ICST 2022

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2ND INTERNATIONAL CONFERENCE
ON SCIENCE AND TECHNOLOGY

PROCEEDINGS
OF PAPERS

BUILDING SUSTAINABLE FUTURE THROUGH TECHNOLOGICAL TRANSFORMATION

FACULTY OF TECHNOLOGY
SOUTH EASTERN UNIVERSITY OF SRI LANKA
SRI LANKA

ICST 2022
2ND INTERNATIONAL CONFERENCE ON SCIENCE AND TECHNOLOGY
SOUTH EASTERN UNIVERSITY OF SRI LANKA - AUGUST 24, 2022

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MESSAGE FROM THE VICE CHANCELLOR

Faculty of Technology of the South Eastern University of Sri Lanka (SEUSL) is the youngest, but growing Faculty at South Eastern University of Sri Lanka. It has proven over the years that it possess excellent traits including novel areas of teaching. research and innovations, and also caters to the needs of the region and country by producing abled and capable undergraduates. Further, the Faculty of Technology is the pioneer Faculty at South Eastern University of Sri Lanka to have commenced start post-graduate degree programme by research.

This is the second that the Faculty of Technology organizes its annual International Conference on Science and Technology, ICST 2022 entitled "Building Sustainable future through Technological Transformation". The faculty has taken steps to disseminate the valuable research outputs generated in Science & Technology by its students, staff, stakeholders from other faculties of the University, other Universities and research organizations from Sri Lanka and overseas. This conference provides a platform for all researchers to present their findings with the presence of an audience of experienced researchers and scholars and with their, endorsements, such research will be disseminated through the proceedings published today.

Moreover, selected research outputs presented will be given the option of publishing in the Sri Lanka Journal of Technology (SLJOT) of the faculty. Hence, this annual research conference of the Faculty of Technology will contribute to achieve the vision of the SEUSL as a hub of world class academic and research institution. The commitment and enthusiasm shown by organizing committee of this conference is commendable. The leadership given by the Dean of the Faculty, Dr. UL. Abdul Majeed as the Conference Chair and Mr. R.K. Ahmadh Rifai Kariapper as the Coordinator of the Conference together with the team of energetic staff made this a very successful event. I hope that this conference will be remembered as one of the annual events that is in the forefront of disseminating science and technology related research in the Country.

I am greatly honoured and pleased to welcome all the paper presenters and the participants to this conference. I extend my gratitude to all who are part of this conference and wish all the researchers who present their findings all the success. I am sure that with all your contributions, the South Eastern University of Sri Lanka could retain its role as a leading University in the country.

Professor A. Rameez, PhD (NUS)
Vice Chancellor
South Eastern University of Sri Lanka

MESSAGE FROM THE CHAIRMAN

As the Dean of the Faculty of Technology, I am privileged to write this felicitation message to the second International Conference on Science & Technology -ICST 2022, proudly organized by the Faculty of Technology of South Eastern University of Sri Lanka. The theme of the conference is- "Building Sustainable Future through Technological Transformation". Here, the theme is the need of the hour and timely as far as the present global phenomena is concerned. The era of technology and its organized transformation will definitely pave the way for a sustainable future. More technologies are needed to tackle the prevailing challenges by the present world. The technologies developed throughout the globe have to be shared again throughout the world to maintain a balanced application so as to encounter the challenges successfully.

Sometimes, the negative reaction of the globe more outweighs than the technologies developed and applied all over the world. It means there is still a gap to develop technology further and extend its application to encounter the challenges to maintain a sustainable future. I strongly believe that technological conferences like this provide an immense and indispensable opportunity for academicians, researchers, scientists, professionals and other stakeholders from all over the world to share and express their views and discuss the ways and means to react for the challenges so as to uphold the sustainable world for the future generations to come.

Based on the above illustrations, the theme of the second international conference of this faculty is very significant and timely. I am very pleased to state that more than fifty research papers have been received from local and international research scientists covering a variety of disciplines. It is a great achievement and endorsement for the commitment extended by the faculty of technology due to its continuous involvement in the field of research and development for the sake of the society.

I wish to congratulate all the researchers, scholars and presenters for their active participation at this international forum to share their views and discuss their research findings/output to facilitate its application to maintain a sustainable future.

Finally, I would like to express my sincere thanks and gratitude to the chief guest of this conference Professor. A. Ramees, Vice Chancellor of South Eastern University of Sri Lanka, the keynote speaker Senior Professor. M.M.M. Najim, the former Vice Chancellor of South Eastern University of Sri Lanka and senior academic, the Department of Zoology and Environmental Management, Faculty of Science, Kelani University of Sri Lanka, the guest speaker Professor H.P. Hewagamage, University of Colombo School of Computing (UCSC), distinguished guests, scholars, presenters, the organizing committee, staff of the faculty, students and the administrative staff for their fullest cooperation and enormous support extended to make this historic event a success. I also wish to extend my thanks for all who directly and indirectly supported during the different stages of this conference to make a very success one.

Sincerely,

Dr. U. L. Abdul Majeed
Dean
Faculty of Technology
South Eastern University of Sri Lanka

MESSAGE FROM THE COORDINATOR

It gives me immense pleasure that the Faculty of Technology, South Eastern University of Sri Lanka, is organizing the 2nd International Conference on Science and Technology 2022 (ICST 2022) on the 24th of August 2022 at the Faculty of Technology, South Eastern University of Sri Lanka.

Conference speakers will focus on "Building Sustainable Future through Technological Transformation" as the conference theme. Researchers, engineers, scientists, and technologists from all around the world can come together to discuss the latest developments in technology at ICST 2022. Topics covered at the conference include: computing and information systems; multimedia and gaming technologies; networking and security technologies; software and ubiquitous computing; agriculture economics and entrepreneurship; animal and aquatic science and technology; biosystems engineering; crop and food science and technology; and more.

I hope that the distinguished speakers will offer novel insights into their respective fields of expertise. It's an honor for me to declare that this conference will provide useful insights for addressing global problems and promoting long-term growth. The success of this Conference is due entirely to the hard work and dedication of an infinite number of people who have been preparing for it in various ways for nearly a year. To wrap up, I want to say how much I appreciate everyone's time and effort. I hope that ICST 2022 will be a huge success.

Mr. RK. Ahmadh Rifai Kariapper
Coordinator
2nd International Conference on Science and Technology (ICST 2022)
Faculty of Technology
South Eastern University of Sri Lanka

MESSAGE FROM THE KEYNOTE SPEAKER

The youngest Faculty in the South Eastern University of Sri Lanka (SEUSL) is the Faculty of Technology; however, the Faculty has proven to possess excellent traits, including research, postgraduate studies, research dissemination, leadership, novel areas, and modes of teaching, etc. The research and researcher pool in the Faculty caters to the country's needs by producing abled undergraduates and postgraduates. Even though the Faculty is new, it has pioneered driving the University toward the 21st Century research and educational needs giving leadership in many areas. In these aspects, the Faculty's continuous struggle to cope with the external challenges and fulfill the mission of the University, it has organized the second international conference in 2022.

The theme of the ICST 2022 is entitled "Building Sustainable Future through Technological Transformation." Sustainability in all aspects of resource utilization, production, and consumption is vital, and it requires all stakeholders' contributions to achieve sustainability in the future. Achieving sustainability requires appropriate technological inputs, and I am happy to witness the initiative taken by the Faculty in this process. This conference provides the opportunity to present technological transformations in building sustainability in many different aspects with an audience of experienced researchers. Hence, this annual research conference of the Faculty of Technology will contribute to the achievement of the vision of the SEUSL of becoming a world-class academic and research institution.

I am greatly honored to deliver the keynote address at this conference. I would like to extend my gratitude to all who are party to this conference. I wish all the researchers who present their findings all the success.

Senior Professor M.M.M. Najim
Faculty of Science
University of Kelaniya

MESSAGE FROM THE GUEST SPEAKER

I would like to congratulate the organizing committee of ICST2022 on planning a vital conference to present and discuss research and technology findings based on the technology transformation in order to build a sustainable future.

We are facing a lot of challenges in the current context of our society due to various issues, mainly due to social health conditions due to covid-19 and other various viruses, as well as economic downfall due to high expenses and low income. Hence, the future has become uncertain in all sectors of life. When we have problems, we usually try to take many actions to solve them, considering both the short-term and long-term requirements. A sustainable future could be built based on our activities that will be able to retain the solutions for these problems. These long-term activities should be based on different transformation processes in our societies. In other words, it is the change of technology on which these processes are based to carry out different activities. This technology transformation is a must for the future sustainability of our society. A good example to justify this transformation is QR code-based fuel distribution in Sri Lanka for all vehicles based on a single policy. The supply and demand could be affected due to various reasons, including wrong or misinformation in society. The fuel distribution created social unrest, and technology transformation supported through Information Technology-based solution resolved it to a significant extent. All viruses created a society preventing us from interacting as a normal human beings in a F2F context. The Work From Home (WFH) is a new methodology in our society. However, technology facilitated our society, transforming our normal interaction into a new model of interaction through Internet while maintaining the sustainability of society. The best example is online education in all public universities during the last two years, and it helped all universities to reduce the impact on higher education. The integration of different technologies in the transformation process will develop a new society to face all challenges in the future. Hence, this conference presents an important theme for our society, and I highly appreciate all the academic and other staff members who contributed to organizing this important conference. We are eagerly waiting to watch fruitful presentations based on this theme at ICST2022 and congratulate all presenters in advance

Professor K. P. Hewagamage

Professor in Computer Science

University of Colombo School of Computing (UCSC)

ABSTRACT OF KEYNOTE SPEECH

Building Sustainable Future through Technological Transformation

M.M.M. Najim

Faculty of Science, University of Kelaniya

In 1987, Brundtland Report defined sustainable development as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs." The sustainability concept is being considered in managing resources, production processes, consumption, etc. Gaining a sustainable future requires multidimensional, interdimensional, and integrated decision-making under a complex social, economic and environmental context where any of these components can be omitted. Sustainability has become more vital in the current context where climate change is unexpectedly challenging all the systems. In 2015, 193 countries agreed on 17 sustainable development goals (SDGs) to offer the basis for a sustainable future. These SDGs have guided the nations to address poverty, inequality, global warming and climate change, hunger, poor sanitation, diseases, pollution, loss of biodiversity, etc., in achieving a suitable future. Our ability to secure the well-being of the human communities and maintain the health of natural ecosystems determines sustainable future that we can achieve. This process requires facing all the challenges, from very complex phenomena such as global warming and climate change to minor issues such as sharing limited resources.

Sustainable future for people and nature can only be achieved with the existing and expected technology and consumption, however, with major changes in production and consumption processes. In this process, harnessing and maximizing the potential of technological innovations is vital. Technologies such as carbon capture and storage, efficient and effective irrigation systems, essential medical facilities, safe drinking water for households to face challenges of pollution, contamination, and related diseases, waste minimization and abating pollution, etc. are vital in achieving a sustainable future. Existing and expected technology can handle the challenges at national and international levels. However, those have proven inadequate in achieving the sustainability goals and needs of the poorest, the most vulnerable, and marginalized communities. Technologies need transformation to equitably cater to the needs of such communities in ensuring a sustainable future for all. Technological transformations, therefore, play a major role in achieving a sustainable future for all.

ABSTRACT OF GUEST SPEECH

Virtual University: A model to apply Digital Transformation in Higher Education for the Professional Development of Graduates

K. P. Hewagamage

University of Colombo School of Computing (UCSC)

Employability is a key performance indicator of a Higher Education Institute (HEI), and it shows the results of outcome-based education in the curriculum. In some degree programmes, employability is not an issue since there is an external assurance of providing employment for the graduates due to pre-arrangements, such as in Medicine. However, many graduates will have to face the challenge of employability after graduation, and it is a socio temporal issue in society. Economic recession in society directly impacts employability irrespective of academic qualification. However, the common criticism is that graduates do not have the required competency expected by the employers or educational qualification doesn't match with opportunities in the job market.

In Sri Lanka, 35% of graduates are unemployed after one year of their graduation in public universities, where all degrees are offered under the free education system. A careful analysis shows this problem is worst in the non-technical education streams since unemployability moves to 70%. It is not an easy thing to convert these graduates to technical students after graduation, and the conversion should be started early in their education. The current demand for graduates with good IT knowledge and skills is around 22,000 graduates, and both state and non-state universities/institutes cannot produce more than 8000 graduates/diploma holders in a year. If it is possible to convert at least 50% of unemployed graduates and it will have a significant effect on the socio-economical development of Sri Lanka.

The current and future demand for knowledge and skills in the IT industry is very challenging, and it is more than how to use computers to do routine work. This includes the technology which directly affects the 4th industrial revolution, such as Artificial Intelligence, the Internet of Things, Data Science, Blockchain, etc. Traditionally, Professional Development is considered to be necessary after graduation in order to sustain work routines in the organization. If we want to start converting non-technical students to technical streams, professional development needs to be introduced as early in the academic career as a parallel scholarly activity. Continuing Professional Development (CPD) credits could be introduced to indicate the portfolio of the graduate. Virtual universities could play a central role in facilitating the professional development of graduates of all universities while they are engaging in studies in their formal disciplines. Professional development is based on the target employment, and undergraduates could follow different courses from the Virtual University as a part of their CPD to increase their chance of employability in high-demand job environments. Hence, the virtual university could play a significant role in the digital transformation of future graduates, considering the professional development for employability.

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TRACK - UBIQUITOUS COMPUTING TECHNOLOGIES (UCT)

Density-Based Real-Time Traffic Controlling System Using Image Processing

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Abstract

The vehicle population is growing rapidly with the growth of the population. Therefore, traffic congestion is increasing in urban areas. Associated problems such as accidents, stress, and pollution also increase in proportion to traffic problems. In most cities, traffic light systems are used to reduce traffic congestion. Most traffic lights work with a pre-programmed method, or Traffic Police control traffic congestion manually. In Sri Lanka, there is usually heavy traffic congestion during peak hours. During peak hours, Traffic Police control traffic congestion manually. Since this manual procedure is inadequate to control heavy traffic congestion, a real-time traffic controlling system is needed to solve this problem. Our proposed system is implemented to control this traffic congestion problem using real-time traffic density. Further, it is expected to avoid or minimize traffic congestion using image processing techniques.

Keywords: Traffic light systems, Traffic congestion, Image processing, YOLO, Queuing Theory

I. INTRODUCTION

Traffic light systems are used to control and reduce traffic congestion at intersections. In addition, they are one of the best ways to guarantee safe traffic flow everywhere. There is a universal code for traffic lights to follow with a sequence of illuminating lamps or LEDs (Light Emitting Diodes) of three standard colors which are red, green, and yellow. In most cases, traffic light systems are programmed according to the time allocation for each directional traffic flow during the cyclic process. It is the mainly used timer model. They operate according to preset times stored in memory, which is processed by a processor and powered by electricity. Most developed modern counties use sensor-based traffic control methods to detect the number or the density of vehicles and produce the appropriate signals (Nafeel, 2015). The traffic control system, based on vehicle density with image and video processing techniques, is a better alternative to time-based systems (Sable et al., 2020). This system is based on the actual traffic density of the road and real-time traffic monitoring. Python

Open CV can be used as an image processing tool to detect and count the number of vehicles in each lane. This system is mainly implemented for four-lane junctions and considered when pedestrians cross the road.

An implementation of a video-based real-time traffic controlling system and respective methodologies are presented in this study. The rest of the paper is structured as follows. Section II describes related work. Section III discusses the methodologies used, Section IV Discussion and section V presents the conclusion of this paper.

II. RELATED WORK

This section discusses the related work used to develop traffic light control systems, and it briefs the variety of methods that can be used in traffic control. There are two main traffic light controlling methods. One is the Fixed Time Technique (Siddamma and Pashupatimah, 2018). Here, the system is programmed based on the time allocation provided to each directional traffic flow during the cycle. This is a fixed-time technique, i.e. for a specific time interval, say 15 seconds, the

cyclic pattern of time distribution will remain the same (Subramaniam, Esro and Aw, 2012). The second one is Vehicle Activated Time Technique. This is a pre-defined mode, and adjustments can be made based on the approaching traffic flow detected by the sensors. These observations made by the sensors are then processed and appropriately timed by the traffic controller. However, this method has not been introduced in Sri Lanka. The comparison between the fixed time technique and the vehicle's activated time technique is shown in Table 01.

Table 01: Comparison between the fixed time technique and vehicle activated time technique

Fixed time technique	Vehicle activated time technique
Based on a pre-programmed sequence	Based on sensors
Operates without any consideration of real-time behavior	Operates in real-time
A time-allocated cyclic process	Commonly used sensors are inductive loops, cameras, radars, infrared sensors

Some of the traffic control methods which can be used as alternatives for traffic problems are described in the following.

A. Density-based Traffic Controlling

With the rapid development of road infrastructure, the density of vehicles on the road network has increased. This is mainly due to the rapid increase in vehicles in a certain area in a short period. The density-based traffic control system is a better solution to overcome those kinds of problems. Using real-time video and image processing techniques, this can be achieved. In most cases, electronic sensors embedded in the pavements are used to detect vehicles in a lane. Magnetic loop sensors are the most used sensors in vehicle detection, but the maintenance and installation costs are inconvenient (Guerrero-Ibáñez, Zeadally and Contreras-Castillo, 2018). Therefore, cameras can be used as image sensors to capture images. They can be analyzed using digital image processing for vehicle detection, and according to the density of traffic, traffic lights can be controlled (Raj A.M. *et al.,* 2020).

