (7) students.

ii. To find out the influencing factors for the low attendance to Zoom Sessions of grade seven (7) students.

2. LITERATURE REVIEW

2.1 DEFINITIONS OF "ONLINE EDUCATION"

Online Education can be defined as a "kind of learning and teaching in which the learning content is available online and provides automatic feedback to the student's learning activities" (Paulsen, 2002). As mentioned by him, there are some characteristics of online education. First of all, there is a deviation of teachers from students in face-to-face teaching and learning environment. Secondly, there is a high demand for self-learning and self- tutorial. Thirdly, both the parties; teachers and students use computers and the internet for studies and corrections. Lastly, it is a two–way communication.

2.2 A SHIFT FROM CONVENTIONAL CLASS TO "ZOOM"

With the pandemic, conventional education has been replaced by online education. Instead of blackboards teachers had to use virtual whiteboards. As the students could not engage in physical classrooms they had to meet each other at breakout rooms virtually to share their ideas. "Zoom is a collaborative, cloud-based videoconferencing service offering features including online meetings, group messaging services, and secure recording of sessions" This feature is freely accessible on desktops, laptops, i-pads, tablets, and even smartphones. (Zoom Video Communications Inc., 2016) Serhan (2020) stated that many government agencies, universities, non-profit organizations, and individuals moved to Zoom web-based collaborative video conferencing during the pandemic. Zoom is the most used online platform among school teachers and students. According to Priyadarshani and Jesuiya (2021), it is acknowledged zoom is the most used (51%) and favored utensil for virtual classrooms among the teachers and students in the Colombo district. Moreover, Utomo (2020), also stated that during the pandemic period, Zoom is the most used video conference among teachers and learners.

2.3 EXISTING ATTENDANCE STATE IN ZOOM CLASS

Wang et al. (2018) pointed out that, though the students have flexibility towards Zoom webinars, there is a low attendance to Zoom Conferencing. Students switched off their cameras and did not respond when the instructors asked. There is a lack of communication between teacher and student in the zoom classes. There is a lack of feedback given by the teacher to students. Moreover, less control and feedback given by the teacher weakened the commitment of students. (Nartiningrum and Nugroho, 2020)

2.4 FACTORS AFFECTING LOW ATTENDANCE TO ZOOM CLASSES

There are difficulties in operating online applications. Some children lack the abilities in computer skills and it makes them uncomfortable in joining and handling online classes. Even the low awareness of students and parents about online learning makes them feel online is an informal platform and they think to spend a good holiday. Some students argued that online classes are less interactive but more informative and there is no communication between students and educators which feel them tougher to join. (Nambiar, 2020)

A survey in 2020 reported that around 12.70% of poor families do not have at least a smartphone or a stable internet connection to attend online classes (Tariq and Fami, 2020). Further, Atmojo (2020) found

that some children do not have devices because of the financial condition of the family. Not having a separate room to engage in online classes make distracts concentration. Another reason may be due to the lack of PCs or phone service to attend the lecture. (Elhadary1, 2020) In 2021, Indah Komsiyah said that "not all students have sufficient internet quota to zoom". Further, he mentioned that parents are greatly affected by economic challenges. Therefore they cannot buy enough data for the students.

According to Nartiningrum and Nugroho (2020), poor network connection such as bad signals and electricity blackouts is a challenge to joining online classes. Internet coverage is not strong in rural, remote, and mountain areas. At the same time, students can't afford enough data quota online. The unstable connection and the electricity are the two main reasons behind the irregularity of student participation. (Atmojo, 2020) Student participation in online learning range between 40% to 60%. Even there is a disparity between the distribution of rural and urban resources. (Al-Amin, 2021)

3. METHODOLOGY

This study is expected to find out the existing situation and the underlying reasons for the low attendance to zoom classes in type 02 schools of the Ibbagamuwa division.

3.1 RESEARCH DESIGN

For the study, the researcher considered 40 students and 8 teachers of the grade 7 class. The quantitative research design is adopted in the study. A questionnaire sheet for the students and a face-to-face interview for each teacher were used as the primary data collection tools for the study. The teachers' interview was used to achieve more accurate and genuine information in drawing conclusions and recommendations. The distributed amount for conducting the research is fair.

3.2 POPULATION AND SAMPLE

All the students and teachers who engage in the learning and teaching process in the Ibbagamuwa Educational division were taken as the population of the study. The target population was the students and teachers in Type 2 schools. The accessible population was composed of 250 students and 135 students who enrolled in grade 07 in the year 2021 type 2 schools. The samples were assured by both female and male students and female teachers of grade seven. Out of the 40 students and 8 teachers were selected using convenience sampling and purposive sampling respectively.

3.3 METHODS OF DATA COLLECTION

For this study two surveys were conducted; a questionnaire for the students and a face-to-face interview for the teachers. The questionnaire for the students is the main instrument and the interview for the teachers is the second. The teachers' interviews were recorded for further use. The design included 26 questionnaires for the students and a face-to-face semi-structured interview allocating 10 minutes for each teacher using their mother tongue (Sinhala) and translating it to English. All the data were collected for further purposes.

3.4 METHODS OF DATA ANALYSIS

Quantitative data can be interpreted in graphs clearly and accurately. Therefore, in this research also the collected data were analyzed and presented by using pie charts and bar graphs with the help of MS excel.

4. RESULTS AND DISCUSSION

The first part of the questionnaire was aimed at investigating the existing situation in zoom classes. When analyzing the collected data, the following results could be seen. These questions were aimed to know the number of hours students engage in zoom classes per week and the way they log in.
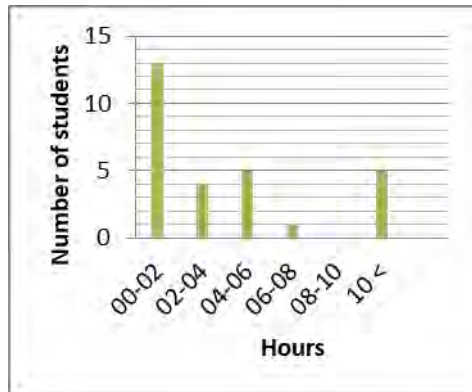
Figure 1: The Number of Hours Students Engage in Zoom Classes per a week
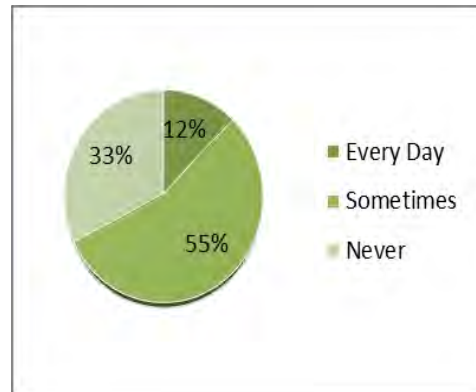
Figure 2: Frequency of the Students Log into Zoom Classes

According to Figure 1 majority (13) of students, engage in Zoom classes for only up to 2 hours. Only, 5 students engage in Zoom classes for more than 10 hours per week. 12 students do not respond to the question in the survey. As depicted in Figure 2, only 12% of the students engage in zoom classes every day while the majority (55%) sometimes join the class. But, 33% of the students answered that they never joined the zoom classes regularly.

The teachers also responded that there is less attendance to Zoom, even more than 50%. The students do not stay until the class ends and they cannot switch on the webcams as the results of signal drops. In advance, students log out and rejoin the class several times automatically. One teacher said in the interview, "I asked my students to switch off their webcams to keep a strong connection." Another teacher added that it takes a time to hear the responses from the students. Their voices dragged and echoed making a nuisance for the whole class. The parents always complained about the difficulties in using zoom saying "We don't have enough signals and enough equipment at home."

The second part of the questionnaire was designed to know the reasons behind low attendance. The research pointed out that there are several reasons which affected this low attendance.

Figure 3 indicates the computer literacy of students. Among the students, 97.50% answered that they did not follow the ICT course. But 77.50% of the students answered that they can operate a device while 22.50% of them cannot operate a device. The students who can operate the Zoom application (70%) are more than the students who cannot operate the zoom application (30%).

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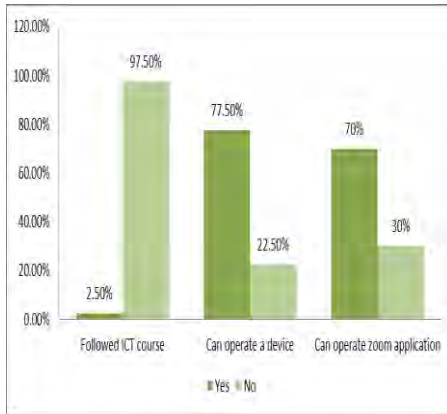
Figure 3: Computer Literacy
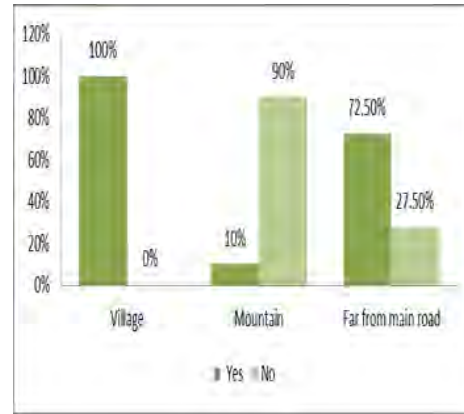
Figure 4 Location Issues

As depicted in Figure 4, almost all the students (100%) who were involved in the research live in the village. Out of them, 10% of the students live close to mountain areas and 72.5% far from the main road. Among these students, only 12.5% of students have laptops at home and only 7.5 % have computers. The students are using smartphones as they do not have computer devices. They answered that they receive calls while engaging in the classes and leave the class. Few students mentioned that, as they have schooling sisters and brothers at home, the devices are not enough. They also have online classes at the same time as them. Another teacher said that "the given free 40 minutes by Zoom are inadequate to conduct the class. We cannot ask students to buy the license because they have many economical issues at home. In most families, the parents do not have a proper job. Even the teachers cannot buy it." This idea was verified by the answers of students that, in most families, only the father or mother earns for the family.

The answers proved that these areas are equipped with electricity and other infrastructure facilities. The majority of students have telephones at home. But they do not have wifi or broadband facilities. Though Dialog can be considered the most used mobile partner, its connection is not strong enough for online platforms.

Students responded that they prefer to study in a physical classroom with the interaction of peers. Most of the teachers admitted that they like to conduct physical classes. A teacher answered that "Zoom is important in this pandemic as there are no other options." She added that there is a risk of addicting students to online games and chatting groups while in class. Another teacher mentioned that she conducts the zoom class early in the morning at around 5.30 a.m in order not to clash it with other school classes and tuition classes. Additionally, she mentioned that signal coverage in the early morning is better than in the daytime.

5. CONCLUSION(S) & RECOMMENDATIONS

5.1 CONCLUSION

This study revealed that there is a low attendance to zoom classes. Many students had not joined even a single class during the pandemic. Students have to switch off their cameras when joining because of signal

issues. The teachers also instruct not to switch on their web camera as it is important to keep the signal strength. The students prefer the physical classrooms because they love the company of their friends. They feel bored while engaging in zoom classes and can't hear the teacher. Students face difficulties in taking down notes as the time duration is less.

There are different types of issues with this problem. One of them is the financial issues. In most families, only the mother or father works and earns for the family. Though their parents buy enough data quota, they lack devices such as laptops and computers to log in to classes. As a result, they have to use smartphones. When using smartphones, they find personal calls in between classes that disturb their lessons. They cannot buy the zoom license to have a long-hour class because it's expensive. The students lack basic computer skills. They had not followed any ICT course yet. Though they can handle the computer or zoom application, more knowledge and skills are needed to handle advanced features.

Another reason is that they live in village areas far from the main road and close to mountains. The village areas have bad signals. These areas are not equipped with technological strategies and facilities such as wi-fi and broadband. There are no signal towers nearby to provide the connection. Therefore, they are facing many technical issues like poor network connectivity, broadband issues, poor audio and video quality, and getting disconnected in between classes.

Another issue highlighted in the research was that the students have classes for other subjects and tuition classes at the same time. Therefore, they found difficulties in joining both classes. Even the signal connection in the daytime is slower than in the early morning.

5.2 RECOMMENDATIONS

The following recommendations are suggested to improve the attendance of students in zoom classes. The villages situated far from the main road and close to mountain areas should be facilitated with broadband connections and Wi-Fi facilities. Mobile and internet coverage should be broadened and improved from town to village. It is better if the Dialog internet partner can make strong connections. At the school level, steps should be taken to improve computer skills among students. As well the schools should be provided with computer devices, internet facilities, and trained ICT subject teachers. Teachers should arrange a timetable to have online classes for students without clashing with other classes and subjects. On the other hand, careful attention should be given to students when they are studying online.

REFERENCES

Al-Amin, M., Al Zubayer, A., Deb, B. and Hasan, M., (2021). Status of a tertiary level online class in Bangladesh: students' response on preparedness, participation and classroom activities. *Heliyon, 7(1)*, p.e05943.

Atmojo, A.E.P. and Nugroho, A., (2020). EFL classes must go online! Teaching activities and challenges during the COVID-19 pandemic in Indonesia. *Register Journal, 13(1),* pp.49-76.

Ferri, F., Grifoni, P. and Guzzo, T., 2020. Online learning and emergency remote teaching: Opportunities and challenges in emergencies. *Societies, 10(4),* p.86.

Nambiar, D., (2020). The impact of online learning during COVID-19: students' and teachers' perspective. *The International Journal of Indian Psychology*, *8(2),* pp.783-793.

Nartiningrum, N. and Nugroho, A., (2020). Online learning amidst global pandemic: EFL students' challenges, suggestions, and needed materials. ENGLISH FRANCA: *Academic journal of English language and education*, *4(2)*, pp.115-140

Paulsen, M.F., 2002. Online education systems: Discussion and definition of terms. *NKI distance education, 202,* pp.1-8.

Serhan, D., 2020. Transitioning from Face-to-Face to Remote Learning: Students' Attitudes and Perceptions of Using Zoom during COVID-19 Pandemic. *International Journal of Technology in Education and Science*, *4(4),* pp.335-342.

Tariq, S.B. and Fami, T., 2020. Is the online education system suitable for Bangladesh? *Retrieved from The Business Standard: https://tbsnews. net/thoughts/online-education-system-suitable-Bangladesh-112546*.

Utomo, M.N.Y., Sudayanto, M. and Saddhono, K., 2020. Tools and strategy for distance learning to respond COVID-19 pandemic in Indonesia. *Ingénierie des Systèmes d'Information, 25(3),* pp.383-390.

FACTORS AFFECTING THE CHOICE OF YOUNG SCHOOL DROP OUTS TO SELECT THREE-WHEEL DRIVING AS THEIR EMPLOYMENT: A CASE STUDY BASED ON RATMALANA, SRI LANKA

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ABSTRACT

For a long period, the Sri Lankan labor market has been recognized for unemployment and underemployment, in a contrast statement there is a shortage of labor in various industries. Studies reveals that while shortage of labor increase, a large number of youths leaving schools are entering to self-employment as three-wheel drivers. The objectives of this research are to identify factors related to youth school dropouts, reasons for attracting three-wheeler driving as employment for youth, and youth awareness on vocational training opportunities. Methodology of this study is a quantitative analysis with a deductive approach. Four independent variables and one dependent variable used to test four hypotheses. Findings of this study reveal that; there is a positive relationship of student related factors, school related factors, family related factors and community related factors towards the desire to take up self-employment as three-wheeler driver.

Keywords: School dropouts, Three-wheeler, unemployment. Labor shortage.

1. INTRODUCTION AND BACKGROUND

Unemployment and underemployment are identified in the Sri Lankan labor market for a long period (Ranasinghe et al., 2016 & 2014). In contrast, the Chairman of Board of Investment (BOI), the regulating body of all free trade zone manufacturing facilities reveals that there are over 200,000 vacancies in Sri Lanka (Ranasinghe et al., 2016, Sri Lanka Brief, 2016). Per International Labor organization, unemployment is defined as a person who is available to work or looking for work, and who did not work and took steps to find a job during the last four weeks and ready to accept a job given a work opportunity within the next two weeks (www.ilo.org). Further in the statement by chairman of BOI, statistically shows that younger generation is preferred to take up employment as three-wheeler drivers and drastic increase in registration of three wheelers annually (Sri Lanka Brief, 2016)

Dissanayake (2020) explains that the youth unemployment is not a result of lacking employment opportunities, but voluntary unemployment. Youths are reluctant to take up hard working and scheduled employment, but to have a physically and financially comfortable living. Employers' main recruitment challenge is to find the right candidate with the right skills and other characteristics to fill their vacancies. Apart from minimum education qualifications provided by the school system, employers are always searching for additional qualifications to fulfill their carders (Dissanayake, 2020).

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Many manufacturing and service organizations are facing a serious labor shortage while there is approximately a 5% unemployment rate in Sri Lankan annual statistics. Construction, Garment and allied manufacturing, Hotel and tourism industry are few of them and all the time need skilled and semi-skilled youth. In contradiction, many youths are on the road under employment as three-wheeler drivers with less contribution to the economy (NHRDC, 2019; Sri Lanka Brief, 2016).

Previous research work identifies that there is a tendency of school dropouts and young school leavers to take up driving of a three-wheelers than joining the skilled or semi-skilled labor force, despite of government and private institutions provide vast training needs for the youths (Mayadunne and Kariyasekara, 2021).

1.1 OBJECTIVES

Objectives of this study are to identify (a) factors related to youth school dropouts, (b) reasons for attracting three-wheeler driving as employment for youth, (c) youth awareness on vocational training opportunities.

2. REVIEW OF LITERATURE

In the context of human rights and human needs, education is identified as one the basic needs (Farwis, M. 2020). Education provides development to society and countries including rights of education to their constitutions and practice with their economic and cultural policies (Perera, 2015).

As per census in 2016, Sri Lanka had 353 national schools and 9809 provincial schools totaling 10,162 with a student population of 4,143,330 and teacher population of 232,603 which can provide adequate support to educate the student who are in schooling age (School-Census-Report-2016).

Primary education is compulsory for the children between 5-14 of age in Sri Lanka has invested wisely on education (Perera, 2015). Such investment has achieved 92% literacy rate by 2020 (World bank data, 2020). Even though Sri Lanka has spent large amounts of their expenditure on education, many studies have found that the student drop outs are causing economical challenges with difficulties in finding ways for proper employment upon leaving the school (Farwis, M.(2020).

In the statistics published by UNESCO (2018), Sri Lanka has reached closer to universal access to primary and lower secondary education. As in 2018, enrollment rates were 99.1% in primary, 98.5% in lower secondary, and 81.4% in upper secondary education. Gender parity was achieved in primary and lower secondary schools, but at the upper secondary level, 107 girls are enrolled for every 100. But in tertiary education it has dropped to 19.1% total, with gender parity of 23.4% female to 15.8% male (UNESCO, 2018). It shows a large drop from school between the ages of 14 to 16 years.

Findings of study work by Arunatilake (2006), Mayadunne and Kariyasekara (2021) shows that (a) poor quality of teaching, (b) lacking good teachers, (c) weak student- teacher relationship, (d) shortage of basic facilities, (e) access barriers to school are key reasons for such drop. Concluding comments of research by Perera (2015), children from poor families attend schools, but their socio-economic background compel them to leave the school and engage in activities to support their parents to ease monetary burdens.

Research work by Mayadunne and Kariyasekara (2021) finds the majority of school dropouts are after failing G.C.E. (O/L) and no matter poor or better off. Poor students are more likely to take up employment than a second attempt. Better off students are also not interested in sitting for the second attempt and seek easy earning employment with a comfortable lifestyle (Mayadunne and Kariyasekara, 2021).

Four common factors being identified by Perera (2015) & Farwis (2020) in their research work for school dropouts, (a) Student related factors such as no interest on education, scoring poor marks in examinations, parents need their help to ease financial burdens, lack of facilities (b) Family related factors such as family size and no of siblings, poverty, parents lacking education etc., (c) Factors related to school such as quality of teaching and learning support, poor cohesion between teacher and student, student feeling of belonging to the school etc., (d) Community related factors, such as distance to the school, poverty etc.

Dissanayake (2020) finds a disconnection with the reality and youth expectation, which demotivate and discourage youth to less ambitious options or start up self-employment. Youths look for more convenient and flexible work such as driving a three-wheeler for hires, engaging in illicit work, which generate income than the traditional employment (Dissanayake, 2020). Statement by chairman of BOI, that younger generation is preferred to take up employment as three-wheeler drivers and drastic increase in registration of three wheelers annually (Sri Lanka Brief, 2016). Study by NHRDC (National Human Resources Development Council of Sri Lanka, 2019) shows fast growing self-employment in Sri Lanka is hiring three-wheelers, quoting statistics of Department of motor traffic reports, Sri Lanka had 766,784 in 2012 and grown to 1,062,447 vehicles by 2016, the total vehicle fleet does not engage in hiring, but at-least 75% appeared to be hired at any stage. Further NHRDC (2019) report reveal that out of their sample lot, 16% of Three-wheel drivers were below 30 years of age and more than 33% of them were below 35 years. For the category of below 30, around 50% has completed GCE (O/L) and 42% has dropped without qualifying GCE O/L (NHDRC, 2019).

Also, in NHRDC (2019) study findings, drivers are able to earn higher level of income compared to other forms of self-employment, based on the sample survey, average income is Rs. 39,000, within a income of minimum of Rs. 4,800 to a maximum of Rs. 140,000 in year 2017 at the time of survey which highly attract youth.

Findings of this study may help to bridge the gap of vocational training needs and guide youth to take up high skilled jobs rather than being underemployed or unemployed.

3. METHODOLOGY

The quantitative analysis methodology adopted for this study. The approach for the research was deductive and four independent variables were selected from literature survey, namely (a) Student related factors, (b) School related factors, (c) Family related factors, (d) community related factors towards the school dropout emerged from previous research work. Conceptual framework designed and developed four hypotheses is given in Figure 1.
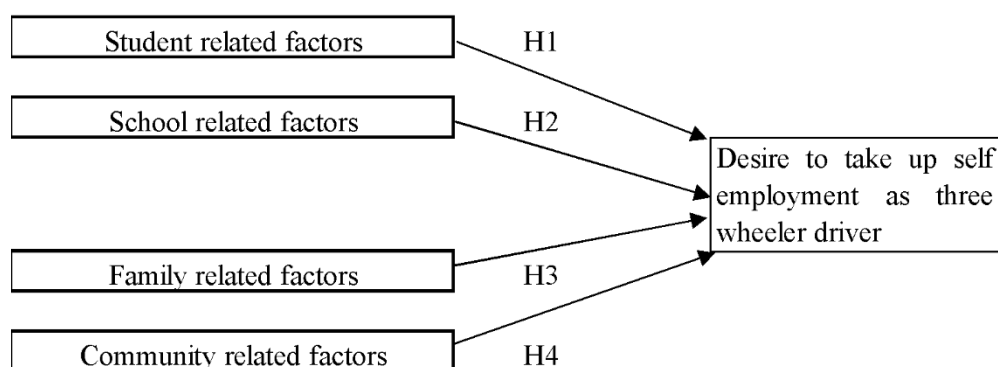
Figure 1

To obtain information systematically, a descriptive survey method was used. A questionnaire comprising research related questions developed and administered to collect primary data. It contained a total of 35 questions, Part A with 07 demographic and exit questions, Part B with 21 questions with 5 Likert scaling related to independent variables, 4 questions with 5 Likert scaling related to dependent variables and Part C with 03 awareness and likeliness questions.

Statistics on NHRDC (2019) shows that there are approximately 800,000 three-wheeler operators island wide, while 352,540 are operated in the western province. Based on Krejcie and Morgan (1970), the research sample lot has to be 384 to cover the population in the western province, but due to the time constraint this study had to limit to the youth three-wheeler drivers in the area of Ratmalana with a convenience sample lot of 110.

4. RESULTS AND DISCUSSION

110 responded to the questionnaire and all were valid responses and confirmed. (a) they are currently engaged as self-employed three-wheel drivers. (b) 107 were males and 3 were females. (c) 93 were within the age group of 18-30 years, 6 were within the 31-40 years, and 11 were within the 41-50. (d) 14 has completed primary education, 34 studied up to O/L, 36 passed GCE O/L examination, 13 studied up to GCE A/L and 15 passed GCE A/L examinations.

Collected data analyzed using SPSS 26 and results are tabulated from Tables 1 to 4.

Table1: Reliability analysis

Variable	Cronbach's alpha	No of items
Independent variable		
Related factors		
Student related factors	0.801	6
School related factors	0.830	4
Family related factors	0.794	7
Community related factors	0.831	4
Dependent		
Desire to take up self employment as a three wheel driver	0.895	4
Total items		25

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Reliability analysis in Table 1 shows values of Cronbach's alpha over 0.7 indicating good internal consistency between items in the questionnaire. The variable creation is accepted corresponding items included in the questionnaire.

Results of descriptive statistics in Table 2, mean values of variables are close to Likert scale 4 interpreting variables are within agreed level. Highest standard deviation is 0.70 with desire related factor variable interpreting comparatively high variance. Minimum variance results are from community related factors with standard deviation of 0.511 with low variance. All coefficients of skewness lie within -1 and +1 indicating data are normally distributed and values.

Table 2: Descriptive statistics of sub variables connected

		Student related factors	School related factors	Family related factorss	Community related factors	Desire related factors
N	Valid	110	110	110	110	110
	Missing	0	0	0	0	0
Mean		3.9909	3.9364	3.7468	3.9159	3.8409
Std. Deviation		0.59167	0.6869	0.54653	0.51165	0.70363
Skewness		-0.858	-1.002	-0.588	-1.11	-0.574
Std. Error of Skewness		0.23	0.23	0.23	0.23	0.23
Kurtosis		1.713	1.599	0.406	3.36	0.699
Std. Error of Kurtosis		0.457	0.457	0.457	0.457	0.457
Minimum		2.17	1.75	2.43	2	2
Maximum		5	5	5	5	5

a. Dependent Variable: Desire to take up self employment as three wheeler driver, Source: Survay Data

Correlation analysis results tabulated in Table 3 showing all the probabilities are highly significant between dependent variables (desire related factors) and four independent variables. All values are above 0.7, interpreting strong positive association.

Table 3: Relationship analysis between independent variable and dependent variable.
Correlation is significant at the 0.01 level (2-tailed)

Independent variable diamensions	N = 110	Dependent variable *
Student related factors	Pearson Correlation	.735[**]
	Sig. (2-tailed)	0.000
School related factors	Pearson Correlation	.700[**]
	Sig. (2-tailed)	0.000
family related factorss	Pearson Correlation	.771[**]
	Sig. (2-tailed)	0.000
Community related factors	Pearson Correlation	.792[**]
	Sig. (2-tailed)	0.000

* Dependent Variable: Desire to take up self employment as three wheeler driver, Source: Survay Data

In the coefficient analysis results tabulated in Table 4, all four independent variables are highly significant with positive beta values providing interpretation of selected four independent variables are positively influence individually and jointly on dependent variable of desire to take up self-employment as three-wheeler driver.

Table 4 : Individual variable effect on Desire to take up self employment as three wheeler driver

Coefficients[a]

Dependent	Independent	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
Desire to take up self employment as three wheeler driver	(Constant)	-0.887	0.281		-3.151	0.002		
	Student related factors	0.205	0.101	0.173	2.042	0.044	0.350	2.857
	School related factors	0.181	0.079	0.177	2.284	0.024	0.417	2.400
	Family related factors	0.351	0.108	0.273	3.259	0.002	0.357	2.798
	Community related factors	0.480	0.119	0.349	4.023	0.000	0.332	3.010

a. Dependent Variable: Desire to take up self employment as three wheeler driver, Source: Survay Data

5. CONCLUSION(S), IMPLICATIONS AND LIMITATIONS

In conclusion, it is statistically proven there is a positive relationship of (a) Student related factors, (b) School related factors, (c) Family related factors, (d) community related factors towards the desire to take up self-employment as a three-wheeler driver.

The results provide an alarm to the relevant authorities, that there is a high tendency of school leavers to take up self-employment to drive a three-wheeler due to low cost, flexibility, convenience, earning more income than traditional employment

Due to the timing, restricted mobility and epidemic situation, the sample lot was limited to the Ratmalana area. It is suggested to expand to provincial level and later to national levels, for better understanding of current needs towards vocational training needs.

6.0   RECOMMENDATIONS

Per study, interviews and analysis findings, four recommendations can be listed. (a) The mentality of children in the school leaving age have to be monitored within the school system. Career guidance system should educate the youth that there is high potential employment available in service and production sectors with long term benefits. (b) Out of 110 respondents, 86 respondents have shown willingness to continue further education while 68 of them are aware of vocational studies available for school leavers. It provides clear evidence that the youth can be redirected to vocational studies to enhance knowledge and improve their living. (c) Preventive actions to be taken to discourage school leaving youth taking up self-employment as three wheelers driver unless they have vocational training with a compulsory NVQ level etc. (d) Encourage to enroll and achieve NVQ qualification for the existing three-wheeler operators such as tourist guides, plumbers, carpenters or versatile maintenance labor work. All suggestions will increase the utilization of man hours of the three-wheeler driver, reduce new entrants for driving three wheelers and enhance their living skills. Meantime to improve the living standards of their families through increased earnings.

REFERENCES

(NHRDC) National Human Resources Development Council of Sri Lanka (2017). Study on Upgrading Livelihood Strategies of Three-wheeler Drivers in Sri Lanka. *ISBN 978-955-764-13-9* https://nhrdc.gov.lk/nhrdc/index.php/publications/research-reports

Arunatilake, N., (2006). Education participation in Sri Lanka—Why all are not in school. *International Journal of Educational Research*, *45*(3), pp.137-152.

Daily FT. (2021) Upgrading livelihood strategies and the redeployment of three wheeler drivers in Sri Lanka. https://www.ft.lk/Columnists/Upgrading-livelihood-strategies-and-the-redeployment-of-three-wheeler-drivers-in-Sri-Lanka/4-69348 (Accessed: 13th August 2022)

Dissanayake, M., (2020). Explaining Mismatch Between Labor Supply and Demand in Sri Lanka: Youth and Gender Qualitative Study.

Economy next. (2021) Sri Lanka school dropout crisis of poor kids could worsen from Coronavirus: think tank. https://economynext.com/sri-lanka-school-dropout-crisis-of-poor-kids-could-worsen-from-coronavirus-think-tank-77476/ (Accessed: 14th August 2022)

Krejcie, R.V. and Morgan, D.W., (1970). Determining sample size for research activities. *Educational and psychological measurement*, *30*(3), pp.607-610.

Mahrool, F., (2020). Analysis of School Dropout among Secondary School Students: Case of Sammanthurai Education Zone. *Farwis, M.(2020). Analysis of School Dropout among Secondary School Students: Case of Sammanthurai Education Zone. International Journal of Academic Multidisciplinary Research*, *4*(12), pp.79-85

Mayadunne, Geetha, and Kalana Kariyasekera. Dropping out of school at secondary level: an exploratory study. *Sri Lanka Journal of Social Sciences* 44(2), pp. 199-212.

Ministry Of Education. (2016) Sri Lanka School Census Preliminary Reports 2016. Available at https://moe.gov.lk/wp-content/uploads/2020/06/School-Census-Report-2016.pdf (Accessed:14th August 2022)

Perera, M.A.N.R., (2015), February. School dropouts in Sri Lanka: A sociological analysis. In *Proceedings of International Conference on Humanities and Social Sciences Tiblisi, Georgia. https://journals. sjp. ac. lk/index. php/IRCHS/article/view/2262*. https://journals.sjp.ac.lk/index. php/IRCHS/article/view/2262

Ranasinghe, A., (2014). Youth Labour Market in Sri Lanka: A Challange for Policy Makers. *Youth and Social Transformation: Improving Life Chances of Youth in Sri Lanka. Colombo: Friedrich Ebert Stiftung SPARC University of Colombo*.

Ranasinghe, A., Madurawala, S., Su, J.J. and Senadeera, T., (2016). An empirical investigation of labor shortage in the manufacturing sector in Sri Lanka. *Griffith Business School*.

Sri Lanka Brief. (2016). 200,000 JOb Vacancies: Huge HR Dilemma at all BOI Zones. *Sri Lanka Brief:* https://srilankabrief.org/200000-job-vacancies-huge-hr-dilemma-at-all-boi-zones/

The World Bank. (2022) Country indicator Data – Sri Lanka. Available at https://data.worldbank.org/indicator/SE.ADT.LITR.ZS?locations=LK (Accessed:13th August 2022)

UNESCO- Country facts – Sri Lanka. (2021) http://uis.unesco.org/en/country/lk (Accessed:13th August 2022)

USAGE OF THE LIBRARY AMONG THE UNDERGRADUATES OF THE UNIVERSITY OF VOCATIONAL TECHNOLOGY

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ABSTRACT

University libraries invest a huge amount of money every year for the development of their resources and the purchase of new references for undergraduates and other uses of the university. Most of the students use the library during their examination period. It was also discovered that resources currently available are fairly adequate The main objectives of the study are to examine the purpose of the use of library resources, the occurrence of library visits, to determine the type of information needed, find out the duration of time spent in the library, and to determine the level of satisfaction of users towards library resources and services. A structured questionnaire was distributed to 120 undergraduates of all 4 faculties of the University of Vocational Technology. A total of 88 (74%) filled-in questionnaires were received. It was found that the habit of using the library should be improved, library collection has to be enhanced, Library space should be extended, photocopy facilities and internet facilities have to be improved and a computerized system should be introduced to the library.