B. Traffic Controlling Using Image Processing

Traffic parameters can be estimated using real-time traffic monitoring. Vision-based cameras are

more versatile for traffic parameter estimation. The captured images provide quantitative and qualitative parameters (Guerrero-Ibáñez, Zeadally and Contreras-Castillo, 2018). Speeds of vehicles and vehicle count are some quantitative traffic parameters. It can give complete traffic flow information to meet traffic management requirements (Prakash *et al.*, 2018). An example of vehicle tracking is shown in Figure 01(a). The real-time traffic density on the road can be measured using image processing. The images are continuously captured and stored in a server and compared with live images captured by the camera to determine density. This process can be used to determine the traffic density on both sides of the roads and enable traffic signal control options for drivers or users by using a software application. Some image processing techniques which can be used in vehicle detection are described below.

(a) (b) (c) (d)
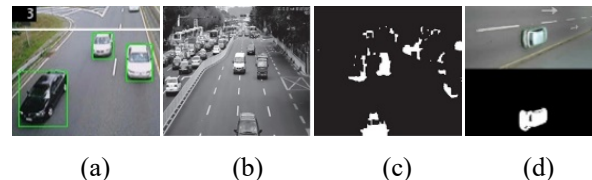
Figure 01: (a) Vehicle tracking using image processing (George, George, and George, 2018) (b) Image computed by GMMs input (Bhaskar, 2014), (c) output (Bhaskar, 2014) (d) Detected image using background subtraction(Sobral, 2015)

1) YOLO (You Only Look Once) Algorithm:

Traffic sign detection is a challenging task due to obstacles such as occlusions in natural scenes, changing lighting conditions, and camera perspective. Deep convolutional networks are used for image recognition and object detection as they provide the desired performance in terms of speed and accuracy (Vikram, 2018). Test time latency is one of the important factors in real-time traffic detection. Due to the complex computation, Convolution Neural Networks (CNNs) are considered unsuitable for real-time traffic detection. You Only Look Once (YOLO) architecture can be explored to detect and classify the signs in real-time. It can be used to exhibit object detection in real-time and classification at a rate of around 45 frames per second (Redmon *et al.*, 2016).

2) Background Subtraction:

This is a common method used to detect moving objects in a series of frames from cameras. It is

based on detecting moving objects from the difference between the current frame and reference frame which is called the 'background image' of the 'background model'. This is usually done through detection; foreground detection is the main task. All current detection techniques are based on modelling the image background, i.e. setting the background and detecting changes that occur. Defining a proper background can be difficult when the background contains shadows, shapes moving objects, etc. When defining the background, all techniques assume that the color and intensity of stationary objects will change over time. Figure 01(d) shows an example image detected by the Background subtraction technique.

3) *Gaussian Mixture Model:*

Gaussian Mixture Models (GMM) are used to measure parametric probability densities, expressed as a weighted sum of Gaussian component densities (Dahiya, 2021). GMM is used for various applications in different fields such as astronomy, machine learning, computational biochemistry, and other applications (Reynolds, 2009). GMM sorts the foreground and background from image frames by learning the background of a certain scene. In vehicle detection and tracking, GMM uses the common observable attribute change factor between the current image and the reference image to deal with the changes in the image frames and automatic gain by the camera. Then, the Mahalanobis distance of the Gaussian is calculated based on the common observable property change factor, the current color intensity, and the Gaussian component means estimate. The threshold is calculated to determine the similarity of an objective norm of color quality, regardless of its brightness between the background and the pixels in the foreground where the currently observed image is learned by obtaining GMM. Figure 01(b) and (c) show an example image computed by GMM and the output (Bhaskar, 2014).

C. *Fuzzy Rule-Based Control*

Adaptive Neuro-Fuzzy based modules are used for the analysis of traffic data. A set of 40 fuzzy decision rules are used to adjust the signal timing parameters (Wannige and Sonnadara, 2009). The rules for adjusting cycle time, phase splitting, and offset are decoupled so that these parameters can be adjusted independently (Mohanaselvi and Shanpriya, 2019). Adjusting the cycle time is used

to maintain good saturation when the top is close to the saturation (George, George, and George, 2018). Saturation is defined for a given method as the actual amount. The vehicles passing through the intersection during the green light time are divided by the maximum number of vehicles that can pass through the intersection during that time (Mohanaselvi and Shanpriya, 2019). Adjust the offset to coordinate adjacent signals to minimize the direction of dominant traffic flow. The controller first determines the number of dominant directions of the vehicle according to each method. The arrival time of the convoy leaving the upstream intersection can be calculated based on the time of the next green light at the upstream intersection.

D. *Queueing Theory*

Queuing theory is a mathematical study of the movement of people, objects, or information through lines to identify and correct points of congestion in processes (Gosvi, 2020). Queue theory is used to break in down the line into six elements such as the arriving processes, the serving and departing processes, the number of serving and departing processes, the number of servers available, the queue capacity, and the number being held (The Investopedia Team, 2022). When creating a model of the whole process from beginning to end, it is necessary to identify and resolve the cause of congestion.

| (a) | (b) | (c) |
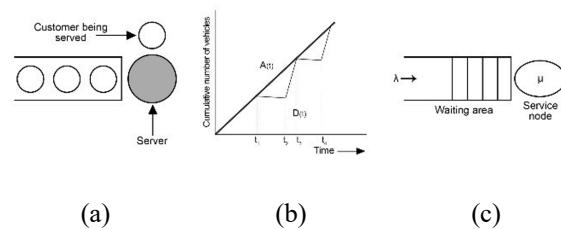
Figure 02: (a) Queuing System (Gosvi, 2020) (b) Analyzing the traffic flow using queue theory (Papacostas and Prevedouros, 1993) (c) M/M/1 Queuing system (Anokye, Annin and Oduro, 2013).

1) *Traffic Flow Analysis Using Queue Theory:*

Vehicle traffic provides the basis for measuring operational performance on the road. Various dimensions of traffic, such as the number of vehicles per unit of time, vehicle type, vehicle speed, the variation of traffic flow over time, and highway operations can affect the performance of

highways (Chandra, Mehar and Velmurugan, 2016). It is important to use theoretically consistent quantitative techniques to analyze traffic conditions. These techniques can be used to simulate traffic flow, speed, and temporal fluctuations (Srinivas *et al.*, 2013). Queuing theory can be used to analyze the traffic flow approaching and passing through intersections controlled by traffic lights. This is used to analyze the cumulative transit time of vehicles as a function of time. The above queuing diagram (Figure 02(b)) for interrupting flow shows the flow on one intersection approach. t_1 to t_2 time of Figure 02 (b) is the red signal interval, then the traffic is stopped. Traffic starts to leave the intersection at the start of the green interval (t_2) at the saturation traffic flowing rate (qG) and continues until the queue runs out. The departing rate $D(t)$ equals the arriving rate $A(t)$ until t_3, which is the beginning of the next red signal. This process is started over at this point (Papacostas , C.S. and Prevedouros, 1993).

2) M/M/1 Queuing Theory:

M/M/1 refers to negative exponential arrival and service times with a single server. This is the widely used queuing system for analysis purposes. M/M/1 is a good approximation for large queuing systems (Anokye, Annin, and Oduro, 2013). The conditions of the M/M/1 queuing system are, (1) The number of objects (vehicles) in the system is very large, (2) A single object consumes a small percentage of system resources, and (3) All vehicles are independent, i.e. their decision to use the system is independent of other users (Schwarz *et al.*, 2006).

III. METHODOLOGY

This research presents a solution for traffic light management using cameras. In this system, the cameras are used as image sensors for capturing vehicles. Images will be analyzed, and image processing techniques will be used for detecting and counting vehicles. Vehicle types and their traffic parameters will be measured for implementing an algorithm for traffic light waiting time. It will be mainly based on quantitative traffic parameters such as the speed of a vehicle, arrival time, size of a vehicle, etc. The system will not be dependent on the type of camera and the number of lanes in the road structure. It will depend only on the traffic parameters. There are two main parts included in this proposed methodology. They are (1) Vehicle detection and counting using image processing and (2) Creating an algorithm for traffic light control using Queuing Theory.

1) Vehicle Detection and Counting Using Image Processing

This part is done by using Python OpenCV background subtraction. Firstly, the relevant video was cropped using the algorithm and converted into grayscale, and filters such as blur, dilate, and the kernel were used. After that, the number of vehicles in each lane of the four-way intersection was counted.

2) Creating an Algorithm for Traffic Light Controlling

The traffic controlling algorithm is based on queuing theory. We have considered the traffic flows which follow the M/M/1 Queuing Theory. This algorithm mainly finds the green light time of the traffic light, and according to Traffic Engineering, it is equal to the waiting time of a vehicle.

Figure 03: (a) Sample frame for detection and counting vehicle (b) Grayscale image of the sample frame

The main assumptions we have made in this method are that the arrival pattern follows the positioning process, the arrival of vehicles is from one direction, there is no turning lane at the intersection, and the queue process follows the FIFO discipline.

The commonly used equation for traffic light waiting time calculation is given below. In this equation, λ refers to the arrival rate, and μ refers to the departure rate of vehicles. W is referred to as the waiting time.

$$W = \frac{1}{\mu - \lambda} \qquad (1)$$

The waiting time of each lane can be calculated by using equation (1) and then can control the traffic light according to the number of vehicles at the relevant time.

IV. DISCUSSION

Throughout this project, we have tested several image processing techniques and we have chosen

Python OpenCV as our image processing algorithm among them because the highest accuracy has been achieved by using that. We have achieved more than 90% accuracy using vehicle detection algorithm. It has been tested using several video sets. Most of them have more than 90% accuracy.

Real-time traffic control can be done using sensors and this paper is based on image sensors and image processing techniques. This project is mainly focused on four-lane junctions and these algorithms are independent of types of cameras and number of lanes. This can be developed into any number of lanes. We have used the Python-OpenCV background subtraction method and it can be changed for certain image processing methods and also can be developed to connect several traffic nodes and it can be easy to use a IoT platform for node-to-node communication.

V. CONCLUSION

This paper is based on developing a density-based traffic-controlling system. The proposed method consists of two main parts for detecting and calculating the vehicle density and the waiting time according to the vehicle density. Python OpenCV background subtraction method was used in vehicle detection and counting, and creating a waiting time algorithm was done based on M/M/1 Queuing Theory. This system would be a real-time traffic-detecting system. With the help of this system, we can manage and control traffic congestion and minimize the number of road accidents.

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Automated Vehicle Parking Slot Recognition and Monitoring using Optimised Image Processing Techniques

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Abstract

Due to the increase in individual vehicle usage, detecting an unoccupied parking slot and collecting payment for parking in an ample parking space have become monotonous tasks in the modern era. Traditional and manual parking slot management in large parking slots was inefficient and required a number of human resources. To address these issues, an automated, intelligent, and efficient parking system is required. This work presents an automated parking slot identification and monitoring technique that can be used to search for unoccupied parking spaces, a guide to parking spaces, negotiate parking fees, and track vehicles using number plate recognition. The proposed method employs optimized image processing and optical character recognition techniques to implement the system. When a vehicle approaches the parking entrance, cameras automatically capture its image and number plate information (registration number) and process it to direct the driver to an unoccupied parking slot. The system counts the number of parked vehicles and displays the current parking status. The system can also be used to collect electronic parking fees based on number plate information and parking duration. The presented method in this paper was tested in a modelled environment and yielded more acceptable performance (accuracy 94.28%) with very little use of hardware resources to keep the system cost as low as possible.

Keywords: Image Processing, Parking Slot Detection, Optical Character Recognition (OCR), MATLAB

I. INTRODUCTION

Due to the growth of vehicle production and individual usage of vehicles, people spend a tremendous amount of time and effort finding a parking space in a vehicle parking. Even after finding a parking space, some may occupy it before reaching it (Dutta, Bhattacharjee and Gupta 2021). Therefore, we require a huge parking space with proper management. Presently, most existing vehicle parks do not have systematic monitoring and management. Most of them are manually managed with little effect. The majority of the parking system is based on the technique used to determine whether or not a vehicle is parked in the space. This technique could be as simple as an ultrasonic sensor or as complex as cloud-based solutions. The time spent searching for available parking spaces is the most significant concern in the car park (Mufassirin and Naleer 2017). Drivers will circle the parking lot until they locate an open spot. This problem is most common in urban areas and supermarkets, where the number of motor vehicles exceeds the number of parking places available (Ding, X. and Yang 2019). Parking slots

management should be responsible for informing the availability and location of parking spaces at the entrance. If the status of the parking slots is shown at the entrance, it would be very convenient for the drivers to locate and park their vehicles in an appropriate place.

However, manually managing such a parking space system necessitates a large number of people (Moranduzzo and Melgani 2014). As a result, numerous systems have used unsupervised parking slots detection to ensure smooth traffic at vehicle parking zones by measuring the number of parking spaces, identifying their position, and tracking changes in space status over time (Karunamoorthy, Suresh and Jaya 2015). In recent years, various researchers have proposed many methods for improving parking slot detection systems, such as ultrasonic sensors, IR sensors, and magnetic sensors (Karunamoorthy, Suresh and Jaya 2015). Magnetic sensors have recently been suggested for parking space occupancy detection. However, these methods are affected by

adjacent interference problems, i.e. the magnetic signal is easily interfered with by the vehicles parking in adjacent spaces (Dong, Zhang & J Chen 2019). A parking management system with image processing technology provides the latest and innovative solution for temporary parking places: where no approach is used for parking a car, reducing the hustle at a rushed time, helping to park and manage properly and efficiently (Waqas *et al.*, 2021).

The proposed system in this paper is based on image processing and Optical Character Recognition (OCR) which consists of three subsystems working simultaneously to ensure security and integrity. In this research, a camera is used as a sensor for video image detection. This camera is used to capture images at the entrance and the parking slot. These images are used to detect the parking space and vehicle identity. The image captured from the entrance identifies the number plate and the type of vehicle. The image acquired from the parking slot area detects the free parking space and counts the total number of vehicles parked in the area. Based on this information, the vehicles are directed to appropriate parking spaces. MATLAB is used as a software development tool in this research to implement and test the system.

The rest of this paper is structured as follows. Section 2 describes the existing studies and motivation. Section 3, it is presented the proposed system and objective. The methodology is presented in Section 4. Section 5 describes the results and discussion, and we conclude this paper in Section 6.

II. EXISTING WORKS

The industrialisation and enhanced lifestyle of people accelerated the advancement in automobile technology. Thus, many people started to use their own vehicles for travelling. On the other hand, these advancements have become hard at times, requiring a vast number of parking spaces in busy cities and developed organisations (Juneja, Kochar and Dhiman 2018). Various technologies are used in vehicle tracking, identification, and related fields (Maalik and Pirapuraj, 2021) (Razeeth, Kariapper and Nawaz, 2021). Moranduzzo and Melgani (2014) proposed a technique for automatically detecting and counting the vehicle in uncrewed aerial vehicle (UAV) images. SVM is used as a classifier for detecting and counting cars.

Karunamoorthy, Suresh and Jaya (2015) suggested a parking space detection and vehicle classification system based on image processing. Image segmentation and area calculation were used to detect the parking space and direct the vehicle towards it, while feature extraction and Artificial Neural Networks (ANN) were employed for counting and classifying the vehicle.

There are many systems proposed and implemented for automated parking systems to solve parking problems based on magnetic, ultrasonic, and IR sensors (Mithari, Vaze, and Sanamdikar, 2014) (Kianpisheh, Mustaffa, Limtrairut and Keikhosrokiani 2012). When we looked into those systems, we discovered that they required a lot of hardware, which increased the cost and required much maintenance. In such systems, the possibilities of failure and false-positive outcomes were high. Furthermore, we discovered that vehicle tracking was impossible to implement with these systems because it would have necessitated the use of other technology.

Waqas *et al.* (2021) suggested a method for detecting and recognising vacant parking spaces in real time. The camera is mounted on the rooftop of a neighbouring building or a supporting pole at an angle that allows it to cover the entire parking lot. Then obtained image will be sent to a processing module, which is used to detect the cars within the region of interest (ROI) using a Neural Network. The parking space detection module generates virtual lines for parking, which will be visible to the user on an app assisting in vehicle parking. Overall management will be done using a mobile app.

Koushika *et al.* (2021) proposed an automated car parking system design that would decrease human control. Furthermore, the model has a user interface that directs users to available parking spaces. The car parking system counts how many cars are parked and how many idle spaces there are. Rather than using an electrical sensor, image processing was employed to detect the presence of automobiles and the number of available parking spaces. The current image of the parking space with cars is subtracted from an empty image of the parking space. As a result, the number of unfilled slots is calculated. The data will be sent from the server in response to the user's request via the user interface application. Arun, Karthick, Selvakumarasamy and James (2021) propose a

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cloud-based system to improve parking vacant identification.

Therefore, we developed a single technology solution for our complete system using image processing techniques. Some existing works were done using image processing. However, those methods, such as edge detection with boundaries condition and point detection with canny operator methods, were more complex (Al-Kharusi & Al-Bahadly, 2014) and required improvement.

III. PROPOSED SYSTEM

Objectives:

- The main objective of this research is to develop and implement a fully automated parking space detection system which uses the camera video frames as input for processing.

To implement unsupervised parking slot detection for counting the number of parking spaces, identifying the location, vehicle number plate recognition and monitoring the changes in space status over time.

The proposed framework comprises three subsystems which are working at the same time. The first subsystem, which is located at the entrance to the parking space, consists of a camera that records the picture of the car number plate and uses the OCR technique to keep a log file of the vehicle registration numbers. This log file can also be used to collect parking fees electronically. The second subsystem comprises a camera in the parking slot that monitors and broadcasts real-time availability of parking slot information to the administrator and a display near the entry through a Graphical User Interface (GUI). The customer is directed to the nearest available parking spot by a
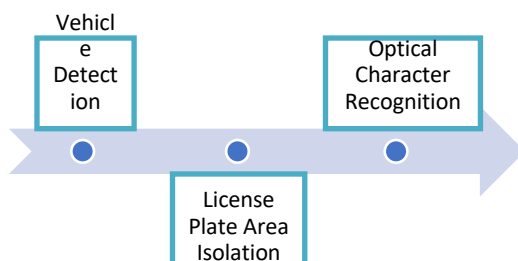
Figure 1. License Plate Recognise Layers

display at the door. The third subsystem is a back-end system that maintains a log and relates the parking slot to the car registration number, as well as the date and time stamp. It allows the user to

locate his/ her vehicle's parking place from any location using the vehicle's registration number. However, in our system, we adopted a more straightforward technique using a point detection method, in which only parking spots are identified and processed; our system also has the capability of identifying the vehicle, which is a novel feature in an automated parking system. In addition, our system captures photographs of vehicle number plates, processes them to extract vehicle registration numbers using the Optical Character Recognition (OCR) approach, and keeps a log file for vehicle tracking and finding.

IV. METHODOLOGY

A. Methodology for Vehicle Number Plate Recognition

Firstly, the vehicle image was captured using a video/ CCTV camera. Then, the system extracted the number plate of the vehicle alone for the purpose of character segmentation. It was accomplished by combining a morphological procedure sensitive to specific shapes in the input image with an appropriate threshold setting for locating the number plate. The extricated number plate was then resized, and the direction was balanced for a simple procedure. Afterwards, character segmentation was done so as to isolate the character from the background. In general, the background was white or yellow with black letters. The resultant image was converted into a grayscale image. Finally, the optical character recognition (OCR) technique was used to identify the individual alphanumeric characters on the number plate. The proposed method for number plate recognition consists of three main tasks, as shown in Figure 1.

1) Vehicle Detection.

Vehicle image detection consists of the following sub-tasks.

  i. *Vehicle image captured by the camera*

  The image of the vehicle is captured using a camera, and it should be taken from a fixed angle parallel to the horizon. Usually, it should be in RGB (Red, Green and Blue) colour model. Figure 2 shows an original vehicle image captured by the camera.

Figure 2. Original Vehicle Image Captured by Camera

Figure 4. Dilated Image of the Plate

Figure 4. Eroded Image of Plate

ii. Pre-process image

At this stage, images are taken from different backgrounds and lighting conditions to prevent low quality and contrast. Image pre-processing is normally done through image filtering. The captured images are resized into (1024 X 768) resolution. The use of pre-processing enhances the processing speed and improves the contrast of the image.

iii. Identify moving vehicle

In this step, vehicles will be identified using the background subtraction technique.

2) License Plate Area Isolation.
i. Convert into Gray Image

Converting grey images helps to reduce the noise of the image to some degree, and also it makes the processing of the images simpler.

ii. Dilation of an Image

Dilation occurs after Erosion, and it is proceeded to eliminate noise in the black-and-white image. When the complicated image erodes, the extension replaces the displaced image, and the image's primary components have been improved.

iii. Horizontal & Vertical edge processing

The dilated pictures are then passed through a variety of processing models for further analysis at this point. Vertical edge processing and horizontal edge processing are the two main types of edge processing. Both vertical and horizontal edge processing has histograms. Two RAMs are used to store the addition of the pixel values horizontally and vertically.

iv. Passing histograms through low pass filter

Each histogram value should be averaged in this step, considering the values on both the right and left sides. This phase is also completed for both horizontal and vertical histograms. Filter off any regions that you do not even wish to see. The undesired areas are identified by low histogram values in the rows and columns, showing very tiny variations between adjacent pixels.

Grayscale image

Sobel vertical edge detection
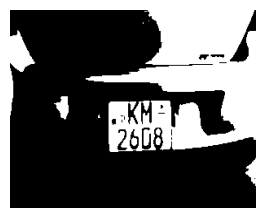
Effect of threshold

Figure 5. Steps of Horizontal & Vertical Edge Processing

v. Segmentation of region of interest

This step is used to find all the areas of the high-probability image with a license plate. In the previous step, dynamic filters detected all undesirable rows and columns. As a result, these likely candidate zones are formed by additional columns and rows.

vi. Extract license plate area

Of the selected regions, the region with the highest histogram value is regarded as the most conventional choice for the license plate. This is the case because the license plate region is typically thought to have few letters on a translucent cloudy background. To locate a common region with the highest horizontal and vertical histogram values, all of the regions are processed row-by-row and column-by-column. It is thought to be the area with the most excellent chance of containing a license plate.

3) Optical Character Recognition

Optical character recognition is the final layer of the number plate recognition process. It is the process of identifying and recognising characters in a picture and converting them to intelligible text in ASCII (American Standard Code for Information Interchange) or another machine-editable format.

i. Resizing image

Compared to the whole vehicle, the license plate area is too small. As a result, the cropped license plate image may be too small, and the image size may vary depending on the vehicle type.

Isolated
Number Plate

Cropped Image

Figure 6. Resizing Process of Number Plate Image

ii. Character Segmentation
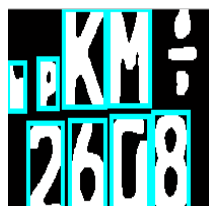
Figure 7. Character Segmented Image

Character segmentation is a kind of technique. It decomposes the image of lines or words into individual characters.

iii. Template matching.

Template matching is also known as matrix matching, and it is one of the most common classification methods. The input photos from the previous step are split for matrix matching, and the template with the highest similarity is regarded as the match. Once a certain template has been
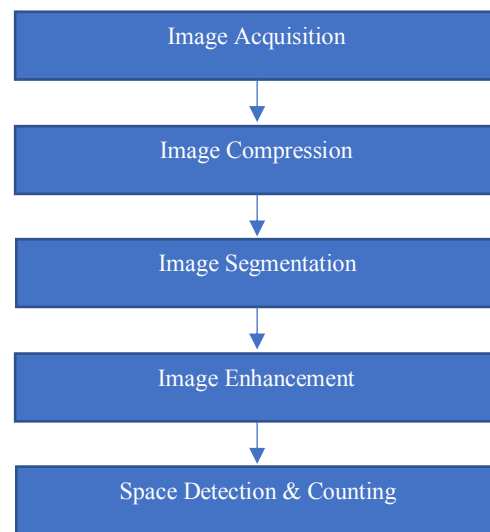
Figure 8. Schematic Illustration of the Parking Space Detection Module

identified, its centre is used to calculate the parameters.

B. Methodology for Parking Space Detection

The proposed method for parking space detection consists of five interrelated modules. The first module corresponds to image acquisition, which automatically captures the parking space's image and the vehicle entering it using video cameras and storing it in the system. These images can be treated as an input for the image processing element in MATLAB. The second module is responsible for image compression. The size of the acquired images through the image acquisition module is large and requires a tremendous amount of storage which will be challenging to process. Therefore, these images are compressed and stored to improve processing speed.

The third module is related to image segmentation, which distinguishes the vehicle objects from the background in order to increase the contrast. The output of this module is a matrix of black-and-

white images. The fourth module is responsible for image enhancement from which the noise is removed from the segmented image using morphology operations such as Dilation and Erosion. The last module corresponds to image detection, which is used to decide the object in each parking slot and display the occupied and unoccupied spaces. Figure 8 shows the schematic illustration overall.

The initial stage of the system is image acquisition, where the image is obtained. Capturing and storing digital images from video cameras is part of this module. After that,

a processing unit is linked to the high-definition camera that was used to capture digital photos.

The software is in real-time mode. The camera is placed inside the view of parking lots, capturing a constant scene. The camera's height must be sufficient to provide a good, unobstructed top view of the parking lots. The image obtained by the camera is shown in Figure 9.

After the image acquisition, the input RGB image was converted to a binary image using grey thresh (as shown in Figure. 10). Then perform the image segmentation, which separates the objects from the background by Dilation and Erosion and differentiates the pixels having nearby values for improving the contrast. After performing image enhancement which removes noise by using morphology functions. Then Classify available points and store them in a matrix. The matrix has the centre points of each parking space in coordinates. The coordinates are obtained using Skeletonization.

followed by Branching. The last process is image detection, which determines the object at each parking slot. The tested prototype GUI is given in Figure 11.

V. RESULTS AND DISCUSSION

The vehicle parking space detection system with parking lots status reporting and guidance parking system based on image processing was designed and tested in the simulated environment successfully. Identifying the image object of the vehicle makes the process of detecting the image as a reference more efficient than the sensor base system. To reduce the cost of sensors and the bother of wiring, the system was created utilising an integrated image processing technique. The
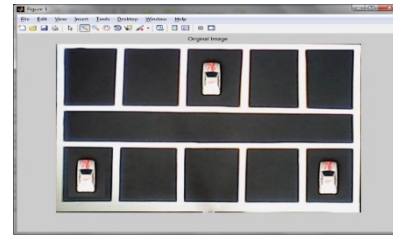
Figure 9: Original Image
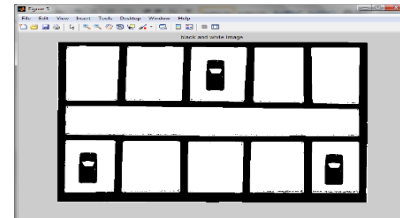
Figure 10: Binary Image
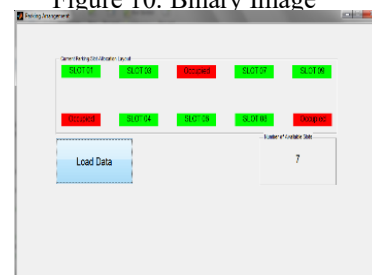
Figure 11: The Tested

performance of our proposed system is listed in Table 1.

Table 1. Performance matrix of our proposed system

Entered Vehicle	Correctly identified number plates	Incorrectly identified number plates	Accuracy	Average time taken
140	132	8	94.28	9 seconds

The performances of a few similar works were compared based on their reported results. Table 2 shows the comparison results.

Table 2: Comparison of our results with other methods

Source	Tested vehicles	Accuracy percentage
Rashid *et al*. (2012)	80	90.00
Ding and Yang (2019)	2315	91.60
Prasetyo, Wibowo and Suhendri (2021)	-	80.00
Our Method (2022)	140	94.28

The current limitation of this work is the processing time. The vehicle should wait at least 8

seconds at the entrance to get the number plate details using the camera. It may result in a long queue during a busy time.

VI. CONCLUSION

The main aim of this study to implement unsupervised parking slots detection for counting the number of parking spaces, identifying the location, vehicle number plate recognition and monitoring the changes in space status over time using video surveillance cameras. The Vehicle Parking Space Detection system with parking lots status reporting and guidance parking system based on image processing was designed and tested in the simulated environment successfully. Identifying the image object of the vehicle makes the process of detecting the image as a reference more efficient than the sensor base system. The proposed parking system integrated an image processing approach to reduce the cost of sensor and wiring issues. Number plate recognition and electronic billing system are in progress for future integration. The detection performance of the vehicle and available parking space is within an acceptable range. We intended to improve the processing time of our method by optimising the method further.

AUTHOR CONTRIBUTIONS

Both authors, M.M. Mohamed Asjath and M.M. Mohamed Mufassirin contributed equally to this work.

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IoT Based Smart Vehicle Parking System for Urban Area in Sri Lanka

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Abstract

The use of vehicles is essential to the human lifestyle. Due to the increase in the number of vehicles, the shortage of parking spaces in urban areas is increasing. Although there are many ways to solve these problems, such problems still exist. This research aims to build a smart parking system to overcome the issue of parking space availability using Internet of Things (IoT) technology. This proposed smart parking system is based on Arduino, Firebase cloud application, and android mobile application. The parking area is built and simulated with Arduino components. Further, this system is connected with an android mobile application for users. This smart parking system gives an opportunity for drivers to park their vehicles by eliminating waiting time and excess money. Drivers can see parking slot availability in the parking area using their mobile. Also, the mobile application displays parking times. On the other hand, the parking area is automated, and human interaction is not required. The gate automatically opens and closes when a vehicle enters the parking entry and exit area. This system provides real-time processes and information about the parking slot in the android application. Also, the parking owner can control the main gate remotely. This project leads to reducing fuel consumption. Also, it resolves the problem of growing traffic congestion and could reduce the human time of finding parking slots.

Keywords: Internet of Thing, Arduino, Firebase cloud, Realtime process, Android

I. INTRODUCTION

These days, almost everyone has used a personal vehicle for their transportation and it has become a basic need for humans. On that, it has been statically proven that the usage of the vehicle is increasing rapidly yearly. Due to this, there is the biggest problem in urban areas to find the parking place, especially in malls, stations, airports, schools and hospitals etc. The workers of the above public and private institutions have faced more challenges like a time consuming, trafficking and additional fuel consumption.

The Internet of Things (IoT) concept explains things with identity communication devices. The IoT devices could be tracked, controlled and monitored using remote computers or mobile phones connected with the internet. Two prominent worlds include in the IoT are "internet" and "things". Internet means a network of devices connected via global such as servers, computers, tablets and mobiles using an internationally accepted protocol. Thing is a term used to refer to a physical object which is connected through the internet.

The microcontroller is the main element used to control IoT devices and sensors. The specific software application is used to control and monitor

the IoT devices and can use an android application to access via mobile phones.

This research mainly focuses on IoT technology and android development. The author built a simulation system that was used to evaluate the performance of the system. The Internet of Things (IoT) is a new paradigm that allows electronic gadgets and sensors to communicate with each other over the internet to make human lives easier. Smart devices and the Internet are used to provide new solutions to a variety of challenges and issues faced by businesses, governments, and public/private organizations around the world (Kumar et al.,2019).

Arduino is an open-source platform used for building IoT-based electronics projects. Arduino is made up of a physical programmable circuit board (also known as a microcontroller) and software known as an IDE (Integrated Development Environment), which runs on a computer and is used to write and upload computer code to the physical board. This research has used the Arduino NodeMCU ESP8266 board as the main controller in the parking area (Louis et al.,2018). Android is an open-source Linux-based mobile operating system developed by Google. It

is used primarily for touchscreen devices, like mobile phones and tablets. Its design allows users to intuitively interact with mobile devices, with finger movements that mirror common movements, such as swiping and tapping.

The Firebase cloud application is used for this research work, and it is a Backend-as-a-Service (Baas). Firebase offers several tools and services to assist developers in creating high-quality applications and expanding their users. It is built on Google's infrastructure. Firebase is categorized under the NoSQL database program, which stores data in JSON-like documents. Firebase optimizes the applications with a number of services like Authentication, Real-time Database, Analytics, Storage, Hosting, Testing, and Monitoring (Moroney et al., 2017). This research has used the Firebase cloud application to establish the data transmission between the Arduino board and the Android mobile application.

There is a shortage of vehicle parking spaces, especially in urban areas, due to factors such as urbanization, population growth, and increased vehicle users. Particularly, Cities like Colombo and Kandy in Sri Lanka face these issues. Even, Traditional parking systems need human interaction to control their gates manual, and drivers are facing more difficulty in finding the availability of parking slots for their purpose.

Therefore, this study proposes an automated smart parking system for vehicle users in urban areas. This proposed system is based on IoT technology controlled by an Android application called Smart Parking System. Smart parking system gives details about available parking slots to drivers. Besides, it can control the gates automatically using sensors. This mobile application is user-friendly. Hence, users can access and understand parking details easily. Additionally, a smart parking system can facilitate the user to make payments through online. So, it saves time and expenses and effective uses of parking space in an urban area.

The objective of this study is to build a smart parking system that overcomes the problem of parking space availability of vehicle users in the urban area. The IoT-based smart parking system gives a user-friendly interface for the application user.

The scope of the study mainly includes Arduino, Firebase cloud application, wireless network and mobile application development.

- This research is mainly based on IoT technology. The Arduino platform plays a major role in IoT projects.
- Arduino NodeMCU ESP8266 board to build a connection in the parking area and as well as used Arduino IDE for programming codes into the Arduino board. Th s Arduino board helps to send information to a mobile app through the firebase cloud using Wi-Fi.
- Used IR sensors, servo motors and RTC modules for the operation of the parking area. IR sensor provided data to Arduino board, when the vehicle was detected or not. Se vo motor operated the parking gates and the RTC module provided time information.
- Firebase real-time database feature used to create data communication between both the NodeMCU board and the Android mobile application.
- Android Studio software is used to develop an Android mobile app. Android Studio is the official IDE for android application development.

II. LITERATURE REVIEW

Problems such as urbanization and population expansion are common in all countries. Scholar around the world proposes IoT technology to solve such kind of issue from a different angle. IoT plays many roles in people's lifestyle changes such as smart city projects, automobiles, agriculture, transportation, public security, environment monitoring etc (Alan T.,2021). This section describes and illustrates a few recent research articles more related to this research.