Keywords*: Library resources, Library users, User satisfaction.*

1. INTRODUCTION

The primary function of any University Library is to provide the most needed and up-to-date information materials that will support teaching, learning, and research studies. The libraries have been described as the "heart" of the learning community, providing a place for students and faculties to conduct their research and advance their knowledge in the education system. Since university libraries are an important part of the higher education system, they should provide support services for formal educational programs as well as facilities for research and the generation of new knowledge. Any other library needs to know the real needs of the user community.

Since the university library is committed to providing excellent resources and services, it has to develop an ongoing dialog with its user community. On the other hand, libraries have to improve the quality of their services to survive in this volatile competitive environment. Therefore it is crucial to evaluate the library service from the service provider's point of view. At the same time to set up user-centered services the library needs to know the users and user needs. One of the main tools that can be used to evaluate and assess library services is the user survey. It is impossible to assess the changing needs of the client unless user surveys are conducted to determine user needs and their reading interests.

1.1. BACKGROUND

The library of the University of Vocational Technology (UoVT) consists of sections for lending, reference, and permanent reference. At present, it possesses more than thirty thousand volumes of books and continues to provide its services to both undergraduates and professionals in the Technical and Vocational

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education sector of Sri Lanka. It has been in existence for the past four decades and there is a timely need of developing it to suit the current demands while improving the infrastructure for the purpose. Hence, the major initiative developed to achieve this goal is conducting a user survey to assess the services of the library to make recommendations for its improvement.

Resources in the University of Vocational Technology library such as books, periodicals, reference books, CDs, Magazines, thesis, dissertation, and e-resources. are being provided to the users of the library. The University allocates money for the library every year. Therefore it is necessary to find out whether user utilizes them in a good manner and find out the issues faced by the students in the library. Further, the users satisfy their need either to visit the library to get the resources by themselves. It is observed that students of the university rarely visit the library.

1.2 AIM AND OBJECTIVES OF THE STUDY

The aim of the study is to find out whether the library resources and services are sufficient and adequately utilized by the students of UoVT Library and if not find a way of improving the situation.

The objectives of the study are;

i. To identify the purpose of visiting the library among the undergraduates

ii. To find out the desired sources of information of the undergraduates

iii. To find out the frequency of library visits among the undergraduates

iv. To find out the duration of time users spend in the library

1.4 REVIEW OF LITERATURE

The library of the university plays a pivotal role in the process of study and research of the student community. Over the past decades, interest in the use of the library by students and information needs have increased mainly due to an increase in the number of students and libraries must meet the needs of their clients in the best way. Research on student attitudes and the use of university libraries has been held in several countries (Eskola, 1998).

Williams (1995) investigated student library use in Canada and found that active learners who participate more in class and read and write and regular and active users of the library are learning more. Fauve (1989) found the difference in the frequency of library use by teachers and students, and that 94.8% of students use the services of the library. Olanlokun (1982) found that students use the library for classroom work, research, discussion, recreation, and other goals. Ajayi (1993) notes that students do not appreciate the value of the library, are at a disadvantage, and can visit the read-only library for exams.

Undergraduate Research relations with the libraries of the Scandinavian countries were carried out in Denmark in 1995, Sweden in 1995, and Finland in 1996. The results show that students are fairly frequent users of the library, although there are large differences in the way students of different specialties use library services. Student wants more learning tiles, more coursework, and more generous opening hours. According to Finnish and Swedish research Journal of the Association of University Librarians of Sri

Lanka. Volume 14 (number 1), June 2010, the students themselves demand more education in their search for information and use of the library (Hoagland, 1996).

Research by Fister (1992) showed that teachers play an important role in the leadership research of their students. She noted that the use of research tools can be a good starting point for the preliminary stage of the research process: later phases force students to rely more on citations because research questions are more clearly defined. User-specific characteristics that have been measured in the past.

Powell (1997) includes the frequency of access to the library and information library usage, attitudes and opinions, reading habits, levels of satisfaction, demographics, personality, lifestyle,e and awareness of library services. Majid (2001) found that the adequacy of the collection, services, and amenities was closely related to the perception of the library's efficiency. Some other factors that positively affect the intended effectiveness of the library were adequacy and effectiveness, library promotion, user involvement in the selection of library documents, convenient location of the library, participation in user training programs, the availability of assistance in the use of library resources and tools, and professional library subject. Adjibero (1980) found that Nigeria's university libraries fell short of user expectations. As a result, most of the students did not learn how to use the library and did not know the attitude of the library to their activities.

2. METHODOLOGY

The study used a mixed (qualitative and quantitative) approach questionnaires were used as the data collection method and convenient sampling was used. A structured questionnaire was circulated to 100 undergraduates among four faculties namely The Faculty of Information Technology, Faculty of Engineering Technology, Faculty of Industrial Technology, and Faculty of Education Technology. Out of which 88 (78%) students responded. Responses were analyzed using MS Excel software. 18 are from the Faculty of Education Technology. The analysis depicts that the Students from the Faculty of IT respondents are more prone to submit the filled-in questionnaire than other Faculty students.

Table 1: Distribution of Respondents according to Faculties

#	Faculty	Number of Respondents
1	Information Technology	26
2	Engineering Technology	22
3	Industrial Technology	22
4	Education Technology	18

3. RESULTS AND DISCUSSION

3.1. PURPOSE OF VISITING THE LIBRARY

The purpose of library visits gives important information about the library resources and information services that are required for the users. This helps the librarian to develop the library collection as well as improve the library services. Figure 1 shows that the majority of 38(43%) students visit the library for borrowing books. 20 students (23%) for studying, 15(17%) to refer materials, 10 (11%) for reading, and only 5(6%) visit the library for relaxing.
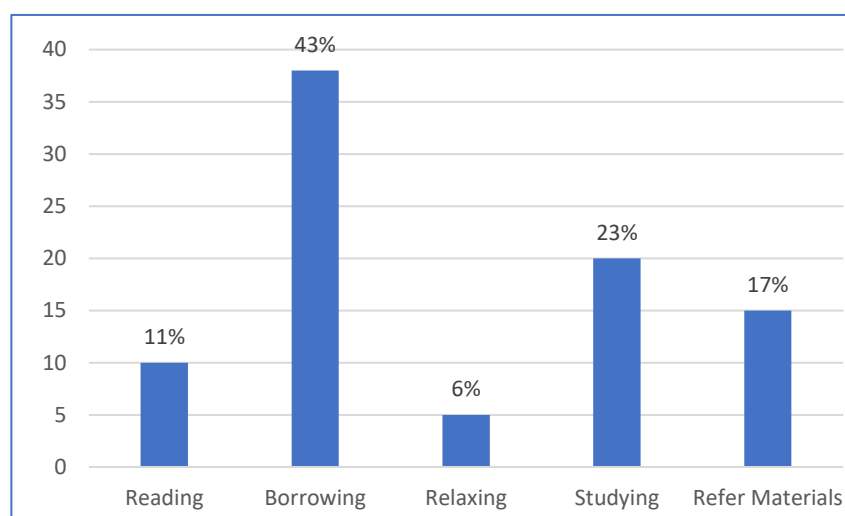
Figure 1: Purpose of visiting the library

3.2. DESIRED SOURCES OF INFORMATION

Figure 2 shows that undergraduates prefer to use books and e-Books which comes to 56 (50%) respondents, followed by 25 (22%) reference material, 14 (13%) Internet sites, 6(5%) journals and Newspapers, and Magazines which a   the least in a number. Generally, the students of the university under the study required a proper guide to use the various information resources such as newspapers, magazines journals, etc. to enable them with a great potential of information for their study and research.
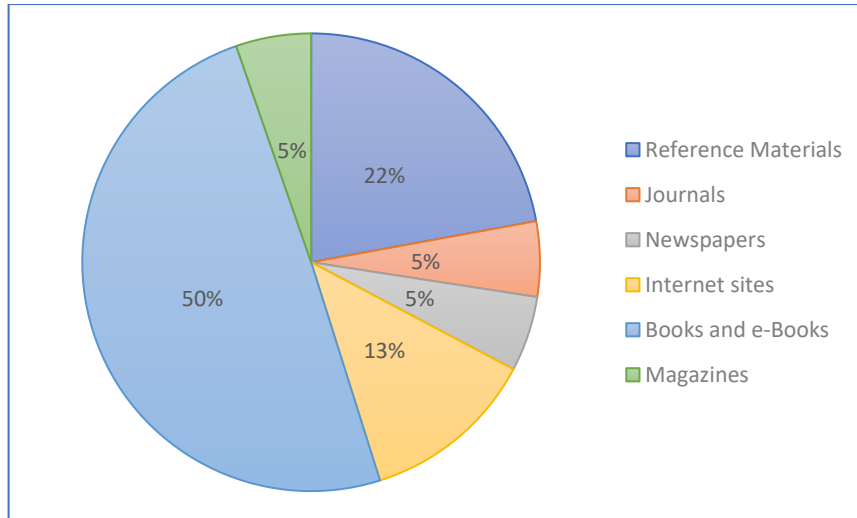
Figure 2: Desired Sources of Information

3.3 FREQUENCY OF LIBRARY VISITS

The frequency of visits to Uthe university library helps us to know about the regularity of the library patron for consulting library resources. Table 2 shows that 28 (32%) of the respondents visit the Library twice a month, followed by 21 (24%) weekly, 18(20%) visited twice a week, 15(17%) on monthly basis, 5 (6%) visited every day and 1(1%) of the respondents never visit the library. This is because the faculties are engaged in different academic activities and hence they are unable to visit the library regularly.

Table 2: Frequency of library visits

S/N	**Periodicity**	Students	**Total (%)**
1	Everyday	5	6%
2	Twice a week	18	20%
3	Weekly	21	24%
4	Twice a month	28	32%
5	Monthly	15	17%
6	Never	1	1%

3.4. TIME SPENT IN THE LIBRARY

Table 4 shows that 541(61%) majority of the respondents prefer to spend 1 hour or less in the library, followed by 27(31%) 2 hours,4 (5%) 3 hours, and 3(3%) respondents 4 hours.

Table 3: Time spent in the library

Time Spent	Students	%
1 hour or less	54	61
2 hours	27	3

254

3 hours	4	5
4 hours	3	3

4. CONCLUSIONS

The results of this survey are presented in four sections under four major objectives:

The findings of the study show that the majority of undergraduate students of the University of Vocational Technology visit the library for borrowing their recommended books while a very minor percentage visit for relaxation purposes.

Most of the respondents have mentioned that their desired sources of information the books (hard copies) and e-books, and very few expect to have journals, magazines, and newspaper

The frequency of library visits by undergraduates is not really at a satisfactory level. The pathetic situation is some students never visit the library. Some actions to be taken to rectify this issue and motivate the students to use the library services and get the maximum benefit to in their competencies and especially update their knowledge.

This study reveals that undergraduates spend less than 1 hour on their visit to the library. This is also not a good indication since there are a lot of new reference materials available in the library. Once again this should be further analyzed and measures are to be taken to encourage students to fully utilize the available library facilities to enhance their competencies to match the modern world of work.

REFERENCES

Dhanavandan, S. &Tamizhchelvan, M. (2012, March).*An Evaluation of E-Resources in Academic Libraries in Tamil Nadu.Journal of Emerging Trends in Computing and Information Sciences, 3 (3), pp* 421-426.

Ethelene Whitmire (2002) Academic library performance measures and undergraduates' library use and educational outcomes, *Library & Information Science Research, 24(2)*, pp 107-128

Google search. Available at: https://www.quora.com/What-is-the-best-definition-of-library-resources (Accessed: 12th October 2021)

Kumar, B. T., & Kumar, G. T. (2008). Use of electronic information sources by the academic community: *a comparative study.*

Rehman, S., & Ramzy, V. (2004). Awareness and use of electronic information resources at the health sciences center of Kuwait University. *Library Review, 53(3), pp*150-156

Stanley O, Unuabor1 and Godsent C. O. Oseghale (2018), Impact of the use of library course for undergraduates' better usage of library resources in Faculty of Education, University of Ibadan: A study, *African Educational Research Journal. 6(3*), pp. 181-189. DOI:0.30918/AERJ.63.18.059.ISSN: 2354-2160

IMPACT OF TEACHING METHODS ON STUDENTS' ACADEMIC PERFORMANCES IN UNIVERSITY COLLEGES, SRI LANKA

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ABSTRACT

This study has been undertaken with the main objective of investigating the impact of teaching methods on students' academic Performances in University Colleges, in Sri Lanka. According to the Labor Market Information Bulletin – 2021, the number of students recruited to university colleges was 1933. But as per the data, the number of students who have completed the studies was only 307. Hence, the main problem area of the study is low academic performance. There can be a lot of factors affecting low students' Academic Performances. This study has been undertaken to study whether there is an impact of Teaching Methods on Students' Academic Performances with Special Reference to University Colleges in Sri Lanka. A stratified random sampling technique has been adopted in the selection of the sample. Regression analysis was used to test the impact and SPSS 23 version has adopted in the data analysis. According to the findings, the researcher was able to find that there is an impact of Teaching Methods on Students' Academic Performances. It was recommended to use teacher-student interactive methods in teaching rather than teacher-centered or student-centered methods.

Keywords: Performance, Students, Teaching methods, University College.

1. INTRODUCTION

Technical and Vocational education is one of the important sectors in a country. Students of technical and vocational education provide a significant contribution to the country's economic growth and development in various ways. However, full completion of the studies in technical and vocational education by the students become a serious concern. In Sri Lanka, there are a lot of institutes that provide technical and vocational education and among those institutes, University Colleges held a priority. There are six University Colleges that has established to promote technical and vocational education. University Colleges offer National Vocational Qualifications through two levels Level 05 and Level 06. When it comes to the student's performance in these University Colleges, the majority of students were unable to complete their studies. There should be a lot of factors affecting this problem. Some of the problems are lack of interest, poor economic conditions to continue the studies, external influences, etc. However, there is another factor to be considered which affects the students' low performances. That is the teaching method. Most of the lecturers have university degrees and some have postgraduate degrees as well. Based on the academic background of NVQ students sometimes, teaching methods may influence the students' performances. So this study has been undertaken with the main purpose of investigating the impact of teaching methods on students' academic performances with special reference to University Colleges in Sri Lanka.

As per the available data, the number of students who have completed their technical and vocational education in university colleges is considerably low. There can be a lot of factors affecting that. Lack of

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interest, poor economic conditions, difficulties in understanding, family problems, etc. are a few examples. However, there is another factor that has to be considered, in finding the reasons for students' low performances. That is the teaching method.

Therefore, the main objectives of this study are:

i.   to find whether there is any impact of the teacher-centered method on students' academic performances with special reference to University Colleges in Sri Lanka

ii. to find whether there is any impact of the student-centered method on students' academic performances with special reference to University Colleges in Sri Lanka

iii. to find whether there is any impact of the teacher-student interactive method on students' academic performances with special reference to University Colleges in Sri Lanka

1.1 BACKGROUND STUDY

Students' academic performance is one of the important areas and it has a growing interest. When it comes to technical and vocational education in Sri Lanka, University Colleges have a priority. University Colleges are mainly responsible for Providing Vocational Education in Sri Lanka. Currently, there are 06 University Colleges in Sri Lanka. These are the University College of Anuradhapura, the University College of Matara, the University College of Jaffna, the University College of Kuliyapitiya, the University College of Batangala, and the University College of Rathmalana. These educational institutes offer a variety of vocational courses which allow students to get the National Vocational Qualification under two levels Level 05 and Level 06.

As per the data of the Labor Market Information Bulletin, in 2021, in 1933 students have admitted to university colleges. But only 307 students were able to complete their studies. This is one of the problems which needs the immediate attention of responsible parties since the government is spending a lot of money on providing vocational education. Table 1 shows the data regarding the number of students recruited in public university colleges' number of students who have completed the courses in 2021.

Table 1: Number of students recruited and completed the courses in 2021

University Colleges	No. Recruited	No. Completed
University College of Anuradhapura	767	48
University College of Jaffna	206	62
University College of Matara	276	32
University College of Kuliyapitiya	249	-
University College of Batangala	164	-
University College of Rathmalana	271	165
Total	**1933**	**307**

Source: Labor Market Information Bulletin, in 2021

According to the Labor Market Information Bulletin in 2021, 1933 students have recruited but only 307 students were able to complete the courses. This indicates the poor academic performance of students. However, there can be a lot of factors affecting this. Among the factors, teaching methods can be considered one of the influential factors affecting students' academic performances.

The main purpose of teaching at any level of education is to bring a fundamental change in the learner (Tebabal & Kahssay, 2011). There are three teaching methods as teacher-centered, student-centered, and teacher-student interactive method. This study will find the impact of teaching methods on student's academic performance in University Colleges, in Sri Lanka.

2. METHODOLOGY

The type of the study is a survey and the study will be conducted in a natural environment, where events normally occur, that is non – a contrived setting. This study is a cross-sectional study. The unit of the study was individuals' i.e. NVQ students in Sri Lanka.

A conceptual framework is the foundation of the entire research project and also conceptual framework helps to identify and define the important variables and their associations that are relevant to a specific problem area (Sekaran and Bougie, 2011). Figure 1 shows the Conceptual Model of the study.
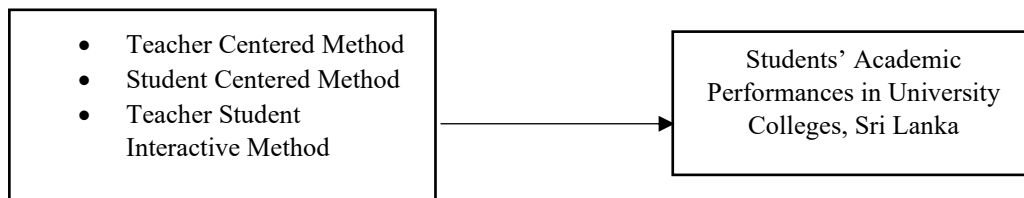
Figure 1: Conceptual model

The population of the study consisted of students who are currently enrolled in University Colleges and approximately consisted 2000 students. A stratified random sampling technique has been adopted in the selection of the sample. The researcher adopted Krejcie and Morgan's table (1970) in deciding the sample for the study. Accordingly, 325 students have selected as the sample. SPSS 23 version was used in data analysis and regression analysis was used to test the impact. The questionnaire developed by Elvis Munyaradzi Ganyaupfu, 2013 has been used to collect data.

3. RESULTS AND DISCUSSION

Table 2: Results of Regression Analysis

Variables	Statistics		
	Teacher-Centered Methods	Student-Centered Methods	Teacher–Student Interactive Method
Method	Linear	Linear	Linear
R Square	.527	.512	.761
Adjusted R Square	.526	.510	.760
F	421.59	395.8	1201.5
Significance	000	000	000
B- Constant	.489	.661	-0.605
b - value	.758	.714	.950

Source: Survey data, 2022

Teacher-Centered Teaching Methods and Students' Academic Performance - The b value of the equation is 0.758. As indicated by R Squared, 52.6 % of the variance in students' academic

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performance is explained by teacher-centered teaching methods with a standardized beta of 0.527. The F value is 421.59, which is significant at 1% which implies that teacher-centered teaching methods have significantly explained 52.6 % of the variance in students' academic performances. Student-Centered Teaching Methods and Students' Academic Performance - The b value of the equation is 0.714. As indicated by R Squared, 51.0 % of the variance in students' academic performance is explained by student-centered teaching methods with a standardized beta of 0.512. The F value is 395.8, which is significant at 1% which implies that student-centered teaching methods have significantly explained 51 % of the variance of students' academic performances. Teacher Student Interactive Teaching Methods and Students' Academic Performance - The b value of the equation is 0.950. As indicated by R Squared, 76.0 % of the variance in students' academic performance is explained by teacher-student interactive teaching methods with a standardized beta of 0.761. The F value is 1201.5, which is significant at 1% which implies that teacher-student interactive teaching methods have significantly explained 76 % of the variance of students' academic performances.

Table 3: Regression between independent variables and dependent variable

Model Summary				
Model	R	R Square	Adjusted R Square	Std. The error in the Estimate
1	.772a	.596	.569	.53234

Source: Survey data, 2022

The 'R'-value of the table explains the multiple regression coefficients which are 0.772 and it shows a positive relationship between independent variables and dependent variables. According to the above table, the 'R^2' value is 0.596. Accordingly, 60% of students' academic achievement can be explained by the three independent variables (teacher-centered, student-centered, and teacher-student interactive teaching methods) jointly and the remaining unexplained 40 % might be due to other factors that were not considered in this study.

4. CONCLUSION(S)/RECOMMENDATIONS

McWhorter & Hudson-Ross (1996) found that without new approaches to instruction that connect to the learning needs of students, many will perform poorly and are likely to drop out of studies. The problem of the research was the low study completion rate among students in University Colleges in Sri Lanka and thereby the low academic performance among students. Based on the findings, the research was able to find that there is an impact of teaching methods on students 'academic performance. Among the variable that comes under teaching methods, the teacher-student interactive teaching method has an impact on the

student's academic performance in University Colleges in Sri Lanka. As per the findings of the study, lecturers have to follow the teacher-student interactive method in delivering lectures so that students will actively engage in academic activities which will add a direct impact on improving the academic performance of the students. Students of technical and vocational education join the university colleges according to their advanced-level examination results. The majority of them do not have top-level English knowledge and considerable time is needed to understand the subject-related facts. If the subject delivery method is teacher-centered, students won't be able to properly understand things. Hence there will be a dropout or the student will fail the subject due to a lack of understanding. On the other hand, these students do not have the competency to follow student-centered teaching methods such as case studies, especially without poor practice. Under the teacher-student interactive method, lecturers can use various interesting tools and techniques to boost the motivation of the students to learn. A typical learning environment will add little or no value to the student but teacher – student's interactive method can add value to the delivery process. Finally it is recommended to adopt the teacher-student interactive teaching method in increasing the students' performance.

REFERENCES

Damodharan V. S. &Rengarajan. V (1999), "Innovative Methods of Teaching," *National Research Council, Educational Journal Publication, 12*(2), pp.49-53.

Hesson, M. & Shad, K.F. (2007), "A student-centered learning model," *American Journal of Applied Sciences*, pp.628-636

Hightower, A.M. (2010), Improving student learning by supporting quality teaching: Key issues, effective strategies, Editorial Projects in Education, *3*, p.14

Hudson-Ross, S. & McWMcWhorter. (1996), Going back/looking in: A teacher educator and high school teacher explore beginning teaching together, *English Journal*, 84(2): pp.46-54

McDaniel, M. A., Friedman, A., & Bourne, L. (1978), Remembering the levels of information in words. Memory & Cognition, 6(2):pp. 156-164

TebTenable. & Kahssay, G. (2011), The effects of student-centered approach in improving students' graphical interpretation skills and conceptual understanding of kinematical motion,*Lat. Am. J. Phy. Edu, 5(2*):pp. 374-381

Tyndale, P. (1998), Traditional studying for examination versus constructivist learning tasks: Do learning outcome differ?. *Students in Higher Education, 23(20):* pp.173-190.

A Review Of The Effect Of Economic Crisis On Education

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ABSTRACT

When a nation's economy is in deep recession, every other sector of the nation rapidly deteriorates qualitatively and quantitatively. Quality education shows how powerful a nation could be. When an economic crisis impacts the education sector negatively, the overall development of a nation worsens leading to illiteracy, unemployment, poverty, restlessness among youth, etc. With the main objective of identifying the effect of economic crises on education systems, this review mainly looked at the positive and negative effects on education. Thirteen articles published between the years 1990 to 2017 were selected based on the keyword search of the respective discipline of study. The review revealed that economic crises could impact education systems both negatively and positively. The impact was observed mainly in the teaching and learning processes taking place at the school level, tertiary level, and in TVET sector. This has negatively affected the improvement of physical resources and the well-being of human resources. In addition, permanently dropping out of both young schoolers and adult schoolers from schools and higher educational institutes and increased rate of unemployment among youth were significant. In reviewing the positive impact of economic crises on education, the expansion of the professional capacity of the education system, and the resilience of teachers and the stakeholders in facing challenges at different levels, were identified as significant.

Keywords: Economic crisis, education, negative impact, positive effect.

1. INTRODUCTION

With the swift expansions in education after World War II, the notion of universal education has been that it is the right of every citizen in a country to access elementary education. According to Heynaman (1990), the practice of universal education as a model was initiated in Western Europe and spread to countries now known as The Organization for Economic Cooperation and Development (OECD) and then socialist countries in Eastern Europe and to the republics in the Soviet Union. By the end of the 1960s, when the colonized countries became independent political states, education was regarded as one of the prime public priorities. Thus, the school-age population urged for universal education and created an expansion of the system of education throughout the world.

The economic system of any country and its growth is essentially related to its educational system. A decline in the economy of a country influences its education adversely. Thus, the economic crisis a country faces throughout deeply affects the quality of human life. Therefore, this paper is an attempt to narrate the findings published in the literature regarding the negative and positive impact of the economic crisis on education. Thus, the review paper looks at the following two objectives

    i.   to find out the negative effects of the economic crisis on education in a country and

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    ii.   to explore the positive impact of the economic crisis on education in a country.

In reviewing the available literature, the focus could not be limited to any specific countries because economic crises had taken place under various circumstances throughout history in both developed and developing countries.

2. METHODOLOGY

The review was conducted based on the narrative review, reviewing 13 articles published between the years 1990 to 2017. The articles were selected based on the keyword search of the respective discipline of study. Selected articles were then categorized into identified common themes analyzed through the review. Since economic crises occurred at different times in different countries due to ample reasons, the review was not limited to the recent past.

Instantaneous assessment of the effect of financial crises on education has become a difficult task mainly due to the rigid patterning of the structure of education systems. Hence identifying the particular effects of a crisis on any education system becomes a slower process. Further, the education system monitors and publishes their statistical progress annually. This delay hinders identifying the effects of financial crises on the education sector. Therefore, identifying research related to recent national economic crises and their impact on education became a difficult task. The collected literature was critically analyzed and the review was limited to two themes; the positive effect of the economic crisis on education and the negative effect of the economic crisis on education.

3. RESULTS AND DISCUSSION

From the reviewed literature, the researchers were able to extract several domains affected by the deteriorated education system as a result of economic crises that occurred since 1990. Hence the review is based on how the economic crises affected school education, tertiary education, and higher education ultimately affecting the well-being of people in society.

3.1. NEGATIVE EFFECTS OF THE ECONOMIC CRISIS ON EDUCATION

Heynaman (1990) notes that the economic crisis has enormously damaged the quality of education in developing countries. Further, it is highlighted that specifically, the recurrent budget resources allocated for non – the salary category in education, such as reading material, stationery, furniture, etc will get affected negatively. Frankenberg et al. (1999) in discussing the effect of the economic crisis in 1998 on education, highlighted how the crisis has affected the operation of schools. The increase in the cost of papers affected the rising costs of books, supplies, and photocopying. In elementary schools in Indonesia, payment of monthly fees became a major issue compared to junior secondary schools whereas, in junior secondary schools, the cost of transportation and shortage of maintenance funds was more problematic.

Frankenberg et al. (1999) studying deeply into the fact how the cost and school fees affected the functioning of schools found certain remedies followed to overcome the issues. For instance, the participants opted to write on the board, read test questions, and increase test fees or ask parents for donations as solutions for the rising costs of papers and photocopying. In addition, the participants opted to request students to share books, keep more copies in the library, and no longer require the use of books as solutions for the shortage of books. Revealing similar findings, Bamigboye et. al (2016) elaborated that the parents could not afford to buy books and other related educational materials in Southwest Nigeria due to the economic crisis in 2016.

According to Heynaman (1990) the attempts made by countries that are affected by the economic crises to control the negative impact on education, encounter severe challenges in changing policies as they drastically affect the salaries of teachers and their service conditions. For instance, Young (2014) studying how the economic crisis in Greece affected English language teaching in Greece concluded that most English as foreign language students attend private language schools in Greece named frontistiria and due to delays in payment of school fees, the salary payments for staff have also been halted. This too has affected students' choice of exams. Further, Bamigboye et. al (2016) reports that Nigeria's education system which depends completely on government budgetary allocations was disturbed severely affecting students, teachers, and parents. The impact had been direct on teachers causing salary reductions. Teaching which attracted the best individuals and was considered much respected among many other professions was treated otherwise consequently affecting the quality of education in the long run, especially in Southwest Nigeria. Reduction in the recruitment of teachers and other resource personnel essential for effective education curriculum delivery has resulted in classroom teaching and learning discouraging, especially affecting the teaching and learning of core subjects. Low budgetary allocations on education affected "the payment of allowances to teachers, purchase of books, subscription for journals needed for effective education curriculum delivery, staff training through workshops, conferences and seminars as well as the rate of renovation of dilapidated buildings" (p. 2894). Another major finding of the study was that the reduced salaries affected teachers' motivation, especially in the effective delivery of their lessons due to lack of concentration. "Some even become unnecessarily harsh to students and would not take time to give a proper explanation on any concept taught, as students lose interest in class activities thereby affecting the impartation of such knowledge." (p. 2894). This economic recession too had caused higher graduate unemployment causing a national crisis causing unrest among youth in the country.

Nambissan (2010), observes that in some studies of the East Asian economic crisis of 1997, the impact of the crisis differs across regions but whatever the region it may be, education and health of children harmfully affected the poor families and increased inequalities in education. Thomas et al. (2004), found that the economic crisis in Indonesia made severe impacts on the education of students from the poorest households, resulting in early withdrawals from schools. One strategy followed by parents to avoid the withdrawal of all children from school was younger children were encouraged to discontinue their

education while older children continue school and gain an education. Further studies by Thomas et al. (2004) revealed that later, even though the economic situation recovered and the family income increased, the children who were taken out of schools during the crisis found it difficult to continue their education. As observed by Highway (2009), as cited by Nambissan (2010), in India, the global economic crisis has severely affected the children of the workers who engaged in informal sector jobs. Some such workers lost their jobs, some had to choose lower-paid jobs and many returned to their hometowns. Consequently, some children belonging to such family backgrounds had been forced to quit school as a result of not being able to afford school fees, others had shifted to cheaper local schools, and the school expenses were cut down. It was further observed that, in India, among the families who were involved in gem and jewelry work compared to the boys, 20% of the girl children were withdrawn from schools.

In analyzing the economic crisis that took place in Indonesia in 1998, Frankenberg et al. (1999) claim that one of the major negative impacts of the economic crisis on education in Indonesia had been that children and young adults withdrew from schools. The researchers predict that the impact of withdrawal from the schools would have long-term effects on the well-being of both age groups. Among the group of older children, those who stopped schooling would never return to school after the crisis. Younger children have the possibility of returning to school after the crisis. This is a different observation from that made by Thomas et al. (2004) regarding the economic crisis in Indonesia and its impact on education. Accordingly, the younger children in Indonesia discontinued their education while the elder children continued. Further, Frankenberg et al. (1999) predict that, if children who permanently drop out of school due to economic crisis, cannot read and write properly, the consequences can be observed only after many years.

Varghese (2009) discusses several ways that higher education and employment were affected due the economic crisis in East Asia. The crisis affected the job prospects of graduates, and reduced funding for education at the three levels the government, private, and household level, universities lost their investments due to the bankruptcy of the banks the universities invested their savings, student support systems such as student loans be severely affected, freezing of the academic programs and the staff recruitment and declining of the aid to education by bilateral and multilateral agencies.

Similarly, when discussing the Tertiary and Vocational Education Training (TVET) sector and its survival during financial crises, Barakat et al (2010) note that the impact of the economic crisis is mixed. According to Barakat et al (2010), the sector seems to have negatively affected Ireland, the Netherlands, Belgium, and Hungary, due to the economic recession. In contrast, As Barakat et al (2010) mention, in the TVET sector during the economic recession in Germany, a significant shortage of training places as a result of the crisis could not be observed. This is reflected both in official statistics of youth seeking and obtaining apprenticeships and in survey responses among private enterprises.

As Koudahl (2010) states, in several countries, especially in the European continent, vocational education and training are based on the principle of dual education, where the apprentices spend one part of their education and training at a vocational school and another part in a company or firm directly involved in

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ordinary working life. The economic crisis in the continent put pressure on the principle of dual education within vocational education and training because the firms and companies were less motivated to provide the necessary number of training places for the apprentices. Further this caused problems for the young people who wanted to take vocational education as they were not able to finalize it without access to a proper training place. On the other hand, it provided problems for businesses and enterprises because there was a shortage of skilled labor in the market. Although certain countries such as Denmark, Germany, and Holland substituted the company training of apprentices with school-based training, the quality of the training was questionable and the status of such apprentices was low in the labor market. Hence the employability rate of them in the market was lower.

In analyzing the impact of the economic crisis on labor and education in Europe, Barakat et al (2010) highlighted that education attainment had a strong influence on job security during an economic crisis. Barakat et al (2010) claim that, in the European context, the impact of the economic crisis on higher education has been affected in contradictory ways, directly and indirectly. On one hand, the students who depend on financial assistance from their parents will face challenges if the parent's income drops or unemployed. Moreover, access to student loans will be restricted. It is also claimed that the expected demand for tertiary degrees might also decline due to future job uncertainty. Barakat et al (2010) note that there are positive aspects of higher education (discussed in subsection 3.2), in discussing the economic crisis that in the European context, there is an overall increase in demand for higher education. Yet, it does not imply that individuals who are engaged in higher education will not be affected. They may interrupt, postpone or abandon their higher education plans due to economic hardships faced by either the students as individuals or by their families. Moreover, there is a necessity of monitoring the different components such as delayed graduation, prolonged stay in the universities as a student, and the negative impact of the economic crisis on higher education.

Heynaman (1990) identifies that, compared to the developed countries, the problems in education largely take place in largely fiscal situations of unavailability of adequate resources to sufficiently finance quality education, in the developing countries. In such countries, Heynaman (1990) finds that the issue is not the insufficient level of resources but the insufficient motivation to utilize the resources effectively.

3.2. POSITIVE IMPACT OF THE ECONOMIC CRISIS ON EDUCATION

Researchers find that the economic crisis makes a positive impact on education as well. Heynaman (1990) highlights that the economic crisis "may increase the professional capacity to manage the education system based upon what is feasible rather than upon precedent" leading to "greater professional credibility" in education (p.115). For instance, Botoul et. al (2017) discussing primary school teachers' resilience during the economic crisis in Athens, Greece mentioned that the economic crisis in Greece too created economic and social problems, and hurt the quality of education. However, teachers did not abandon their jobs, despite the difficulties they encountered as a result of the crisis, since they did not have many job choices,

and if they abandoned it, they would lead to unemployment. The major finding of the study was that half of the primary school teachers in Athens, Greece showed moderately high and high resilience towards the economic crisis and its impact on education. Their resilience had been influenced by the economic crisis at a moderate level facing the difficulties due to the crisis at a good level. Another important finding was that the Greek teachers' resilience was very highly correlated to his/her relationship with their families and his/her colleagues explaining the strength of the Greece family nexus.

Moreover, Heynaman (1990) observed that the economic crisis may allow the policymakers to relook at their policy dilemmas, and the practical measures can be adapted across categories of economic development to find multilateral solutions to basic education. As an institutional-level measure taken to overcome difficulties in continuing the functioning of foreign language schools in Greece, Young (2014) mentions that a reduction in fee structure has been introduced in response to the crisis. To encourage the enrolment of more students, thereby increasing the income, the schools introduced English courses receiving discounts on lessons in a second foreign language and introduced a reduction in fees for younger students if their older siblings attended the school.

The economic crisis too to impacted positively the education sector by enabling the use of multiple teaching-learning techniques. Accordingly, Varghese (2009) highlights through the findings of an online education survey in Berlin in 2008, "the economic crisis boosts e-learning, informal learning, and blended learning, and that the crisis, with a shrinking education sector budget, is enlarging the use of technology" (p.23).

Considering the positive impact of an economic crisis on higher education and employment, Douglass (2010), as cited by Barakat et al (2010) claims that, as an alternative to unemployment, young people may face an increased motivation to enroll in higher education which may increase their employability through increased qualifications and to 'wait out the crisis. In the European context, the experience of the economic crisis is that "demand for higher education generally goes up during economic downturns" (p. 7).

4. IMPLICATIONS

The review revealed that there are both negative and positive impacts of the economic crisis towards education in the teaching and learning process in education at the school level, tertiary level, and in the TVET sector. As for the negative impact, the economic crises that occurred in various parts of the world, the economic crisis led to a lack of finances to support school education in the aspects of reading materials, stationery, furniture, teaching, and learning aids in the schools. In considering the human resources in education, reduction of salaries provided for teachers, and reduction of recruitment of teachers and other resource persons occurred mostly when the countries faced economic crises, while students of several age groups in most affected families of lower social strata, temporarily or permanently dropped out from the schools. In the higher education sector, student support systems were severely affected, while the freezing of academic programs, avoiding staff recruitments for universities, and declining aid to higher education

occurred in several countries. Yet, in the TVET sector, the review revealed that the impact of the crisis is mixed. The available literature related to the TVET sector is limited to developed countries such as Ireland, the Netherlands, Belgium, Hungary, Denmark, Germany, and Holland.

In reviewing the positive impacts of economic crises on education, it is revealed that the economic crisis expands the professional capacity of the education system, and made the teachers and the stakeholders resilient in facing challenges at different levels, such as sharing of resources, using alternative methods in providing teaching learning aids, etc. During the economic crisis that occurred in Greece, teachers' resilience was highly connected to the support of their families and colleagues. Moreover, restructuring the payment of fees creatively, by providing concessions and lessening the economic burdens at the family unit level had been practiced in Greece. In the aspect of the teaching-learning process, the economic crisis has enabled the education sector to practice multiple teaching-learning techniques and magnified e-learning, informal learning, and blended learning by increasing the use of technology.   In considering the higher education sector, the review revealed that, even though the individuals suffer due to several aspects of the economic crisis, it shows an increase in motivation among young people to gain higher education, especially in the European context.

In considering the developing countries, it was observed that the issue is not the insufficient level of resources but the insufficient motivation to utilize the resources effectively. Therefore, economic crises allow countries to relook at their policy dilemmas in the education sector, which is interconnected with employability, development, and well-being of the society while allowing the stakeholders in the education sector to be resilient in facing the economic crisis.

REFERENCES

Ander, M. L., Turbow, S., Willgerodt, M.A., Ruhnke,G.W. (2020). Education in a Crisis: The Opportunity of Our Lives. *Journal of Hospital Medicine*. 15, (5).

Bamigboye, G., Ede, A., Adeyemi, G., (2016). Impact of Economic Crisis on Education: Case Study of Southwest Nigeria, *Proceedings of INTED 2016 Conference 7th-9th March 2016, Valencia, Spain*.

Barakat, B.; Holler, J., Prettner, K., Schuster, J., (2010): The impact of the economic crisis on labor and education in Europe, Vienna Institute of Demography Working Papers, No. 6/2010, *Austrian Academy of Sciences (ÖAW)*, Vienna Institute of Demography (VID), Vienna

Botou, A., Mylo-nakou-Keke, I., Kalouri, O., & Tsergas, N. (2017). Primary School Teachers' Resilience during the Economic Crisis in Greece. *Psychology, 8*, pp. 131-159. http://dx.doi.org/10.4236/psych.2017.81009

Frankenberg, E., Beegle, K., Thomas, D., Suriastini, W., (1999). Health, Education, and the Economic Crisis in Indonesia.

Heyneman, S. P., (1990), Economic Crisis and the Quality of Education, *International Journal on Educational Development*, 10(21, 3), pp. 115-129, *Pergamon Press*

Koudahl, P.D., (2010). Vocational education and training: dual education and economic crises, *Procedia Social and Behavioral Sciences* 9, pp.1900–1905.

Nambissan, G. B., (2010) The global economic crisis, poverty, and education: a perspective from India, *Journal of Education Policy*, 25(6), pp. 729-737, DOI:10.1080/02680939.2010.508180

Pârgaru, I., Gherghina, R., Duca, I., (2009), The Role of Education in the Knowledge-Based Society, *Annales Universitatis Apulensis Series Oeconomica, 11(2)*

Pilz, M., (2017), Vocational Education and Training in Times of Economic Crisis - Lessons from Around the World, Technical and Vocational Education and Training: Issues, Concerns, and Prospects, *Springer.*

Thomas, D., K. Beegle, E. Frankenberg, B. Sikoki, J. Strauss, and G. Teruel. 2004. 'Education in a crisis.' *Journal of Development Economics* 74(1):pp. 53–85.

Varghese, N. V., (2009), Globalization, economic crisis and national strategies for higher education development, *International Institute for Educational Planning, Paris.*

Young, S. (2014). The Impact of the Economic Crisis on English Language Teaching in Greece: a Case Study of a Language School. *MRes: Educational and Social Research*. The University of London, Institute of Education.

NEED FOR GUIDANCE AND COUNSELING TO THE JUNIOR SECONDARY STUDENTS IN WELIMADA EDUCATION ZONE, BADULLA DISTRICT

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ABSTRACT

Personal, academic, and professional, are the broad field of counseling. This study aims to assess the counseling and guidance requirements of junior secondary school children in light of their perceptions. Participants in the deliberate sampling were chosen based on a set of criteria. Ninety-nine percent of the participants in the study had previously acknowledged that they required counseling services from the school counseling department. A total of 91 students who contacted the career counseling section were interviewed. Students who volunteered to take part in the study submitted written applications. The data that was gathered was examined using the content-analysis approach. Finding concepts and connections that might be utilized to analyze the information acquired was the main goal of content analysis. Three categories were recognized after studying the responses provided by the students such as successful learning strategies, getting over test phobia, and self-motivation. One of the most important phases in a young person's development is the transition from childhood to puberty. Individual or group guidance programs about exam anxiety, efficient learning, and motivational techniques should be implemented to appropriately prepare students for courses and lessons. Aggressive behavior and bullying should not be tolerated by teachers or counselors.

Keywords: *Career; Educational; Personal Guidance and Counseling Needs.*

1. INTRODUCTION

The broad field of counseling encompasses three basic areas such as personal, academic, and professional. (Caipang,2014) asserts that a school counselor does not know the subject matter in the interview while a teacher is aware of the results to clearly distinguish between teachers, school counselors, and psychotherapists. According to her, counseling has a wider scope than psychotherapy, which has a deeper one. According to some experts, counseling is a procedure that involves two counselors working with a client who needs assistance. Students in the junior secondary level may require assistance and counseling. These issues often have an impact on students' academic, professional, social, and personal growth. Three important factors significantly influence pupils. 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 (2005). 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), supporting this position of counseling at the educational level says that the counseling program is an integral part of the total educational program. Counseling in the educational system should help boys and girls alike, to develop their capacities to the full. Effective school counseling should help to improve the self-image of

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young people and facilitate achievement in life tasks. Parents expect the school to provide solutions to the indiscipline in junior secondary schools caused by their children and assist them to make career choices.

1.1 BACKGROUND STUDY/ REVIEW OF LITERATURE

According to the American School Counselor Association (ASCA), school counselors are certified 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 be interfering with the student's 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. The school counselor sometimes encounters difficulties while trying to do their job. Reporting the student's success and the problems of the student to the parents sometimes can be challenging. 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 amount of time. It is frequently thought to be under the purview of the classroom teacher, pedagogue, or school psychologist. The school counselor has a significant and vital role in the organization, structure, programs, and policies of the school, according to Lindwall (Coleman,2011School counselors can influence school policies by making sure they mirror the values of the school. They can also have an impact on educational initiatives by ensuring that they are useful for students and provide them with opportunities to engage with the greater school community, according to the American Psychological Association (APA).

School counselors assist students in overcoming obstacles in the classroom as well as other issues that may affect their academic achievement. like one-on-one counseling, counseling in small groups, counseling in big groups, or lectures. Additionally, they take part in behavior plans for the whole school that encourage good behavior and discourage bad. They are assessed to determine whether the Guidance Counseling program has been executed and whether students' needs and expectations have been met, even though they have significant responsibility for the implementation and success of the school program. (Gysbergs,2011), 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 students' 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. Meeting students' needs in the areas of the school, employment, personal/social advice, and counseling is part of preparing them for life. A student 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. Additionally, he or she can gain problem-solving abilities, social skills, and the ability to manage exam anxiety. This study aims to assess the counseling and guidance requirements of junior secondary school children in light of their perceptions. The following questions were addressed in this context:

   i.   What are the educational and counseling needs of junior secondary school students?
   ii. What are the needs of junior secondary school students in terms of career counseling?
   iii. What are the junior secondary school students' requirements for personal and social therapy (related to personal issues)?
   iv. About the friendly environment, what are the personal/social guidance and counseling requirements of junior secondary school students?

2. METHODOLOGY

The qualitative research technique was used for the study and this method emphasizes qualitative technical definitions and meanings. Methods for purposeful sampling naturally develop during the qualitative research process. They allow the researcher to thoroughly examine the situations with lots of information. According to a set of criteria, purposeful sampling was used to select the sample. Ninety-nine of the participants had previously stated they needed advice and therapy from the school counseling unit. They were also included in the research based on this criterion. Students in the junior secondary level in the Welimada Educational Zone participated in the study and they had been advised by the school counseling unit if they were interested in taking part in a survey to learn more about their needs for guidance and counseling. Interviews were conducted with a total of 91 students who contacted the career guidance unit. 16 girls and 14 boys from the sixth grade took part in this study. 15 girls and 16 males from the seventh grade took part in this study. Eleven boys and nineteen girls in the eighth grade took part in this study.

Table 1: Sample Structure

Grade	Girls (N)	Percentage(%)	Boys(N)	Percentage(%)	Total
Grade 6	16	53.3	14	46.6	30
Grade 7	15	48.3	16	51.6	31
Grade 8	19	63.3	11	36.6	30
Total	50	54.9	41	45	91

Data were gathered using a semi-structured interview approach, and relevant literature was examined. Studies with the selected group of junior secondary students concentrated on vocational and personal/social advice and counseling. Students who voluntarily agreed to participate in the study submitted applications in writing. To increase the data's dependability, some of it was delivered directly. Participation in interviews was contingent upon voluntarism. An explanation was prepared for the interviewers. It made explicit the study's objectives as well as the methodology that will be used. The fact that the participants'

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identities would remain private was also highlighted. Written formats were utilized during the interviews. Interviews lasted for 30 to 45 minutes. The content-analysis method was used to examine the data. The fundamental objective of the content analysis was to identify concepts and relationships that might be used to interpret the material that was gathered. The main goal of content analysis was to group comparable pieces of data and remark on them within the context of particular concepts and themes. As a result, the acquired data were considered first, then structured logically in line with the ideas that were forming, followed by themes that explained the relevance of the data. Themes that had been previously decided upon (such as educational, occupational, personal/social, or concerns with oneself and friends) were utilized. For each subject, categories were created, and significant percentages were chosen to make these categories relevant. For each category, examples of student opinions were provided.

3. RESULTS AND DISCUSSION

A total of 58.9% of sixth-grade students, 76.1% of seventh-graders, and 55.9% of eighth-graders identified a need for educational advice and counseling on efficient study methods under the first category of educational guidance and counseling needs. One of the sixth-graders said, "I want to know how to study and listen," about this area. I want to learn about how to focus and study, a seventh-grade student remarked. A student in the eighth grade stated, "I want to learn how to make a successful study schedule. I want the academic advisor to design a study schedule for me and teach me how to speak out in class. 53.1% of sixth-graders, 29.7% of seventh-graders, and 58.9% of eighth-graders identified a need for educational advice and counseling on overcoming test anxiety in the second category of needs for educational guidance and counseling. I get worried during the tests, says one of the sixth-graders. I require guidance to maintain my composure while taking the examinations. "I need to be informed about how to manage worry and tension, as well as how to act throughout the exam," a seventh-grade student commented. One of the eighth-graders remarked, "I get so anxious before examinations that I have stomachaches. Help is needed with this. Additionally, I feel pressured when I have a lot of schoolwork." 9.8% of sixth-graders, 3.6% of seventh-graders, and 6.7% of eighth-graders specified they needed educational guidance and counseling on self-motivation approaches for the third category of educational guidance and counseling requirements. I want my counselor to tell me, "You can do it, you can succeed, and you can have wonderful outcomes," a sixth-grade student said in response. "I want my counselor to say, If you study, you can become successful and pass your tests with good marks," one of the seventh-graders remarked. One of the eighth-graders remarked, "I want my counselor to tell me that if I study hard, I can succeed. I have complete faith in you."

3.1 STUDENTS' VIEWS OF CAREER GUIDANCE AND COUNSELING NEEDS

After analyzing the responses given by the students, two categories were established regarding their career guidance and counseling needs such as information about professions and career decision-making. 96.1% of sixth-graders, 86.1% of seventh-graders, and 76.1% of eighth-graders indicated they required career assistance and counseling in a variety of occupations for the first category of needs related to these services. "I want to be a lawyer or study psychology in the future, a sixth-grade student declared. I need to know

what to do, how to study for these things, and what occupations are available. How many years should I study to become a doctor, said one of the seventh-graders. "Which degrees ought I pursue? What kinds of schools should I attend? I want to be a doctor, a pupil in the seventh grade declared. My academic standing allows me to enroll in a university. But I don't know the opportunity that I have". In the area of need for career guidance and counseling, 3.4% of sixth-graders, 13.5% of seventh-graders, and 22.9% of eighth-graders said that they did. These students were talking about their need for career guidance and counseling concerning making professional decisions. One of the sixth graders responded, "I want to be a teacher in the future," for this category. A counselor, who belief am also a teacher, can assist me with this. I want to be a psychologist, a seventh-grade pupil declared. I need the counselor to let me know whether my decision was good or bad. Only the questions listed were asked of the students since the substance of the personal/social guidance and counseling needs too were sensitive. These inquiries were linked to the various personal and societal issues for which students want career and academic help and counseling. These responses were broken down into individual analyses.

3.2. Students' Views Of Personal/Social Guidance And Counseling Needs

After analyzing the students' replies, it was found that they required personal/social therapy as well as assistance with household issues linked to personal issues. Examples include having strict parents, having issues with siblings, insisting on doing chores, having puberty issues, and having to take extra classes in certain topics. 51 percent of sixth-graders, 29.9 percent of seventh-graders, and 29.8 percent of eighth-graders said they didn't require personal/social supervision and counseling unless difficulties arose when asked about their needs. One sixth-grade student said, "Unless there are major difficulties, I don't need advice and therapy," when asked about this area. When I have tests and issues with my family and friends, I just need assistance and therapy, one seventh-grade student said. "I need assistance and counseling before examinations when I have issues with my family, and when I quarrel with my friends," a student in the seventh grade stated. 19.9% of sixth graders, 63.1% of seventh graders, and 66.1% of eighth graders indicated they required personal/social advice and counseling on domestic issues in response to the question about personal/social guidance and counseling requirements (authoritative parental attitude, problems with siblings, and insistence on responsibilities). One sixth-grade student's observation regarding strict parental behavior was, "They don't often let me go out." stated a pupil in the seventh grade. "My family and I have some issues. They placed me under a lot of strain. They forbid me from using the computer or television for extended periods. They won't let me go where I want to, a seventh-grade pupil remarked. They belittle my buddies and don't comprehend my issues. "I quarrel with my family about going out with my pals," a student in the seventh grade said. My mother wants me to work more on my studies, but I want to play outside for at least an hour. Another eighth-grader remarked, "I feel a lot of pressure from my family, especially my mother. She claims that, "if you don't go to school, you'll soon get married and become a housewife. Regarding family disputes, one sixth-grader remarked, "My issue just involves my brother. He often beats and makes fun of me. Another sixth-grader remarked, "I typically

argue with my family because of my brother or sister. I'm disturbed by their concern for him/her. I have issues with my brother, a seventh-grade student remarked. He often turns the computer on when I'm studying. A student in the eighth grade stated, "My brother claims that if I don't pass the examinations and he won't allow me to go high school. Please let the parents know. They'll demoralize us by saying stuff like that. Regarding the emphasis on potential, one of the sixth-grade students remarked on this. "I fight with my family over how messy my room is." The seventh-grader who spoke forward said, "I fight with my family because I'm messy. They want me to maintain order. One of the eighth-graders remarked, "We usually fight when I don't clean up my room. But it doesn't last long. Another sixth-grader remarked, "My mother gets upset with me because I spend a lot of time playing video games and don't assist her." "I have issues with my family because of computers," remarked a different eighth-grade student. They claim that I talk for a long time. Only 19.6% of sixth-grade children reported needing personal/social advice and therapy for puberty-related issues when asked about their requirements. "I need guidance concerning changes noticed during puberty," one sixth-grader exclaimed. On occasion, a gain in height might be noted along with a breakout that disappears rapidly. The children in seventh and eighth grade did not find this to be a serious issue. 3.4% of sixth-grade students, 6.8% of seventh-graders, and 26.7% of eighth-graders indicated they required personal/social advice and counseling on topics needing specific training when asked about their requirements in this area. One of the sixth-graders said, "I am energetic and cannot sit still," for this category. I make an effort to stop it, but I fail. Could you please aid me with this? Please!" I have trouble hearing clearly and understanding what is being said, one of the seventh-graders mentioned. My buddies make fun of me because of this, which genuinely saddens me. I'm not interested in going to class. I have trouble communicating, a pupil in the seventh grade stated. Before I started elementary school, things began to worsen." Likewise, the students presented more opinions regarding the need for counseling in their lives.

3.3 STUDENTS' VIEWS ABOUT PERSONAL/SOCIAL GUIDANCE AND COUNSELING NEEDS THAT ARE CONNECTED WITH A FRIENDLY ENVIRONMENT

From the replies got from the students, it was found that students required personal/social therapy related to the friendship setting. Verbal abuse (mockery, snitching), social skills, and peer pressure are a few examples. In regards to the need for personal/social advice and counseling for verbal abuse, 9.98% of sixth graders, 6.8% of seventh graders, and 12.9% of eighth graders mentioned that they need such services due to issues resulting from a fear of being mocked. "I can't engage in classes out of concern that my peers will make fun of me or say anything terrible," one sixth-grader said. One of my buddies made fun of me for not wearing a tracksuit to our physical education session. One of the children in the seventh grade remarked, "Some of my classmates make fun of me because I wear glasses. They mock me for speaking. I experience similar experiences and feel sick. One of the eighth-graders remarked, "My peers mock my issues. This is why I disagree with them. In addition, they criticize me whenever they identify a weakness in me. Please resolve this issue." These were some issues they had. 6.78% of sixth graders, 3.48% of seventh graders,

and 19.78% of eighth graders said they required advice and therapy for personal/social reasons related to snitching when it came to their needs for counseling on verbal abuse. One-eighth grader claimed, "My buddies truly talk differently, snitching increased," while a sixth grader added, "Snitches in my classroom make me feel pretty terrible and this becomes a major problem for me." 52.9% of students in the sixth grade, 56.7% of students in the seventh grade, and 58.9% of students in the eighth grade indicated they required personal/social assistance and counseling due to issues they had with social skills. "I don't enjoy my classmates' misbehavior and despising one of the pupils who has just started attending our lessons," a sixth-grade student declared. They are occasionally correct, but it is not essential to criticize someone constantly. Typically, they treat her unfairly and exclude her. My buddies never understand me, a seventh-grader said. I'm always kind and polite to them, yet the contrary is how they treat me. I tried very hard to comprehend the rationale, but I just can't. Due to peer pressure, students in sixth and seventh grade reported needing personal/social supervision and therapy as well. My pals usually do what they want, a sixth-grader remarked. "I don't have any issues. They always make us pay attention to what they say", another student said. We occasionally quarrel for this reason.

3.4 DISCUSSION

The selected junior secondary children were the focus of this study, which also looks at their needs for guidance and counseling. Three topics were included in the research educational, career, and personal/social. It is based on information for pupils who are beginning the time between first and second grade. Exams, according to many parents, are the finest method to get students ready for the future. This conclusion of the research is supported by McDonalds (2001) claim that tests play a significant role in the educational system and that their frequent application leads to exam anxiety. Since seventh graders inevitably move on to eighth grade, they require less counseling on exam anxiety or strategies for overcoming it than other students. To support this fact, students who perform badly in school require counseling and mentoring. More than half of sixth and eighth-grade students need counseling on effective studying skills. Sixth-grade students transfer to the second level and a new adaptation process begins. The problems occurring during the transition to different school stages cause psychological disturbance in students. The second level of elementary education is acclimated to seventh graders in the middle of the school year. As a result, they require less counseling. Selected junior secondary graders participate in professional active learning to a greater extent than their peers. This implies the necessity of active learning. Few junior secondary students claimed that they require direction and counseling on motivational strategies.

3.4.1 CAREER GUIDANCE AND COUNSELING THEMES

According to (Dahir,2001), pupils in sixth and eighth grades ought to be exposed to career awareness. According to (Borg,1996), knowledge about various professions has an impact on the process of choosing a vocation. Students who participated in interviews said they were aware of who they were, but they were

unsure of the qualities needed for the career path they desired. The selected student group needed career counseling as well. Pupils in the junior secondary level require career decision-making counseling. However, a small percentage of students in the second stage of elementary education require career counseling. To acquire knowledge about professional options, they want career coaching. There is a parallelism between this research conclusion and (Okey and Snyder's,1993) assertion that it is crucial to educate students' professional decision-making strategies and provide them with experience in this area before it is too late.

3.4.2 PERSONAL/SOCIAL GUIDANCE AND COUNSELING

There were established categories for household issues (authoritative parental attitude, issues with siblings, insistence on obligations, etc.) and adolescent issues. Most seventh and eighth graders, as well as the majority of sixth graders, require guidance and counseling for personal issues. Students require assistance and therapy for domestic issues (authoritative parental attitude, problems with siblings, and, in- existence of responsibilities). The data that follow, nonetheless, support the pupils. Accordingly, authoritative parenting is associated with the highest levels of interfamily contact and academic achievement. A supportive setting, moderate control, and high tolerance should be used to promote authoritative parenting. Consistent expectations between parents and children for one another may help to solve these issues. A few junior secondary students require assistance and therapy regarding issues with their siblings. Students' requirements for guidance are brought on by improper communication and verbal abuse. Students who don't tidy up their rooms or spend too much time on computers or television instead of studying cause conflict with their parents.

Only a few sixth graders require assistance and counseling to deal with puberty-related issues. Because they could require therapy to successfully adapt to the changes. A few pupils in the selected junior secondary schools require assistance and counseling on topics that call for specialized instruction. Although it is well recognized that children with impairments have issues, according to (Thompson and Rudolph,2000), there hasn't been enough study done to fully understand their unique requirements. In addition, the categories of peer pressure, social skills, and verbal abuse (mockery, snitching) were created. A few pupils in the sixth, seventh, and eighth grades require counseling and supervision because their peers make fun of them. If ridicule and snitching are examined as sub-categories, elementary education pupils require assistance with verbal abuse. They said that they are suffering from verbal abuse. Snitching, backbiting, and fascinating are all serious issues among teenagers. Teenagers require direction and therapy on these difficulties for this reason. According to a different study, girls and boys both engage in more indirect than direct hostility. Compared to younger pupils, older students employ compromise more frequently. More than half of sixth, seventh, and eighth-grade students require guidance and counseling due to issues with peer pressure, social skills, and verbal abuse (mockery, snitching). The excessive dominance of certain teenagers can negatively impact group dynamics and generate issues for others. Positive peer relationships can help pupils to develop emotionally and socially. However, if they are

subjected to peer pressure, it might have a detrimental impact on how they develop their sense of autonomy and identity.

CONCLUSION(S)/ IMPLICATIONS/ RECOMMENDATIONS & LIMITATIONS

For pupils, the word "transition" has two distinct connotations. First, it's crucial for adaptability to the school environment that there be transitions between school levels. The passage from infancy to puberty is the second one. During this crucial period, some students could feel anxious and unsettled. They could thus require greater counseling and assistance services. Based on the results of the findings, these recommendations can be made. To adequately prepare students for courses and lessons, individual or group guidance programs relating to testing anxiety, effective learning, and motivating approaches should be used. Students should regularly get introductory material on careers in the mail from school counselors and guidance agencies. They should also plan classroom exercises to hone their decision-making abilities regarding careers. Families, educators, and counselors should refrain from acting aggressively or bullying others. Services for peer counseling should be made available to students who are going through a change.

REFERENCES

American School Counseling Association (ASCA). *The Role of the School Counselor*.

Astramovic, L. R., & Hoskins, J, W., & Gutierrez, P. A., & Bartlet, A. K. (2013) *Identifying Role Diffusion in School Counseling. The Professional Counselor, 3(3),* pp.175-184 *http://tpcjournal.nbg.org.*

Baskin, W. Th., & Slaten, D. Ch. (2013). *Contextual School Counseling Approach: Linking Contextual Psychotherapy with the School Environment*. The Counseling Psychologist, *42*(1), pp.73-96. SAGE.

Baugh, A. (2018). The Importance of guidance and counseling in the present education system: Role of the Teacher. *International Journal of Advanced Educational Research, 3(2),* pp.384-386

Bein, S. B. (2012). School Counselors: a review of contemporary issues. *Research in Higher Education Journal.*

Caipang, A. M. (2014). Guidance: Principles and Procedures Research Signpost, *T. C. 37/661(2),* Fort, P.O., Trivandrum-p.695 023, Kerala, India.

Corey, G. (2009). *Theory and Practice of Counseling and Psychotherapy (9th Ed).* Thomson Higher Education, Belmont, USA.

Davis, M. K., & Williamson, L. L., & Scarboro, A. B. (2011). Professional activities in professional school Counseling. *In H. L. K, Coleman., & CH, Yeh (Ed). Handbook of School Counseling*, (pp. 811- 824). Taylor & Franciz Group. New York, London: Routledge.

Kapur, R. (2018). *Significance of Counseling and Guidance in Education*. Research Gate.

Lindwall, J. J., & Coleman, H. L. K., (2011). The School Counselor's Role in Creating Caring School Communities. *In, H. L. K, Coleman., & Ch, Yeh (Ed). Handbook of School Counseling*, (pp. 351- 377). Taylor & Franciz Group. New York, London: Routlege.

McMahon, G. H., & Mason, M. C. E., & Paisley, O. P. (2016). *School counseling for the 21st Century: challenges and opportunities*.

Nweze, T., & Okolie, Ch. U. (2014). *Effective Guidance and Counseling Programs in Secondary Schools: Issues and Roles in Students' Career Decision Making*. OSR Journal of Research & Method in Education (IOSR-JRME) e-ISSN: 2320–7388, p-ISSN: 2320–737X, Volume 4, Issue 4 Ver. V, 63-68, *www.iosrjournals.org.*

Schmidt, J. J. (2011). History of School Counseling. In H. L. K, Coleman & CH, Yeh (Ed). Handbook of School Counseling. (pp. 3-13). Taylor & Franciz Group. New York, London: Rotlege.

Subasinghe, W. (2016). An Introduction to Educational Guidance and School Counseling. International Journal of Scientific Research and Innovative Technology. ISSN: 2313-3759, Vol. 3, No. 10.

Walsh, E. E., & DePaul, J. (2011). The Essential Role of School-Community Partnerships in School Counseling. *In H. L. K, Coleman., & CH, Yeh (Ed). Handbook of School Counseling*.pp 481- 495. Taylor & Franciz Group, New York, London: Routledge.

PRESCHOOL TEACHERS' TURNOVER INTENTIONS IN LEAVING THEIR JOB; A CASE STUDY ON WESTERN PROVINCE, SRI LANKA

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ABSTRACT

Teachers play a significant role in early childhood education by creating a supportive learning environment for young children. In Sri Lanka high turnover rate is reported of early childhood education teachers which reduce the quality of education. The lack of knowledge on elements that affect employee retention is a key issue in most early child education centers. The current study investigated the factors affecting early childhood educators' intention to leave, perception of workplace climate and job-related attitude. 50 early childhood educators from western province, Colombo, Sri Lanka were surveyed in the study. According to the findings, the majority of respondents (50.6%) possessed pre-school diploma qualification. The respondents' perception on profession indicated 55.2% attended a pre-school study programme to start their own school. Only 1.7% of respondents mentioned the need to care for their children and many chose early childhood education only as a career option. 69% of Preschool educator's satisfaction on workplace conditions revealed low satisfaction on salary received, promotional path, fellow staff and facilities available. Inadequate salary is considered as the major factor affecting turnover intention of the respondents in the sample with the mean of 4.6 indicating "Strongly Agree". Lack of mental freedom and lack of job recognition and career progress are also considered as major factors affecting turnover intention with mean =4.2 and 4.4 indicating strong agreement by the respondents.

Keywords: *Early childhood education; Turnover intention; Workplace conditions*

1. INTRODUCTION

The early years of a child's life are critical to their long-term development. Children grow, learn, and thrive when they have good health and nutrition, a safe, secure, and responsive home environment, and opportunities for early learning. Leading economists agree that high-quality early childhood education programmes can change children's lives and result in better health and education outcomes as well as good citizens in the long run (Markowitz et al., 2018). Early childhood education has been on the rise over the past decade as more mothers are returning to the workforce by the time their child is of preschool age, if not sooner (UNICEF, 2017). Research shows that children who receive good preschool education perform better than their peers who do not. Barnett (2007) stated that "high-quality preschool education improves later school success, employment and earnings. It has lessened crime and delinquency and unhealthy behaviors".