IoT-based cloud integrated smart parking system was presented by Khanna et al., the Smart Parking system consists of an on-site deployment of an IoT module that is used to monitor and signalize the state of availability of each single parking space. A mobile application is used to check the availability of parking slots and confirm the slot accordingly. This presents a high-level view of the smart system architecture. The working model is explained with a use case model that proves the correctness of the proposed model (Khanna et al., 2016). Gulam et al., proposed a framework based on a deep long short-term memory network to predict the availability of parking space. The authors use IoT, cloud and sensor networks to produce the Birmingham parking sensors dataset data. The experimental results showed the superiority of the proposed model over the state-of-the-art prediction models (Gulam et al., 2020). Luque-Vega et al., presented a novel sensing

solution that is the cornerstone of the smart parking system for vehicles. The system is named as SPIN-V. The SPIN-V is built with a small single-board computer, distance sensor, camera, LED indicator, buzzer, and battery and is devoted to obtaining the status of a parking space (Luque-Vega et al., 2020). Vehicular Crowdsourcing for Congestion Support in Smart Cities (VACCS) proposed by Olariu, Stephan. VACCS provide benefits to Smart City and driving the public to use resource efficiently. Timing planes respond to current traffic conditions, overall traffic flow will improve, fume emissions will be reduced and economic impact will mitigate. VACCS system work efficient in certain conditions (Olariu, Stephan, 2021). Ashok et al., proposed a Smart Parking Energy Management solution for a structured environment. The authors presented an IoT technology to mold with advanced Honeywell

sensors and controllers to obtain a systematic parking system for drivers. Unused vehicle parking slots are indicated using emitting lights and users are guided to an empty parking slot, thus eliminating the users' searching time for a parking slot. The entire system that is fully automated reduces workforce involvement and improves the lighting aesthetics of the parking area. This paper aims to improve the time value of the user and the convenience of the parking system (Ashok D, et al., 2020)

III. METHODOLOGY

Research methodology is the specific procedures or techniques used to achieve the research objectives. This section explains how the parking simulation systems are built, software and hardware requirements, data flow diagram, etc.
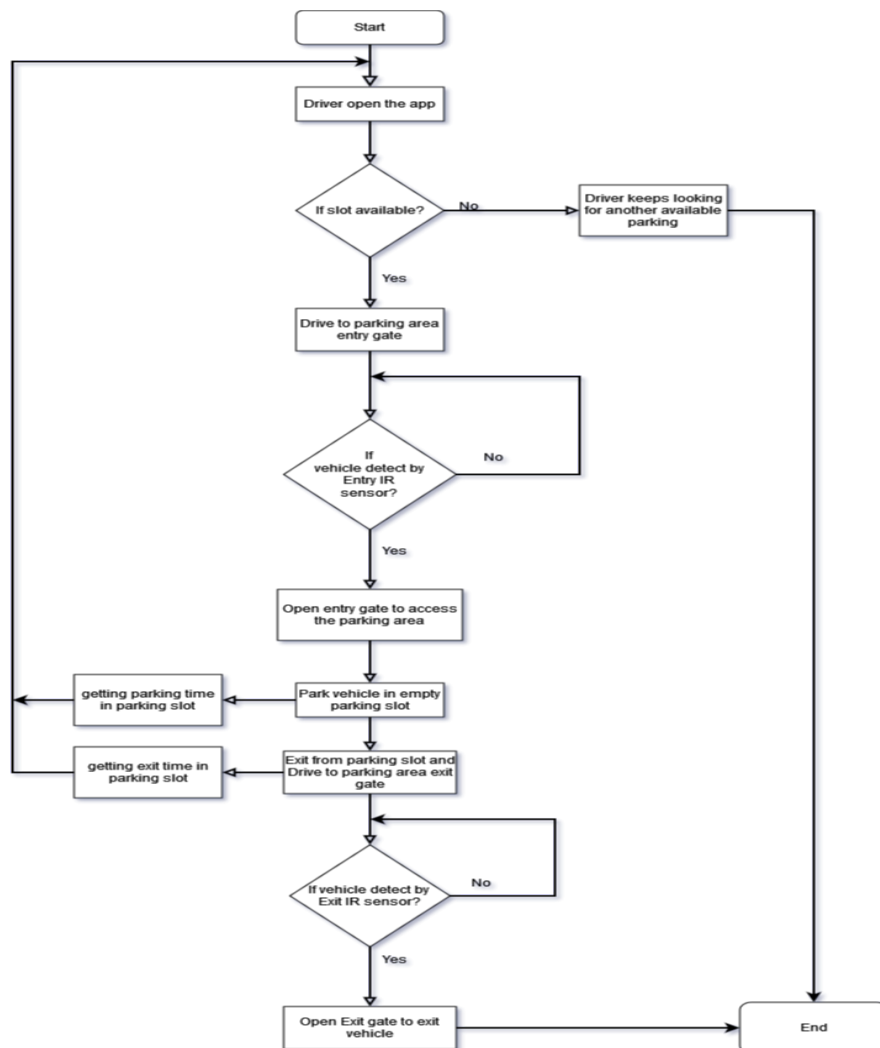
Figure 9: Data flow diagram of the smart parking system

A. Smart parking system overview

Figure 1 describes the data flow diagram of the parking simulation system. The parking simulation system consists hardware system controlled by an Arduino microcontroller and android application software for controlling the hardware devices. The Firebase cloud is always connected with both the Arduino system and the android application. Figures 2 and 3 explain the top and front views of the simulation system.
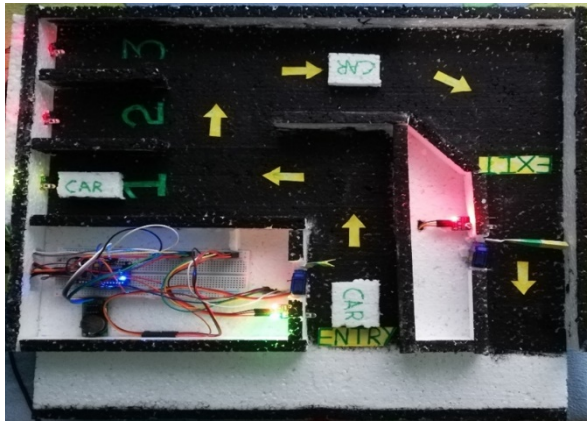
Figure 2: Top view of parking simulation
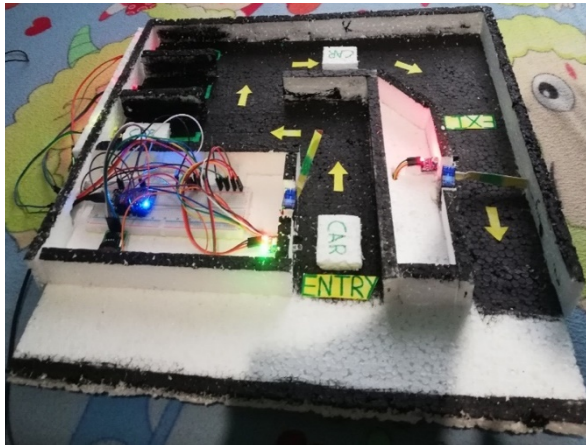
Figure 3: Front view of parking simulation

Whenever the driver wants to park his vehicle, the driver should access the android application. While the driver searches for a parking slot, then the system notifies the availability of the parking slot. If the parking slot is available, then the driver will move to the parking area. If the vehicle comes near the entry gate of the parking area, the IR sensor detects the vehicle near the gate and sends a signal to the Arduino microcontroller. The Arduino microcontroller sends instructions to the servo motors to open the entry gate. Then the vehicle moves to the parking slot, and the microcontroller sends the parking information such as time and date to the android application via the Firebase cloud. The same procedures will

follow when the vehicle exit from the parking slot. All these information is sent to the user's mobile phone.

The researchers are building a simulation system to evaluate the research objectives. This system is built using the following electronic hardware item and software.

- Hardware
  - NodeMCU ESP8266 Arduino Wi-Fi board
  - Five IR sensors
  - Two Servo motors
  - DS1302 RTC module
- Software
  - Firebase application
  - Android Studio
  - Arduino IDE

1) NodeMCU ESP8266

The Arduino platform plays a major role in IoT projects. There are many kinds of Arduino microcontrollers available for different usage, but in this project, the researchers used NodeMCU ESP8266 Arduino Board because it enables the Wi-Fi module.
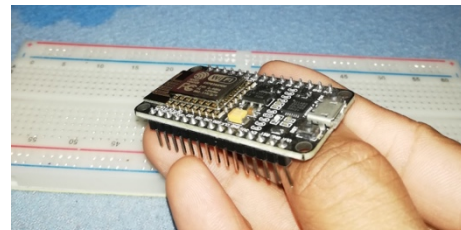
Figure 4: NodeMCU ESP8266

2) IR sensor (infrared sensor)

The IR sensor is a type of electronic component that emits or detects IR radiation to detect specific characteristics in its surroundings. An IR sensor can detect motion as well as measure the heat of an object. These sensors only measure infrared radiation rather than emitting it, which is known as a passive IR sensor. IR sensor detection range is 2cm – 30cm, and it can be adjustable using a potentiometer. Vacuum, atmosphere and optical fibers media are used for infrared transmission.

This project used two IR sensors to send data to the entry and exit gates. Another 3 IR sensors are used to detect if the parking slot is available or occupied and send the data to NodeMCU. The IR sensors placed in parking slots identify a car has or is not in their slots. After that, the sensor sends data to NodeMCU. NodeMCU program for

sending those data to firebase database. This database stores those data & sends it to the android app for the view.

Figure 5: IR Sensor overview

Figure 6: Servo Motor

3) *Servo motor*

Figure 7: Servo Motor Pin

A servo motor is a linear actuator or rotary actuator that allows for precise control of linear or angular position, acceleration, and velocity. If we want to rotate an object at some specific angles or distance, then can use a servo motor. A servo motor is made up of a control circuit that provides feedback on the current position of the motor shaft; this feedback enables servo motors to rotate with great precision.

In this project, two servo motors are used as an entry and exit gate, so whenever the IR sensor detects a car, the servo motor automatically rotates and returns to its initial position after a delay.
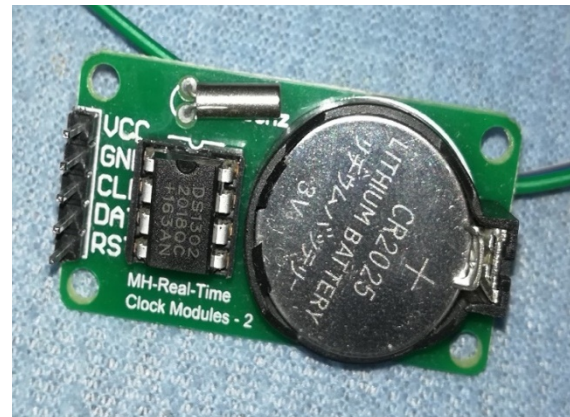
4) *RTC module*

Figure 8: DS1302 RTC Module

RTC (Real Time Clock) modules are simply TIME and DATE remembering systems with a battery setup that keeps the module running in the absence of external power. This keeps the TIME and DATE up-to-date. Therefore, this project used RTC (DS1302) module because it keeps track of the real-time using an internal clock mechanism.

5) *Firebase application*

Firebase is a mobile application development platform from Google with powerful features for developing, handling, and enhancing applications. Firebase has three main services a real-time database, user authentication, and hosting. This project used Firebase Real-time Database and Firebase authentication for Mobile applications. This project involved with Firebase's real-time database to get parking details from the NodeMCU board and store that data in the database. Besides, Firebase sends that parking data to the android mobile application to view parking availability details for users.

6) *Android Studio*

Android Studio is an IDE used for developing android apps, which is officially supported by Google. It is based on IntelliJ IDEA which offers a powerful code editor and developer tools. It is an integrated development environment for Google's Android platform.

Android Studio supports application development within the Android operating system by utilizing a Gradle-based build system, emulator, code templates, and GitHub integration. Every Android

Studio project has one or more modalities with source code and resource files. Library modules,

7) Android mobile application

displays the Admin login and the User login. The owner of the parking may only use Admin login because, it has an authentication process. Admin login allows to view parking availability details, the number of vehicles in the parking area. The Admin can control parking entry and exit gates using this application. User login can access drivers without authentication. The user tab includes parking availability and parked time details. If parking is available, the driver can drive the vehicle to the parking area. This application was developed by using java and XML files. Java language is used to execute the running process, and XML language is used to design the app (Nikolov et al., 2019) (Moroney et al., 2017).

Figure 10:Data flow diagram of Android application

Figure 9 describes the data flow of the Android mobile application. The play store allows installing this application. The application

Figure 10: App Icon

IV. RESULTS AND DISCUSSION

The demand for parking systems is increasing because of the increasing number of vehicles in busy areas. On that design, many parking systems with new technology. This system allows real-time access to parking availability. This smart parking system provides a solution for parking in urban areas. Using this system, people can reduce the time of finding parking slots, reduce fuel consumption in vehicles and reduce traffic on the road.
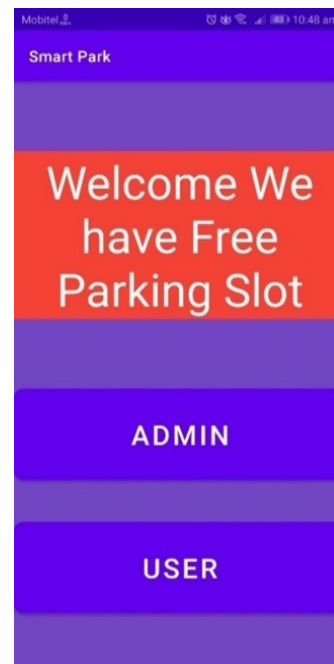
Figure 11: Main User Interface Image
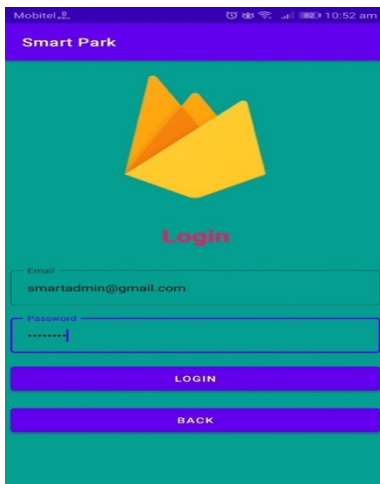
Figure 12: Admin Login Interface
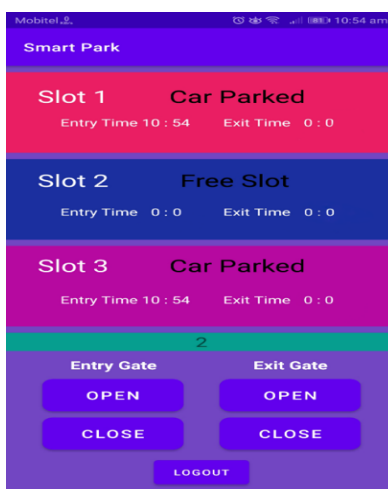
Figure 13: Admin User

Figure 14: Driver Interface Image

Figure 11 shows the main interface of the system. Admin can login by using the 'ADMIN' button, and it navigates to the login page which is shown in figure 12. Admin needs to login using his username & password. Figure 13 shows the user

interface of the admin. This interface displays the number of slots in the parking area as well as the availability of parking slots. And also displays parking entry and exit times. Other than that, the admin can control the open and closed gate using the console button displayed on the penal. Admin can logout using the logout button available at the bottom.

Figure 14 shows the driver's interface. Drivers can access the driver interface using the 'USER' button in the main interface. The driver can notify parking slot availability and available slot numbers and place. For this driver interface no need to login, which means anybody can view the interface. In future, we can build an interface for login, which limit access, and the driver can book prior to parking the vehicle. But, at the movement, this system provides open access for all who can access the parking details if they have only an android app. The parking space owner can control the parking area remotely. Here the sensor modules are used to identify the vehicles. Also, sensors count the number of vehicles in the parking area. Servo motors are used to control the open and closed gates of the parking. Other modules are used to record the entry and exit times of the vehicles. We used this simulation set-up to test our objectives and design and evaluate the number of random test cases. The system shows 90% good results. The results of the project could reduce the fuel consumption of the vehicle which is used for searching for parking and could reduce traffic on the road. Also, could reduce the human time of finding parking slots.

V. CONCLUSION

The concept of a smart city has always been a dream for humans. Over the past few years, the smart city concept has become a reality with great progress. The development of the Internet of Things and cloud technology has provided a new opportunity for designing smart cities.

Various modules are involved in this IoT-based parking system to maintain this system such as NodeMCU board, IR sensors, servo motors, and RTC module. Also included an android app. This system provides real-time processes and information on the parking slot in the android app. This project enhances the performance of saving time and fuel. Also, it resolves the problem of growing traffic congestion.

As for future work, the users can book a parking space from a remote location using their mobile.

Also, can send parking fee details for mobile, and users can pay the parking fee online.

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Understanding the Identity of a COVID-19 Suspect or Victim through the use of Google Glass

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Abstract

Coronavirus disease (COVID-19) is a coronavirus-borne ailment that has just been discovered. In most cases, the infection will cause mild to moderate breathing difficulties. As time goes on, the COVID-19 pandemic continues to get stronger. A wide range of disciplines must therefore provide reliable solutions to the problem of risk mitigation. A useful technology is gaining worldwide acceptance because of the rapid growth of Google Glass. An AR-enabled Google Glass is envisioned in this idea, which details the overall design of the device and key components. It was investigated whether a sensor might be used to monitor a person's temperature from afar. Google Glass receives the temperature reading from the sensor. The GPS coordinates of the wearer will be sent to the cloud if the measured value is higher than the national average. There have been a lot of past studies done with Google Glass and other smart glasses for a range of different applications. We think that if the idea is used in real-time, the death rate can be significantly reduced while maintaining social distance, and many infected patients can be found.

Keywords: Google Glass, Coronavirus, Firestore, IR Thermal Sensor, COVID 19

I. INTRODUCTION

Coronavirus disease (COVID-19) (Organization and others, 2020b, 2020a; Singhal, 2020) is a newly found coronavirus-borne infection. Most patients who contract the COVID-19 virus will suffer mild to moderate breathing problems and recover without specific treatment. Aged and adults with underlying medical conditions such as cardiovascular disease, diabetes, chronic lung disease, or cancer are at an increased risk of developing severe medical conditions. The most effective method of preventing and slowing transmission is understanding the COVID-19 virus, its sickness, and how it spreads. Prevent infection in ourselves and others by frequently washing hands or using an alcohol-based rub and refraining from touching the face.