Many research findings reveal how important preschool education is to a child's future success, leading to the assumption that quality teachers, leadership, and curriculum are needed in these facilities to see these results. Because effective teachers are needed in these early years of education, it is important for

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researchers to look at different factors of job satisfaction to increase retention of qualified early childhood educators. (Geiger and Pivovarova, 2018; Mérida et al., 2020)

In Sri Lanka, early childhood educators and caregivers are frequently underprepared to provide high-quality preschool experiences. Early childhood education entry qualifications are currently non-specific and ill-defined, with no tertiary qualifications required. (Sri Lankan National Policy on Preschool Education, 2018) As a result, teacher attrition has been significant in the Sri Lankan context (Sumanasena et al.,2020).

Furthermore, data and research on the Sri Lankan preschool sector are scarce and dispersed across numerous stakeholders and systems, making it difficult for the government to use data for policy making, efficient resource allocation, and effective public service delivery. As a result, the aim of this study is to investigate perceptions of early childhood educators' satisfaction on working conditions, attitudes and intentions to leave the job position.

1.1 BACKGROUND STUDY/ REVIEW OF LITERATURE

Early childhood educators are required to build a strong foundation in the classroom, but they are also expected to build strong relationships with the parents of their students and their community (Pivovarova, 2018). Mérida et al., (2020) explain that "accomplished teachers know that positive outcomes result from viewing families as allies in their work" .These demands require early childhood educators to maintain a strong physical and mental capacity to keep up with the day to day requirements of teaching young children. When the teachers begin to deplete mentally and physically, it is not only affecting their own lives, but the lives of many young children in the classroom. Exploring what makes early childhood teachers happy in their positions can provide the necessary information to eliminate the possibility for job dissatisfaction. Grant and Buettner (2019) suggest that teachers' well-being and perceived working conditions relate with their intentions to remain at their job or within the field and to their commitment to the profession.

Preschool is compulsory for children aged three to five in Sri Lanka. In Sri Lanka, there are approximately 17,020 early childhood education centers serving a total population of 475,620 children aged 3 to 5. Approximately 89% of Early childhood education centers are standalone preschools, with the remainder being a mix of preschool and day care facilities. (National Census, 2018) Preschools or early childhood education centers in Sri Lanka are either for-profit businesses or non-profit organizations. The government establishes standards and regulates the industry. In Sri Lanka, preschool education is not compulsory. Hence preschool education is not included in official educational policy or administration.

According to the National Census of Early Childhood Development Centers in Sri Lanka, in 2018, there are 19,668 preschools in Sri Lanka, with 71% managed by private organizations or individuals, 19.8% managed by public institutions and local government authorities such as municipal and urban councils, 6.8% managed by religious organizations, and 3% managed by non-governmental organizations (NGOs).

Fees are charged by 88.2% of these preschools. In 2018, 578,160 children aged two to five years were enrolled in preschools. In Sri Lanka, 55.6 percent of three to five-year-old preschool children are enrolled. 50.3 percent of those in this age group are boys, while 49.7 percent are girls. Enrollment rates by sector show a significant disparity between the urban (67.6 percent), rural (47.5 percent), and estate (43.9 percent) sectors. When it comes to Early Childhood Educators, 59.9% of the 28, 449 preschool teachers have passed the General Certificate of Education (Advanced Level) Examination. It was observed that 83% of teachers have completed a one-year or longer professional training programme whereas 9.5% of current teachers are without any formal qualification.

Although the number of public and private preschools is growing, many lack quality standards and a regulatory framework. This is because the majority of preschools are run by for-profit private service providers. The government's participation in regulating pre-school education may be improved. (UNICEF Discussion Paper, 2018).

To understand work satisfaction in educators, it is necessary to examine human behavior theories to determine what makes individuals happy and dissatisfied in their jobs. Maslow's Hierarchy of Needs Theory (Maslow, 1943) is related to human behaviour and proposes that humans have five needs that must be met in a specific order. Maslow's hierarchy of needs suggests that basic, physiological needs come first, followed by more abstract needs. When it comes to job satisfaction Maslow's hierarchy applies differently. For example, people require food and water in order to survive, followed by safety, social recognition, respect and approval, and, finally, self-actualization. Educators may believe their basic needs are met, but as their needs rise up the hierarchy, their job satisfaction may suffer.

According to job characteristics theory, the characteristics of a position can be directly related to the outcomes of the position. Hackman, Oldham, Janson, and Purdy (1975) compare work to play, arguing that successful people regard their jobs as satisfying as they do play. These perspectives translate to high job satisfaction because they provide workers with intrinsic satisfaction and motivation to work hard. The model has five characteristics: autonomy, task identity, task significance, skill variety, and feedback. These characteristics have an effect on the three psychological conditions of experienced meaningfulness, experienced responsibility for outcomes, and knowledge of actual results, which in turn stimulate outcomes such as job satisfaction (Hackman et al., 1975). The three psychological factors cause someone to feel good when they believe their performance was of a high caliber. According to the Job Characteristics Theory, there is a domino effect that determines whether a position is satisfied or unsatisfied. Workplace conditions don't just refer to the actual workspace; they also take into account the accessibility of resources such as tools and equipment as well as the safety of the workplace and relationship with fellow workers (Sumanasena et al., 2020).

2. METHODOLOGY

The researcher used the survey research design to carry out this study. According to Sekaran and Bougie (2016) the survey design attempts to describe and explain conditions of the present by using many subjects

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and questionnaires to fully describe a phenomenon. Begi (2009) explains that a survey is used to assess the distribution of specific behaviors in a given population. He further explains that the design can be used to collect detailed data needed in justifying the current conditions and practices. The current study aims at answering the main research question that, what are the possible factors that affect early childhood educators' turnover intention in Sri Lankan context?

The study setting for the research is western province of Sri Lanka and participants for the survey were drawn from a random sample of teachers located in Western Province early childhood education centers. According to the Children and Women's Bureau. There are 2317 registered teachers in the Western Province. For the study a sample of 50 preschool teachers contributed and selected based on a convenient sampling method representing Colombo, Gampaha and Kalutara Districts.

This study employs questionnaire instrument as survey strategy , because questionnaire allows researcher to examine and explain relationships between constructs and cause and effect relationships .Use of questionnaire in this study is justified based on relatively low cost and it's a quick and efficient way of collecting large amount of information as described by Sekaran, U. and Bougie, R., (2016).Scales for the measurement of each item were identified through literature with considerably accepted Cronbach Alfa values and adapted slightly to suit the local context. The questionnaire has four sections. First section covers the demographic profile of the respondents, section 02 includes questions related to job satisfaction, section 03 related to attitudes on the profession and section 04 covers the possible reasons for turnover intention.

Demographic profile included the items of age, gender, district, marital status, educational qualifications, A/L stream followed and job related qualification of respondents. Early childhood educators answered the six items on their satisfaction with working conditions. Relationship with coworkers and management, work itself, physical facilities, salary and promotion. Respondents rated answers on a five-point scale (1=Strongly Agree , 5=Strongly Disagree). The measurement items were adapted from Work Attitudes questionnaire (Baker et al.,2010)

To capture teachers' turnover intentions regarding their job and career, we asked what teachers would cause teachers to quit the profession. Their responses were evaluated by 7 items indicating possible reasons for turnover. These items were adapted from Early Care and Education Workforce Survey (Sandstrom ,2021) To measure teachers' attitudes for their job, we asked why they chose to work in the early childhood education field and how they feel about the work assigned to them in the Early childhood center. Teachers were evaluated using 6 items with the rating of point scale, 1=Strongly disagree ,5= Strongly agree. The items were adapted from Watt & Richardson, 2008. Data are analyzed descriptively using SPSS version 23.0.

3. RESULTS AND DISCUSSION

3.1 DEMOGRAPHICS

Descriptive statistics of the sample reveal early childhood educators' demographics and job characteristics which were generally consistent with the findings from the National Census of Early Childhood Development Centres in Sri Lanka ,2018. In terms of age group,78% of respondents were in-between 40-60 age groups and 22% are in the age group of 30–40 years of age. All teachers in the sample were female (100%). 58 % of the respondents were from Kalutara district, 28% from Colombo and 9% from Gampaha. With regard to marital status, 64% were unmarried and 36 % were married and no divorcees or widows have reported. Within our sample, 50.8% passed GCE A/L and 28.6% sat for GCE A/L examination and were not successful in passing all the subjects. 20.6% had only GCE O/L qualifications and none reported without O/L qualifications. With regard to the GCE A/L subject streams taken, 71% of respondents have followed Art stream, Business Studies 25%, Mathematics & Information technology 2% and none from the science stream.

Teacher diploma has the highest percentage which is 50.6% and 39.8% of the respondents have national certificate of competence NVQ level. This illustrates that most of the respondents have reasonable knowledge in preschool teaching. Further, respondents with national certificate of competency & NVQ level 5 certificates 8.4% & 1.2% respectively. (Figure 01)
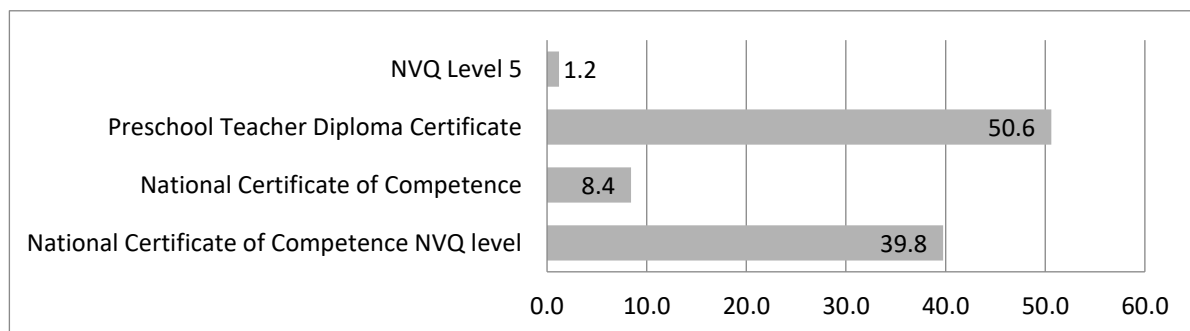

Figure 01: Professional courses followed in preschool teaching

3.2 TEACHER ATTITUDES WITH RESPECT TO PROFESSION

The outcome of attitudes of respondents with respect to profession was evaluated by why respondents attended an early childhood education programme in the first place and selection of early educator as a career option which is depicted in Figure 02. It is highlighted that respondents attended a preschool study programme in order to start their own preschool (55.2%), and 32.8% of respondents stated that they wanted to work in the public sector. Furthermore, 25.9% said they wanted to work in a preschool, and 17.2% said they wanted to travel abroad. Only 1.7% respondents mentioned the need to care for the children. With regard to the question why respondents chose early childhood education as a career option reveals that 69% of respondents wish to work in preschool as a job while 43.1% of respondents wish to do preschool teaching as a social service. On the other hand, 12.1% of them chose this sector

as self-employment and 8.6% were chosen as a business. Therefore, the majority of respondents selected early childhood education simply as a job.
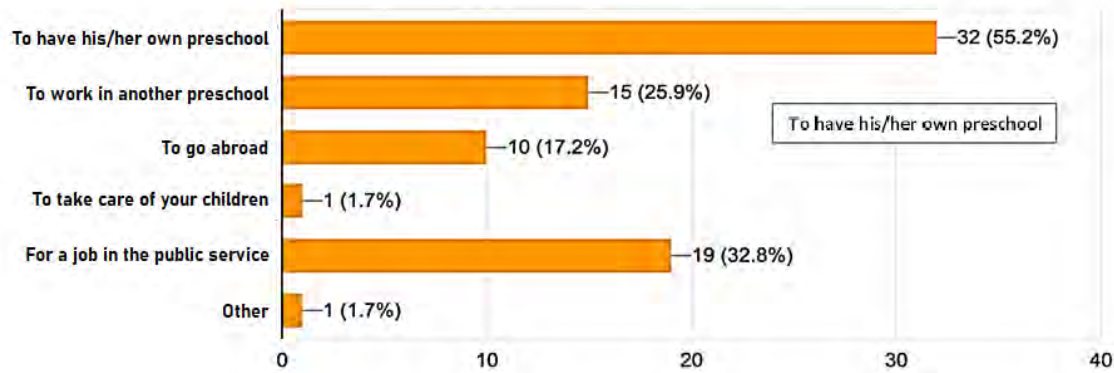

Figure 02: Reason for attending early childhood programme

3.3 SATISFACTION ON WORKPLACE CONDITIONS

The survey asked Preschool educator's satisfaction on workplace conditions was evaluated with five-point scale (1=Strongly Disagree , 5=Strongly Agree), which analyzed descriptively (Table 1)

Table 1: Preschool educator's satisfaction on workplace conditions

Statements	N	Min	Max	Mean	SD
I like work assigned to me	50	3	5	4.02	.654
I can rely on supervisors and coworkers for help	50	2	5	3.38	1.086
There are enough teaching staff available	50	1	4	2.58	.950
I feel the work I do is appreciated	50	2	5	3.18	.896
I feel like I am working too hard	50	3	5	4.12	.594
I'm happy with the salary and other benefits I receive	50	2	4	2.36	.776
I have sound promotional path	50	2	4	2.10	.416
Centre environment has sufficient facilities	50	1	4	2.02	.869

Note. 5 strongly agree, 4 agree, 3 neutral, 2 disagree, 1 strongly disagree

According to Pimentel (2010), the five-point Likert scale is considered an interval scale. The mean is very significant. From 1 to 1.8, it means strongly disagree. From 1.81 to 2.60, it means disagree. From 2.61 to 3.40, it means neutral; from 3.41 to 4.20, it means agree; from 4.21 to 5, it means strongly agree. In the first statement, the mean is 4.02. Hence, it means that the majority of participants are in agreement with the satisfaction of work assigned to them. The mean of second statement is 3.38, which denoted respondents are neutral to the support and collaboration they receive from supervisors and coworkers. The third statement is about availability of sufficient staff, the majority of respondents were not satisfied (Mean=2.58). Majority of respondents remained neutral on the appreciation they receive

from supervisor or management (Mean=3.18). Many respondents (Mean=4.12) agree that they work too hard. Perceptions on Salary and benefits, promotional path received very low satisfaction mean =2.36 and 2.10 respectively denoted many respondents were not happy about the salary, benefits and promotional avenues. The sufficiency of physical facilities at the workplace too received a lower rating as seen in the mean of 2.02.

3.5 TURNOVER INTENTION

Table 2: Factors that would cause leaving the job/ turnover intention

Statements	N	Min	Max	Mean	SD
Inadequate salary	50	4.00	5.00	4.6600	.47852
Working environment is not conducive	50	3.00	5.00	4.4000	.69985
Lack of sufficient physical material to work	50	2.00	4.00	3.2000	.85714
Lack of mental freedom	50	3.00	5.00	4.2000	.83299
Difficulty in engaging in frequent practical activities with children	50	3.00	4.00	3.3000	.46291
Lack of appreciation and support from Management	50	3.00	5.00	3.8400	.58414
Lack of Job recognition and lack of career progress	49	4.00	5.00	4.4082	.49659

As per the survey results, inadequate salary is considered as the major factor affecting turnover intention of the respondents in the sample with the mean of 4.6 indicating "Strongly Agree" (Pimentel 2010). Not conducive work environment also identified as a strongly agreed factor (mean = 4.4) for possible turnover of early childhood educators. "Lack of sufficient physical material to work" and "Difficulty in engaging in frequent practical activities with children" are considered as "Neutral" factors with the mean of 3.2 and 3.8 respectively. Lack of "mental freedom" and "Lack of Job recognition & career progress" are also considered as major factors affecting turnover intention with mean =4.2 and 4.4 indicating strong agreement by the respondents.

4. CONCLUSION(S)/ IMPLICATIONS/ RECOMMENDATIONS & LIMITATIONS

Based on the findings of the study it can be concluded that, childhood educators demographics and job characteristics were generally consistent with the findings from the National Census of Early Childhood Development Centers in Sri Lanka ,2018. Majority of respondents have GCE A/L qualifications and Diploma qualification in preschool education. When considering the GCE A/L subject stream, the majority (71%) have followed Art stream subjects and none with science stream subjects. The respondents' perception on profession indicated 55.2% attended a pre-school study programme to start their own school. Only 1.7% respondents mentioned the need to care for their children and many chose early childhood education as a career option mainly as a job. (69%) Preschool educator's satisfaction on workplace

conditions revealed low satisfaction on salary received, promotional path, staff and facilities available. Inadequate salary is considered as the major factor affecting turnover intention of the respondents in the sample with the mean of 4.6 indicating "Strongly Agree "Lack of mental freedom and Lack of Job recognition & career progress also considered as major factors affecting turnover intention with mean =4.2 and 4.4 indicating strong agreement by the respondents.

Future research using a larger sample size to examine actual turnover behaviour can help confirm whether these teachers' inclinations translate into their actual decisions. Furthermore, further research into specific working conditions and coping mechanisms may shed light on the dynamics of their relationship with early childhood education teacher turnover.

REFERENCES

Barnett, W.S. and Yarosz, D.J., (2007). Who Goes to Preschool and Why Does It Matter? Preschool Policy Brief. Issue 15. National Institute for Early Education Research.

Begi, N., (2009). Research, monitoring and evaluation made simple: A Guide Book. Nairobi: Blesmo Research and Publications.

Brien, M., Hass, C. and Savoie, A., (2012). Psychological health as a mediator between need satisfaction at work and teachers' self-perceptions of performance. *Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement, 44(4),* p.288.

Craig, C.J., (2017). International teacher attrition: multiperspective views. Teachers and Teaching, 23(8), pp.859-862.

Geiger, T. and Pivovarova, M., (2018). The effects of working conditions on teacher retention. Teachers and Teaching, *24(6),* pp.604-625

Grant, A.A., Jeon, L. and Buettner, C.K., (2019). Relating early childhood teachers' working conditions and well-being to their turnover intentions. *Educational Psychology, 39(3),* pp.294-312.

Geiger, T. and Pivovarova, M., (2018). The effects of working conditions on teacher retention. *Teachers and Teaching, 24(6),* pp.604-625.

Hackman, J.R. and Oldham, G.R., (1975). Development of the job diagnostic survey. *Journal of Applied psychology, 60(2),* p.159.

Mérida-López, S., Sánchez-Gómez, M. and Extremera, N., 2020. Leaving the teaching profession: Examining the role of social support, engagement and emotional intelligence in teachers' intentions to quit. *Psychosocial Intervention, 29(3),* pp.141-151.

Markowitz, A.J., Bassok, D. and Hamre, B., (2018). Leveraging developmental insights to improve early childhood education. *Child Development Perspectives, 12(2),* pp.87-92.

Mérida-López, S., Sánchez-Gómez, M. and Extremera, N., (2020). Leaving the teaching profession: Examining the role of social support, engagement and emotional intelligence in teachers' intentions to quit. *Psychosocial Intervention, 29(3),* pp.141-151.

Maslow, A.H., (1943). Preface to motivation theory. *Psychosomatic medicine.*

Sri Lanka, Ministry of Women and Child Affairs, National Census of Early Childhood Development

Pimentel, J. (2010). A note on the usage of Likert scaling for research data analysis. (18). pp.109-112.

Sri Lanka, Ministry of Women and Child Affairs, National Census of Early Childhood Development Centres in Sri Lanka 2016 (Colombo, 2018)

Sumanasena, M. L. H., Nawastheen, F. M. & Jayawardena, P. R., (2020). Job satisfaction of teachers working in the most difficult schools, with special reference to Puttalam Education Zone, Sri Lanka. *Sri Lanka Journal of Social Sciences, 43(1),* pp. 39-52.

Sri Lankan National Policy on Preschool Education (2018). Retrieved from http://nec.gov.lk/wp-content/uploads/2019/11/PreSchoolPolicy_EN.pdf

Sekaran, U. and Bougie, R., (2016). Research methods for business: A skill building approach. john wiley & sons.

United Nations Children's Fund, "Required Investments to Deliver High Quality Early Childhood Education (ECE) in Sri Lanka", discussion paper presented at the 'Building Brains, Building Futures' - Sri Lanka Early Childhood Development High-Level Meeting, July 2018.

UNICEF Annual Report 2017. (2022). Retrieved 8 August 2022, from https://www.unicef.org/reports/unicef-annual-report-2017

RESILIENCE THROUGH INNOVATIONS IN LANGUAGE STUDIES

An Analysis Of Attitudes Of Teachers Of English On Competency-Based Curriculum

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ABSTRACT

Competency Based Curriculum (CBC) has been used in school education worldwide. It was introduced to Sri Lanka in two phases. This descriptive survey analyzes the attitudes of secondary school teachers of English on curriculum in Deniyaya Education Zone. The objectives are to find out whether the teachers are familiar with the competencies, these competencies are achievable through the prevailing syllabuses, to examine the attitudes of teachers and to identify other options instead of competency- based syllabus. 25 participants were used in three education divisions of Pasgoda, Morawaka and Kotapola. Semi structured interviews and a questionnaire were used to collect data. The data were analyzed both quantitatively and qualitatively. It was found that the teachers do not follow the curriculum irrespective of their awareness on the basic concepts. In the textbooks, focus was given to improve reading skill rather than other skills. It is recommended to introduce teacher training programs together with the curriculum developers without using the cascade model. It must introduce a series of simple to complex textbooks and to design new supplementary materials to change the current evaluation process by including eight competencies. An awareness program for the other stake holders also is recommended.

Keywords: *Attitude, Competency, Curriculum, ELT teachers, Secondary Education.*

1. INTRODUCTION

English has become the principal language of the modern world and the second language in many countries. With the rapidly growing demand for English language, it is used as the medium of communication as well as the medium of instructions. In education sector, there is a growing interest in the concept of "Competency-Based Education (CBE)". CBE approach permits students to improve based on their ability to master a skill on their own way in any environment. This method is designed to meet different learning abilities and can produce more efficient learners.

Most of the earlier research on this have pointed out that teachers have negative ideas about CBC. Those revealed that teachers have taken it as an extra burden on them. They also highlighted that; teachers do not use CBC effectively in the classroom. With the introduction of the second phase of competency-based syllabus textbooks and Teachers' Instructional Manual (TIM) were introduced with the same content in a particular order and teachers are allowed to use a suitable methods and approaches when teaching. (Nawastheen, 2019). As the researchers noticed, the issue on attitudes regarding CBC is still there and the findings of the earlier research are applicable to the present also. Therefore, it was worth to have a new consideration on this focusing on teachers of English. Hence, the researcher was conducted this research with the aim of achieving the following set objectives.

 i. To find out whether the teachers of English are familiar with the competencies.

 ii. To find out that whether these competencies are achievable through the prevailing syllabuses.

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iii.   To examine the attitudes of teachers of English on competency-based curriculum.

iv.   To identify another option that can be used instead of competency- based syllabus.

The researcher aims at examining the attitudes, feelings as well as to find the challenges face by teachers of English in Deniyaya Education Zone in the process of teaching and learning as far as the CBC is concerned.

1.1 BACKGROUND STUDY/ REVIEW OF LITERATURE

CBC appeared for the first time in 1970's in United States of America. Subsequently, it extended to other countries. The need of this curriculum was firstly seen in the field of adult education. The change from content-oriented curriculum to competency-oriented curriculum was seen as a solution for the above-mentioned need and to the innovation of education system. (Komba & Mwandanji, 2015; Richard & Rogers, 2014; Wong, 2008)

By the end of the 1980's, Competency- Based Language Teaching (CBLT) was accepted as the "state-of-the art" approach to English as Second Language (ESL) by national policymakers and leaders in curriculum development in United States. (Joel, 2017)

Hence, Sri Lanka also identified the need of a change in the curricular of the education to meet the global needs. A study regarding educational and curriculum changes in Sri Lanka reveals that, a new CBC was introduced in several stages and firstly it was introduced in 2007 focusing on the secondary school curriculum replacing the existed CBE as a continuation of the previous curriculum reforms of 1998. It also points out that the aim of this implementation was to eliminate the previous methods of teaching and give a chance for teachers to become more active and creative in the classroom and prepare students to face the challenges of 21st century by giving them a chance to develop all the 4 skills. (Reading, Writing, Speaking, Listening) It was an eight-year curriculum cycle. TIM was introduced for teachers with instructions about various competencies and competency levels. The lessons were based on a model called E5. A set of textbooks and workbooks were designed and introduced for students to practice the language. The second phase of this syllabus was introduced to the system in 2015. Identifying the difficulty in planning lessons according to E5 model, 3P model was introduced as a new instructional approach. The syllabus from grade 6 to 11 consists of 8 competencies and 72 competency levels. (Nawastheen, 2019)

With this change, most of the teachers criticized it saying that this has put an extra burden on them and according to earlier research, attitudinal change is needed. In a journal it has mentioned that, teachers should give more attention to develop student competencies through "exploration" by students. (Nawastheen, 2019) Also in another research it clearly said that most of the teachers neither use E5 model nor 3P model and those who write are at the initial stage. As this method gives more freedom for teachers to be creative in the classroom than earlier, students also get a chance to be active. (Nawastheen et al., 2021) The teaching methodologies recommended are learner- centered. These include activity learning (individual/pair/group), educational visits (visits to various relevant institutions and organizations), role-play, debate, demonstration, question and answer technique and teacher exposition.

(Komba & Mwandanji, 2015) Anyhow, this curriculum change had failed due to the lack of supports from the stakeholders especially from school level. (Nawastheen, 2021) Therefore, this proves that still teachers are not ready to get rid of content based traditional method due to vague understanding on CBC. It was mentioned in research that, English teachers needed proper training which should coincide with the current theoretical, empirical, and pedagogical views of SLA. (Samaranayake, 2016) Also, still there is a lack of trained teachers to address the needs of the present learners. (Aloysius, 2015)

Further, "English Pupils Textbook series introduced by the Department of Educational Publications (DEP) under the directives of the National Institute of Education (NIE) in Sri Lanka highly focus on reading, writing, and grammar while listening and speaking skills are slightly tackled and some speaking activities are intended for writing rather than speaking." (Samaranayake, 2016) This shows that still there are some issues with related to the content and the structure of the textbooks.

Moreover, the studies revealed that this existing curriculum had not been able to fulfil the students' or social expectations due to heavy academic workload, exam-oriented nature, and lack of relevance in addressing the global needs of the changing world. (Nawastheen et al., 2014) This clearly shows that there are issues with this CBC and teachers also have some issues in changing themselves in accordance with the novelties of the curriculum.

According to the findings of a research it clearly stated that, "teachers have undergone several training programs offered by institutes such as the Regional Educational Service Centre (RESC), Zonal Educational Office, and Ministry of Education, where they were not exposed to any research as means of improving quality of teaching and learning English in Sri Lankan school system. Through all programs, the knowledge of 'outside experts' has been disseminated." (Gunawardana et al.) This suggested to make teachers to be involve with research as a remedy to overcome the issues with their professionalism and the quality of the education. In contrast to that it is recommended to organize regular training for in-service teachers to enable them to acquire up-to-date teaching skills as required by the changes introduced in the school curricula. (Komba & Mwandanji,2015)

As alternatives, suggested to introduce new higher education software by cooperating technology with education. (Leuba, 2019) Moreover, as a support for this showed the importance of using blended learning as it can be introduced to improve the quality of education by breaking the monotony in the education. (Liyanagunawardena et al.,2014) As the same, the findings also added a new outlook on this issue.

2. METHODOLOGY

The research was conducted according to descriptive survey design using mixed method. Quantitative method was used to gather more reliable data as researcher wants to analyze the findings statistically. The study was conducted covering Deniyaya Education Zone which is one of the Education Zones located in Matara District. This study obtained its information from the three educational divisions

named Morawaka, Pasgoda and Kotapola in Deniyaya education zone. The researcher chose this area due to the possibility of access.

The target population of the study consists of 160 teachers of English in Deniyaya education zone. (Teacher census report of Deniyaya Education Zone, 2018) The population was selected based on the study area as this basically consider upon the attitudes of English Language Teaching (ELT) teachers on CBE.

Sample of 25 people were selected including 23 teachers of English and 2 In-Service Advisors (ISA) covering all the three divisions of Deniyaya Education Zone, since it is not feasible and not productive to involve the entire population for data collection.

The method of snowball and purposive sampling was used to develop the sample of the research. For that researcher selected 8, 7 and 8 ELT teachers respectively from Morawaka, Kotapola and Pasgoda and 2 ISAs from Deniyaya Education Zone.

The researcher collected primary data by sending a questionnaire via online to three ELT teachers covering all the three divisions who teach in different types of schools in Deniyaya education zone. A Questionnaire with 25 questions was prepared to collect information towards the satisfaction of research objectives. It consisted of both close-ended and open-ended questions and those questions are formed according to the five-point Likert scale (Strongly disagree, Disagree, neither agree nor disagree, Agree, strongly agree) and Dichotomous Scale type of Likert scale (Yes, No). Data were collected under three sections: demographic details, experience and approaches and the use of competency-based curriculum. The researcher asked those three teachers to send the questionnaire to another four ELT teachers using snowball sampling method due to the difficulties in finding contact information of others. At the end researcher was able to receive 15 responses covering the three divisions out of 23 (5 from Morawaka, 5 from Kotapola and 5 from Pasgoda). The sample of teachers were different in age, experiences, and gender.

Further, with the purpose of collecting the rest of primary data the researcher conducted semi-structured interviews over the phone with 8 teachers of English, selecting 3, 3 and 2 from Pasgoda, Morawaka and Kotapola respectively. Also, with 1 ISA from Deniyaya Zonal Education Office using purposive sampling method. These interviews were done using similar and the same questions used in the questionnaire as researcher's target was to obtain responses which helps in achieving the set objectives of the research.

Researcher divided the whole sample into two groups with the purpose of receiving more reliable details and suggestions on CBC. Because researcher had a doubt in receiving unreliable data through questionnaire as it gives more freedom and due to the inability of identifying the expressions, and clarity of what they wanted to say. The main advantage of personal interviews is that they involve personal and direct contact between interviewers and interviewees. Moreover, it helps to eliminate nonresponse rates. All the secondary data were collected by referring relevant articles and papers from the websites.

The quantitative data which were gathered through the questionnaire were analyzed using MS excel and critical comments to come to certain judgments. All the qualitative data gathered via semi-structured interviews were analyzed using thematic analysis. The data collected through both instruments were put into themes and bar charts and further analyzed and interpreted to obtain final findings of the survey.

3. RESULTS AND DISCUSSION

The theme, familiarity of teachers of English on competency based English curriculum was set to achieve the first objective of the study.
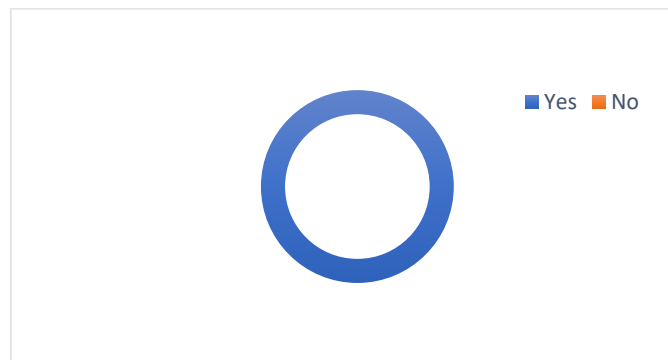

Figure 1: Familiarity on CBC

So, the above findings depicts that all the participants had a basic idea about CBC. But in the interviews, they mentioned that their major concern was to complete the textbook and workbook without referring to the curriculum or the recommended competency-based syllabi as most of the time administration and parents force them to complete the textbook at the end of the year.
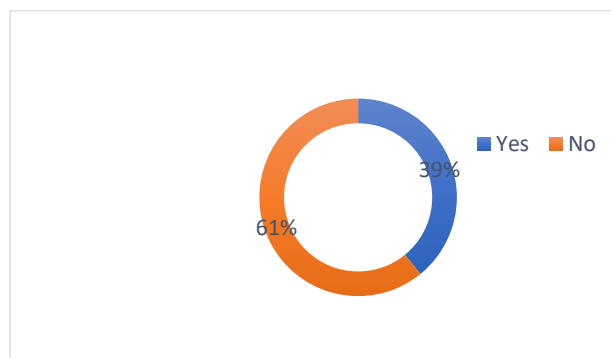

Figure 2: Writing Lesson Plans Using 3P/5E Models

The above pie chart clearly shows that even though it has been several years of introducing the CBC majority of teachers were not writing lesson plans according to competencies and competency levels. Some of the teachers has taken it as an extra burden mentioning it has created a big workload on the teachers in the process of teaching and learning.
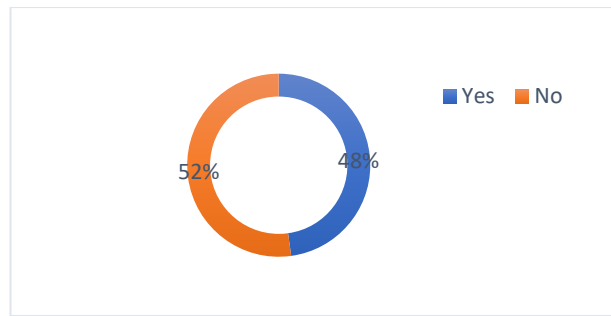
Figure 3: Training on CBC

Apart from that, the above results of the questionnaire depicts that many teachers did not receive any training on CBC and some were unable to attend in trainings due to personal issues. Hence, majority of them were not confident in teaching competency-based curriculum.

To achieve the second objective of the study the researcher analyzed the data on the theme, achievability of competencies. According to majority of the teachers, vocabulary, pronunciation, grammar, speaking, listening, and writing activities are insufficient when compared to reading activities. Teachers claimed that it was difficult to teach and use the given vocabulary at the same time with different level of learners. This is clearly depicted in the Table 1.

Table 1: Analysis of Responds Received for Questionnaire on Achievability of Competencies

#	Question	Scale	Percentage
1	The new competency levels are appropriate to improve the reading skills of the students.	Strongly agree	6.6
		Agree	80
		Neither agree nor disagree	6.6
		Disagree	6.6
		Strongly disagree	0
2	The new competency levels have achievable goals to provide writing task to the learner individually.	Strongly agree	6.6
		Agree	53.3
		Neither agree nor disagree	0
		Disagree	40
		Strongly disagree	0
3	The vocabulary load focus from the new competency levels is adequate to the learner's level.	Strongly agree	0
		Agree	33.3
		Neither agree nor disagree	26.6
		Disagree	40
		Strongly disagree	0
4	Grammar points are recycled through the competency levels.	Strongly agree	0
		Agree	46.6
		Neither agree nor disagree	20
		Disagree	26.6

		Strongly disagree	6.6
5	The competency levels include oral activities to develop the communication which is relevant to the students' levels.	Strongly agree	0
		Agree	46.6
		Neither agree nor disagree	20
		Disagree	26.6
		Strongly disagree	6.6
6	The competency levels are appropriate to improve the listening skills with well-defined objectives.	Strongly agree	0
		Agree	66.6
		Neither agree nor disagree	13.3
		Disagree	20
		Strongly disagree	0
7	There are sufficient competency levels to teach pronunciation to the students.	Strongly agree	0
		Agree	33.3
		Neither agree nor disagree	6.6
		Disagree	60
		Strongly disagree	0

In interviews, they mentioned that though there are oral activities they did not focus more on those as it was not evaluating in the exams and did not pay much attention on listening activities as well due to some impracticalities such as noise, distractions, large number of students in a class etc. Also, some teachers accepted some difficulties faced by them in using proper pronunciation which sometimes a great barrier in teaching. Some claimed on the fact that the activities in the textbooks are repeated in the workbook and highlighted it as a reason for the boredom of students.

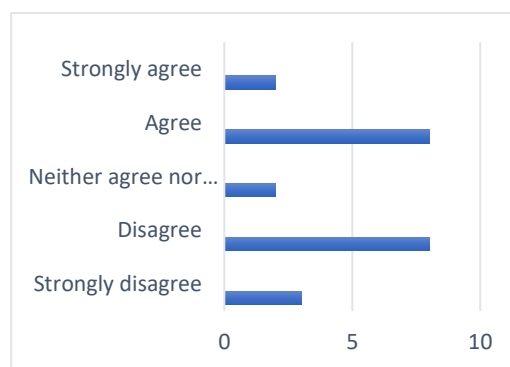Attitudes of teachers of English was the third theme used to achieve the third objective of the study.

Figure 4: Suitability of CBC

According to the above pie chart teachers had a passive idea on CBC where they highlighted its unsuitability for Sri Lanka as still the responsible authorities did not introduce any new evaluation process to evaluate all the competencies by changing the existing system. Majority believed CBC is not challenging enough as visualized in the following graph.
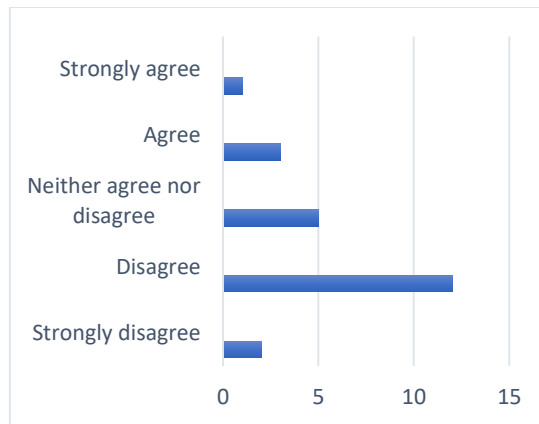
Figure 5: Challenge of CBC

According to teachers of English in Deniyaya Education Zone, CBC is not sufficient to develop the language skills of all types of learners in the classroom.
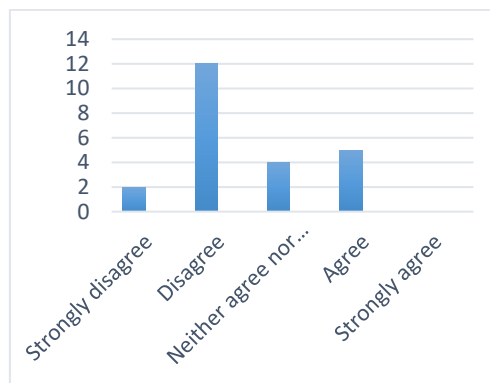

Figure 6: Sufficiency of CBC in Developing Language Skills

Anyhow, most of the teachers had the attitude of improving themselves on this as they interested to be trained.

Options that can be used to replace competency-based curriculum was the last theme of the study which depicts the findings of the last objective of the study. The sample came up with another option to replace CBC while providing some ideas to develop it. Teachers liked to have more training sessions related to the competency-based curriculum and to use more creative approaches in teaching. Further, suggested to use practical approaching methods in learning-teaching process while using activity-based curriculum instead of competency-based curriculum. Most of the teachers preferred to have proper evaluation method at the examinations to evaluate all the competencies and the ISA suggested to do awareness programs for students, parents, and principals on the process of CBC.

4. CONCLUSIONS & RECOMMENDATIONS

Sri Lanka as a country with free education, has more than 92% of literacy due to the gradual changes of the curricula in the field of education in Sri Lanka. By conducting this research, the researcher was able to find that though the teachers were familiar on CBC still shows reluctancy in following its concepts practically. Next, competencies were not achievable as CBC based textbooks highlighted more

on improving reading skill rather than other skills. Then, ELT teachers had a passive attitude on CBC as they emphasized the unsuitability of it to Sri Lankan context. Finally, some teachers suggested to use activity-based curriculum with practical approaching methods instead of CBC while some suggested to develop CBC.

Based on the above findings the researcher recommended to have more awareness programs without using cascade model or to have curriculum developers and more competent resource people to conduct sessions in training the easiest ways of making lesson plans or to introduce new lesson planning approach, to remove or revise the textbooks setting the activities to cover-up all the skills in a balanced way as suitable to the learners with different knowledge levels and to change the evaluation process by including criteria in evaluating 8 competencies, to identify flexible ways of developing CBC among different levels of learners by identifying the geographical context and balancing the facilities among schools, to implement new practical method of learning rather than following textbooks by making aware parents, principals, and students as English is a language. Therefore, this study will be a help for the curriculum implementers in Deniyaya Education Zone to focus on awareness programs of teachers of English on competency-based curriculum. In addition to that to think of the possibilities to change the evaluation process of learners when conducting term tests and other examinations related to English language. The proposed recommendations will be a help for teachers, parents, principals, learners, and other responsible parties to achieve the goal of learning within this education zone. Furthermore, all the decision makers and the responsible bureaucrats in Deniyaya Education Zone, related to the field of education will be benefited by this in the future.

There were few limitations as time and the pandemic situation of the country was a big restriction in conducting the survey. Also, the busy schedules of respondents were also a barrier in collecting information. Due to that only 1ISA could contact in collecting details. The study was limited in terms of its area and subject. The sample size was limited to 25, due to the difficulties in accessing the samples in Island wide. Also, the data given by the sample would not be highly reliable as this study builds up considering on personal attitudes.

REFERENCES

Aloysius, M. (n.d.). Problems of English teaching in Sri Lanka: how they affect teaching efficacy. *Available at: https://uobrep.openrepository.com/bitstream/handle/10547/622477/Aloysius.pdf?sequence=1&is*

Gunawardana, A.A., Karunarathna, B. and Gunawardana, A. (n.d.).(2020). Teacher Research: Remedy for Failures in English Language Teaching in Sri Lanka. *www.academia.edu*. Available at: https://www.academia.edu/33667220/Teacher_Research_Remedy_for_Failures_in_English_Language_Teaching_in_Sri_Lanka.

Joel, R. (2017). Students and Teachers' Perception on Competency-Based English Language Curriculum in Secondary Schools: A case of Mvomero District Council. scholar.mzumbe.ac.tz. Available at: http://scholar.mzumbe.ac.tz/handle/11192/2207 [Accessed 7 Nov. 2022].

Komba, S.C. and Mwandaji, M. (2015). Reflections on the Implementation of Competence Based Curriculum in Tanzanian Secondary Schools. *Journal of Education and Learning*, 4(2). doi:10.5539/jel. v4n2p73.

Leuba, M. (2015). Competency-Based Education: Technology Challenges and Opportunities. *Educause.* Available at: https://er.educause.edu/articles/2015/10/competency-based-education-technology-challenges-and-opportunities [Accessed 5 Jun. 2019].

Liyanagunawardena, T., Adams, A., Rassool, N. and Williams, S. (2014). Blended learning in distance education: Sri Lankan perspective. *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*, 10, pp.55–69. Available at: https://files.eric.ed.gov/fulltext/EJ1071196.pdf.

Mohamed Nawastheen, F. (2019). Educational and curriculum changes in sri lanka: in light of literature. *Muallim Journal of Social Science and Humanities*, pp.342–361. doi:10.33306/mjssh/43.

Richards, J.C. and Rodgers, T.S. (2001). Approaches and Methods in Language Teaching. *2nd ed. Cambridge University Press. Cambridge*. Available at: https://www.cambridge.org/core/books/approaches-and-methods-in-language-teaching/3036F7DA0057D0681000454A580967FF.

Samaranayake, S.W. (2016). Oral Competency of ESL/EFL Learners in Sri Lankan Rural School Context. *SAGE Open, 6(2),* p.215824401665420. doi:10.1177/2158244016654202.

Wong, S.-C. (2020). Competency Definitions, Development and Assessment: A Brief Review. *International Journal of Academic Research in Progressive Education and Development, 9(3)*, pp.95–114. Available at: https://hrmars.com/index.php/IJARPED/article/view/8223/Competency-Definitions-Development-and-Assessment-A-Brief-Review [Accessed 7 Nov. 2022].

CAREER PROGRESSION OF GRADUATES OF BACHELOR OF EDUCATION IN ENGLISH LANGUAGE TEACHING OF UNIVERSITY OF VOCATIONAL TECHNOLOGY

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Abstract

Bachelor of Education in English Language Teaching degree is offered by the University of Vocational Technology since 2012.Although several batches have passed out no literature is available on the impact of the degree on the personal and professional lives of the graduates. Therefore, this study attempts to fill that gap. A randomly selected sample of 50 graduates were selected for data collection. The respondents were contacted over the phone, through social media and an online questionnaire was administrated to collect data. Thirty-three responded. According to the respondents the employers have given due recognition for the degree and that has enabled them to secure promotions as well as change the career for better prospects. Further this has opened avenues for them to obtain post graduate qualifications from local and foreign universities. Therefore, it can be concluded that the degree has a positive impact on the personal and professional lives of these mid-career teachers.

Keywords*: English Language Teaching, English as a Second Language, mid-career.*

1. Introduction

English is taught as second language in the education system of Sri Lanka. Formal English Language teaching for the students starts at grade three in the government schools. However, students are introduced to English vocabulary through Activity Based Oral English (ABOE) program from year one in the school. English medium instruction was introduced to national schools from the year 2007.Manjority of the tertiary education programmes at diploma and higher level are conducted in English medium. To deliver English as a second language in schools, teachers are developed through the Colleges of Education system of Ministry of Education. Further Sri Lanka Institute of Advanced Technological Education (SLIATE) offers Higher National Diploma in English (HNDE) of which majority joins to the national schools as Teachers of English. Formerly,National Institute of Technical Education of Sri Lanka and now University of Vocational Technology (UoVT) also offered National Diploma in English Language Teaching targeting to produce English language teachers required by the TVET sector. All these teachers had limited opportunities for obtaining higher education level qualifications at degree level and above. They had to be contented with the diploma qualifications that they had already earned. This had limited their career progression as well as promotional opportunities. Having identified this need, Bachelor of Education in English Language Teaching degree was launched by the UoVT in the year 2011.The first batch of undergraduates was enrolled in 2012 which comprised

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of English as a Second Langue (ESL) teachers serving in state and private sector schools of Sri Lanka. Since then, four batches of such teachers have graduated and returned to serve as graduate ESL teachers. University of Vocational Technology was established with the aim of providing opportunities of achieving higher education qualifications to those in Sri Lanka who have acquired technical and vocational education and training qualifications at Diploma level. The University became operational from 2009. However, no study has not been undertaken to examine their career progression after graduation. Therefore, this study was undertaken as a tracer study to find out career progression of the graduates which will reflect the impact of the degree they earned to their personal and professional life. Hence, following objectives were formulated to guide the study.

2. OBJECTIVES

i. To assess the impact of Bachelor of Education in English Language Teaching degree on the personal and professional development of the graduates.

ii. To ascertain the perception of the graduates on the usefulness of the Bachelor of Education in English Language Teaching degree.

iii. To examine the level of acceptance of the Bachelor of Education in English Language Teaching degree by the employers.

3. REVIEW OF LITERATURE

Follow up studies help universities to evaluate the results of the performance of institution-specific education and training, and provides information for analysis and evaluation of current and future career and employment opportunities of graduates (Boaduo, Mensah & Babizeng 2009).

It may reveal important facts of positions of graduates, work experience, the nature of the job, income level and curriculum (Schomburg, cited in Millington nd). One way for universities to understand success of their graduates is that they must undertake postgraduate studies. Burke (2005, 314) argues that tracer studies assess the perception of graduates of their learning experience over several years of study. It is expected that such study will improve the understanding of the university on student preparation and success of Alumni.

3.1 ENGLISH LANGUAGE IN THE GLOBAL CONTEXT

English is considered as the global language. Learning English raises the status of the individual and opportunities in education, technology, global careers and business. In addition, English plays an important role as a communication channel (Kannan, 2009). Teaching English has been a major problem in countries where English is not their first language. Therefore, learning a second language is difficult for L2 learners as they do not use English in real life situations. The Difficulties are encountered because they have to learn phrases from textbooks and not in a real-life environment.

It is noted that teachers should always look for helpful strategies to reduce learning difficulties in teaching English (Long, 1969; Chen, 2007; Nunn, 2011). They have to deal with many challenges and often ask questions about the best ways to teach.

3.2 THE CONTEXT OF SRI LANKA

Sri Lanka is a multi-ethnic, multi-cultural and multi religious country and people who speak many languages live here. English is taught and studied as a second language in the public schools in Sri Lanka. Although English was the main medium of instruction in the school system during colonial period, since independence it has been taught as a Second language.

The introduction of the National Language Policy (Constitution of Sri Lanka, 1978) had a significant impact on the English language, when Sinhala and Tamil became the national languages of Sri Lanka. English remains the local and international link language between and among peoples and countries.

The government of Sri Lanka has adopted various approaches in teaching English in the education system which has changed from time to time. Communicative approach to teaching English in public schools (National Institute of Education, 2001) is one among such approaches. The process of teaching English is entirely based on textbooks. There are Teacher's guides and work books for students. Sri Lanka provides training and sets of guidelines for teachers.

The official language of government and the relationship of Sri Lankans with government functions should be carried out in familiar language of the people. Although the provisions on the formation of the reforms of 1946 aimed at raising the status of local dialects and reviving their teaching and study, the teaching of English was recognized as important in the education system of Sri Lanka; It was mandatory for all schools to include the study English in their curriculum (Coperahewa, 2009).

While medium of education of everyone from pre-school education was to be Sinhala or Tamil, as the case may be, native or bilingual (Sinhala/English, Tamil/English) teaching was allowed in junior high school, and in high school and options included that medium of instructions in English only (Balakrishnar & Thanaraj, 2015).

However, there was no immediate opportunity to teach English in all schools; most schools did not have an English teacher(s), and the quality of English teachers - in particular, their level of English proficiency and their knowledge and experience in language teaching pedagogy was much better (Balakrishnar and Tanaraj, 2015).

This meant that it was and it is unlikely that students receiving local primary education, especially those attending rural schools with few resources will be able to join English Language Teaching Classes in High School (EMI).

The use of local languages such as medium of instructions in secondary schools to provide effective education and with acceptable outcomes has also faced a resource hurdle for the program with teaching materials in local languages (Balakrishnar and Tanaraj, 2015).

Until this is fixed, a limited number of many public high schools had no choice but to continue the use of medium of English, and private fee-paying schools, of course, only offered English medium education. Thereby, politics had no direct impact on relative socioeconomic status for users of three languages: Sinhalese, Tamil and English.

Obviously, there are serious problems with teaching English. Whereas there is no obvious shortage of teachers, many of them are either low-skilled or unskilled. A 2009 government investigation found nearly 21,000 English teachers in primary and secondary schools who have been untrained (Lim, 2013). Combined with weaknesses in the program classroom learning itself is characterized by ineffective teaching methods from unsuitable materials.

That many of those in charge of delivery of English language education programs are under-prepared as some (e.g., Walisundara and Hettiarachchi, 2016) see (English) teachers as a major barrier to achieving policy objectives, but few attempts have been made to remedy the situation (Wijesekera, 2011/2012).

Perhaps an inevitable consequence of persistent failure in teaching and learning English is the poor English proficiency of many English teachers, and the notion of proficiency is further complicated by the fact that the target is Standard British English rather than Standard Sri Lankan English (Mendis and Rambukwella, 2010; Mailer, 2015).

The grammar rules, vocabulary, and writing that students encounter in the curriculum, study materials, and exam mode are not very consistent with the English they speak. They do not support improving their experience outside the classroom. Along with adding another dimension to questions about teacher competence, focusing on British English to meet the obvious need to communicate with English-speaking foreigners devalues local diversity and reinforces "English" as a guarantor of access to elite ranks (Parakrama, 2012).

However, with liberal market policies and international firms operating in the country and shift towards service-based economy, the commercial value of English started to gain and government recommenced English medium instructions in selected school from 2007 onwards.

Further, educational establishments preparing students for overseas examinations also emerged as people wanted to give their children English medium education so that they are are compatible with the social economical challenges they have to face in the future and to broaden their horizons. This increased the demand for the teachers who are competent in teaching English a sa Second language and who could deliver subject matters in the medium of English.

Hence, many students who have successfully passed G.C.E (A /L) but unable to enter to state universities selected to be enrolled in the Colleges of Education of NIE (National Institute of Education) or SLIATE (Sri Lanka Institute of Advanced Technological Education) or other establishments to pursue study programs in order to become qualified as ESL teachers. However, their careers were stagnated due to non-availability of progression from Diploma to Degree. Although University of

Vocational Technology has provided this opportunity for such teachers, literature is not available to examine the impact of the program.

4. METHODOLOGY

The graduates are the best source to identify the usefulness of the degree to the holders. The recognition given by the employers to the degree is reflected by the promotions and other career prospects given to the graduates. Therefore, data was collected from the graduates through a questionnaire aiming to find information related to the objectives of the study. The study employed a descriptive survey design. Data was collected by a questionnaire administered online, from the graduates of the first four batches of the B. Ed in ELT degree, who graduated in the years from 2014 to 2017. It was decided to identify the impact of the degree on personal and professional development of the graduates by collecting information about their career promotions and further studies.

The questionnaire consisted of 12 closed type questions and one open ended question. The questionnaire was pilot tested by administering it to three graduates and modifications to the questionnaire were made based on the feedback received, before wider circulation. The total population was 87 graduates and the questionnaire was circulated to a randomly selected sample of 46 graduates. It was administered through electronic media due to the context that prevailed in the country. Thirty-three graduates responded which amounts to 72 % of the sample, which a very high response rate in the questionnaire survey approach.

5. RESULTS AND DISCUSSION

5.1 PROFILE OF GRADUATE AT THE ENROLLMENT

There respondents minimum experience in teaching ESL was three months whereas the maximum was 28years. The age distribution of the respondents ranged from 22 years to 52 years at the enrollment. Table 1 illustrates G.C.E. (A/L) subject streams that respondents had followed.

Table 1: G.C.E. (A/L) Subject Streams of the Respondents

Stream	Percentage
Arts	21.2%
Biological Science	51%
Commerce	18.7%
Physical Science	9.1%
Total	100%

Interestingly, 60.1 % of the respondents had studied in the science stream in G.C.E.(A/L) whereas only 21.2 had studied sin Arts stream where languages are taught at the G.C.E. (A/L). This shows the level and the demand for English Language teaching as a career. The majority of the respondents were females amounting to 66%.

5.2 GRADUATES PERFORMANCE AT GRADUATION

Majority of the graduates at the enrolment were in their mid-career taking to learning path after lapses of many years which is not an easy task. However, a very high percentage of 80.6% had graduated with a class and it indicates that they have been fully dedicated and committed for studies at the university amidst their family and employment commitment. This is an indication of quality of delivery.

5.3 IMPACT OF THE DEGREE ON EMPLOYMENT

Within three months to two years of graduation, a 59.4% of the graduates had received promotions in their employment, whereas 1% had changed their employment from teaching ESL to educational administrator with better prospects.

Table 2: Impact of Degree on Employment

Question	Strongly Disagree	Disagree	Cannot say	Agree	Strongly Agree
Do you think that the B.Ed. ELT degree helped you to get a promotion/ change employment?	3.1% (1)	3.1% (1)	21.9% (7)	18.8(%6)	53.1 % (17)

Table 3: Recognition of the Degree by Employers

Question	Cannot say	Not recognized at all	Somewhat	Recognized	Highly Recognized
How was your qualification recognized at the workplace and other agencies you are working with?	12.1% (4)	0% (0)	9.1 (3)	48.5% (16)	30.3% (10)

Table 2 & 3 illustrate the usefulness of the degree for promotional aspects as well as the recognition given by the employers as perceived by the graduates. A 71.9 % of the graduates are of the opinion that the degree helped them to get promotions or change the employments for better prospects. Further,78.8 % of graduates were of the opinion that their employers have given due recognition to the qualification although they have earned it at their mid-career from a relatively new university.

5.4 IMPACT OF THE DEGREE ON FURTHER STUDIES

Out of the respondents a 36.4 have already completed their postgraduate studies at diploma and master level. They had studied in the universities of Colombo, Kelaniya, Peradeniya, Sri Jayewardenepura, Sabaragamuwa and Open university of Sri Lanka. Out of the 63.6 graduates those who have not completed post graduate studies a 52% are currently pursuing higher studies and one is at University of Wales, England.

6. FINDINGS

According to 78.8 % of graduates, the respective work places have given due recognition to the degree they have earned. Further, the degree has helped 71.9 percent of graduates to obtain promotions or change careers for better prospects. A 36.4 % of the respondents have already completed post graduate

qualifications in national universities of Sri Lanka. Majority of the respondents who have not completed post graduate studies are pursuing studies in local and overseas universities in the relevant field. One has left the job and joined the private sector at a higher managerial position. Three respondents have got promoted positions and joined higher education institutes in state sector as Lecturers which they would not have obtained, if they had not followed the degree. The above discussion illustrates that the recognition given to the B.Ed. ELT degree by the state universities, the employers as well as the positive impact it had on the professional lives of the graduates. Further, majority of the respondents highlighted the importance of extending the degree for four years for which the university has already taken steps. However, graduates have raised concerns on the applicability of the content of the teaching methodologies in the present context. The respondents are of the view that the degree in general is a tough and excellent course which gives a comprehensive coverage of subject matter and the competencies required by the ESL teachers. They have felt that the due publicity has not been given to the degree by the authorities. Such publicity campaign among stake holders would attract more needy ESL teachers to the degree.

7. CONCLUSIONS

The guidance, support and the friendly atmosphere created by the university staff during their period of study has been highly appreciated by the respondents which had enabled them to complete the studies successfully amidst their personal and professional commitments. They highly commended on the applicability of the content covered in the degree. Hence, the graduates have a positive perception of the degree program. Findings of the study indicate that the degree has a positive impact on their personal lives and professional career as the degree has been given due recognition by the respective employers.

REFERENCES

Balakrishnar, J., & Thanaraj, T. (2015). Instruction in the English medium: A Sri Lankan case study. In: H. Coleman (Ed.), *Language and Social Cohesion in the Developing World (Selected Proceedings of the Ninth Language and Development Conference, Colombo, Sri Lanka, 2011) (*pp. 166–177). Colombo, Sri Lanka.

Boaduo, NA-P, Mensah, J & Babitseng, SM. (2009). Tracer study as a paradigm for the enhancement of quality course programme development in higher education institutions in South Africa. *Educational Colloquium, University of North-West, Potchefstroom,South Africa*, 20–21 August 2009.

Burke, J. C. (2005). The Three Corners of the Accountability Triangle: Serving All, Submitting toNone. In: JC Burke (Ed.), *Achieving Accountability in Higher Education. (*pp. 296-324). San Francisco: Jossey-Bas

Chen, Y. , (2007). Learning to learn: The impact of strategy training. *ELT Journal*, *61(1),* 20-29. http://dx.doi.org/10.1093/elt/ccl041

Coperahewa, S., (2009). The language planning situation in Sri Lanka. Current Issues in Language Planning, *10(1),* 69–150.

Kannan,R.(2009). Language in India Problems in Speaking English with L2, *ESP World 5(8),* ...https://www.academia.edu › Language_in_India.

Long, R. B. (1969). Linguistic universals, deep structure, and English as a second language.*TESOL Quarterly*, 3, 123-132. http://dx.doi.org/10.2307/3586098

Mendis, D., & Rambukwella, H. (2010). Sri Lankan englishes. In: A. Kirkpatrick (Ed.), *The Routledge Handbook of World Englishes* .pp. 181–196. London/New York: Routledge.

Meyler, M. (2015). Sri Lankan English: An appropriate model for the teaching of English in Sri Lanka? In: H. Coleman (Ed.), *Language and Social Cohesion in the Developing World*, *Ninth Language and Development Conference,* Colombo, Sri Lanka, 2011).

Millington, C. [nd]. The use of tracer studies for enhancing relevance and marketability in onlineand distance education. http://wikieducator.org/images/e/e1/PID_424.pdf (Accessed 1 June 2010).

Nunn, R. (2011). Improving method-in-use through classroom observation. *IRAL, 49*, pp.55-70. http://dx.doi.org/10.1515/iral.2011.003

Walisundara, D. C., & Hettiarachchi, S. (2016). English language policy and planning in Sri Lanka: A critical overview. In: R. Kirkpatrick (Ed.*), English Language Education Policy in Asia* .pp. 301–332. Cham, Switzerland: Springer.

Wijesekera, H. (2012). Dreams deferred: English language teaching in. Sri Lanka. *Journal of Humanities & Social Sciences*, 7(8,) pp.16–26

ATTITUDES TOWARDS USING AUTHENTIC MATERIALS FOR TEACHING AND LEARNING IN ENGLISH AS A SECOND LANGUAGE CLASSROOM: TEACHERS' PERSPECTIVES

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ABSTRACT

The present study is based on action research to investigate teachers' attitudes toward using authentic materials for teaching and learning English as a Second Language (ESL). The study was carried out in Education Division, Bentota. 46 teachers have been selected using a convenient sampling method from all four categories of schools such as 1AB, 1C, Type 2, and Type 3 for the study. This research is based on primary data gathered using a structured questionnaire and interviews. The collected data was analyzed using descriptive-qualitative analysis. The results indicated that the knowledge of the utility value of authentic materials of the respondents is very less and teaching has been restricted to the textbook and teacher's guide prescribed by the Ministry of Education. Teachers' limited knowledge of authentic materials can be identified as the main reason for the limited use of authentic materials and their inability to recognize very easily available and accessible authentic materials. The findings have been stated that the training in using authentic materials will be useful and effective for teachers in providing a better understanding of authentic materials and in creating a conducive learning environment so as to facilitate a learner-centred approach.

Keywords: Authentic Materials; ESL; Learner Centred; Learning Patterns; Textbook.

1. INTRODUCTION

The purpose of learning English as a second language is to communicate with ease and to move into the realm of the elite. English is taught in various countries using innumerable methods, which comply with their own requirements. In order to achieve the expected fluency, the four skills in a language i.e., listening, speaking, reading, and writing have to be mastered. For this process, the innovative use of authentic materials is suggested so as to make teaching and learning a more effective and efficient one. The term authentic materials or authentic texts refers to any written or spoken texts which are commonly not intended to language teaching (Tomlinson, 1998). Peacock (1997) defines authentic materials as materials that have been produced to fulfill some social purposes in the language community while Nunan (1999) defines authentic materials as spoken or written language data that has been produced in the course of genuine communication and not specifically written for purposes of language teaching. Further, Kramsch (1993: 177) points out that authentic refers to everyday language used, it is not intended for academic purposes (as cited in Mohammad and Ibrahim, 2019, p.24).

Many empirical researchers have found out how authentic materials are used effectively in learning language skills. Studies such as Guo (2012) and Parmawati and Yugafiati (2017) reveal the use of authentic materials in improving the reading skills of learners.

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Further Sukmawan, Setyowati and Sulukiyyah (2021) reveal the use of authentic materials in improving critical reading and writing abilities in English. Rao (2019) reveals the effective use of authentic materials in English language classrooms and how they assist in teaching and learning process.

According to Rogers (1988), "the authentic materials should be qualified in terms of objectives, learners' needs and nature of the meaningful communication" (p. 467). In addition, Dornyei (2003) has demonstrated that students' motivation and, learning achievement are highly influenced by the teachers' attitudes (as cited in Akbari, Razavi, 2016). Therefore eliciting the attitude of teachers in using authentic materials is unavoidable before focusing on the effectiveness of using them.

Hense the aim of the study is to elicit teachers' attitudes towards using authentic materials in the classroom, the intended objectives are as follows.

1. To elicit teachers' attitudes on using authentic materials in teaching

2. To identify why teachers use authentic materials for their teaching

3. To investigate whether the teachers need training in using authentic materials

1.1 BACKGROUND STUDY

Education Division, Bentota, is located under Elpititya Zonal Education Office, Southern Provincial Ministry of Education, Land and Land Development, Highways, and Information. There are twenty-one schools located in Bentota Division covering all the fifty Grama Niladhari Divisions in Divisional Secretariat, Bentota. All these schools are under four different varieties of schools 1AB, 1C, Type 2, and Type 3 covering 4 schools in 1AB category, 5 schools in 1C category, 6 schools in Type 2 category, and 6 schools under Type 3 category. Sinhala is the medium of instruction in twenty schools and Tamil is the medium of instruction in one school. In every school, English has been taught as the learners' second language. 51 teachers are included in Education Division, Bentota by the year 2021 and 46 teachers responded to the questionnaire. Among them 58.7% of the teachers are government Trained Teachers, 21.7% of the respondents have Bachelor's Degree from government universities, and 19.6% of the respondents have diploma from National Colleges of Education. Among the teachers, the majority 56.5% of them are 21 years or above. 17.4% of the teachers have 1–5 years of experience in teaching.17.4% of the teachers have 11–15 years of experience in teaching. 4.3% of the respondents have 16–20 years of experience in teaching and 4.3% of the respondents have 6–10 years of experience in teaching. There are only two schools, conducting literature for the G.C.E. Ordinary Level and all the other schools teach English as the Second Language. None of the schools offer English as the main subject at G.C.E. Advanced Level.

All the teachers in the Education Division, Bentota use only teacher's guide prescribed by the Ministry of Education as a result the utility value of authentic materials of the respondents is significantly less. Their limited knowledge of authentic materials seems to be a reason for their inability to recognize very easily available and accessible authentic materials. Therefore the present study is carried out to

investigate teachers' attitudes toward using authentic materials for teaching and learning English as a Second Language (ESL).

2. METHODOLOGY

Quantitative and qualitative data collection was done using two- approaches: a survey and interviews

2.1. SURVEY

Quantitative data was gathered using a structured questionnaire. The total population which means 51 teachers in all four categories of schools in Education Division Bentota was used as the sample of the study utilizing the convenience sampling method and responses were received from 46 teachers only. A pilot study was conducted to improve the questionnaire and modifications were done based on the given feedback.

2.2. INTERVIEW

Respondents who filled out the questionnaire were interviewed to gather qualitative data about classroom context and methods used in teaching and the reactions of the respondents were recorded. 30 respondents were interviewed physically and the other 16 respondents were interviewed over the phone.

3. RESULTS AND DISCUSSION

Education Division, Bentota is heterogeneous due to the teachers' perceived needs. They use various teaching methods in varying degrees according to the needs of the students and their consent. Classrooms are never equipped with technology and most students do not have personal desktops or laptops. Sometimes the available equipment is shared among the other siblings at home. 100% of the respondents use materials for their classroom teaching. 76.1% of the respondents use materials prescribed in the textbook and teacher's guide by the ministry of education. 84.8% of the respondents mentioned that they have a habit of collecting authentic materials. 80.4% of the respondents have stated that they use authentic materials in classroom teaching.