Globally, the COVID-19 pandemic has claimed many lives and posed unexpected threats to public health, food systems, and workplace safety. With the pandemic, tens of millions of people are poor, and the number of undernourished people could rise to 132 million by the end of the year. Nearly half of the world's 3.3 billion workers face unemployment. Informal workers are highly vulnerable, as they lack in social protection, adequate health care, and productive assets. The pandemic has destroyed sources of livelihood for millions. Hunger and malnutrition threaten millions worldwide, especially in low-income nations and among the most marginalized communities such as local producers and native tribes. And yet, millions of agricultural workers – both salaried and self-employed – are routinely exploited, abused, and malnourished while feeding the world. In addition to transportation, work, and living hazards, migrant agricultural workers struggle to access government assistance. This crisis touches on food security, public health, employment and labor issues, particularly worker health and safety (Paul et al., 2021). To address the crisis' human dimension, all industries must adhere to safe and healthy work practices, and labor rights must be protected. Immediate and purposeful action to save lives and livelihoods should include universal health coverage and income support for the poorest. COVID-19's effects are most severe in countries facing humanitarian crises. The rapid pandemic response is critical to getting humanitarian and recovery aid to those in need. Global solidarity and support are urgently required, especially for the most vulnerable in the emerging and developing world. We can only overcome the pandemic's intertwined health, social, and economic consequences by working together, avoiding a prolonged humanitarian and food security catastrophe that could undo previous development gains. We are committed to pooling our expertise and experience to help countries respond to crises and achieve

SDGs. We need long-term, sustainable solutions for the health and agro-food sectors. Achieving universal social protection, safe migration pathways, and formalizing the informal economy should be prioritized over addressing the underlying food security and malnutrition issues.

Many strategies and tactics have been planned, organized, and executed by the globe to avoid and demolish the pandemic. Still, it is a nightmare for to whole scientists and the globe. As modern solutions for the epidemic, a variety of therapies, including vaccinations, are being offered. Nonetheless, those are only temporary fixes, and the world has realized that the Covid19 is a permanent problem. As a result, instead of focusing on a temporary remedy, the world focuses on a long-term solution to prevent the risk. The most valuable therapy for avoiding risk from the virus is perfectly utilizing technologies. The virus has defeated the essential solutions and grows stronger by the day. As a result, trustworthy avoidance solutions are required from a variety of fields.

The famous and highly impactable technologies of current trends are the Internet of Things (IoT), Artificial Intelligence (AI), Image Processing, Cloud Computing, Swarm Intelligence, Wireless Sensor Networks, Robotics, Deep Learning, Data Science and Mobile applications. These cutting-edge technologies are highly classified and deliver timely service. Those technologies are used in various fields, including health, agriculture, transportation, education, and libraries, and they achieve near-perfect accuracy.

In addition to those classified technologies, Google Glass is a growing, unexpected handy technology that most people of the globe like and accept. Nowadays, people do not like carrying an additional device in their hand; instead, they prefer easiness. Of course, google glass eliminates that problem and provides more solutions than a smart mobile device. Current statistics show that more than 21.15 million people have been using google glass since 2018 (Google Glass Usage, 2021). Which indirectly indicates the acceptability of google glass among people. This technology's flag is rising in almost every domain. Education, health, military, and supply chain are a few of those domains.

Though there are countable mechanisms available to identify and protect from covid infection, this paper critically proposes a concept to avoid the infection in advance by reading the temperature of the people coming in front. Google glass is being used for this purpose with significant modifications.

II. LITERATURE REVIEW

The software industry incorporates with the University College Cork (UCC), which developed a Covid-19 Remote Early Warning System (CREW) using digital thermometer sensor to monitor the body temperature of the front-line staff of the hospitals that further can work with wearable and IoT devices via cloud computing (Cusack et al., 2020). Meanwhile, a review article summarized that the drone with the temperature sensors could identify and screen COVID-19 patients in any crowded places (Khan et al., 2021). Likewise, the DOHA international airport developed a Smart Screening Helmet (SSH) for their staff to identify passengers' temperature and COVID-19 affected travellers (Jay Singh, 2020). Similarly, in Malaysia, an intelligent AI helmet was developed using various sensors based on AI to detect human temperature in real-time (Al-Humairi et al., 2020). Likewise, research proposed a system to detect human temperature using a thermal infrared camera and send the details to the relevant authorities via a mobile app if a person's temperature is more than the typical case (Mohammed et al., 2020).

A wearable oura ring device was developed to identify COVID-19 affected people with various sensors build-in, which also used temperature fingerprint sensors to measure the body temperature (Poongodi et al., 2021).

A Japanese older man used a robot to avoid COVID-19 transmission from others that also used to measure the temperature of a human using infrared sensors (COCO LIU and CHAN, 202AD). Comparably, in China, Public Health Clinical Center (SPHCC) used a real-time patient monitoring system that used VivaLNK's temperature sensor to monitor COVID-19 patients (Dean Koh, 2020). Furthermore, China uses infrared temperature sensors installed in drones to monitor human temperature across the country to avoid human interaction in public places (Jaime Perez, 2020). In addition, they have upgraded their facial detection into a contactless temperature detection system to identify fever patients in crowded places (Pratik Jakhar, 2020). Similarly, in the US, dragonfly drones were used to identify COVID-19 affected people using various sensors such as temperature sensors and cough sensors (Cozzens, 2020). Likewise, the Italian government

implemented LoRa temperature detector devices to find the human temperature in real-time (David Maliniak, 2020).

A study proposed a framework to develop a smartphone app based on AI techniques, especially for the healthcare staff to identify COVID-19 symptoms via sensors, which included identifying human temperature (Maghdid et al., 2020). Similarly, research was proposed to reduce the false results in finding COVID-19 patients via temperature sensors using smart devices (Magesh et al., 2020).

A systematic review article mentioned that a biosensor was under the developing stage called 1AX with minimum cost that can help read and store the human temperature in real-time in terms of early detection of COVID-19 symptoms (Javaid et al., 2020)

S.No	Device/ Application	Thermal Detector	Technology used	LR
1	Covid-19 Remote Early Warning System (CREW)	digital thermometer sensor	Internet of Things (IoT), Cloud Computing	(Cusack *et al.*, 2020)
2	Pandemic drone	plasmonic sensor	Drone	(Khan *et al.*, 2021)
3	Smart Screening Helmet	infrared thermal imaging	Artificial Intelligent (AI), Augmented Reality (AR)	(Jay Singh, 2020)
4	Dual-functional plasmonic photothermal	plasmonic sensor	dual-functional plasmonic biosensor	(Qiu *et al.*, 2020)
5	Temi (Home Nursing robot)	Infrared sensor	AI, Google Voice	(COCO LIU and CHAN, 202AD)
6	Smart Helmet	Thermal infrared Camera	IoT, Global Positioning System (GPS), Arduino IDE	(Mohammed *et al.*, 2020)
7	Patient monitoring system	VivaLNK's temperature sensor	IoT, Bluetooth	(Dean Koh, 2020)
8	Smartphone app	Temperature fingerprint sensor	AI	(Maghdid *et al.*, 2020)
9	Biosensor	1AX	Wireless	(Javaid *et al.*, 2020)
10	Dragonfly	Any temperature sensor	Drone, Computer vision	(Cozzens, 2020)
11	Temperature auto-sensing robot	Thermal sensor	IoT, Wireless, AI	(Advantech, 2020)
12	Airborne infrared cameras	Infrared sensor	Drone	(Jaime Perez, 2020)
13	AI-enabled fever detection system	Thermal sensor	AI	(Pratik Jakhar, 2020)
14	LoRa temperature detection device	Infrared sensor	IoT, Wireless	(David Maliniak, 2020)
15	Temperature detection device	Infrared (IR) sensor	AI	(Magesh *et al.*, 2020)
16	Smart AI helmet	Adafruit Thermal (IR) Camera	AI, Raspberry Pi OS, Wireless	(Al-Humairi *et al.*, 2020)
17	OURA ring	Temperature fingerprint sensor	Machine Learning (ML)	(Poongodi *et al.*, 2021)

It was confirmed that the innovative materials with the sensor technologies could identify COVID-19 that can develop at a low cost (Erdem et al., 2021). Similarly, the efficiency and cost-effectiveness of Google glasses help increase their use in the medical sector (Dougherty and Badawy, 2017).

The authors discussed how wearable and robotics technologies could measure human temperature via different thermal sensors (Tavakoli, Carriere and Torabi, 2020). Likewise, another article proposed a system to detect significant symptoms of COVID-19 via sensor-enabled smartphones, including body temperature (Stojanović, Škraba and Lutovac, 2020).

Google Glass is a wearable device working on the Android operating system. It can be worked with the help of AR. It has built-in Wi-Fi, Bluetooth, audio, and video devices. Furthermore, it has a semitransparent screen. Also, it can implement machine learning and computer vision (Steele, 2019). In addition to that, it permits to implementation of sensors within it as it operates (Pennic, 2014).

A Technology expert strongly confirmed that the wearable devices demand increasing during the COVID-19 pandemic, especially Google glasses (Maffei, 2020). Furthermore, the TemPredict study was conducted to prove that the OURA ring with thermal sensors can monitor fever patients (Smarr et al., 2020). Further, A study pointed out that IoT-based smart glasses can be used to identify people with higher temperatures in crowded places (Nasajpour et al., 2020).

A study reported that A Google glass with Biosensors and actuators can be used to measure temperature in real-time via wireless transmission (Zhang et al., 2016). Similarly, China was developed AR glasses to measure human temperature (Emory Craig, 2020). Further, an analysis study supported that Google glass can be used in journalism (Ware, 2018). Likewise, it can be used as a personal assistant to deaf and visually impaired persons (Berger and Maly, 2019). Similarly, Google Glass was used in education and medicine, too (Dafoulas, Maia and Tsiakara, 2018), (Munusamy et al., 2020).

Meanwhile, it can be used during the pandemic as it has a remote access mechanism (Scales, 2020). Similarly, the same feature is available from the smart glass too (Proceedix, 2020); likewise, It was used for virtual ward round using telemedicine during the pandemic crisis (Market Insight, no date), (Martínez-Galdámez et al., 2021). Meanwhile, a study proposed a framework to estimate body temperature via infrared-installed smart glasses (Ruminski et al., 2016).

S.No	Technology used	To/ by	Device	Purpose	LR
1	Text-To-Speech	Blind and Deaf	Google Glass	Watch, Listen	(Berger and Maly, 2019)
2	Remote Access	Onsite Employees	Google glass, Smart Glass	Virtual Access or Monitoring	(Proceedix, 2020; Scales, 2020)
3	Augmented Reality	Doctors	Smart Glass	Virtual Monitoring	(Market Insight, no date),(Martínez-Galdámez et al., 2021)
4	Infrared Sensor	Anyone	Smart Glass	Temperature Measure	(Ruminski et al., 2016)
5	Bio Sensor	Anyone	Google Glass	Temperature Measure	(Zhang et al., 2016)
6	AR, Infrared sensor	Anyone	AR Glass	Temperature measure	(Emory Craig, 2020)

Research work pointed out that the thermal scanner is not recommended to diagnose COVID 19 patients since it can only detect the temperature more than fever temperature, and COVID-19 patients can have less temperature (Madurai and Pugazhendhi, 2020). The previous statement supported by (Surya and Teja, 2020). Furthermore, Google Glass has negative issues such as low battery endurance, data protection issues, and interruption during network problems (Muensterer et al., 2014)

III. METHODOLOGY

This section explains the overview of the system suggested as a concept in this paper and the architecture of Google Glass. The suggested system is based on modular architecture as it includes several modules of programs to handle the different tasks. Section 3.1 describes the architecture and the components of Google Glass, and section 3.2 explain the suggested system overview.

A. Architecture and Components of Google Glass
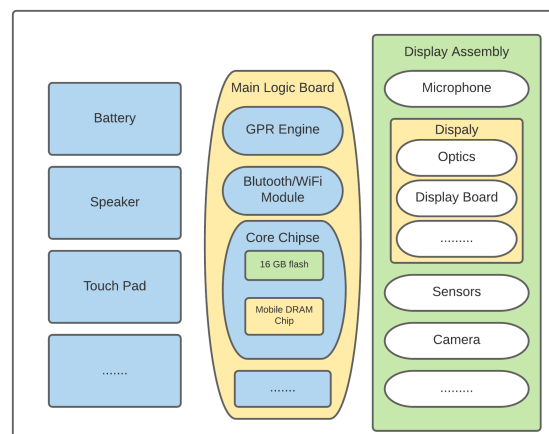
Figure 01(b): The General Architecture of Google Glass

Google Glass is a wearable, voice- and motion-controlled Android device that looks like a pair of eyeglasses and shows information right in front of the user's eyes. The augmented reality experience

offered by Google Glass provides relevant information through visual, audio, and location-based inputs. It is possible to implement, for example, automatically showing the current flight status as a user enters an airport. As it is a very tiny computing device, its architecture and components are a bit complex. Figure 1 (a) and (b) show the internal components of the Google Glass.

not a monolithic system where equally distributed small components are built. We examined Google Glass more closely and discovered that it is made up of many assembles that are loosely dependent on one another. First, we unpack the primary assemblies such as the main logic board, display assembly, battery, speaker, etc. Figure 3.2 shows the general architecture of google glass. Many of

Figure 1(a): All the components of Google Glass. (b) The side opened view of the Google Glass (Google Glass Teardown)

Google Glass consist of several tiny modules in it such as the touchpad, main CPU board, behind-ear module, speaker, display assembly, display, optics, camera, battery, logic board, US dime, built-in Wi-Fi and Bluetooth and some sensors (accelerometer, gravity, gyroscope, light, linear_acceleration, magnetic_field, orientation (deprecated), and rotation_vector)(Interpreting the Evolution of Google Glass).

The intelligent eyewear considers motion and voice recognition, helping the wearer manage his/her day. Another option is the pad that is located on the glasses' rims. To get the information they need, the device sends the information to the wearer using a small package of information which is projected on the wearer's skin using a micro-projector, through a private channel of communication that only the user can access. To see the image in the captured colors, Google Glass uses a field sequential color (FSC) liquid crystal on a silicon (LCOS) system. The term FSC denotes a television system that employs continuous images to carry out color processing and then combines what the viewer sees with his or her natural capabilities to create a color image. LCOS is a method of creating video displays

Any architecture specifies what system modules will be included and what they will be used. It is

the components that Google Glass is made up of are not created solely for Google Glass. Nearly all of them have been with us for quite some time.

B. Suggested System Overview
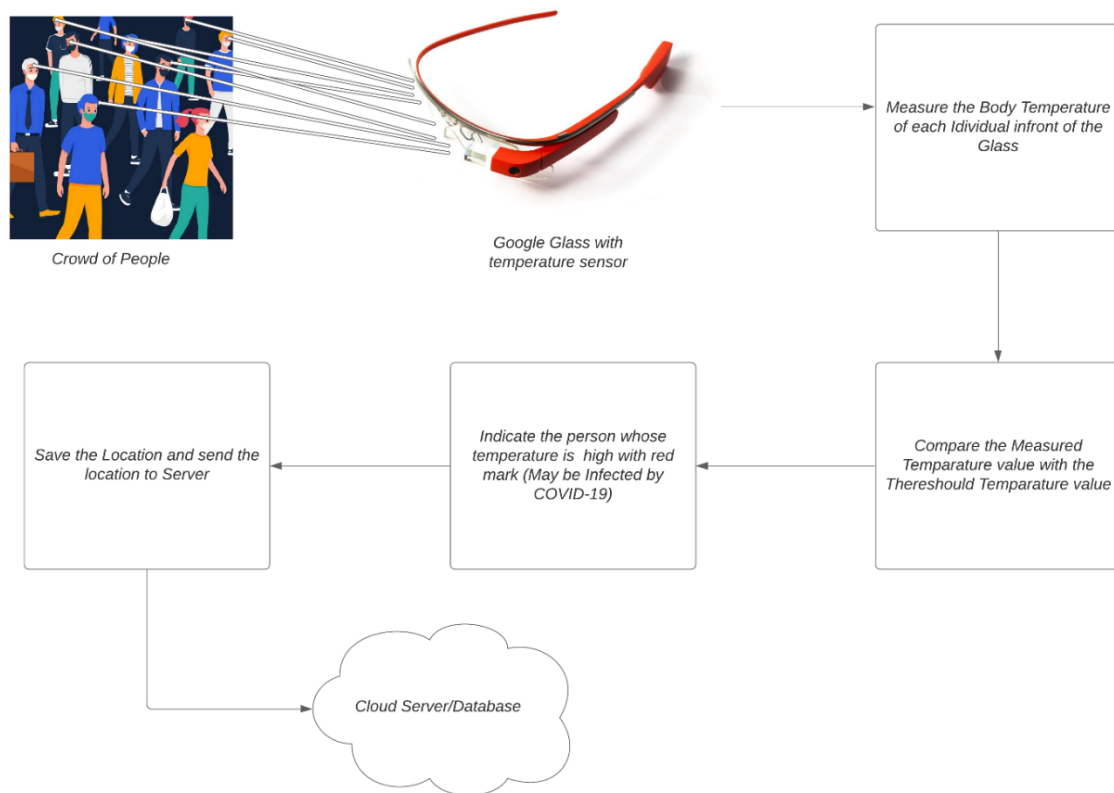
Figure 02. The Suggested System Overview

Figure 0-3 shows the proposed architecture of the potential concept of this study. As shown in the figure, a security guard of the organization wears google glass at the security gate. Whenever crowded people enter the gate, he/she use this glass to measure the body temperature. This study looked at using a sensor to assess body temperature from a distance—the sensor embedded with google glass to do this task. Here the sensor measures the body temperature and passes that value to google glass. Which immediately compared that value with the average human body temperature. If the value is greater than a typical threshold value, the person will be suspected of being Covid-19, and security measures will be taken to avoid entering the building. If not, they can move to the building without any interruption. Also, if the measured value is higher than average, then the locations of the person will be updated to the cloud by google glass to notify the responsible person. Generally, google glasses have multiple features compared with other Virtual reality glasses, and location passing to the cloud easily done by google glass than other devices

IV. RESULT AND DISCUSSION
This section will focus on the necessary sensors and working procedure of the given concept in the methodology part.

A. Equipment and Working Procedures
1) IR thermal sensor
The sensor is used to gather the body temperature at a distance. Generally, IR thermal sensors can absorb the body temperature of a human or object with radiation. The mechanisms by which heat is transferred from one body to another are conductivity, diffusion, and radiation. Radiation is when a hot object radiates heat energy in electromagnetic waves, which are absorbed by fabulous. Although some of it reaches the visible light spectrum, most of this radiation is in the electromagnetic spectrum's infrared (IR) section (Saha, Dewangan and Dasgupta, 2016).

IR thermal sensor encompasses three components: optical components, IR detector, and electronics. When the item emits infrared energy, optics transmits it to the IR detector, converting it to an electronic signal. The electronic signal is transformed to a temperature after a sequence of electronic procedures (SESOR TIPS, 2021).

When infrared photons collide with the human body or any other object, heat energy is reflected, absorbed, or transmitted. When the reflected heat energy reaches the sensor, it is measured using its three components.

3) Android application for a location transfer

When the temperature coming from the IR sensor needs to be stored in the google glass OS, it needs applications to move on further. Here we suggest some interfaces with the android operating system as below.

When we check Figure 05, we can recognize the two interfaces. In each interface, the longitude, latitude, and average temperature are static. Longitude and latitude are used for getting the

Figure 03: Working mechanism of IR temperature sensor

$$WInc = WRef + WTra + WAbs$$

WInc – Incident energy
WTra – Transmitted Energy
WAbs – Absorbed energy
WRef – Reflected energy

location purpose of the covid 19 infected patients. Those will be vary based on the place. The data coming from figure 05 will be passed to this interface as quickly as possible to update the value to the cloud to notify the needy person. Here green circle implies the pass information of the gate

Figure 04: Google glass view with IR thermal sensor

2) Google glass camera view with IR thermal sensor

When the security guard looks at the people by the google glass, they will get Figure 04. When the security guard identifies the blue tag as in the figure, it is normal and has a green signal to enter the gate. If it is red, they will have become a suspect of covid 19

4) Cloud database with location information

Figure 06 merely shows the cloud database and the method of information stored in it. When we look at the figure, it sends the detail with temperature. It will further be shared with the responsible person from this point. The emergency team will reach the spot as soon as they get the message from the database.

V. CONCLUSION

Smart wearable devices play a significant role in the current pandemic situation in monitoring COVID-19 patients in the health sector. Throughout the study, we have proposed a timely remedy for identifying COVID-19-affected

Android OS, we can have thermal sensors for measuring the body temperature; hence, this study proposed a possible way to implement the IR sensor with google Glass due to its infrastructure. We strongly believe that the concept implemented in real-time, a high number of infected cases can
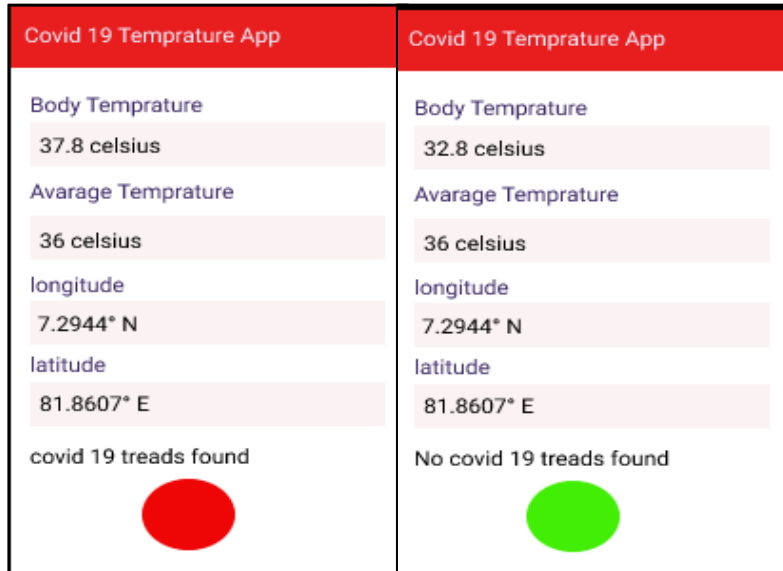
Figure 05: Sample Interface of google glass for Covid 19 detection
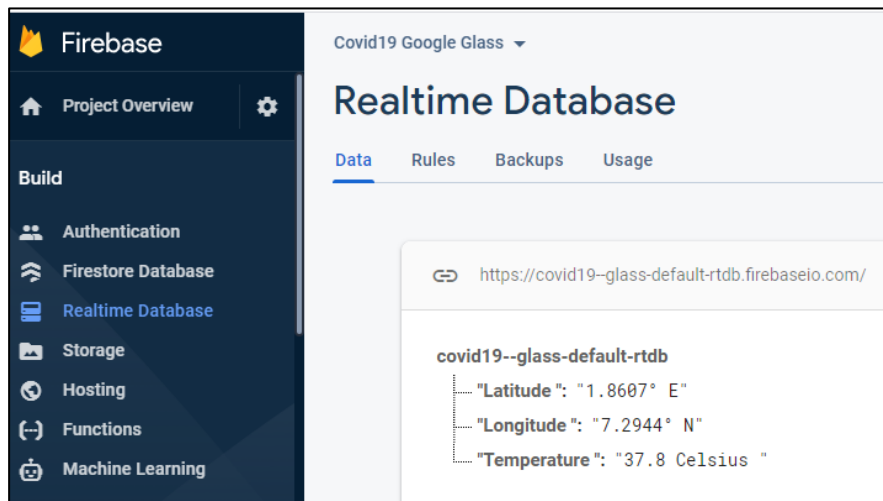
Figure 06: Location shared in the real-time database

humans in crowded places while following social distance measures. Most previous research studies were conducted using Google Glass and Smart glasses for different purposes. However, research studies on these devices for the temperature measurements of moving humans during the pandemic have yet to be completed. However, working with Google Glass has many features compared with the recent VR and AR glass applications. Though the said idea is a potential concept, it has higher robust throughput when it is implemented. Also, in the wearable devices of the

be found while keeping social distance measures, and death rates can be reduced considerably without any suspects. Furthermore, this study can be extended to find the affected human with the help of the inbuilt camera of Google Glass and notify the relevant authorities about the victim using the image processing technique. It was very tough to find the related studies since the concept is very new, and very few articles were found related to COVID-19 and Wearable devices

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Big Data Application Analysis: A Review

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Abstract

The term "big data" describes datasets that are not only large but also have a high level of diversity and velocity, making it challenging to manage them with conventional tools and methods. Through enhancing decision-making and vision searching, the big data explosion is reshaping lifestyles in terms of working and thinking. This paper conducts an analysis of recent research and studies projects in a variety of sectors that make use of big data. This paper studies 45 previously published articles and conducted a systematic literature review. According to the survey, many fields achieve various benefits, mainly when they apply big data technology. Further, selected algorithms perform better with specific domain data. This paper summarizes the different techniques used in the various domains and their benefits. Also, the article discusses the limitations in this study and limitations in big data applications.

Keywords: Big data analysis, Big data applications, Big data technologies

I. INTRODUCTION

Big Data is becoming a global trend. Although it does not yet have a widely accepted academic or scientific definition, it continues increased commercial expansion for its surrounding industries and related study fields (Hernández-Leal, Duque-Méndez and Moreno-Cadavid, 2017) (Soomro et al., 2019). Big data analytics is seeing patterns, trends, and correlations in massive amounts of unprocessed data in order to make data-driven choices. These processes use well-known statistical analysis techniques, such as clustering and regression, to bigger datasets utilizing contemporary technologies. NASA scientists invented the phrase Big Data in 1997 to characterize the challenge of presenting data sets that are too huge to fit in a computer's main memory, restricting analysis of the data set as a whole (Austin and Kusumoto, 2016). It is particularly formidable when managing large amounts of data and has had much more success in various fields (Li *et al.,* 2019).

The word "big data" refers to data sources that are too large or complicated, and conventional data processing methods are insufficient to process them. It is crucial to consider the data's size, complexity, and velocity in big data. The big data set is expanding in size at an exponential rate. This data is too big, too unstructured, or too "raw" compared to traditional data. In relational databases, processing methods employed still do not worry about the amount of data but are rather concerned the quality of the data (Gorodov and Gubarev, 2013) (Huda et al., 2016). The amount of data in one big data collection currently ranges from a few dozen terabytes (TB) to many petabytes (PB). Because of this, gathering, storing, searching, sharing, analyzing, and displaying massive data can be challenging. Enterprises are currently examining vast amounts of highly detailed data in order to learn something they did not know previously (Du et al., 2021). A Variety of data is generated from multiple sources such as social media, machine logs, sensors, transactional data, etc.

The demand for big data processing technology has increased in the age of big data. Big data brings a quick and significant rise in data resources and a greater difficulty in extracting useful information that customers require (Tulasi, 2013). Processing data is becoming increasingly more complicated. Traditional data analysis techniques have glaring flaws, which raises new demands on big data-based resource services for digital libraries (Li *et al.,* 2019) (Ying, Chan and Qi, 2020).

This paper aims to give an analysis of the big data analytics research that is currently accessible. Some of the numerous big data tools, approaches, and technologies and their potential in various decision fields are examined. In this review, the authors discussed what big data is, what the field big data is used for, how to analyze big data applications, and what obstacles big data faces.

II. LITERATURE REVIEW

Willis et al. discuss the ethics and analytics of big data in higher education (Willis, Campbell and Pistilli, 2013). This paper discusses ethical questions such as the "role of big data in higher education", 'role of big data in student experience", "application of big data in student retention" and "what is the impact on successful outcomes". Authors conclude that the actual issue in higher education when applying big data is that statistical likelihood within an academic prediction matrix has significant ramifications for both organizations and specific students. (Kamilaris, Kartakoullis and Prenafeta-Boldú, 2017) discuss big data in agriculture and smart farming using big data.

Using new healthcare-specific big data technologies, data from numerous sources studies to understand the industry best practices and give high-quality insights. Most countries, especially the United States, use big data to enhance their medical facilities (Batarseh and Latif, 2016). Wang et al. (Wang et al., 2018) discuss big data analytics in healthcare. This paper demonstrates a link between big data analytics capabilities, IT-enabled transformation practices, benefit dimensions, and business values through a big data analytics-enabled transformation model constructed from a practice-based approach. The growing requirement for healthcare management to handle the influx of clinical data supporting evidence-based medical practice is recognized as a potential solution in big data analytics (Wang et al., 2018).

Big data is a term used to represent the increasing expansion and accessibility of organized and unorganized data. It may be just as significant to industry and society as the World wide web has been (Singh Jain et al., 2017). Big data analytics using Deep learning performs exceptionally well nowadays using huge data and the introduction of potent computer hardware like the GPU. It can fully use enormous volumes of unprocessed data and fully automatically find abstract knowledge. Voice recognition, picture categorization, and other industries have effectively used great learning capacity (Peng et al., 2017).

Govindan et al. (Govindan *et al.*, 2018) discuss big data in logistic and supply chain frameworks by applying the capability maturity model. Researchers used Twitter data to analyze the food supply chain management problems. Further, they used a text analytics method that uses clustering techniques, support vector machines, and multiscale bootstrap resampling to analyze the content of the Twitter data. The paper suggests that a big cluster of phrases can help decision-makers learn how to improve different parts of the logistics and food distribution chain (Govindan et al., 2018).

Data is regarded as a competitive resource and a new way to provide value for organizations, and the notion of big data is receiving a lot of attention in both the industry and the scholarly literature (Müller and Jensen, 2017). The quantity of data that can now be collected and used is increasing in today's smart cities. The ability to quickly collect, analyze, and store large amounts of data from various types of quantitative and qualitative domain-specific information sources has been made possible by recent advancements in hardware and software components, including social media, the IoT, monitoring devices, mobile technologies, data storage, and cloud computing (Iqbal et al., 2020).

Big data applications enable knowledge service providers to imbibe, procedure, analyze, and distribute content, transforming enormous amounts of data into insightful and compelling understandings. However, it is important to note that big data poses challenges to the methods and means of handling and analyzing data (Maqsood Ahmad Sandhu, Ahm Shamsuzzoha, 2018). Big data are data that, due to their size, complexity, and difficulty, demand novel management strategies, processing methods, algorithms, and analyses. Data collection, processing, storage, analysis, and visualization problems that were initially quantitative problems with data become qualitative problems as the scale of the data exceeds a certain threshold (Lee and Yoon, 2017).

III. METHODOLOGY

This study was conducted using a qualitative approach known as systematic literature review, based on earlier research and review papers over the last five years. The collected data were analyzed qualitatively to examine Big data's Fields, Technologies, and Purpose.

Table 01: Summary of big data application fields and techniques

References	Application Domain	Tools/Techniques and Data used	Purpose/Benefits
(Kamilaris, Kartakoullis and Prenafeta-Boldú, 2017), (Guo and Wang, 2019),(Horita *et al.*, 2017)	Agricultural	Big Data sources - Weather stations, Remote sensing (satellites, synthetic aperture radar, airplanes), geospatial data, historical datasets (land characterization and crop phenology, rainfall and temperature, Ground sensors (salinity, electrical conductivity, moisture), cameras (optical) **Techniques for big data analysis** - Machine learning (scalable vector machines, K-means clustering, random forests, extremely randomized trees), statistical analysis, modelling, cloud platforms, MapReduce analytics, GIS geospatial analysis, NDVI vegetation indices	Improve the accuracy of analyzing and forecasting disaster management, improve farmers productivity, weather forecasting
(Lee and Yoon, 2017),(Stieb, Boot and Turner, 2017),(Bofill-De Ros *et al.*, 2019), (Luo *et al.*, 2016),(Alyass, Turcotte and Meyre, 2015),(Tetko *et al.*, 2016)	Medical	Big Data sources – clinical data, sensors data, wearable medical devices data, DNA/RNA sequence data, biological image data **Techniques for big data analysis** – Machine learning (Decision trees, logistic regression, naive Bayesian approaches, Bayesian networks), Data mining, Neural network, Pattern Recognition, Natural Language Processing	personalized medicine. early detection of diseases(heart disease, cancer), identification of chronic diseases,
(Yan *et al.*, 2018),(Zeng, 2015),(Xie, Zhou and Li, 2016)	Transport	Big Data sources – IoT sensors data, Automatic data(automated passenger counts (APCs), camera video, automated vehicle location (AVL)), Global Positioning System (GPS) **Techniques for big data analysis** – machine learning, data mining, crowdsourcing	Traffic analysis to identify roads with a high risk of accident, transport route optimization
(Bajpai and Mani, 2017),(Willis, Campbell and Pistilli, 2013),(Kim and Ahn, 2016),(Zhu *et al.*, 2019)	Education	Big Data sources - social networking sites (like Facebook, Twitter, Blogs) Course Management systems (CMS), Learning Management System (LMS) and physical world data like library usage **Techniques for big data analysis** – machine learning, data mining, crowdsourcing	Prediction of performance of students, improve the resource management, providing feedback, course recommendation, and students behavior analyze.
(Muliawaty *et al.*, 2019),(Yu and Zhou, 2019),(Jordan, 2014)	Bureaucracy	Big Data sources – social media(Twitter, Facebook, blog and news website) **Techniques for big data analysis-** classification technique for sentiment analysis (Naive Bayes algorithm, Decision Tree, Artificial Neural Network)	Big data can used by local government agencies to enhance administrative and public services by knowing the public opinions.
(Padma and Ahn, 2020)	Tourism	Big Data sources - Satellite images, Geo-tagged images, conventional map, Google Analytics **Techniques for big data analysis** –data mining, crowdsourcing, Statistical and spatial analysis, Regression analysis, Sentiment analysis, Content analysis	Forecast tourist's arrival and predict the tourist volume, identify the potential area of tourism, identify which places are popular among different nationalities
(Du, Liu and Lu, 2021),(Ouyang, Wu and Huang, 2018),(Ishika and Mittal, 2021)	Security	Big Data sources – IoT devices data, sensor data **Techniques for big data analysis** – machine learning, data mining, crowdsourcing	Used to enhance the neural network's performance in order to increase the precision of early warning and Internet credit prevention
(Zhang, Zhan and Yu, 2017)	Business	Big Data sources – Sensor data (detect location in store), transaction logs **Techniques for big data analysis** – machine learning, data mining, crowdsourcing	Big data minimize resource waste and the inventory of the automotive industry. Reduce inventory and operational cost

A keyword-based search for articles and conference papers was conducted in the first stage using the databases IEEE, Emerald, Sage, and ScienceDirect and works indexed in Google Scholar.

The keywords "Big data Application" and "Big data technologies analytics" from scholarly publications from journals and conference proceedings were found using Google Scholar. The possessed publications included qualitative investigations, and the search period was set from 2017 to 2022.

A. Criteria for selecting and excluding articles

A first assessment of the recovered records was carried out by one of the writers. After analyzing individual titles and abstracts, duplicate articles were deleted, and more records were discarded. The included studies were then examined by a second author, who assessed the full-text papers or eligibility.

The authors selected 45 research articles from 75 based on the following criteria and all papers published in conferences or journals. The authors believed these two venues were more likely to contain current and relevant scientific papers related to this study.
- Majority of the Published papers between 2017 and 2022
- Only full papers
- Peer-reviewed papers
- Articles were an open access

B. Research Question

The following are the research questions (RQ) used in this study to collect data analysis.
- Which fields are most frequently utilized in big data applications?
- What emerging techniques support big data technologies across various domains?

IV. RESULTS AND DISCUSSION

Big data has a wide range of possible effects across many disciplines. This study aimed to understand the Techniques and the purposes for implementing Big data technology.