Data gathered through the interview revealed that the respondents did not clearly understand the difference between authentic materials and non-authentic materials and the materials prescribed in the textbook and teacher's guide have been understood as authentic materials by the respondents. Newspaper articles, magazines, pictures, and brochures that can be used in the classroom context have been collected by the respondents as additional resources as they are nominated for activities in the textbook and teacher's guide.

The results of the study indicate that majority of the respondents perceived an uncertain attitude towards using authentic materials in facilitating learning. Many have understood various benefits of using authentic materials and at the same time, the respondents have an uncertain attitude towards learners' attitude towards authentic materials where traditional teaching and learning has been the order of the day.

3.1. ATTTITUDES TOWARDS USING AUTHENTIC MATERIALS

Table 1: Attitude towards Using Authentic Materials

Factor	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
Authentic materials avoid students' boringness of learning grammar	14 (30.4%)	32 (69.6%)	Nil	Nil	Nil
The need for authentic materials to improve reading skills of the students	5 (10.9%)	41 (89.1%)	Nil	Nil	Nil
The assistance of authentic materials for the respondents to prepare students for real-life situations	8 (17.4%)	32 (69.6%)	6 (13%)	Nil	Nil
The need for authentic materials to improve writing skills of the students	6 (13%)	33 (71.7%)	7 (15.2%)	Nil	Nil
The need for authentic materials to improve listening skills of the students	8 (17.4%)	27 (58.7%)	11 (23.9%)	Nil	Nil
Respondents motivate students to use authentic material	5 (10.9%)	30 (65.2%)	11 (23.9%)	Nil	Nil
The need for authentic materials to improve speaking skills of the students	6 (13%)	28 (60.9%)	12 (26.1%)	Nil	Nil
Students' interest in using authentic materials than textbooks	3 (6.5%)	31 (67.4%)	9 (19.6%)	3 (6.5%)	Nil
Authentic materials suppot creating more creative approach in teaching	10 (21.7%)	24 (52.2%)	12 (26.1%)	Nil	Nil
Authentic materials provide motivation for the respondents to prepare more, outside the classroom	8 (17.4%)	25 (54.3%)	8 (17.4%)	5 (10.9%)	Nil
Authentic materials help learners to improve their vocabulary	7 (15.2%)	23 (50%)	16 (34.8%)	Nil	Nil
Authentic materials increase knowledge of vocabulary items, needed in respondents' real-life situations	7 (15.2%)	22 (47.8%)	11 (23.9%)	6 (13%)	Nil
Authentic materials create opportunities for interaction	10 (21.7%)	17 (37%)	10 (21.7%)	9 (19.6%)	Nil
Authentic materials help to develop respondents' writing styles more than textbooks	7 (15.2%)	17 (37%)	22 (47.8%)	Nil	Nil
The effectiveness of using authentic materials in improving students' proficiency more than textbooks	8 (17.4%)	14 (30.4%)	22 (47.8%)	2 (4.3%)	Nil
Real language use in authentic materials	9 (19.6%)	11 (23.9%)	26 (56.5%)	Nil	Nil

The assistance of using authentic materials to deliver the respondents' lessons effectively	7 (15.2%)	12 (26.1%)	23 (50%)	4 (8.7%)	Nil
Authentic materials encountered with the syllabus	4 (8.7%)	12 (26.1%)	20 (43.5%)	6 (13%)	4 (8.7%)
Students are more comfortable in using authentic materials than non-authentic materials	Nil	9 (19.6%)	28 (60.9%)	9 (19.6%)	Nil
Traditional materials do not provide any room to use authentic materials as a part of its content	Nil	6 (13%)	33 (71.7%)	3 (6.5%)	4 (8.7%)

The above table indicates the attitude of the respondents towards authentic materials. 100% of the respondents agree that authentic materials avoid students' boringness of learning grammar and they feel authentic materials are needed for improving the reading skills of the students. 87% of the respondents feel that authentic materials are needed to prepare students for real-life situations. 84.7% of the respondents feel authentic materials are needed to improve the writing skills of the students. 76.1% of the respondents feel authentic materials are needed for improving the listening skills of the students. 76.1% of the respondents motivate students to use authentic materials. 73.9% of the respondents feel authentic materials are needed for the speaking skills of the students. 73.9% of the respondents believe students are more interested in using authentic materials than textbooks. 73.9% of the respondents feel authentic materials support creating a more creative approach to teaching. 71.7% of the respondents believe authentic materials are a motivation for the respondents to prepare more, outside the classroom. 65.2% of the respondents feel authentic materials help to improve their vocabulary. 63% of the respondents feel authentic materials increase knowledge of vocabulary items needed in respondents' real-life situations. 58.7% of the respondents believe authentic materials create opportunities for interaction. 52.2% of the respondents feel authentic materials help to develop respondents writing styles. When considering all the responses, majority of the respondents have a positive attitude towards using authentic materials in the classroom context. At the same time, some uncertain attitudes towards authentic materials can be identified in their responses.

Meanwhile, 52.1% of the respondents disagreed with the effectiveness of authentic materials in improving students' proficiency more than textbooks. 56.5% of the respondents disagreed with the factor that authentic materials consist of real language. 58.7% of the respondents disagreed with the assistance of using authentic materials to deliver the respondents' lessons effectively. 65.2% of the respondents disagreed with the factor authentic materials encounter with the syllabus. 80.5% of the respondents feel students will not be more comfortable using authentic materials than non-authentic materials. 86.9% of the respondents feel traditional materials do not provide any room to use authentic materials as a part of their content. When considering the information, even though the majority of the

respondents have a positive attitude towards authentic materials, respondents who bear a negative attitude towards authentic materials cannot be ignored because the number of respondents can be regarded as a major populace in influencing and changing the attitudes of many. Limited understanding on authentic materials seems to be the main reason for these misconceptions.

3.2. REASONS FOR USING AUTHENTIC MATERIALS

Table 2: Reasons for Using Authentic Materials for Teaching

Statement	No. of respondents	%
Relevance	28	(60.9%)
Intrinsic	18	(39.1%)
Quality	12	(26.1%)
Linguistic demand	9	(19.6%)
Cognitive demands	5	(10.9%)
Explicability	Nil	Nil
Cultural appropriateness	Nil	Nil
Interest of the topic/ theme	Nil	Nil
Logistical considerations (length, legibility/audibility)	Nil	Nil

The above table indicates the reasons for using authentic materials in teaching. Among them, 60.9% of the respondents use authentic materials in classroom teaching as they feel authentic materials are relevant for classroom teaching. 39.1% of the respondents stated that they feel authentic materials are intrinsic. 26.1% of the respondents stated that they use authentic materials because of their quality. 19.6% of the respondents use authentic materials due to their linguistic demands. 10.9% of the respondents use authentic materials because of their cognitive demands. None of the respondents have identified the most significant features such as explicability, cultural appropriateness, interest in the topic or theme, and logistical considerations where these features are significant in authentic materials. While the respondents use authentic materials for their teaching, the reasons for not using authentic materials were mentioned as below.

3.3. REASONS FOR NOT USING AUTHENTIC MATERIALS FOR TEACHING

Table 3: Reasons for Not Using Authentic Materials for Teaching

Statement	No. of respondents	%
Workload	46	(100%)
Not much aware about them	40	(87%)
Special operation is necessary	38	(82.6%)
Lack of authentic materials	35	(76.1%)
Huge content of the planned lesson	33	(71.7%)

Difficult to deal with the students	32	(69.6%)
Difficult to adapt the syllabus	31	(67.4%)
Wasting time	25	(54.3%)
Cost is high	25	(54.3%)
Rarely available	22	(47.8%)
The material can become outdated easily	Nil	Nil
Difficult to understand outside the language community	Nil	Nil

The above table illustrated the respondents' attitude towards the limited use of authentic material in the classroom context. Among them, 100% of the respondents use limited authentic materials due to the existing workload. 87% of the respondents use limited authentic materials as they are not much aware of them. 82.6% of the respondents use limited authentic materials in the classroom as they feel a special operation is necessary for them. 76.1% of the respondents use limited authentic materials in the classroom as they feel authentic materials are very rare. 71.7% of the respondents use limited authentic materials as huge content is existing in the planned lesson. 69.6% of the respondents use limited authentic materials in the classroom teaching and learning as they feel difficulty adapting the syllabus. 54.3% of the respondents use limited authentic materials as they feel authentic materials waste time and the cost is high. 47.8% of the respondents believe that authentic materials are rarely available and therefore they do not use them in the classroom.

When considering the overall responses, it can be concluded that the awareness of the use of authentic materials seems to be less. Authentic materials can be used along with the existing workload and the respondents do not need to take separate attempts for using them. The majority of the respondents undoubtedly believe that the knowledge of authentic materials is less and that is a reason for the limited use of authentic materials. As a result, respondents believe a special operation is needed to use authentic materials in the classroom. Authentic materials such as train tickets, bus tickets, newspaper articles, leaflets, posters, maps, comics, charts, greeting cards, catalogs, TV guides, brochures, telephone directories, and advertisements are a few authentic materials that can be used in the classroom. Meanwhile, the respondents have misconceptions about authentic materials as the special training or awareness or advocacy is needed and authentic materials are highly based on technology. Different authentic materials are available using technology as well as there are a certain amount of materials that are not based on technology. Since the teachers are not much aware of authentic materials, they feel authentic materials as technology-based materials only. Since the understanding of authentic materials is less, the respondents have not recognized the easily available and accessible authentic materials in different contexts. Therefore they responded as authentic materials are rarely available.

Authentic materials can be used along with the planned lesson. Since they are additional materials that are part and parcel of the planned lesson, the teacher can use them along with the planned lesson. As teachers when planning a particular lesson, the content can be managed using authentic materials. Further respondents feel that authentic materials are not easily manageable with the students. Since the respondents do not have a thorough understanding of authentic materials they feel so, at the same time they fail to identify the easily available authentic materials which can be made use of in their teaching. The most notable factor of authentic material is that it can become outdated easily and that has not been taken into consideration or identified by the respondents, which pertinently points towards their limited understanding.

3.4. REASONS FOR USING NON-AUTHENTIC MATERIALS

Table 4: Reasons for Using Non-authentic Materials for Teaching

Statement	No. of respondents	%
Cost is affordable	35	(76.1%)
Always contain well-formed sentences and structures	33	(71.7%)
Specially designed for learning purposes	23	(50%)
Highly planned	13	(28.3%)
Easily available	12	(26.1%)

The above table indicates the responses to using non-authentic materials in the classroom by the respondents. Among them, 76.1% of the respondents feel the cost of non-authentic materials are affordable, 71.7% of the respondents feel non-authentic materials contain well-formed sentences and structures, 50% of the respondents feel that authentic materials are much suitable in the classroom as they are specially designed for learning purposes, 28.3% of the respondents feel non-authentic materials are effective in classroom teaching as they are highly planned and 26.1% of the respondents adhere to the idea that non-authentic materials are easily available. Respondents feel that the cost for non-authentic materials is affordable since it is free of cost when compared to authentic materials. Since the understanding is less they have come to a conclusion as such. As teachers, they expect to use materials that are designed for the purpose of learning due to the well-formed sentences and structures.

The results show that the respondents have a positive attitude towards using authentic materials but an uncertain attitude also exists for them. They consider authentic materials to consist of significant features such as improving four skills in language and exposing the students to real language use. The finding of this study is closely related to some previous research done and confirmed the positive attitude towards authentic materials prevailed among teachers Akbari and Razavi (2016). Further as well as the positive attitudes of the respondents towards using authentic materials, some uncertain attitudes can be seen among them. Concerning the need training on using authentic materials, 89.1% of the respondents have mentioned that training in using authentic materials is needed while 10.9% of the respondents are in disagreement. The respondents' idea was that they need a better understanding on authentic materials to select the existing resources which can be made available for their teaching.

4. Conclusion

The study explored the attitude of teachers towards using authentic materials in an English as the second language classroom, and the results revealed that the majority of the teachers had a positive attitude towards using authentic materials in the classroom while some had uncertainty about using authentic materials which is due to lack of awareness towards authentic materials and misconceptions with regard towards employability of authentic materials. Furthermore, the results indicated that since teachers always believe authentic materials are technology bounded materials and therefore special skills are needed when using them in the classroom. Since classrooms are not equipped with the technology they feel students will be alienated in the new classroom environment if authentic materials are used. These types of misconceptions have prevailed among teachers and the majority of the respondents feel that training in using authentic materials would be effective for the better use of authentic materials in the classroom.

References

Akbari, O., Razavi, A., (2015). Using authentic materials in the foreign language classrooms:

Teachers' perspectives in EFL classes. *International Journal of Research Studies in Education. 4.* https://doi.org/10.5861/ijrse .2015.1189

Guo, S., (2012). Using authentic materials for extensive reading to promote English proficiency. *English Language Teaching* 5, 11. pp. 196-206.

Mohammed, M.A.A., (2019). The effectiveness of authentic material in promoting spoken English. *International Journal of English Language Teaching* 7. pp 23-28.

Parmawati, A., Yugafiati, R., (2017). Using authentic material to improve students' reading interest (A Classroom Action Research in the Second Semester Students of STKIP Siliwangi Bandung). *ELTIN Journal English Language Teaching Indonesia* 5, 1. https://doi.org/10.22460/eltin.v5i1.p1-8

Rao, P., (2019). The effective use of authentic materials in the English language classrooms. *Shanlax International Journal of Art, Science and Humanities.* 7, 1–8. https://doi.org/10.34293/sijash.v7i1.556

Savarimuttu, J.S.R., (2022). *The Education of English Language through English Literature: In Sri Lankan Context.*

Sukmawan, S.-, Setyowati, L.-, El-Sulukiyyah, A.A., (2021). The effect of authentic materials on writing performance across different levels of proficiency. *International Journal of Language Education* 515–527. https://doi.org/10.26858/ijole.v5i1.15286

EFFECTIVENESS OF TEACHING ENGLISH PRONUNCIATION IN SRI LANKAN GOVERNMENT SCHOOLS: A STUDY BASED ON KEBITHIGOLLEWA EDUCATION ZONE, SRI LANKA

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Abstract

Teaching English pronunciation is critical in the teaching of the English language because it is one of the language skills that must be mastered. Pronunciation practices and techniques are designed in prescribed textbooks and teachers' guides to teach English pronunciation. However, it can be shown that English pronunciation is not taught at a suitable level in Sri Lankan government schools. Therefore, the objectives of this research were to investigate the existing English pronunciation practices and techniques which are introduced by prescribed textbook series and teachers' guides in primary grades, to find out whether the teachers have facilities to help practice English pronunciation in primary grades and to find out whether the teachers feel confident and proficient in English pronunciation teaching. This study used the mixed method. Utilizing the random sampling technique thirty-two English language teachers and in-service advisers were identified as the sample from the Kebithigollewa zone. A questionnaire was given to gather perception on the effectiveness of teaching English pronunciation in government schools. The results of the study revealed that songs and nursery rhymes, listen and repeat, loud reading, tongue twisters, drills, poetry, directions, simple stories, simple descriptions, and dialogues exist in textbooks and teachers' guides to teach English pronunciation. Teachers and in service advisers have asserted that they lack adequate facilities to teach pronunciation and they should be also provided appropriate pronunciation courses to train them to teach English pronunciation to primary grades.

Keywords: *Effectiveness, Government Schools, Primary Grades, Teaching English Pronunciation, Techniques.*

1. INTRODUCTION

Pronunciation is one of the most difficult areas for learners as well as for teachers in Sri Lankan Government schools. Teaching pronunciation is still a relatively marginalized skill in many English as a Second language (ESL) classrooms. In Sri Lankan ESL classrooms, different techniques and methods are used by ESL teachers to teach pronunciation. Since there is a lack of fluency in pronunciation with students even after a long period of teaching pronunciation, some challenges in pronouncing skill of students can be observed in Sri Lankan school system. Sri Lankan students, who have bad pronunciation, are usually unable to score well for oral examinations and assessments, which are based on the oral skill and less participating for events such as morning assemblies and English day competitions.

There are different techniques and practices which are designed in the primary grades' syllabus in government schools. However, an investigation of the effectiveness of teaching English pronunciation in Sri Lankan government schools can be considered as a requirement to find out whether the included

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pronunciation practices and techniques in prescribed English textbooks help teachers to teach the English pronunciation in primary grades effectively.

When observing literature of English pronunciation in Sri Lankan government schools, different teaching techniques and practices are used to teach English pronunciation in primary grades. Teaching pronunciation and teaching materials are also mainly from the textbooks and the use of other classroom activities for teaching pronunciation is extremely rare. However, the output of teaching English pronunciation is not up to the standard. It is problematic whether those measures have fulfilled the requirements of teaching English pronunciation or whether the teachers have facilities to teach English pronunciation and the teachers feel confident and proficient to teach English pronunciation in Sri Lankan government schools. Hence, the aim of this research is to investigate the effectiveness of teaching English pronunciation in primary grades of Sri Lankan government schools which is based on Kebithigollewa Zone and the researcher intend to focus on achieving the following objectives.

i. To investigate the existing English pronunciation practices and techniques which are introduced by prescribed textbooks series and teachers' guides in primary grades.

ii. To find out whether the teachers have facilities to help practice English pronunciation in primary grades.

iii. To find out whether the teachers feel confident and proficient in English pronunciation teaching.

2. REVIEW OF LITERATURE

Teaching English in Sri Lanka begins formally grade one onwards. Grade one and two focuses on oral English helping students speak commonly used expressions and grade 3 onwards teaching of English happens focusing on all four skills speaking, listening, reading and writing. According to (Gunawardana, 2018), the "Let's learn English" course books for grades three and four practice pronunciation skills through a variety of activities such as songs, rhymes, chants, dialogues, and other listening activities, whereas the grade five course book departs from the above activities and introduces more advanced activities such as reading passages for pronunciation practice.

Teachers and students have to face difficulties when teaching and learning pronunciation in the Sri Lankan context. According to Hewawasam and Amaratunga (2016), students produce pronunciation problems as a result of the effect of their mother language. Fernando (2019) also asserted that teaching pronunciation is a difficult endeavor with distinct objectives at each level. This is especially true in the Sri Lankan setting, where English teaching has primarily become exam-oriented, with little emphasis on pronunciation. Similarly, Widyalankara (2014) stated that, the literature identifies numerous additional factors influencing the degree of pronunciation variation, including aptitude (phonemic coding ability), psychomotor skills, age, gender, stage of L2 acquisition, the learner's attitude, motivation, and language ego, as well as other sociocultural and socio-psychological variables.

According to Rohan (2012), the concern identified among the teachers is their low vocabulary and inaccurate pronunciation. Most of the regions that are usually deemed difficult to pronounce by the Sri

Lankan speakers of English (diphthongs, consonant clusters, f z, etc.) were mispronounced by the teachers. Since most of the teachers are in their middle ages. They have lost the suppleness of speaking muscles.

3. METHODOLOGY

The research method employed in this present study is the mixed method. Hence, the researcher has presented the perceptions and attitudes of the teachers and in service advisers gathered through the questionnaire and the researcher's own in-depth analysis of the textbooks descriptively, qualitatively and quantitatively.

At present, 170 English language teachers and 3 In Service Advisors serve in Kebithigollewa zone. Out of 170 of English language teachers and 3 in service advisers, the researcher randomly selected the teachers and in service advisers, then distributed the questionnaire as a Google form and the researcher selected 32 respondents who responded promptly. Qualitative data was analyzed using thematic analytical method. Quantitative data was analyzed using Microsoft Excel. Firstly, the researcher read textbooks and teacher guides in order to gather data for the first objective. Secondly, the researcher analyzed the data collected from the questionnaire which focused on the second objective and third objective.

4. RESULTS AND DISCUSSION

4.1. EXISTING ENGLISH PRONUNCIATION PRACTICES AND TECHNIQUES

According to the researcher's own in-depth analysis of the textbooks, songs and nursery rhymes, listen and repeat, loud reading, tongue twisters, drills, poetry, directions, simple stories, simple descriptions, instructions, and chants and dialogues have been found in primary school textbooks and teachers' guides. The researcher observed that the songs and nursery rhymes are being widely used in textbooks for teaching English pronunciation. That technique is used for practicing sounds of basic vocabulary. Listen and repeat technique and loud reading have been also used to teach pronunciation of letters, words and phrases related to the immediate environment. It was observed that the role plays and tongue twisters are the least frequently employed techniques in primary grades text books and teacher's guides.
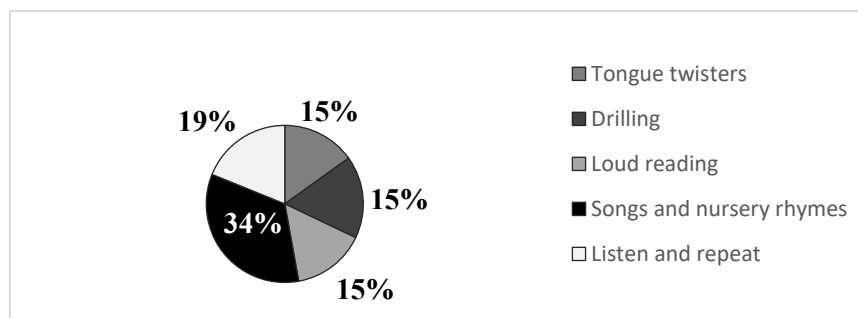

Figure 1: The Favorite and Effective Pronunciation Practice or Technique

Figure 1 illustrates the favorite and effective pronunciation practice or technique of the participants. Accordingly, 34% of the sample which is the highest in number selected "songs and nursery rhymes" as their favorite and effective pronunciation practice saying it helps to break up the monotony of the teaching-learning process as students enjoy singing more than other pronunciation practices. Sample in similar percentage 15% use tongue twisters, drilling and loud reading as effective techniques to practice articulation in pronouncing. For instance, teachers who choose tongue twisters mentioned that they help to practice the movements of the tongue for practicing pronunciation, students can imitate the same phrase and words with the correct pronunciation and students can pronounce easily. 19% of the sample selected "listen and repeat" technique and they said that the students of primary grades are more likely to depend on the sounds they hear, they can listen to someone and follow he or she for practicing pronunciation effectively. Hence, "songs and nursery rhymes" technique is the most favorite and effective pronunciation practice of the participants. Further, the participants recommended using strategies such as phonemic charts, movies, and games to practice pronunciation outside of the classroom.

4.2. *AVAILABILITY OF FACILITIES FOR TEACHERS TO HELP PRACTICE ENGLISH PRONUNCIATION IN PRIMARY GRADES*

From the analysis of the responses received on the availability of facilities for teachers to help practicing English pronunciation, all of the participants described the resources they had access to teach English pronunciation to primary grades. According to the data analysis, only a few participants use technological devices like multimedia, mobile phones, computers and laptops, internet, portable Bluetooth speakers, smart TV, audio players and cassette for teaching English pronunciation for primary grades. Most of the participants use visual materials like textbooks, picture cards and black board while a few participants utilize YouTube, dictionary app, OHP projectors and power point for teaching English pronunciation for primary grades. Small no of participants use other facilities like language labs. Responses to the questionnaire illustrates that schools provide only a few resources to teach English pronunciation to primary students.
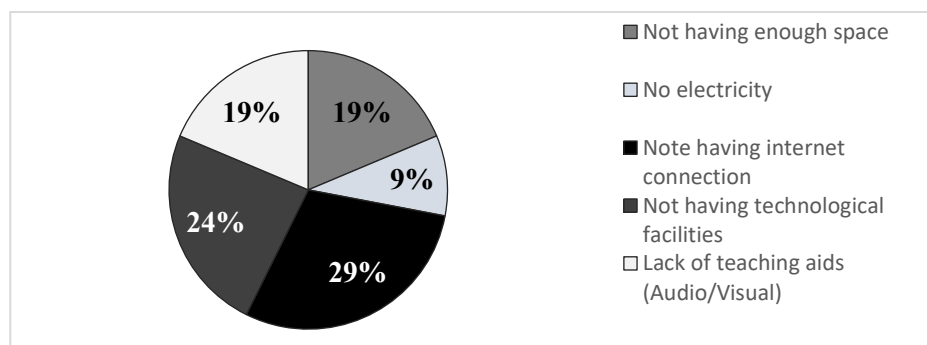

Figure 2: Difficulties Encounter by Teachers when Utilizing Existing Facilities for Teaching Pronunciation

As shown in Figure 2, 29% of the participants lack internet connection and 24% of the participants lack technological facilities. Therefore, it is evident that lack of new technology along with internet facility is the main barrier in teaching pronunciation for primary grades. Teachers also complained about lack of teaching aids and not having sufficient space to carry out pronunciation practices. Electricity facility is also a hindrance for certain teachers. In addition, 28.1% of the sample complain that they require resource persons to practice teaching English pronunciation. Similarly, they also require enough textbooks and work books and a peaceful environment without having big sounds for teaching pronunciation effectively. Additionally they suggest other facilities like language labs for every school and providing additional technical resources such as tabs, Bluetooth speakers, smart boards, multimedia, online apps like "read to me", and internet access for primary students, as well as establishing at least two or three technology centers with all necessary equipment for each division and allowing all teachers to use them according to the established schedule.

4.3. REVIEW ARE TEACHERS CONFIDENT AND PROFICIENT IN ENGLISH PRONUNCIATION TEACHING?

According to the responses received from the questionnaire, 84% of the sample have not taken a pronunciation course and 16% of the sample say that they have completed a variety of pronunciation courses, including the Dip TESOL, British Council courses on pronunciation, and online courses like how to teach pronunciation. Participants use several strategies to assist strengthen their pronunciation skills, such as listening to English news, online websites, referring to online dictionaries, listening to native speakers, watching English movies and YouTube videos, listening to English songs, online apps like read to me, and using loud reading. When teaching pronunciation, most of them check their pronunciation for words they thought they already know, while others check their pronunciation practically every time. This demonstrates that they are not confident enough to teach English pronunciation.
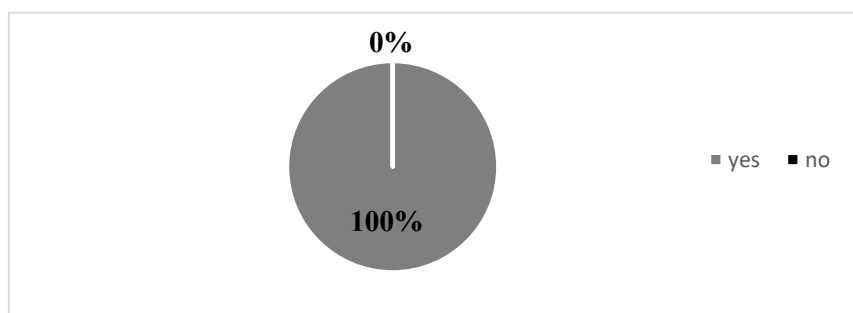

Figure 3: Readiness of Teachers to Improve Their Pronunciation Skill

According to Figure 3, all the participants are ready to undergo courses to improve their teaching English pronunciation skills. 89% of the sample which is the highest in number, wish to improve their skills in teaching English pronunciation through self-learning, by following English pronunciation

courses which are conducted by the government free of charge and by participating seminars and workshops. A few participants prefer to improve their teaching skills in English pronunciation by following English pronunciation courses by paying their own money. They also suggest that proper pronunciation trainers provide pronunciation training, that some online English pronunciation courses for teachers be developed, that the government supply materials for teaching pronunciation, and that teachers be provided with the necessary facilities for teaching English pronunciation in the primary grades.

5. CONCLUSION AND RECOMMENDATIONS

In conclusion, it is clear although several pronunciation activities have been included in the text books and teacher guides, teacher's guide does not provide any specific guidelines to teachers as to what pronunciation lessons should be done and which vowel sounds should be focused for each grade which is one major drawback of the syllabus. The teacher's guides and textbooks should offer teachers with particular instructions for what pronunciation lessons should be done and which vowel sounds should be concentrated on for each grade level. Further, more pronunciation activities and practices should also be included in primary textbooks and teacher's guides by devoting more time. Further from the analysis it is clear that the majority complain lack of internet facilities as the most significant challenge they face while using facilities for teaching English pronunciation and other participants express dissatisfaction with the absence of technological resources. As a result, most of the participants utilize traditional techniques to teach English pronunciation, while a small number use new technology to teach English pronunciation. The majority of them also double-check their pronunciation of words they already know and this demonstrates that they are not confident enough to teach English pronunciation. It was observed that all most all of the participants had not taken a pronunciation course to practice teaching English pronunciation and they are eager to participate in a pronunciation course to improve their ability to teach English pronunciation.

Hence, based on conclusions, the researcher suggests to textbook and curriculum designers provide supplementary books for primary grades that include pronunciation practices such as songs and nursery rhymes, listen and repeat, loud reading, and tongue twisters, as well as introducing specific vowel sounds for each session. Textbooks and teachers' guides should be provided on time for schools and a resourceful person should also be provided for each school to instruct on teaching English pronunciation. It is also established that teaching English pronunciation should be improved by making supplemental materials like a language lab with the appropriate facilities, or at least, internet access. As a result, teachers should be equipped with teaching pronunciation courses at the divisional, zonal, provincial levels and internationally recognized coursers can be recommended for teachers and In Service Advisers.

REFERENCES

Fernando, R. (2019) *Pronunciation theory*. Facebook: Available at: https://facebook.com

Gunawardana, A. (2018). A critical evaluation of government textbook series *"Let's Learn English."*.

Hewawasam, I. A., & Amaratunga, J. G. I. D. (2016) Pronunciation errors in English among Sri Lankan school children.

Rohan, R.M.D. (2012). A Study on the impact of student heterogeneity on the implementation of activity based oral English program in primary classes.

Widyalankara, R. (2014) Does proficiency in the second language influence bilingual word retrieval and pronunciation?

PERCEPTIONS ON ONLINE PRESENTATIONS: AN INSIGHT INTO THE VIEWS OF UNDERGRADUATE ELT STUDENTS ON DOING ONLINE PRESENTATIONS DURING COVID – 19 PANDEMIC

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ABSTRACT

Education is the main aspect of any human being while presentation skills become a valuable asset to students in achieving their goals. This paper discusses how it is important to improve education along with computer literacy and digital technology. Eventually, last few months of the year 2019, the entire world faced the Covid -19 pandemic, and almost all the educational programs were conducted online on various platforms. The sample was taken from the University of Vocational Technology Education Faculty. 50 students were taken from two batches of the degree programs such as a Bachelor of Education in English Language Teaching, and a Bachelor of Education in Technology. This was done through the convenient sampling method. The study revealed that the students were less motivated to do online presentations. Further, the students were monetarily challenged and that kept them away from both online education and online presentations (no strong signals, no smart devices, etc). The phobia for the online presentation was not seen, once the presentations were done physically as per the views. The study recommends that with a strong solution to signals and financial support, benefits could be reaped one would benefit from online education presentations.

Keywords: Online Education, Online Presentation Skills, Personality Development, Physical Presentation Skills.

1. INTRODUCTION

Most of the undergraduates experienced online presentations or virtual demonstrations after the first wave of the Covid Pandemic. It was in March 2020, when all the educators and students were asked to start educational programs virtually. Nevertheless, at the time the online educational programs started, all the undergraduates and the lecturers were unprepared. This was not catering only to Sri Lanka but worldwide educators and undergraduates were experiencing it. This newfangled experience was executed successfully where students get more chances to do online presentations and other subject-related activities. "As already mentioned, many schools and teachers were not prepared to run virtual classes," (Babincakova and Bernard, 2020, pp 3296). In the beginning, there were many problems for students who follow undergraduate courses in Sri Lanka. This virtual platform was very new to them hence some students were reluctant to involve in the live sessions. This asynchronous learning was very challenging for some students when it is a day for online lessons. However, wholly the state universities decided to take the next level of tertiary education virtually while having a pre-practiced online evaluation. Once it is processed, the evidence has proved that online education is not a challenge any longer subsequently the students' participation is very high. Even if the attendance of the students was blameless, their fear of online presentations remained. "According to the universities surveyed, nearly 90% of student respondents have been able to access online education" (Hayashi et al.,2020). The

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research problem is what are the perspectives and attitudes displayed by the undergraduates related to online presentations? The research objective is to explore the perceptions of undergraduates relevant to online presentations.

2. LITERATURE REVIEW

"Student presentations are a common part of many courses at colleges and universities as they are one of the ways to improve the learning of course material. The potential benefits of student presentations include greater class interaction and participation, increased interest in learning, new perspectives not covered otherwise, and improvement in communication and presentation skills." (Girard, Trapp and Pinar 2011)

According to Girard and the team, presentations are a common technique for improving students' awareness of the course materials. In this article, the writer states that permitting opportunities for students to perform in classwork influences positively and negatively in students. Since every class has different types of learners, most of the learners are capable of identifying their potential whereas some students are very reluctant to show their true colours. Allowing students to do presentations in class diminish the fear of public speaking, develops interpersonal communication skills, improves language coherence, builds up innovative and creative ideas, etc. Improving presentation skills among students can be done only through good assessment procedures. If the students are evaluated and provided positive feedback is more advantageous in developing their presentation skills. Online presentation skills help to uphold students' online education. Teaching presentation skills in online business courses in the US was popular in 2011.