In the agriculture domain, there are some opportunities and berries to apply big data. For example, the lack of expert human resources and reliable infrastructures to collect data are some barriers. Further, there is a huge gap in structure

and governance related to agricultural big data. Big data can be used to recommend guidance to farmers based on their crop conditions, weather and responsiveness to fertilizers. Moreover, by integrating agricultural data with the supply chain framework farmers can gain more from planned harvesting.

Nowadays, big data play a crucial role in biomedical and healthcare. By combining data from many sources, practitioners can present a new perspective on patient care that takes a patient's entire health status from DNA to behaviors. Also, the accessibility of cutting-edge mobile health devices enables more accurate real-time data collection and saves many lives by early detection of the seriousness of diseases.

Today businesses use big data for multiple purposes. Researchers conclude that having a positive review on social media for a product effect on the market of the product. Further big data can use to identify market trends, customer satisfaction, develop personal recommendation systems and etc.

Big data applications impact the field of transportation in numerous ways. Understanding passenger behaviors helps in decision making. Further, statistical methods such as Multiple linear regression, factorial analysis of variance (ANOVA) and etc. are used to analyze the tourism data. In all references include various fields and the benefits of big data technology for these studies. Finally, to obtain the best possible outcome from our study, authors may propose big data technology applications uses various fields of applications.

Only 45 articles, 2% of the Google Scholar results for the phrases "Big data Applications" and "Big data Technology Analytics" were examined. Another limitation of this assessment is that articles written outside of English were not taken into consideration. Because only Google Scholar was searched, academic databases and journal articles were also excluded from the search. Data collection from online websites only has possible drawbacks. It was unable to adopt data from a variety of sources, including first-hand information obtained from interviews and questionnaires (Ying, Chan and Qi, 2020).

There are still several issues with deploying big data approaches in real-world applications,

including a lack of pertinent supporting policies and an absence of uniformity of standards and norms (Li *et al.*, 2019).

V. CONCLUSION

Big data analysis was reviewed in this article. This paper examines the applications of big data in different fields and the most current uses of big data technologies in various areas. Big data applications are used in agricultural, medical, transport, education, bureaucracy, tourism, security and business domains. Further to analyses the big data nowadays, mainly machine learning techniques are used. Additionally, some algorithms perform far better in some specific fields. For example, decision trees, logistic regression, naive Bayesian approaches, Bayesian networks, neural networks, etc., perform better in medical applications. Big data applications in all industries have a bright future since they develop new data values. Pertinent research and technology, the collaboration between research institutions and businesses, and strong government encouragement help further bring considerable data value.

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Artificial Intelligence Applications for Distributed Energy Resources: A Survey

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Abstract

Distributed Energy Resources (DER) is a concept that is still being worked on in the power grid of today. It makes it possible for electricity and data to move back and forth between adjacent power sources in the networks and clusters of the electricity system. Smart Grid is meant to replace the old grid with a network of Distributed Energy Resources. It combines many new and old technologies, such as information and digital communication technologies, to do a lot of different things. With this, the New System would be ready to identify, respond, and act to changes in utilization and cope with a variety of issues while making sure the power system runs on time. Distributed energy resources are a big part of artificial intelligence (AI). In the past few years, these promising technologies have changed quickly and been used in a growing number of ways. This study focusses on analyzing the applications of AI on DER in the different areas of DER, such as renewable energy, grid control, energy management, and AI in virtual power plants.

Keywords: Distributed Energy Resources, Smart Grid, Artificial Intelligence, Renewable Energy, Energy Management

I. INTRODUCTION

Devices for power generation, transmission, and distribution that are connected to the electric grid are referred to as distributed energy resources. They are typically situated in close proximity to load centres, and they individually or as a collection provide services to the electric grid (Worighi et al., 2019). DERs can be made up of a diverse range of generation, transmission and distribution assets. There are virtual assets that can contribute to the performance of DER electric system.

Physical DERs include things like power plants, battery banks, and solar panels that have a capacity of 10 MW or less. The utility company, a private company, independent power producers operate these facilities. Similarly, to how it supervises the functioning of large central power plants, the utility requests start and stops from these smaller facilities. Like with physical power plants, digital twins can be used to analyze the efficiency of a virtual power plant before it is added to the grid.

The need for energy is going through a significant transformation. Some of the older concepts are becoming obsolete, and it is necessary to develop new ones in order to address the issues posed by climate change and the scarcity of resources. The demand for electricity is skyrocketing at a pace that no one has ever witnessed before. The new cities and their infrastructure need to lessen their impact on the environment caused by carbon emissions. Getting there will be heavily dependent on the proportion of renewable energy sources that are incorporated into DERs (Facchini, 2017).

The emerging model of distributed generation is getting more and more attention, mostly because infrastructures are becoming more and more digitalized. This makes data more accessible and gives users more control over the stability of the network than ever before, even when there are occasional problems and interactions with customers.

Using PV, a wind turbine, fuel cells, and other DERs to make electricity on-site is a faster and less expensive option. Central power plants have larger installed peak capacities, but they also take longer to build than onsite distributed energy resources (DER) power plants. It also takes more time to put up high-voltage transmission lines (Notton et al., 2018).

Consumers benefit from increased service reliability, increased performance delivery, and energy security when they use an electrical network that is based on distributed energy resources (DER). When distributed energy resources (DER) make use of a renewable technology, they provide a significant contribution to the overall mix of power generation and are a component of the environmentally friendly approach for a cleaner planet.

The paper initially discusses about the AI for power system applications. It discusses the context on renewable energy, grid management, grid control, predictive maintenance and autonomous learning. Further, it is discussed about the use of AI Energy Management, AI for Virtual Distributed Energy Resources. There are edge IoT devices which facilitate the use of AI on the edge. Similar systems are discussed on the paper.
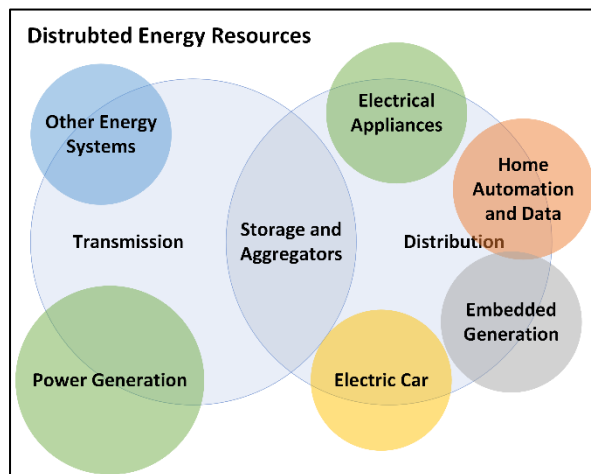
Figure 01: Distributed Energy Resources

II. DISCUSSION

A. *ARTIFICIAL INTELLIGENCE FOR POWER SYSTEM APPLICATIONS*

The growth of analytical models has made it possible to utilize various different tactics from the field of machine learning across a variety of industries, including the field of electricity generation and distribution. (Hossain et al., 2019). At the moment, most researchers are focusing on Machine Learning (ML) and Deep Learning (DL). People have thought of the Deep Learning (DL) as a new area for extracting features and dealing with a lot of data when ML methods fail. AI as a whole includes many subfields, such as machine learning, deep learning, big data, computer vision, neural networks, natural language processing, and

many more. (Hossain et al., 2019). DL uses huge computational models like neural network algorithms with many levels of processing units to increase computational power and improve training methods. These networks are used to learn different trends from huge datasets. AI can help make systems in the power industry that are smarter and more reliable.

There are several Deep Learning Algorithms, particularly used in the Distributed Energy Resources. Some of the relevant algorithms are given here in Figure 02(China Electric Power Research Institute et al., 2018; Hafeez et al., 2020; He et al., 2017).
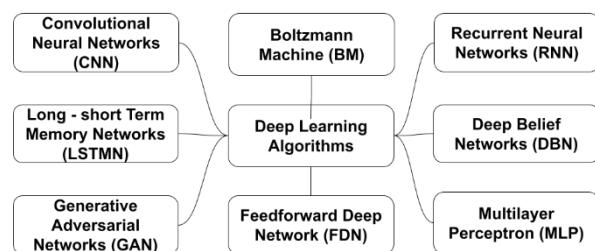
Figure 02: Deep Learning Algorithms

1) *Renewable Energy*

AI has the potential to revolutionize the renewable energy market. Using AI, electricity firms can improve their forecasting, grid management, and maintenance scheduling. Undoubtedly, renewable energy is the future, but its unpredictability poses a significant obstacle. Renewable energy relies on resources such as sunshine, airflow, and water. All of these resources are dependent on the weather, which is uncontrollable by people. Artificial intelligence has helped overcome this obstacle because it is a dependable tool for weather forecasting. It uses machine learning to analyze current and historical meteorological data in order to give reliable forecasts. These forecast data are utilized by the energy corporations to manage the energy systems. If the outlook is favourable, the corporations create and store renewable energy. If the prediction is poor, power firms adjust their load management accordingly. They anticipate the problem and utilize fossil fuels to maintain a continuous power supply.

The good forecast of production can be done by aggregating the forecast that is achieved through traditional method of power curves and the

forecast using Artificial Neural Networks. The method is explained using the Figure 04.

2) Grid Management

Grid management is another essential part of a DER system. Likewise, artificial intelligence and machine learning play a crucial role in this field. These systems utilize data analytics to anticipate residential energy consumption. The forecast is based on a certain portion of the year and data from prior years. This helps power companies predict how much energy will be needed over the next few days. Consequently, they can control their grids without interruption. If consumption is expected to be high, energy production can be increased. Alternately, during periods of the year when energy use is low, production might be reduced to prevent waste.
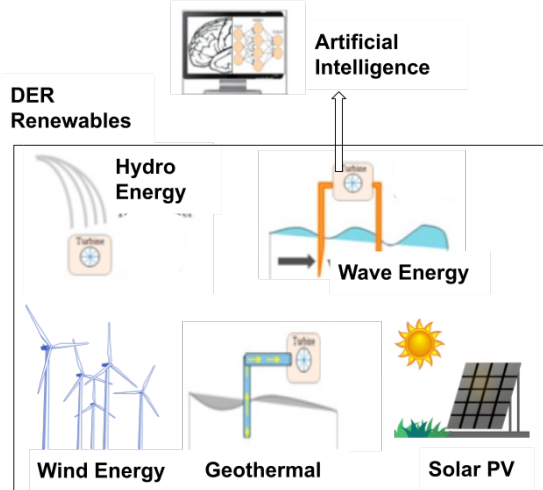
Figure 03: Renewables Associated with AI Forecasting
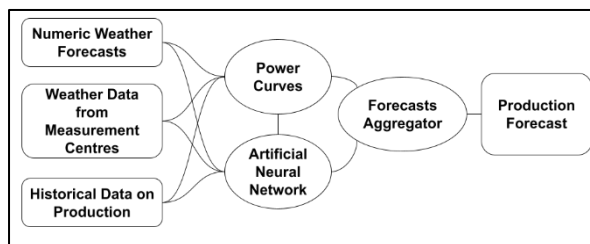
Figure 04: Renewable Forecasting using Artificial Neural Networks and Power Curves.

Advanced Metering Infrastructure (AMI), Distributed Automation (DA), Distributed Generation (DG), Distributed Storage, Home Energy Management Systems (HEMS), and Demand Response are examples of SG applications for monitoring and grid management (DR)(China Electric Power Research Institute et

al., 2018). Smart Grids are one of the greatest possible IoT network deployments, with smart meters, wireless smart sensors, and smart appliances communicating to ensure reliable and effective power generation and distribution. Utility companies have to submit AMI end-user sensor, monitoring system, and smart meter data for billing, grid management, and forecasting. Sensor network data and SG interactions(Kimani et al., 2019).

3) Predictive Maintenance

There are times when electrical networks require repair, regardless of how effectively they are managed. It is essential that the entire system operates efficiently. By utilizing the power of AI and machine learning, it is simple to predict which system component will require repair(Shin et al., 2021). When power companies are made aware of imminent grid repair, they are able to inform customers. Scheduled maintenance allows users to anticipate upcoming power outages. Currently, we are experiencing power outages with no prior notification.

Predictive maintenance can be done via signaling systems through mobile alerts. They also can be alerted with Dashboard warnings. Here the previous historic data in Distributed Energy Resources are stored in the cloud. The data is then fed to an AI system which works as a decision-making system. These decisions are then given to the user in order to achieve predictive maintenance. This is shown in Figure 05.
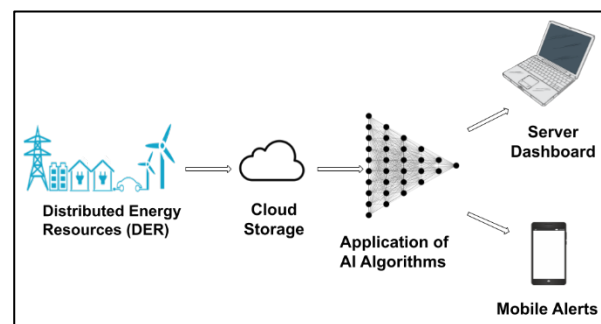
Figure 05: Usage of Artificial Intelligence for Predictive Maintenance

4) Grid Control

In power systems, new AI models in power systems are constructed using recursive neural networks. Transient stability of the electrical grid has been identified and its defining properties retrieved using data mining technologies(Rafik et

al., 2020). This has resulted in answers for problems like assessing the current state of the system's operations, optimizing its controls, and coordinating their actions. The findings were used in load forecasting and standby dispatching systems, allowing for more informed choices in power grid monitoring, network analysis, index management, and index control(Ali and Choi, 2020).

5) Autonomous machine learning drives smart grid autonomy.

Using machine learning, DER - smart grid autonomous management can improve the intelligence of its planning, decision-making, and system comprehension(Jiao, 2020). In the field of smart grid applications, researchers frequently run into issues including adaptability in relay protection, assessing grid equipment defects, assessing grid parameters, and identifying stealthy faults. The smart grid's ability to learn on its own will be bolstered by the cumulative effects of autonomous machine learning, which will also raise the smart grid's level of learning in terms of perception, cognition, and behaviour(Azad et al., 2019).

6) Knowledge Information System

The expert system was the first and most important use of artificial intelligence. It was closely related to knowledge engineering. At the moment, experts' experience and knowledge are also needed to solve many issues in smart grid DERs. With an insight knowledge information system (KIS), specialists can learn more about a certain field and gain more knowledge and experience in it. The KIS's inference engine can be used to simulate how experts make decisions on the job. Setting up power grid knowledge data about fault diagnosis, intelligent control, fault localization and analysis, energy router self-determination, and other things will be a big step in the right direction for smart grid knowledge engineering (Kabalci and Kabalci, 2019; Li et al., 2018).

B. AI IN ENERGY MANAGEMENT

The world of energy has always faced problems with sustainability. By using energy at its best level, any industry can help save energy and use it efficiently without wasting it. As we've already talked about, AI is giving different services and industries new ways to use unmapped data and link it to decentralized energy resources(Lee et al., 2022). So, industries can use AI to optimize how

energy is used in different sectors. This gives us real chances to solve the problems facing the environment. When AI, machine learning, and deep learning algorithms are used with an organization's core energy system, it's easy to get insights into how the energy operations work. Then, it breaks down the data and suggests an actionable way to manage energy while helping you save money on energy you don't need. It is a real-time way to cut down on energy waste and find new ways to save energy by using untapped data to optimize how much energy each industry uses.

A successful AI Energy Management system can be taken into action by considering the following factors.

- Always keeping an eye on the AI control system to make sure it doesn't go against safety rules (Khargonekar and Dahleh, 2018).
- If the AI control system does break the safety rules, the system will automatically switch to a neutral state (Khargonekar and Dahleh, 2018).
- Maintain a smooth transfer during failovers to prevent the system from going through any abrupt changes (Urlini et al., n.d.).
- Verification of the acts taken by AI on two different levels before implementation (Schneier, 2005).
- Communication that takes place continuously between the cloud-based AI and the physical Infrastructure (Kumari et al., 2020).
- Estimation of the degree of uncertainty in order to guarantee that we will only carry out actions with a high level of confidence (Kläs and Vollmer, 2018).
- Human override is always an option and will take precedence over any actions taken by the AI algorithm (Hendrycks et al., 2021).

C. AI FOR VIRTUAL DER

To begin, a digital twin model is produced that is a reflection of the real environment. This model includes each item and the location at which it is located. Utility companies are gaining more insight into their power grids and DERs with the use of digital twin models, which is increasing their level of safety and productivity while

simultaneously cutting down on equipment downtime (Steindl et al., 2020). After the data has been incorporated with digital twin, the AI equipped simulations, analyze performance, and identify potential areas for improvement in order to maximise the intended level of performance (Novais et al., 2021). To achieve strategic and compliance objectives, different rules can be implemented, and the insights acquired can then be dynamically transferred back onto the original power system by means of AI-based asset controllers. A virtual environment is developed when more assets are added, and inside this environment, numerous different simulations may be run, problems can be investigated, and feedback can be sent to the DERs and smart grid. The AI models will continue to learn with the real-time data as they learn continuously through continuous learning in order to maximize long-term performance (Nikam and Kalkhambkar, 2021). This continuous influx of data and knowledge in real-time enables the models to become more intelligent over time and benefit from the decisions they have made in the past. An all-encompassing AI strategy may also actively synchronise and optimize traditional and newer DER with one another and with the electricity network. This opens the door for machine-to-machine interaction and decision-making. Because all of the assets are being controlled by AI, this active synchronisation capability ensures that they are all working together to achieve both individual & combined goals of the devices and systems in the grid.