Kenkel's research elaborates on some innovative ideas to develop students' online presentation skills to improve online education. The researcher described further the students' perspectives were positive after introducing a few innovative ways for them to be motivated. Further, the students were not much supportive of online education before he started his project. "Oral presentations are often eliminated from online courses because of the logistics involved." (Kenkel, 2011, p.412).

3. METHODOLOGY

The research design is the framework of the research; it helps to find the best way to execute the research. This research arena is focused to find out the different perspectives of undergraduate students towards online presentations and the development of their interpersonal skills. According to the objectives, the researcher will be using a mixed method including both qualitative and quantitative aspects. The primary data related to this research will be the data collected from the questionnaires, and the group interviews. Data collected through the literature review will be secondary data. According to this research background, the researcher will select a Descriptive survey design. Descriptive survey

design means collecting data through structured questionnaires and interviews to get dissimilar views of respondents.

Table 1: Description of the sample

Stakeholders	Number of participants	
	questionnaire	Group interviews
Undergraduates in Technology	25	5 interviews consisting of 10
Undergraduates in ELT	25	members in a group

4. ANALYSIS OF DATA

The data was collected in two ways: a questionnaire and group interviews. 50 sample data have been gathered and it is being analyzed to find out the perspectives of the undergraduates in doing online education and which method improves their interpersonal skills. In a class or a batch, there are different types of students therefore, their interest levels might be varied. Although the education is given online, it built confidence and the gained knowledge is beneficiary for undergraduates. The questionnaire consisted of 15 questions to analyze the perspectives of undergraduates related to online presentations. The data collected via a questionnaire is described different perspectives of different undergraduates. The questionnaire was very important in collecting most of the data. The study group has given the best support to this research and to make it more successful. The data has been interpreted and described under some subtitles. That is to understand the basic areas to be improved and to show the perspectives that the undergraduates obtained.

In most of the online educational programs during the covid pandemic, the students acquired the opportunity to do online presentations. In practical conversations, most undergraduates say they do not like doing presentations physically or online. The study group was given a chance to interpret their own ideas as short answers to some questions. It was very successful to know what are their perspectives on this using their own words and phrases. The question was "What do you feel when you are asked to do an online presentation?". The study group has given various answers to show their real perspectives on the ONLINE PRESENTATIONS. Undergraduates have commented as they get nervous when they start a presentation and at a point, they get relief from that feeling. In addition to that, some undergraduates stated when they do the presentations, they were nervous throughout. Further, for some students, it is challenging. The majority feel good when they were asked to do an online presentation. The following chart shows precise details about their perspectives towards online presentations. This gives a hint of the perspectives that students had toward online education during the Covid pandemic.
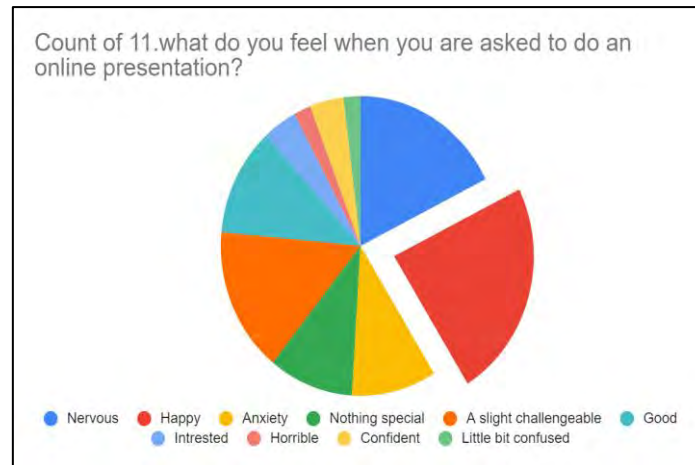
Figure 1: Perspectives of undergraduates when they are asked to do an online presentation

Collecting data from an interview is more successful, it is because the interviewees could give more accurate responses to the interviewer. It also helps to stimulate thoughts and place the best productivity. Especially, group interviews are more successful since the whole group put forward their ideas freely, all the participants could contribute and they tend to think more deeply about the ideas heard from the others. The interviewer can give more flexible questions where the students can open the memories of their good and bad experiences.

Interviews are done as small group interviews, consisting of 10 members in a team. The same set of questions was asked of each interviewee. It was a serious discussion conducted online and it was more interesting when they share their experiences. The interviews started with one common question to lay a foundation for the discussion, so the moderator asked, "what are the unforgettable memories you have, regarding online education?" They gave interesting answers in order to share their personal experiences. Group A shared that commonly how their families interrupted when the lectures were going on. One said Every time when he speaks to the computer his father comes and has peek behind. He had to advise his father thoroughly telling him not to come near watch from far.

The interesting part is that the father comes in an upper naked body so several times he faced that embarrassment. Another girl from the same group stated that the sound from the kitchen made by the family members mostly by her mother is irritating. Though she advised just a moment before she starts, they forget it suddenly, or maybe someone starting to scrape coconuts and so forth. After two or three incidents everybody decided to scream just before starting telling that "Please Don't make any noise, I am doing a presentation" (*Ane kee Gahanna epa,, man presentation ekak*).

The funniest experience had in group 'B' was when one undergraduate unknowingly kept the microphone unmuted and he was blaming to the lecturer for troubling him to do the presentations and it was a group presentation. Then the other members informed the person. However, that particular undergraduate had begged for pardon and the lecturer was telling that is not something to be worried about even though he doesn't like to do things online. Another interviewee stated that when doing the

presentation at the very beginning the family members had not seen any. Furthermore, the candidate has to do it in English so all the family members come near the particular student when the presentation starts. It was something very interesting for the family so that always that particular undergraduate faced difficulty to present what exactly needed to be presented. Sharing personal experiences to make a conclusion and decide what suits them finally a is very important fact he life. Similarly, it affects this study as well.

As the third step in the interview, the researcher needed to identify the obstacles that each individual has faced including a concluding comment on that. As the third question, the interviewer put forward "What are the shortcomings that you experienced when doing online presentations?" There were many difficulties students faced and they had different perspectives towards those barriers. Importantly group A stated that network issues come first when they do the presentations. A presentation should be clear and concise due to the short period of time allocated. If network issues occurred that leads to scoring low marks.

According to them, there were undergraduates who walked miles and settle in someone's house to participate in the online lectures. For those students having physical lectures and presentations are more effective. Group B and C stated that sudden technical issues in the laptops, desktops, smartphones, and other devices are the main shortcoming that they have faced when the presentations are done online.

5. CONCLUSION AND RECOMMENDATIONS

The study discovered that the students were less motivated to do online presentations and were challenged. The results revealed that the students were financially challenged and that kept them from both online education and hence doing online presentations. The results revealed that the phobia for online presentations was not seen more, once the presentations are done physically as per the views.

However, it could be recommended that with a strong solution to signals and a way to support the individual financially, one would benefit from online education and doing presentations as it saves time spent on traveling especially for students living far. It was also seen that stage fear was less common with online presentations than with physical presentations. The recommendations found and the factors were affected as barriers as follows; The poor readiness of the students is prominently affecting the students' performances therefore; the authority can arrange pre-sessions for the students to practice the online presentations while the lecturers do observe. Noisy background always interrupts the smooth flow of the presentation so that students can be asked to find a calm atmosphere, strictly. The state of anxiety is another factor that the students have to avoid, the recommendations brought for this factor are friendly discussions before the presentations, pre-recorded self-video from each student, and playing it before starting the class.

 The common issue the undergraduates face when they do online presentations is that network issues and technical problems. This is the factor that nobody can give a direct recommendation it is because network problems are common in online sessions and demographic features also matter in this scenario.

The fair recommendation for this factor is ready with another prompt device and network supporter (if no Wi-Fi, working with mobile data). Moreover, the factor of Demanding the mark rather than the quality; to ignite this the instructors must explain the value of the output and make them aware of its importance, and off good remarks than numerical grades. The time factor also affects the students so that allows the students to select the convenient time of sessions. These recommendations can be easily applied in the practical life of undergraduates' education.

REFERENCES

Babincakova , Bernard. (2020), 'Online Experimentation during COVID-19 Secondary School Closures: Teaching Methods and Student Perceptions', pp. 3296

Girard, Tulay., Pinar, Musa, Trapp, Paul. (2011), 'An exploratory study of class presentations and peer evaluations: Do students perceive the benefits?', *Academy of Educational Leadership Journal,15, pp.77*

Hayashi, R., Garcia, M., Maddawin, A. and Hewagamage, K.P. (2020), 'Online Learning in Sri Lanka's Higher Education Institutions during the CO VID-19 Pandemic', *ADB Briefs*, 151,PP.1

Kenkel, C. (2011), 'Teaching Presentation Skills in Online Business Communication Courses', *MERLOT Journal of Online Learning and Teaching*, 7(3), pp.412

Kuzma. (2011), 'Using online technology to enhance student presentation skills', *Worcester Journal of Learning and Teaching, Issue* 5, pp.1

Developing Pronunciation Skills with Particular References to /o:/ and /ɔ:/ Vowels Production among ESL Learners in Grade 6 in Sri Lanka

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Abstract

It is of paramount importance for English teachers to help students to develop their pronunciation skills on par with standard practices. This paper discusses the issues on vowel production of the 'o' sound, and how to prevent the 'hole' and 'hall' issue which is commonly known as 'Not pot English'. Although many research studies have been conducted at the university level in identifying this 'o' vowel production issue, no research has been done on finding remedial measures. Using purposive sampling, the research sample is drawn from the bilingual class of grade 6 students in a 1AB category girls' school in the Colombo education zone. The researcher focused on identifying erroneous pronunciation and measuring the effectiveness of visual aids, teacher demonstration, and guidance in rectifying them. This action research consists of three stages including two action research cycles with the researcher's intervention. The total number of correct and incorrect vowel production in the four vowel categories are analysed carefully, and findings indicate that the most difficult vowel category to pronounce is the long vowel /ɔ:/ in L2 and the least difficult is the short vowel /ɔ/ in L2. Further, timely guidance will remedy this issue of fossilisation and social stigma.

Keywords: *ESL Learners and Teachers, Fossilisation, 'O' Vowel Production, Rectifying Erroneous Pronunciation, Social Stigma.*

1. Introduction

English plays a vital role in the success of every individual; as a local language as well as a global language to reach greater heights. Pronunciation is one of the aspects of speaking skills and therefore, the use of Standard Sri Lankan English (SSLE) is important to avoid mispronunciation, which leads to miscommunication and stigmatization. Thus, English teachers need to identify pronunciation issues in keeping with standard practices and pay attention to problem areas students face when learning English as a second language (ESL) in the Sri Lankan context.

According to Gunasekara (2005), there are four 'o' sound vowel monophthongs in SSLE. They are /o/ the short half-close/mid-back rounded vowel (e.g., only), /o:/ the long half-close/mid-back rounded vowel (e.g., old), /ɔ / the short half-open/mid-back rounded vowel (e.g., doctor), and /ɔ:/ the long half-open /mid-back rounded vowel (e.g., bought) respectively. However, in Standard British English (SBE) there are only three sounds as /əʊ/ the close/high back rounded diphthong (e.g., go), /ɔ/ - short low back rounded monophthongs (e.g., hot), and /ɔ:/ the long mid-back rounded monophthongs (e.g., all) respectively. In Sri Lankan English there are no diphthongs, and therefore, /əʊ/ this diphthong is replaced by the previously mentioned two half-close/mid back rounded vowels (/o/ the short vowel and

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/o:/ the long vowel) which are easy to pronounce since these two sounds are found in the Sinhala language (L1) as well.

Widyalankare (2015), had used the two vowel sounds of the 'o' sound with its short and long monophthongs /o/, /o:/, /ɔ/, /ɔ:/ of SSLE. The words 'only', 'boat', 'pot', and 'call' are used respectively in her study involving English graduates regarding acoustic characteristics of vowel sounds in SSLE. The mixing up of /o/ and /o:/ vowels/ in L1 with /ɔ/ and /ɔ:/ vowels in L2 respectively, and overusing of /ɔ/ and /ɔ:/vowels in L2 for /o/ and /o:/ vowels in L1 respectively is the most problematic and difficult to be corrected Nevertheless, the habit of using erroneous pronunciation over a long period result in fossilisation, which cannot be corrected even if one is aware of the issue as an adult learner. Moreover, it is looked down upon as "Not pot English" in society.

As an ESL teacher in the Sri Lankan government school system, it is observed that even in urban schools some fluent speakers including students and English teachers find it difficult to differentiate the long mid-back vowels /o:/ in L1 and /ɔ:/ in L2 correctly. Further, the overusing of /ɔ/ and /ɔ:/ in L2 substituting /o/ and /o:/ in L1 respectively is also prevalent. Unfortunately, not much attention is paid to making students aware of this issue except in the General English Advanced Level textbook in 2001 (old syllabus). According to Gunasekara (2005) confusion in the sound /o/ makes it difficult for them to distinguish between 'bowl' and 'ball' and 'hole' and 'hall'. Also, overuse of /ɔ:/ rather than /o:/ as in 'phone' and 'yoghurt'.

Despite the many reasons that would attribute to mispronunciation, students would be deprived of good pronunciation unless they are properly guided by teachers of English. Moreover, the researchers believe that this could be easily remedied with proper guidance and systematic practice to avoid unnecessary miscommunication and social stigma which is faced by some fluent speakers and academics in the field of education. A stitch in time saves nine. Hence, the researchers intend to focus on achieving the aim of developing pronunciation skills with particular reference to /o:/ and /ɔ:/ vowel production among ESL learners in grade 6 in Sri Lanka with the help of the following measurable objectives.

  i.   To examine the erroneous use of mixing up of /o/ and /o:/ vowels in L1 and /ɔ/ and /ɔ:/ vowels in L2 and overusing of /ɔ/ and /ɔ:/ in L2 that prevails among ESL learners in Grade 6.

  ii. To find out the effectiveness of the use of visual aids, teacher demonstration, and guidance in rectifying these pronunciation issues among ESL learners in Grade 6.

1.1 REVIEW OF LITERATURE

Gunasekara (2005) discusses, "The use of two distinct back vowels /o/ and /o:/ between half-closed and half-open, with /ɔ/ being more open than /o/, and it is this distinction which led to the naming of 'Not pot English' as a non-standard variety". Further, she adds, "The average Sri Lankans struggle with the rounded back vowels /ɔ/ and /ɔ:/ symbolized a mark of social class and possibly a mark of resistance to SSLE". However, in my observations, most of the students can pronounce /ɔ/, but find it difficult to pronounce /ɔ:/, the long half-open/mid-back vowel correctly. As a result, they tend to substitute it with

/o:/ the long half-close/mid-back rounded vowel easily, which is available in L1. Further, people who have no access to learning L2 will struggle to pronounce both /ɔ/ and /ɔ:/, which are absent in L1. For example, those who are deprived of learning English at very remote schools.

Fernando (2008) comments that "… the pronunciation of SSLE speakers has long been privileged in terms of social prestige and employment. Today, however, other dialects are used by people holding high-ranking posts, challenging SLE as its standard" (p.71). The researcher agrees with this comment since some fluent speakers holding high ranks in the field of English are unable to pronounce /ɔ:/ in L2 due to mixing up with /o:/ in L1 which had not been identified and guided before fossilisation. However, they can pronounce /ɔ/ in L2 correctly. Therefore, the researcher feels it is not justifiable to look down upon their English as 'Not pot English'. The researcher is genuinely concerned about this issue, based on the researcher's experience with some fluent students in 1AB urban schools who mispronounce due to mixing up of /o:/ in L1 and /ɔ:/ in L2. Fernando, (2008) further comments that "With relation to SSLE vowel sounds /ɔ/, /o/, /ɔ:/, and /o:/, if the differentiation of all four sounds is to remain, Sri Lankan speakers in English should be made aware of the rules governing SSLE in opposition to SBE; as well as to other dialects in SLE". Moreover, Fernando (2008) provides guidelines and rules governing the use of /ɔ/, /o/, /ɔ:/ and /o:/ in SSLE (p.75-78).

Widyalankare (2014), study provides the measurement of formant frequencies in synchronically recorded sound data for six selected vowels, short and long monophthongs /ɔ/, /ɔ:/, /o/, /o:/ and /a/, /a:/ of SSLE. The difference in the formant comparison illustrates that the SSLE is more open, moves slightly to the front, and is higher in lip roundedness. According to Jordan and Mackay (1978, p.15), the L1 interference attributes for pronunciation errors: "…. For English sounds which have no equivalent in the first language, the pupil will turn to substitute that sound which appears to him the nearest …." This proves that why some students pronounce "hall" as "hole". The word 'hall' should be pronounced with /ɔ:/ in L2. However, students substitute that sound with /o:/ in L1. This wrong usage over a long period will lead to fossilization which cannot be reversed back.

However, in the present-day context, Premarathne (2018) reveals that L2 learners of English had not received feedback on the vowel contrast when they produced /o/ instead of /ɔ:/ or vice versa even though all of them had been learning English as L2 for more than ten years at school. She emphasizes proper feedback on pronunciation to rectify pronunciation errors. Moreover, Wijetunge (2008) states that this vowel contrast has become one of the key elements that differentiate the high prestige dialect (HPD) and low prestige dialect (LPD) or "Not pot English".

However, there has been no research done in rectifying pronunciation errors regarding the production of the specific vowel contrast, which is so prevalent among Sri Lankan ESL learners. Thus, the researcher intended to carry out this research as action research at the school level.

2. METHODOLOGY

The research was carried out in three stages while using the action research methodology in two cycles with twelve practice sessions using mixed methods, both qualitative and quantitative. The action

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research model proposed by Nelson (2014), was used as the research process of this study and planned carefully implemented, observed, and reflected upon to improve the vowel production among ESL learners in mixing up /o/ and/ɔ/ and /o:/ and /o:/, and overusing /ɔ/ and /ɔ:/.

The accessible population was Grade 6 students of Gothami Balika Vidyalaya in Colombo Education Zone, an urban national school belonging to the 1 AB category. The research sample was 24 participants drawn from the bilingual class, of 44 students using the purposive sampling method.

The research process was divided into three stages. In the preliminary session, stage one the pronunciation problems were identified, and the pre-test was conducted. During the action research cycle 1 which was stage two, the first 6 practice sessions and post-test 1 were conducted. During stage 3, the action research cycle 2, the second 6 practice sessions and post-test 2 were conducted.

2.1 WORD ELICITATIONS FOR PRE-TEST, POST-TEST 1 & POST-TEST 2

Table 1: Word Elicitations

	Short Vowel	Long Vowel	Short Vowel	Long Vowel
	/o/	**/o:/**	**/ɔ/**	**/ɔ:/**
1st word	only	old	pot	ball
2nd word	obey	bowl	on	hall
3rd word	hotel	hole	doctor	call
4th word	hero	coal	top	saw
5th word	zero	boat	dog	bought

Celce-Murcia, Brinton, and Goodwin (1996) propose to use of the colour-coding system to indicate the pronunciation of each vowel with a specific colour, which requires the correct pronunciation of each vowel. Accordingly, a colour code was used to indicate phonological differences as shown above.

3. RESULTS AND DISCUSSION

3.1. POST-TESTS ANALYSIS
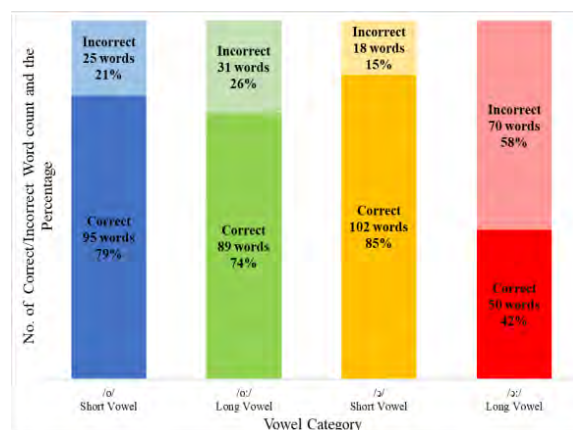
Figure 1: Pre-test - Total Correct and Incorrect Production of the Vowels

The purpose of the pre-test was to examine the erroneous use of mixing up the short /o/ and long /o:/ vowels in L1 with /ɔ/ and /ɔ:/ vowels in L2 respectively and overusing of /ɔ/ and /ɔ:/ vowels in L2 that

prevails among ESL learners. Furthermore, post-test 1 and post-test 2 were held to find out the effectiveness of the use of visual aids, teacher demonstration, and guidance in rectifying the identified pronunciation issues using voice recordings. Furthermore, the students were guided by the researcher by obtaining voice recordingss from time to time through 'Whatsapp' as required.

Figure 1 shows the percentages of incorrect vowel production in all 4 'o' categories as 21%, 26%, 15%, and 58% respectively. The total number of words is counted as 120 words since each of the 24 students pronounce 20 words on the pre-test. Further, the number of incorrect words pronounced out of 120 total words by 24 students are 25 words, 31 words, 18 words and 70 words respectively. Out of all 4 vowel categories, it is evident that the short vowel /ɔ/ in L2 is the most correctly pronounced, and the least correctly pronounced is the long vowel /ɔ:/ in L2.

It is apparent from Figure 2 the word 'only' was mostly mispronounced. Also, the researcher has come across not only students but also fluent speakers with this issue who overuse /ɔ/ when pronouncing the word 'only'. The word 'dog' was mostly mispronounced /ɔ/ in L2 and the researcher has not come across fluent speakers who usually mispronounce this due to mixing up of /o/ in L1 owing to mother tongue influence in 1AB school. Despite the fact this is a new sound for ESL learners, they tend to pronounce it well when compared to the other 3 vowel categories. The word 'saw' and 'bought' were mostly mispronounced in L2 due to mixing-up /o:/ in L1 owing to mother tongue influence.
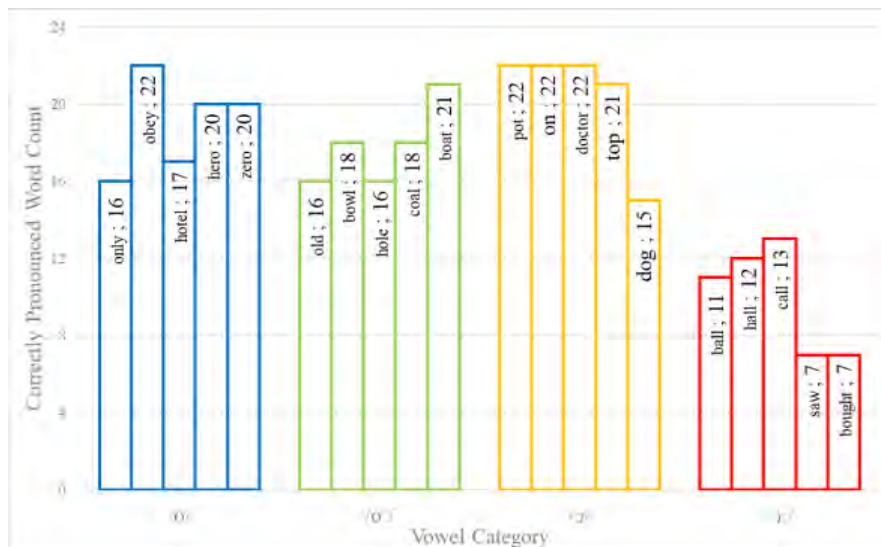
Figure 2: Total Correct Vowel Production of the Word Elicitation

3.2. POST-TEST ANALYSIS

It is apparent from Figure 3 that there is an improvement in the production of all 4 vowel categories due to the researcher's intervention with visual aids, teacher demonstration, and guidance. Although the long vowel /ɔ:/ in L2 remains the most difficult to be pronounced correctly, there is a significant improvement in the pronunciation ability of the students even with /ɔ:/ in L2.
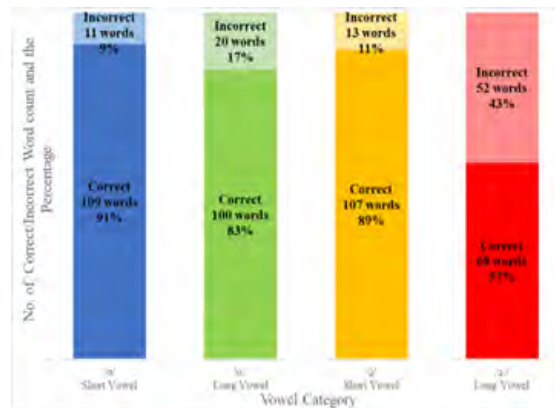
Figure 3: Total correct and incorrect production of the vowels – Post-test 1

It is apparent from Figure 4 that the achievement of the success rate of rectifying the pronunciation issues in this action research is commendable. The first three vowel categories show 100% success which means out of 24 students almost all were able to pronounce all 20 words correctly at the end of cycle 2 except for a few in the last category, the long vowel /ɔ:/ in L2 which is the most difficult in general. However, there is a significant improvement in this category too.
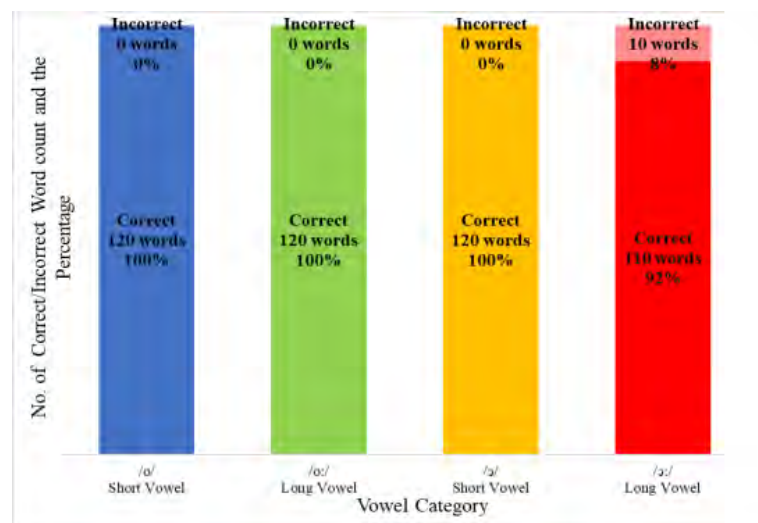
Figure 4: Total correct and incorrect production of the vowels – Post-test 2

Further, the methods used by the researcher to rectify the pronunciation issues using visual aids, teacher demonstration, and guidance proved successful beyond doubt to a great extent. This is a clear indication of the importance of identifying the erroneous use of pronunciation among ESL learners by teachers to provide proper guidance to overcome the difficulties preventing fossilisation.

3.3. MEAN SCORE ANALYSIS OF PRE-TEST, POST-TEST 1 AND POST TEST 2

As per Figure 5, after the completion of all three stages the mean value increases to 5 in the first 3 'o' vowel categories: /o/, /o:/, /ɔ/ and /ɔ:/. It shows all students were able to pronounce all the words correctly in the post-test 2 except for the long vowel /ɔ:/ in L2 which is found to be the most difficult.

However, there is an increase in the mean score from 2.08 to 4.58 in the vowel /ɔː/ which indicates a significant improvement in the pronunciation ability of students in that category as well.
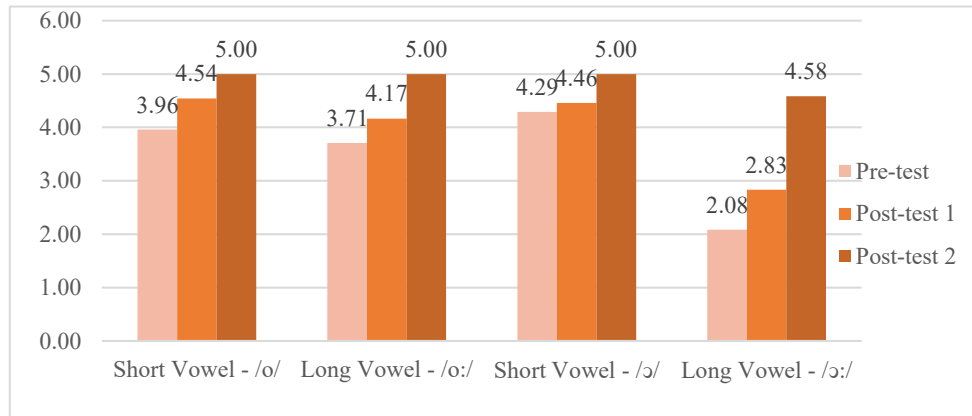

Figure 5: Mean score improvement of Pre-test, Post-test 1, Post-test 2

Further, the methods used by the researcher to rectify the pronunciation issues using visual aids, teacher demonstration, and guidance proved successful beyond doubt to a great extent. This is a clear indication of the importance of identifying the erroneous use of pronunciation among ESL learners by teachers to provide proper guidance to overcome the difficulties preventing fossilisation.

4. CONCLUSIONS AND RECOMMENDATIONS

It is proved that visual aids, teacher demonstration, and guidance are effective in rectifying pronunciation issues regarding the 'o' vowel production in SSLE. Further, this action research proves that the erroneous pronunciation can be rectified beyond doubt with some effort and proper remedial measures taken in ESL classrooms.

Developing pronunciation skills with 'o' vowel production is something achievable within our limits in ESL classrooms. Gunasekara (2005) and Fernando (2008) point out the advantages one can gain socially as well as professionally. Thus, the researcher would like to request all stakeholders in the field of English education to take the necessary initiation towards bridging the gap between Standard Sri Lankan English and Non- Standard English. Necessary steps should be taken by curriculum developers to include mainly the four different 'o' sounds, tongue twisters, and minimal pairs in primary grade syllabuses to prevent fossilisation.

REFERENCES

Celce-Murcia, M., Brinton, D., & Goodwin, J. M. (1996). Teaching pronunciation: A reference for teachers of English to speakers of other languages. Cambridge: Cambridge University Press.

Fernando, S. (2008). When is a 'hall' a 'hole'?: Issues and guidelines in Sri Lankan English pronunciation. In D. Fernando and D. Mendis (Eds.), English for Equality, Employment, and Empowerment. 4th International Conference of the SLELTA. Colombo Sri Lanka. Pp.71-82).

Gunesekera, M. (2005). The Postcolonial Identity of Sri Lankan English. Colombo: Katha Publishers

Jordan, R. R., and Mackay, F., (1978) A Handbook for English Language Assistants.

Premarathne, K. (2018). Exploring the Reasons for the Fossilization of Phonological Errors: A case study of the substitution of/o/for/ɔ/by English as Second Language Learners in Sri Lanka. Advances in Language and Literary Studies, 9(4), 105. https://doi.org/10.7575/aiac.alls.v.9n.4p.105

Widyalankara, D. R. C. (2015). Acoustic Characteristics of Three Vowels of Standard Sri Lankan English. International Journal of Science and Research (IJSR), 4(8), 236–242. https://www.ijsr.net/archive/v4i8/SUB157154.pdf

Wijetunge, S. N. (2008). The Stigma of " Not Pot English " in Sri Lanka: A Study of Production of / o / and / O / and Implications for Instructions. Applied Linguistics.

MORPHOLOGICAL PROCESSES USED IN INTRODUCING SRI LANKAN ENGLISH VOCABULARY TO SRI LANKAN POETRY

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ABSTRACT

English Language evolves with the construction of new varieties due to the different language experiencse and social, traditional, cultural and religious influences. This study focused on identifying morphological processes used in introducing Sri Lankan vocabulary to Sri Lankan poetry. Moreover, the primary objectives were to find out Sri Lankan Lexicons used to express local expressions in the Sri Lankan Poetry and to analyze identified Sri Lankan English lexicons under morphological processes specifically related to six morphological processes. Essentially, 75 Sri Lankan English poems were selected as the sample of the study. Meanwhile, data collection was done by deep reading and observation. Findings were analyzed by classifying them into six morphological processes. Qualitative content data analysis method was employed. 190 Sri Lankan lexicons belonging to different fields were identified. Classification of the identified lexemes into the six morphological processes: Borrowing, Hybrid Compounds, Loan Translations, Semantic Loans, Literal Translations and Direct Translations revealed that 78 of them were Borrowing , 43 Hybrid Compounds , 34 Loan Translations , 18 Semantic Loans , 13 Literal Translations and 4 direct Translations.

Keywords: *local expressions, morphological processes in Sri Lankan English, Sri Lankan poetry, Sri Lankan English vocabulary.*

1. INTRODUCTION

Sri Lankan English (SLE) is a variety which is called as Ceylon English, Lankan English and Sri Lankan English (Fernando,1985). According to Sri Lankan history, SLE vocabulary is produced as a result of the British colonization and English medium education which was introduced by the British people after 1815. Mainly the British English vocabulary has played a vital role in spoken and written discourse of Sri Lanka.

Moreover, Gunasekara (2005) states that there are two major varieties of Sri Lankan English as Standard Sri Lankan English and Non Standard English which is also known as Not Pot English. The researcher observes, that, some studies have been done based on SLE vocabulary and it is mentioned that the most frequently used morphological processes are SLE borrowings, (Atapaththu, 2019) and SLE compounding, (Senaratne, 2012).

The researcher observed that, SLE writers were the rebellions in the history as, at that time due to less usage of technological advanced mass communication, people used to read books and newspapers. Many SLE writers portrayed criticism, perceptions about the social injustice and suffering due to the conflicts, traditional, political and cultural influences and SLE poets play a huge role as influencers and advisers and made aware about the social hidden suffering of the innocent SL women to the SL society.

Therefore, SLE poems were not only creations of SLE poets and it can be considered as the descriptive historical documents which consisted details of the suffering, pain, happiness of the pure Sri Lankan people. Sri Lanka is an Island. Basically, Sri Lankans developed their lifestyle with the nature. Many religious rituals and events heavily affected to their mother language such as Sinhala Buddhists celebrated 12 full moon *Poya days* by symbolizing specific event that happened in the Buddhist culture. Additionally, *Awurudu festival* which is celebrated by the Sinhala and Tamil people by following special customs which is related to Sinhala and Tamil culture. Many local expressions and cultural words are added to SLE vocabulary due to this special food culture, dressing culture and religious rituals related to this special festival. In fact, *Wesak and Poson* seasons which are celebrated by the Buddhists during the May and June also fine example for local flavored symbols. Many SLE poets added Local flavored words related to above two *Poya days*' celebrations. Moreover Tamils celebrate religious and cultural events such as *Thai Pongal, Deepavali*, and *Holly ceremonies*.

The researcher identified that, the reasons of generating and using pure local terms of Sinhala and Tamil to SL poetry. They are inability of find proper English terms for local terms and there were not such local terms were translated to English words. Besides, SLE poets believed that, English translation is not always productively and effectively helped to present local expression with the same sense as there were not rich and suitable English words to elaborate specific local expression. Additionally, this study is based on the personal experience of the researcher in fact, the researcher observed the usage of Sinhala and Tamil expressions in Sri Lankan literature has indirectly affected students' use of language. The researcher found that, students added SL local expressions and original Sinhala words and Tamil words unconsciously to English essays. As well as this same fact is observed in the Ordinary level students' answer sheets of reading questions. Moreover, the researcher was questioned by some students about the given reading text piece of Sri Lankan children novel '*Madol Doova*'. They have questioned about the reasons of writer's usage of genuine Sinhala terms in writing English novel.

Therefore, based on the given discussion, it is evident that there is a crucial need to explore and analyze the morphological processes used in introducing local expressions through SLE vocabulary to Sri Lankan poetry and how the Sinhala and Tamil lexicons are formulated and introduced to Sri Lankan poetry as a deeper exploration.

Based on the above background, the researcher focuses on the following research objectives,

    i.   To find out the SLE lexicons used to express local expressions in the Sri Lankan poetry.

    ii.   To analyze identified SLE lexicons under morphological processes.

2. REVIEW OF LITERATURE

Senaratne (2009) states that Sri Lankan English language had been created as a result of long time contact with English Language which was 200 years and SLE refers to English language used in Sri Lanka. Further she states that, SLE language consists and is enriched with both Sinhala and Tamil

vocabularies due to the bilingual background of Sri Lanka and characteristics of Sinhala and Tamil Language have highly influenced to the development of the SL morphology.

Besides, there are two major varieties of Sri Lankan English highly popularized in Sri Lankan context. They are, Standard Sri Lankan English and Non- Standard Sri Lankan English (Not pot English). These two varieties are the two dialects used in SL context. However, SLE is considered as the well-recognized variety due to the significant phonological, morphological and syntactical characteristics (Gunesekera, 2005).

SLE vocabulary refers to the English vocabulary which is used in the Sri Lankan context and SLE vocabulary is considered as a distinguished characteristic of SLE due to the uniqueness and creativity. During the British colonization, Standard British English became the official language of Sri Lanka, then people used Standard British vocabulary related to specific field such as Flora and fauna, clothes , equipment and food and beverages unconsciously due to the higher social pressures from the authoritative power of the British. At the same time people started to mix the British English words with Sinhala and Tamil words specially in Spoken discourse. Due to the language contacts, many loan words came from Sinhala and Tamil words to the SLE vocabulary (Gunasekara,2005).

According to previous studies, the researchers have proved that there had been sociological, cultural and political reasons to generate and mix SLE vocabulary in SLE vocabulary. Sociological incidents, cultural events such as Thai Pongal, Awurudu, Deepavali, Kandy Perahara heavily influenced in order to creating new vocabulary to SLE vocabulary. Such as pirith, gok kola and Awurudu sale. Moreover, Political conflicts and ethnic conflicts between Sinhala and Tamil and racism become the reasons for generating novel vocabularies to SLE (Meyler,2007).

Additionally, this study is narrowed down to the specific area poetry. On the other hand, Fernando (2012) explored the reasons for word formation and the strategies of creating novel vocabulary. Furthermore, she explains that the linguistic, and social tensions have influenced the improvement of SLE vocabulary. In fact, Fernando (2012) refers to the findings on as borrowings as the category with the highest number and hybrid compounds and loan translations as the next highest.

Bough (1935), states that, most of the new words have been derived from the other languages and this is one of the older methods of generating new words and further explains a few strategies such as affixation and self-explaining compounds.

Additionally, Bough (1935) explains that, compounding is the oldest method of creating new words in English language. Specifically it is evident that, many new SLE vocabulary is generated through compounding (Fernando ,2012) such as Loan translations, Hybrid compounds, loan blends and Semantic loans.

Besides, the researcher Haughen (1950) describes that, there are new strategies used to generate new vocabularies in new varieties and bilingualism influences in formulating novel words. This fact is studied in previous studies (Kachru ,1983) and he further mentioned that few strategies are being used for word formation such as loan words, loan shifts, loan blends and hybrids.

To discuss investigation of morphological processes in Sri Lankan fiction, Wickranage (2019) investigates morphological processes used in introducing local vocabulary in five SL fictions and marked borrowing, hybridization, compounding, coinage and literal translations as the used processes Moreover, Canagarajah (1994) explains that, there is a confusion started after the post –colonial period due to the influence of colonization, what language need to use and what strategies need to use for writing literary texts. Then, he explains the special strategies used by the SL poets. He reveals that, Jean Arasanayagam fuses the Tamil lexical items with English and tries to add Tamil culture to the SL poetry whereas Lakdasa Wikkramasinha attempts to fuse Sinhala and English by adding original Sinhala lexical terms to SLE poems. Canagarajah (1994) further reveals that, Patrick Fernando uses Standard British with westernized idioms to SLE poems whereas Yasmine Gooneratne uses irony by fusing Sinhala and English lexical items. Rambukwella (2006) explains that, Jean Arasanayagam uses Tamil lexical items to SLE poetry in order to express Tamil expressions and suffering due to the ethnic conflict between Sinhala and Tamil during past decades.

SLE Poets were displayed ultimate talent of presenting localism through SL work of arts. For example, Premaramanathan (2014) states that, Sri Lankan style, aristocratic feudal system and local idioms are highlighted Highly in Lakdasa Wikkramasinha 's poetry.

3. METHODOLOGY

The present study used descriptive qualitative research design. Accordingly, the present study selected 75 poems as the target population and sample out of 100 poems which were written by famous well recognized SLE poets from 1983 to 2012 based on five themes: Aristocratic system of Sinhala tradition, Plight of the Sri Lankan women and feminism, Ethnic conflicts and riots, Sinhala and Tamil traditional, cultural customs and myths and perspectives on love, people and society which were designed by the researcher. The non-probability purposive sampling method was used and thematic framework was used as the sample plan for the selection of purposive sampling method.

Primary data collection was done thorough an in-depth analysis of SLE poems in order to identify the Sri Lankan lexicons with local expressions. Secondary data was collected through scholarly articles. The researcher used Webinars in You Tube as primary data. You Tube Webinars were conducted by two modern poets. They are Malinda Seneviratne who won the Gratiaen Award in 2013 for the poetry collection Edges and Vivimarie Vanderpool who won the Gratiaen Award in 2007. As secondary data, the researcher used two poetry collection books for the study. They are Contemporary Sri Lankan Poetry in English and A Selection of English Poetry was written by Rajiva Wijesinha and the researcher used Web Sites to collect modern poems which were written by the Modern poets: Malinda Seneviratne and Vivimarie Van der poorten. The data collection was done by reading the poems in depth and identifying the SLE lexicons based on the morphological processes. A4 papers, sticky notes, highlighters, pencils and pens were used to data gathering and whole data collection was done manually. The textual findings were analyzed under the four steps of data processing: identification, classification and description.

4. RESULTS AND DISCUSSION

The researcher elaborates the steps of the data analysis process with examples: Identification, Classification, Description and the researcher used descriptive qualitative content analysis for analyzing data. The researcher presents the research findings by using tables and pie charts.

4.1 IDENTIFICATION

The researcher identified 190 SLE lexicons out of 75 poems and the researcher identified, 55 Tamil expressions out of 190 SL lexicons and 135 Sinhala expressions out of 190 SL lexicons.

4.2 CLASSIFICATION
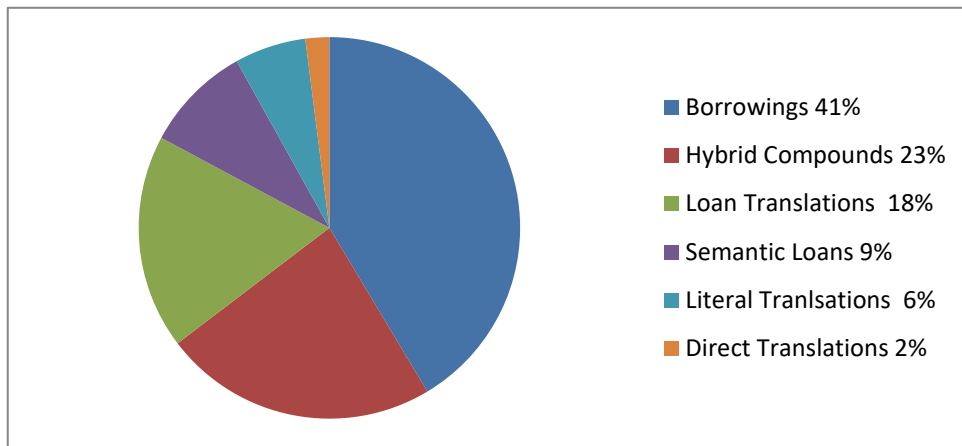
Figure 1: Percentage of morphological processes

Figure 1 presents the percentages of findings related to six Morphological processes: 41% Borrowing, 23% Hybrid compounds, 18% Loan translations, 9% Semantic loans, 6% Literal Translations and 2% Direct Translations. The amounts of Sinhala Borrowings are 46 out of 78 Borrowings. It is higher than Tamil Borrowings which is 32 out of 78 Borrowings. The amount of Sinhala and Tamil Hybrid Compounds are 43 out of 190 SL lexicons.

Table 1 : Number of word formation processes

Word formation Process	Sub categories of word formation process	Amount	Total
Borrowing	Sinhala Borrowing	46	78
	Tamil Borrowing	32	
Hybrid Compounds	S+E Hybrid Compounds	29	43
	T+E Hybrid Compounds	14	
Semantic Loans	-	-	18
Loan Translations	-	-	34
Literal Translations	-	-	13
Direct Translations	-	-	04

Observed 190 SLE Lexicons were classified in to two morphological processes based on the theory of word formation by Yule (2012): Borrowing and Compounding. Additionally, Hybrid Compounds, loan translations Semantic loans, Direct Translations and Literal translations are the specific morphological processes which were explained by the scholars and used for classification purpose for this study, as illustrated in Table 1.

3.3 DESCRIPTION

3.3.1 BORROWINGS

The researcher described the significant findings of Borrowings: (S+S) Sinhala Borrowing which are compound nouns. For instance: *Kiribath* (S+S) ⟶ *Kiri* (S) + *bath* (S), (S+T) Sinhala with Tamil Borrowings which are compound nouns, (T+T) Tamil with Tamil borrowings which is originated from compound nouns: *Kum-kumum*(T+T) ⟶ *Kum* (T) + *Kumum* (T). Sinhala Borrowings: *Upatha and Vipatha, gok kola, pol mal, sar, pirith, Samanala Kanda, Aluth Avurudda*, Tami Borrowings: *Poosari, attiyal, mukuthi, siva, mukuthi, alponas, kolam, Achchi, swarmi, Yogaswami, Guru, Brahmins.*

3.3.2 HYBRID COMPOUNDS

Next, described the Hybrid compounds word formation: (S+T), (S+E), E+S), (T+E), (E+T). and most of the hybrid compounds are compound nouns and there was only one hybrid compound adjective.

Brown Kahata ⟶ *Brown* (E) + *kahata* (S)

Na flower (S+E) ⟶ *Na* (S) + *flower* (E)

Velvi rituals ⟶ *Velvi* (T) + *rituals* (E)

Brilliant niyagala ⟶ *Brilliant*(E) + *niyagala* (S)

Brass kuthuvillaku ⟶ *Brass* (E) + *kuthuvillaku* (T)

3.3.3 SEMANTIC LOANS

Semantic Loans can be called as semantic changes. Semantic Loans do not show replacement of any word from another language but it portrays the change of meaning of the word. The researcher identified 18 Semantic loans which are related to different fields such as jewellary, people, culture, customs and ethnic groups as given below;

For example: Semantic change

Seven Necklaces   ⟶   *Seven Necklaces*

(Jewellary)   (Traditional Bride)

3.3.4 LOAN TRANSLATIONS

According to the Fernando (2012), Loan Translations are created as a result of translating morphemes in SLE compounds to English Translations as a replacement of SLE compounds. Such as SLE Sinhala compound *kaha bath* is replaced as *Yellow rice*. For example: *Betal chew, Milk Woman, Harvest song*

Thel (oil) + *pegunu*(soaked) + *thira*(wicks)   ⟶   *Oil-soaked wicks*

3.3.5 LITERAL TRANSLATIONS

Literal Translations are created as a result of translating the literal meaning of model language to English language. It portrays the pure local expressions, local flavored phrases and idioms of SL people specifically related to Sinhala and Tamil people.

The milk heated at the auspicious hour is a direct translation of the Sinhala sentence. But it has ironical literal meaning. The Sinhala sentence is *suba nakathatha kiri ithiraweema*. Sinhala people used to heat the milk at the auspicious hour for special celebrated moments of life and specifically it is a main ritual of the Sinhala and Tamil New year which is celebrated in April 14. It is as a symbol of fertility and prosperity and it is considered as a good omen for starting special events.

3.3.6 DIRECT TRANSLATIONS

Direct translation is a one of best of translating method of translating texts from other languages. The researcher identified that, mother language influence is highly affected on the usage of direct translations and poets used direct translations in order to familiarize the poem to the SL audience.

Amma sleeping?

The question *Amma sleeping?*, is a direct translation of Sinhala language which is grammatically incorrect but it has original flavor. The Sinhala question *Amma nidida* is directly translated to English language without changing the grammatical order. The sentence is created as a result of bilingual exposure. The sentence is translated in to English without adding Auxiliary verb.

5. CONCLUSION AND RECOMMENDATIONS

According to research findings, the researcher found 190 SL Lexicons that express local expressions out of 75 SLE poems. Under data analysis of the present study, the researcher explained significant expressions related to Tamil culture and found out diversity of Tamil culture which merged with Hinduism. As recommendations, the researcher recommended to start writing SL Glossary at the end

of the SL Novel or Fictions, start to write Novels, Poems using SLE vocabulary manually. As suggestions , the researcher believed there should be more researches need to be done based on SL literature specialized to SL drama and short stories. Additionally, the researcher suggests that, it is better to do investigation on morphological analysis based on morphological analysis on SLE vocabulary related to SL Muslim and Burger culture.

REFERENCES

Athapaththu, A. P. (2019). Morphological Processes of Sri Lankan English in Four Sri Lankan Short Stories. *Proceedings of 12th International Research Conference 2019*, KDU.

Baugh, A. C. 1978, A history of the English language. New York.

Canagarajah, A.S. (1994), Competing discources in Sri Lankan English Poetry

Fernando, S. (2012), Sri Lankan English vocabulary (SLE) a new vocabulary in a new variety, *Journal of Humanities and Social Science*, p.7.

Gunasekara, M. (2005).The postcolonial identity of Sri Lankan English*, Katha publisher.*

Haugen, Einar. (1950a). Problems of Bilingualism.

Haugen, Einar. (1950b). The analysis of Linguistic Borrowing.

Kachru, B.B (1983).The Indianization of English', The English Language in India, *Oxford, Oxford University Press.*

Meyler, M (2007), A dictionary of Sri Lankan English.

Rambukwella, H (2006). A Question of Belonging: Reading Jean Arasanayagam through Nationalist Discourse.

Senaratne, C. D. (2009), Sinhala-English code mixing in Sri Lanka.

Senarathne, C. D. (2012). The process of hybridization in sinhala-english verb.

Senarathne, C. D. (2019). Nativizing Strategies in Mixed Contexts.

Wicrkamage, N. P. (n.d.), Enhancement of Sri Lankan English Vocabulary in Sri Lankan Short Stories and Poems in English. P.163.

THE LANGUAGE DEVELOPMENT IN SRI LANKAN ENGLISH PRINT MEDIA: ANALYSIS OF VOCABULARY CHANGES IN TECHNOLOGY IN SRI LANKAN ENGLISH NEWSPAPERS FROM 1991-2020

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ABSTRACT

Due to technological changes, a significant amount of vocabulary has been added to the English language and there is a plethora of neologisms of technologically added vocabulary. As a result, the aim of the study is to find out the changes of vocabulary in technology that have occurred in Sri Lankan English newspapers. This is a longitudinal study that used a qualitative descriptive content analysis method to collect and analyze data on the changes in English vocabulary in Sri Lankan English newspapers from 1991 to 2020. Two newspapers per year were used as purposive sampling method in this study. As the primary data collection method, Sunday Observer English newspapers published between 1991 and 2020 were obtained from the public library. Secondary sources such as scholarly articles, technology-related articles and classified articles were utilized for further data collection. The researcher found four major vocabulary categories: obsolete vocabulary, changed vocabulary, newly added vocabulary, and vocabulary with a semantic shift. This research was to shed light on changes in the English language's lexicon in technology that have been added to Sri Lankan English newspapers.

Keywords: Digital Era, Language Changes, Newspapers, Technology, Vocabulary Plethora.

1. INTRODUCTION

The present study aims at an analysis of vocabulary changes in Sri Lankan newspapers from 1990 to 2020. In this chapter, the researcher elaborates on the background of the study, the rationale of the study, the research problem and research question, the research objective and scope, and the limitations. The ability to change is a feature of a language. Technology, according to linguists and lexicographers, is by far the most powerful force for change in the English language today. English is widely used in print media such as newspapers, books, and journals. In Sri Lankan newspapers, the vocabulary may be subjective due to the historical events, political situation, and socio-cultural aspects as well as the technological advancement of the country.

For many journalists in Sri Lanka today, English is one of the primary languages used in newspapers and magazines. The purpose of this research focuses on the recent changes in the usage of the English language that have been brought about by the impact of technology, as seen by the popularity of the internet. Since its introduction in the early 1990s, the internet has become a critical component of globalization and the expansion of the English language. As a result, the English language has changed and evolved with the ever-changing world of technology.

The impact of technology on the present English language can be noticed in newspapers. Newspapers can now be referred to electronically as well, and newspapers are the ideal place to look for language changes because they represent a specific time period. As a result, the researcher began to search for

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vocabulary changes that have occurred in the English language as a result of technological advancements by analyzing language used in newspapers.

We require lexicons of new words to describe ourselves as our lifestyles, cultures, and technology evolve and advance. Abbas (2019) says that there is a lexical gap in communication as a result of technological advancement. As a consequence, neologisms are required to fill the vacuum in the lexicon. The researcher intends to identify the changes that have happened to vocabulary in use from 1990 to 2020 as a result of technological advancement in society. Therefore, the researcher intends to focus on achieving the objective to find out English vocabulary changes in technology in Sri Lankan newspapers from 1991 to 2020.

2. REVIEW OF LITERATURE

The English language evolves for a variety of reasons. Essentially, it evolves in response to the changing needs of its speakers. New technologies, new products, and new experiences necessitate the use of new words to refer to them in a clear and efficient manner. Particularly in South Asia, English has been the dominant language since colonization.

Abbas (2018) says that it is clear that electronic communication has had a significant impact on the use of modern English. This trend of using the internet and other forms of social media is expected to continue in the near and distant future, introducing new forms of language, such as new graphology and "net-speak," which do not adhere to the grammatical and syntactic rules of systematic English writing. This study aimed to reveal the most recent and current lexical, abbreviation, new spelling, new punctuation, and any other grammatical deviations in the English language.

Perera (2012) says that since the introduction of English to Sri Lanka in 1756, its vocabulary has undergone a steady change, and she has presented "Developing trends in SLE in journalistic writing" using randomly and purposefully selected English newspapers. According to Perera (2007), SLE has unique phonological, morphological, lexical, and syntactic features that have undergone a gradual development throughout the history. This analysis was done for the decades 1955–1965 and 2005–2015.

Jana (2019) focuses on how even education has changed due to computers, smart phones and the internet. Singh (2021) states, "English greatly changed in structure as well as lexicon, and it emerged into a new version of language." "The rise of the Internet, mobile phones, and social media has led to a huge increase in the usage of the English language." The critics assert that because of the widespread usage of the internet, English has a propensity to change into a different version of itself.

In Sri Lankan English newspapers, SLE has been used more commonly. Ariyasinghe (2018) investigates the features of SLE syntax based on the newspapers. The reason for selecting newspapers as the method of data collection was the fact that they consist of authentic language usage.

Modern English is different from old English. The English language today is vastly different from that of the past for a variety of reasons, including colonization, socio-cultural influences, political affairs,

and, most notably, technological advancement. As a matter of fact, the researcher focused on determining the changes that have occurred in the English language in Sri Lankan print media as a result of the current study.

3. METHODOLOGY

This was a longitudinal study that utilized the qualitative descriptive content analysis method to collect and analyze data on the changes in English vocabulary in Sri Lankan English newspapers from 1991 to 2020. For this purpose, the researcher deeply analyzed the use of technology-related vocabulary in Sri Lankan English newspapers published between 1991 and 2020. The purposeful sampling method was used in this study. Sunday Observer English newspapers from 1990–2020 were used for the study. The Sunday Observer newspaper, published once a week on Sunday, was used to gather data. As the sample, two newspapers from each year totaling 60 papers were analyzed, and four technology-related articles for each newspaper were referred. Primary data collection was done for a period of two months, from February 2nd to March 24th. The Sunday Observer papers published on Sunday from January 1991 to January 2020 were accessed by gaining membership at the National Library of Sri Lanka. Two newspapers from each year, one from each semester, were selected for the analysis. Utilizing the in-depth descriptive content analysis method, vocabulary items related to new technology were identified. To gather further data related to the study, secondary sources such as scholarly articles, technology-related articles, and classified articles were utilized. The identified data was first classified by dividing into four categories: obsolete vocabulary, replaced vocabulary, newly added (but still used in communication) vocabulary, and semantically shifted vocabulary. Next, the categorized data was described to gain an understanding of how vocabulary related to technology has changed over the past three decades. Even though this study utilized the qualitative method, to present data, the researcher used tables.

4. RESULTS AND DISCUSSION

4.1. OBSOLETE VOCABULARY

Obsolete vocabulary refers to the vocabulary that is no longer needed because something better has been replaced. (Table1)

Table 1: Obsolete Vocabulary

1991-2000	2001-2010	2011-2020
Type writer	computer	
Floppy Disk	CD	DVD
television	3D TV	
Codeless phone	Cellular phone /Mobile phones	Mobile phone / Smart phone
Computer link	Internet page	webpage

Information age	Digital age	
Desktop	Personnel computer (PC)/Laptop	
Internet traders	e-business/e-marketing	
Computer operator	Data entry analyst	
Video games	Computer games	E-sports
Landline	hotline	CDMA phones
CD (Compact Disc)	DVD /pen drive	Google drive
Stenographer	-	-
Typist	Computer operator	Data entry analysts
Cassette recorder	-	
Film rolls	.	.
Y2k	-	-

The study discovered 17 vocabulary words between 1991 and 2000, including terms like stenographer, cassette recorder, film rolls, and Y2K that had not emerged in the previous two decades.

Typewriter: This was popular in the 1990s but was replaced by the computer, and it is no longer used. This is a less-used word and was found in the 1990s. The word "typewriter" has not been found since 1999. Between 1991 and 2000, this was found four times. According to the description in the Cambridge Dictionary, this is a manual machine that uses keys to print letters and numbers on paper before computers and typewriters were commonly used to type letters. In American English, the typewriter is considered obsolete. Therefore, this word is less used since the computer was invented. It is not stated that this machine is not in use, but rather that it is used less frequently.

Stenographer: Stenographer was popular in the 90s. A person whose job it is to transcribe speech in shorthand. Stenographers were found four times in that era. This term was found four times between 1991-2000. This term faded out gradually.

Floppy disk: Floppy disks are data storage units, and they were replaced by the CD from 2001 to 2010, and then they were also replaced with the DVD, which has more storage capacity. The portable pen drive and now Google Drive, which is used for cloud-based storage, superseded the use of CDs in the late 1990s.

Internet Traders: When the internet was not widely used in Sri Lanka, those who conducted business over the internet were referred to as "internet traders." This was found between 2001 and 2010, and with the advancement of the internet, these were referred to as "e-business" or "e-marketing." In between 2011 and 2020, e-business and e-marketing were found, respectively.

Computer link: In the 1990s, when computer technology had just been introduced and the internet was not very popular in Sri Lanka, English-language newspapers used this term to refer to a webpage. The information page was a little more advanced than the computer link. Then, as websites were introduced gradually in newspapers, the term "computer link" was replaced by the term "webpage." The term "computer link" was found three times in the 1990s. In Sunday Observer Newspaper article 1999, page

3, under the article on technology for schools, it is mentioned that "*a computer link creates for the ministry of education."* This refers to the webpage. According to the Cambridge Dictionary, "webpage" is a collection of internet pages about a specific subject published by a single person or organization. As a result, the researcher concluded that this "computer link" refers to the "webpage." From 2001 to 2010, the researcher discovered five web pages.

Codeless phone: In the 1990s, a codeless phone was discovered six times. However, according to data identification, this word was not discovered until 1999. According to the PC Magazine Encyclopedia, cordless phones, the first landline phones that were not attached to a desk or a wall, were invented in the 1950s but did not gain popularity until the 1980s. However, with the introduction of mobile phones, these codeless phones were replaced. The researcher identified the "codeless phone" six times in the 1990s, and then it was not found again after the 1990s. In the 2000s, the cellular phone came with more advanced features than a cordless phone. Between 2001 and 2010, "cellular phone" was found two times. Then "mobile phone" was discovered in the middle of 2000, and between 2001 and 2010 it was found five times, then between 2011 and 2020 it was found five times. The term "smartphone" with internet access was discovered in the late 2011s. This was found seven times.

4.2. CHANGED VOCABULARY

The second category includes terminology that has undergone a full transformation from its original form due to advancements in technology. Only one such term, though, was found.

Application ⟶ App

4.3. NEWLY ADDED VOCABULARY

 Newly added vocabulary refers to either a new word has been added, or an old word that has not changed, has been utilized. The researcher detected 76 terms in all. (Table 2)

Table 2: Newly Added Vocabulary

1.Computer	2.Computer language	3.Output device	4.Input device
5.Virtual	6.Operating system	7.data	8.Backup copies
9.Install	10.Internet	11.multimedia	12.e-mail
13.Graphic designer	14. IT-manager	15.online	16.Data processing
17.Color photography	18.Computer literacy	19.hardware	20.software
21.virtual	22.3G	23.Digital media	24.Cyber politics
25.Cyber age	26.e-ticketing	27.e-services	28.Information system
29.Upload	30.Download	31.Mobile payment	32.Youtube
33.MP3player	34.Wi-Fi network	35.Digital banners	36.Cyber skills
37.e-readers	38.Google	39.3 G connection	40.User account
41.Hotspot	42.Coverage	43.e-book	44.e-waste
45.e-commerce	46.e-features	47.Online- shopping	48.Internet connection

49.Twitter	50.Mp3 track	51.Net user	52.Anti-virus
53.Internet banking	54.Link	55.4G	56.Online marketing
57.Mobile banking	58.Facebook	59.Wi-fi zone	60.social media
61.3G network	62.Digital banking	63.Online tutoring	64.virtual classroom
65.Instagram	66.social media platform	67.Facebook moderators	68.Online space
69.Livestreaming	70.Selfie	71.memes	72.WhatsApp
73.Cyber source	74.Zoom platform	75.digital photography	76.you tuber

Internet: A worldwide electronic communications network that connects computer networks and organizational computer facilities Because of the invention of the "internet," technology has caused a revolution. Because of the invention of the "internet," technology has caused a revolution. This term was discovered numerous times between 1991 and 2001: "internet, twice, internet page at the same time," The word "internet" From 2001 to 2010, seven times from 2011 to 20202, the term "internet" was found 10 times. The phrase "internet connection" appeared two times.

Digital: Electronic tools, systems, devices, and resources that generate, store, or process data are referred to as "digital technologies." Social media, online games, multimedia, and mobile phones are well-known examples. Throughout the data collection, the researcher discovered that the term "digital" is associated with many words: digital age, digital media, digital banners, digital photography, and digital banking.

Wi-Fi: Wi-Fi is a facility that allows computers, smartphones, or other devices to connect to the internet or communicate wirelessly within a specific area.

Livestreaming: This trend is very popular on social media. When someone watches video on the Internet, the method of data transmission used is live streaming. It is a method of delivering a video file in small chunks, typically from a remote storage location. Client devices do not have to download the entire video before starting to play it because the file is transmitted a few seconds at a time over the internet.

Zoom platform: Zoom is a video conferencing platform that can be accessed via a computer desktop or mobile app and allows users to connect online for video conference meetings, webinars, and live chat. Because of the coronavirus pandemic, this term was particularly prevalent in Sri Lanka.

4.4. SEMANTIC SHIFT

The researcher discovered semantic shift vocabulary, which has various meanings but similar pronunciations and spellings. Words that have been semantically changed in this context have two meanings: one is their usual sense, and the other is their technological sense. Only seven semantically shifted terms have been discovered by the researcher: format, cloud, site, web, virus, file, programme, network, and tablet.

Format: In general, a format is a pattern, plan, or arrangement; in technology, it is the way information is organized and stored on a computer. Reformatting a computer requires erasing the hard drive and reinstalling the operating system, as well as all other applications and files.

Cloud: Cloud in normal usage gray or white mass in the sky. When it comes to computing, it is defined as a connection with more than one computer via the internet.

Site: A site is a place where something is, was, or will be built, or where something happened, is happening, or will happen. When referring to technology terms, it is an indication for the website.

File: In general, a file is any of several different types of containers used to store papers, letters, and other documents in an organized manner, particularly in a workplace. In computing, a file is a place to store data on a computer.

Web: A web is a net used to catch insects that is made by a spider from the sticky thread that its body produces; the various tools and techniques used in the process of communicating between various types of devices over the internet are often associated with the web, including website and web connection.

Virus: A disease is the common term, and a computer problem is the technological term. A virus cannot reproduce itself. Instead, it will infect a living cell, forcing it to replicate the virus. When the virus does this, it stops the cell from doing whatever it was doing before killing it. This also applies to the computer virus. It causes computer system damage by embedding self-replicating code illegally in a computer program, frequently causing damage or shutting down a system or network.

Programme: In general, a program is a plan for activities to be completed or goals to be met, whereas a computer program is a set of instructions written in a computer language to create or run a computer programme.

Tablet: The researcher found "tablet" as a semantically shifted word. According to the Cambridge dictionary, a "tablet" can be described as: "In medicine, a small, solid piece of medicine; in information technology, a type of small computer with a screen that can be written on with a special pen."

Network: In general, a large system consists of many similar parts that are connected together to allow movement or communication between or along the parts, or between the parts and a control center in computing. In computing, a network is used to connect computers together so that they can share information.

5. CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the researcher found four major vocabulary categories in this study: obsolete vocabulary, newly added vocabulary, changed vocabulary, and vocabulary with semantic shift. The category with the most vocabulary is "newly added vocabulary." Then comes the obsolete category. The study only discovered seven semantically shifted words, whereas changed words are one. Further, this study recommends creating a dictionary of technological terms because we could find such dictionaries introducing new technological vocabulary only rarely. It is further recommended that similar studies be carried out in relation to other areas of language use, such as science, fashion, culinary, etc.

REFERENCES

Abbas, J. (2019). The Impact of Technology on Modern English Language.

Ariyasingha, D *(2018).* Features of Written Sri Lankan English in Newspapers: Analysis of Letters to the Editor

Ana. B (2019) *Six Technological* Innovations *That Change English Language.*

Perera, N. (2012) *Developing Trends in Sri Lankan English (SLE) Vocabulary in the Domains of Journalistic Writing*.

Singh.V (*2019) E-learning in Pandemic.*

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