D. EDGE AI FOR DER

The use of machine learning and deep learning algorithms make the edge IoT smart system intelligent and powerful (Loven et al., n.d.). Therefore, the following systems can be made smarter with the use of AI.

1) Advanced Measurement and Sensors

Smart metering, which customers and utilities can use to find out how much and when they use electricity, is part of the AI powered smart grid. This checks the safety of the system, the integrity of the grid, and helps with highly developed protective relays (Kabalci et al., 2019). This gives customers more options and lets them meet demand. It also makes the grid less crowded. Evaluation and monitoring carried out in advance make the grid more stable by finding problems early and isolating them so that power outages

don't happen. The sensors collect data which is very helpful for forecast, analysis and predictive maintenance works.

2) Automatic Monitoring and Control

Smart Grid DER offers direct tracking and presentation of the statuses and efficiency of energy system devices over vast geographies, allowing device controllers and users to recognize this information and optimize electric grid components, activities, and output (Hancke et al., 2012; Meral and Çelík, 2019).Monitor and control technology from SG assist inform decisions, minimize wide-area problems, and enhance distribution reliability and capacity.

III. CONCLUSION

The use of the most recent AI technology is anticipated to be inevitable for the high performance of the newer DER system. Integrating Artificial Intelligence with Distributed Energy Resources (DERs) is a critical component for the successful operation of smart grid. Throughout the course of our study, we investigated the potential applications of AI in areas such as renewable energy, grid control, energy management, virtual power plants, and Edge AI devices. The DERs powered with AI will be able to provide many smart features thereby giving us reliable, less energy consuming electrical systems.

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TRACK - SOFTWARE TECHNOLOGIES (SWT)

Comparative Analysis of Functional Test Automation Tools

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Abstract

The software development life cycle has several stages. Among them, software testing is a continuous process. It begins after the requirement-gathering phase. Today software testing has become a mandatory process. It comes with a variety of challenges also. Although manual testing is an easy task, sometimes it will not be effective due to its incompatibility, lack of coverage, and repetition of test scripts. This study mainly focuses test automation process and its working mechanism, software testing strategies, and different types of software testing tools. For clarification, test automation tools are divided into functional, test management, and load testing tools. The objective is to provide a comparative analysis of test automation tools with similar characteristics such as platform support, the programming language used, and compatibility with web browsers. This research paper also helps the test teams to select the appropriate test tool according to the customer's needs.

Keywords: Software Testing, Test Automation, Test Management, Functional Testing, Load testing

I. INTRODUCTION

Software testing evaluates the performance of software applications to find out if the developed software meets its particular requirements and identifies the shortcomings. Software testing aims to find defects and bugs in the software, system, or product. It also allows us to evaluate the software's quality based on its functionality, usability, efficiency, maintainability, and portability.

We can categorize software testing as manual testing and automation testing. Manual testing, also known as static testing, is performed by testers. In manual testing, the tester acts as an end-user and uses a written test plan to help with the selection of important test cases. There are many drawbacks to manual testing, such as being more time-consuming, less accurate, having no scripting capability, needing much human engagement, and challenging to explore more significant or minor bugs. Automation testing (Polo *et al.*, 2013) has been presented to overcome these errors, which investigates the challenges in manual testing.

Automation testing(Garousi and Elberzhager, 2017) is a software testing technique that uses specialized automated testing software tools to execute a set of test cases. In today's world, most businesses and companies use automated testing tools (Wiklund *et al.*, 2012). Even though testing is a mandatory process in software development,

choosing the appropriate tool for testing is a complex task (Bansal, Muli, and Patil, 2013).

The focus of automated testing tools research is collecting evidence that gives developers and testers access to relevant information that can help improve the tool selection efficiency.

II. METHODOLOGY

The testing process plays a significant role in software development, as every small module must be tested to confirm its validity and accuracy. Nowadays, various test automation tools are introduced to improve the efficiency of the testing process.

In searching for the information relevant to this research, indexed journals and conferences have thoroughly published on this topic. Among them, several studies compare different test automation tools. According to our observation, test automation is described in a small number of research articles based on its functionality. This study analyzed test automation tools by categorizing them as test management, load testing, and functional testing tools.

III. DISCUSSION

A. Software Testing Strategies

In the SDLC (Software Development Life Cycle), the testing process runs concurrently with the

software development, and a test strategy can be described as an overview illustrating the test approach (Sei, 2015). The test team, project managers, functional testing team, and software engineers are primarily responsible for developing these techniques. There are four software testing strategies (Sneha and Malle, 2018).

1) Unit Testing

In coding, the programmer performs several tests to determine if the program unit is faulty. Tests are conducted under the white box text approach. Unit tests help determine if each unit in the program operates as required and is error-free. The developers and testers can both save time if a proper unit testing procedure is in place because bugs can be found at the early stage of the testing process (M. A. Umar and C. Zhanfang, 2019). Furthermore, avoiding or limiting the practice of unit testing might raise problems and it is difficult to correct them at a later stage.

2) Integration Testing

Integration testing is often done in parallel with unit testing. Integration testing ensures that the individual modules of the code work properly as a team of QA professionals. Many modern applications run on microservices and self-contained applications designed to handle specific tasks. Integration testing examines whether the software modules are by the specification in the SRS document (Akinsola *et al.*, 2022).

3) System Testing

QA professionals test the software as a complete product with system testing. With this type of functional testing, the tester validates the complete and integrated software packages to ensure that the requirements are satisfied.

4) Acceptance Testing

Acceptance testing is used to ensure that the end-user is satisfied and able to achieve the goals set in the business requirements. Acceptance tests are customer-owned and defined tests that check whether the developed modules fit the acceptance requirements. Acceptance testing is essential to improve stockholders' awareness of the requirements for the product (Nasir, 2021).

B. Test Automation Tools

Automation tools (Polo *et al.*, 2013) in the market can be classified as open-source and payment tools. The tools chosen here are based on their ease of use and availability for testing (Garousi and Elberzhager, 2017).

The following are several categories of software test automation tools.
- Test management tools
- Load testing tools
- *Functional testing tools*

1) Test Management Tools

There are unique ways to deal with test management tools, and they also have different characteristics. Test management tools allow the assignment of test procedures and easy access to data analytics and simple correspondence with various business groups (Chandraprabha, Kumar, and Saxena, 2015). Test management tools are used to store information on how tests should be performed, plan test activities, and report the status of quality assurance activities (Chaudhary, 2017).

i. *TETware*

TETware is a test implementation management system that administers the test, sequences tests, and reports the results in the standard format. This tool supports Unix and 32-bit Microsoft Windows operating systems; it has portable capabilities with enhanced testing opportunities (Abbas, Sultan, and Bhatti, 2017). TETware gives a platform for the testers to work on consistent, decisive test scripts and allows the software system to be handed over quickly.

ii. *Test Manager*

Test Manager can be defined as an automated software testing tool used for everyday testing activities. This tool uses the java programming language to develop. It simplifies ordinary software development tasks and automates and manages them.

iii. *RTH*

The meaning of the acronym RTH is "Requirements and Testing Hub". This is an open-source test management tool that also provides troubleshooting facilities.

2) Load Testing Tools

Load Testing is a type of testing that evaluates the system's performance. Automated load testing helps to determine any system's performance and functional problems when it is put under load

(Alferidah and Ahmed, 2020). These tools are applied when software projects near their completion level.

i. Load Tracer

Load Tracer is a widely used web performance tool created by Trace Technology. It is a highly convenient tool the company uses to test web app loading and performance. In addition to testing, viewing, and managing the performance of internet applications, this tool provides a variety of techniques to load on the web servers in the manner that the user prefers.

ii. WebLoad

WebLoad has become another open-source load-testing tool but has some limitations, such as the capacity to produce a large number of concurrent users. It is often used for the web application's stress testing and performance testing. It imitates hundreds and thousands of users for load testing and examines the outcomes of any application to address the web application's flaws and limits. It also works with different types of protocols.

3) Functional Testing Tools
i. Selenium

Selenium (Rishab Jain and Kaluri, 2015)is an open-source and freeware test automation framework for inspecting web browsers on various platforms and browsers. Selenium test scripts are written in programming languages such as JavaScript and Python. Selenium also offers support for many browsers. Chrome, Safari, Firefox, and Internet Explorer are a few of these browsers. It also supports many programming languages and operating systems (Mishra and Atesogullari, 2020). Selenium consists of Selenium IDE, Selenium RC, and Selenium Grid.

Selenium IDE is a selenium testing development environment. It is a Firebox add-on that lets to record, edit, and playtests. Selenium IDE allows saving tests in various formats, including Java, Ruby Script, HTML, and others. Selenium RC is a cross-browser testing solution. It is developed in Java and runs on significant platforms (Ramya, Sindhura, and Sagar, 2017).

One of the drawbacks of the selenium web driver is that it has no built-in functionality for generating screenshots for failed test cases. The selenium web driver cannot generate test results (Rishab Jain and Kaluri, 2015).

ii. Junit

JUnit is a free and open-source framework for regression testing. It primarily uses specific software updates to implement unit tests, help accelerate programming and enhance the quality of the Java code. The key objective of this framework is to make it easier for Java developers to script and run recurring test cases. We can identify this framework as one of the most widely used Java testing frameworks. The JUnit framework (Chaudhary, 2017) is primarily used among specialists to test tiny code. We can perform automated testing of a website by integrating JUnit with the selenium web driver for Java automated testing.

iii. HP UFT

HP UFT is a functional testing tool that is ideally suited for the implementation of regression testing. It is a licensed/commercial tool from HP that is commercially available. It measures the current and projected outcomes and reports the results in implementing summarized information. It is also a simple and effective tool that operates great with Windows and Windows-based applications (Sneha and Malle, 2018). It also supports dynamic testing and saves snapshots on every page visited during activation.

iv. Test Complete

Test complete is a test automation platform developed by SmartBear software. It enables testers to generate automated test scripts for Microsoft Windows, Web, Android (iOS), and iOS applications. Test Complete is a software testing tool that allows for building and automating various types of software testing. Record and replay testing is performed manually by an examiner and enables it to be replayed and maintained as an automated test (Kaur and Kumari, 2011).

v. Ranorex

This is a simple, efficient, and low-cost automated testing tool. It is an enhanced option to other testing tools because it analyzes applications from the user's perspective, utilizing main programming languages and methods such as C#, VB.net, and Iron Python. Commercial software firms and businesses deploy it all around the world. Future work for Ranorex (Kakaraparthy, 2017) includes the development of an open, well-documented platform that enables customers to create their

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plug-ins and provide their applications with full recognition.

C. Comparative Analysis of Functional Test Automation Tools

The above table analyzes the different kinds of test automation tools based on various characteristics. By seeing Table 01, we can identify the primary key factors we have to consider when selecting the test automation tool. Here we have only considered some of the most commonly used test automation tools available in the market (Chaudhary, 2017).

IV. CONCLUSION

Testing plays an essential part in the development of any software product. Multiple test automation tools have been proposed and are currently available on the market today. Researching various software tools to compete with other software developers and offer the highest quality software product becomes a critical challenge for the team. The drawbacks of manual testing compared to automation testing and some of the most important and frequently used software automation tools used in different platforms have been reviewed in this article.

When selecting test automation tools, it is important to consider ease of use, cost, and supporting platforms. Moreover, before deciding to automate testing, be sure to have skilled workers to work with automation tools.

Table 01: Comparison of Functional Testing tools

Automation Tool	Developed By	Supported Platforms	Browser compatibility	Programming skills required	Cost	Scripting Languages
Selenium	Jason Huggins	Cross Platforms	Cross-browser	Needed	Open-source	Java, Ruby, Python, PHP, C#, .net
JUnit	Kent Beck, Erich Gamma, David Saff	Cross-Platform	Cross-browser	Needed	Open-source	Java
HP UFT	MicroFocus	Windows	Google Chrome, Internet Explorer, Firebox	Not required (only needed to test advanced test scripts.)	Commercial	VBScript
TestComplete	SmartBear	Windows	Chrome, Firebox, Opera, IE	Needed	Commercial	VBScript, C# ,js JScript++
Ranorex	Ranorex GmbH	Windows	Chrome, Firebox, Opera, IE, Netscape	Partial	Commercial	VBScript supports .Net, C++, C#

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Database Backup and Recovery: A Review with test implementation for MySQL and NoSQL Databases

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Abstract

Databases hold cloud data and applications, and cloud-hosted services and apps must support more data. Therefore, the backup and recovery capabilities of the database are crucial. Regular backups of structured and stored data can reduce data loss and corruption. Administrators restore the database from a backup in the event of a hardware failure, data loss due to bugs, or other issues. The correct methods and features are important to the database administrator and user to apply the right technique at right time. The aim of the study incorporates identifying the available techniques of database backup and recovery with the implementation method. As a result, we can distinguish between the types of backup such as full, incremental, and differential, as well as recovery techniques such as log recovery and shadow paging. Additionally, the results indicated the adoption of MySQL and NoSQL backup and recovery methodologies. The result also showed the implementation of backup and recovery techniques of MySQL and NoSQL. This could be a solution to database backup and recovery issues if we use the appropriate approach and functionality.

Keywords: Database System, Data Management, Database backup, Recovery, mysqldump, mongodump

I. INTRODUCTION

Database systems (Ko et al., 2021; Li et al., 2021; Bao et al., 2022; Hu, 2022) are commonly used to store data in cloud services and applications (Heidari and Navimipour, 2021; Khan et al., 2021; Mishra, Sharma and Alowaidi, 2021; Sahu, Raghavan, and Chandrasekaran, 2021). Data backup and recovery (Bohora et al., 2021; Jing et al., 2021; Zhang, Xu, and Muntean, 2021; Zhang et al., 2022) is an important function of the database system. Periodic backups of structural information (e.g., schema, indexes, and so on) and stored data help database managers and database administrators (Aleryani, no date) avoid data loss and corruption. Administrators restore the database from a backup in the event of hardware failure, data damage due to bugs, system problems, or other circumstances. Cloud-based services and apps must back up expand data.

Many cloud providers execute regular database backups and recovery in order to ensure the safety of their customers' data in the event of a breakdown (Chang et al., 2021; Jiang et al., 2021; Maher and Nasr, 2021). A failure is a situation when the system doesn't operate as expected. Some failures are the result of hardware problems (such as a power outage or disk failure), software

problems (such as program flaws or incorrect data), or human mistakes (For instance, an operator mounting the incorrect tape on a drive or an inadvertent user action.) Failure happens when the system's algorithms attempt to process an incorrect state. Physical and logical backup and recovery are common in database systems. The physical technique uses raw data by copying database files, while the logical technique extracts data as a sequence of query statements. Both solutions offer full backup and restore of the entire database and incremental backup of updated data since the last backup. Both backup options are slow and need extra I/O operations.

A physical technique, which duplicates files containing the database's architecture and table files, is one of the ways. The physical technique is intuitive since it involves duplicating the database's files for backup and recovery. A logical technique, on the other hand, analyzes the whole database for sequences of query statements that may be used to recreate the database. Backup and Recovery data is portable between file systems (Cameselle and Labrador, 2021), operating systems (Banecs, Babarada, and Ravariu, 2020), and MySQL versions since the logical technique are based on query statements.

A. IMPORTANCE OF BACKUP AND RECOVERY

The backup copy can be retrieved if the main data is lost. An attack (virus or malware), accidental data erasure, or data corruption can cause primary data failures. Hardware or software faults can generate these events. Backup copies allow data recovery from an earlier time, which helps a company recover after an unanticipated event.

In order to protect against the loss or distortion of the original data, it is required to keep a copy on a secondary medium. As simple as a USB stick or external hard drive, as complex as a disk storage system, cloud storage container, or tape drive, this additional medium can be used to store data. There is no right or wrong when it comes to where you store your backup media. Keep copies of data from weather-related incidents in remote locations.

Regular backups reduce data loss between backups. The time between backups increases the possibility of data loss when recovering. Multiple data copies allow you to restore to a time before data damage or malicious attacks.

B. DATABASE BACKUP AND RECOVERY TECHNIQUES.

There are p and logical strategies for backup and recovery databases. Physical backup uses raw data, while logical uses query statements. As proposed, both techniques are at the application layer. This section explains backup and recovery mechanisms.

1) Database Backup

A database backup is a method of periodically establishing the second instance of a database. A DBA can perform this task manually, with the use of a backup script, an automated service, database administration software, or by hand. The database can then be retrieved in full or in part from the backup. Backups can be classified as either logical or physical. Physical backups are made up of copies of the original database files. When it comes to logical backups, the Oracle Export tool is used to extract and store binary data. In addition to physical backups, logical backups can be used. There are two main reasons to keep backups. Restoring a system's state is the first step in disaster recovery, whereas restoring specific files that were accidentally deleted or corrupted is the second. (Kadry et al., 2011).

There are three main methods for backing up databases: full, incremental, and differential. Organizations should employ a solid mix of at least two of these techniques to reduce downtime.

i. Full Database Backup

A full backup is the most fundamental and comprehensive kind of backup process. When a full database backup is conducted, all the database's data is saved. For example, Xtrabackup of Percona [6] makes use of a physical backup to give a backup solution. Xtrabackup creates a complete backup of your database by copying all its files (Kim, Yeom, and Son, 2020). Complete backups can copy all data, including user data, system files, and configuration information. This backup replicates data to a disk or tape. Duplicating everything is slow. Complete backups for every operation store all data on a single set of media. This statistic is called a recovery time target. It takes longer to conduct a full backup and requires more storage space.

This backup method is typically done periodically for large data centers, however, if the database is a small one, this type of backup could be done on a daily or even a more frequent interval. This strategy guarantees that all data is in one location from a given date even when a full backup takes some time. The procedure can thus be continued with a substantial amount of data even if there is some data loss during the restoration process.

Full backups are run periodically. Small data centers (especially those with critical applications) may do a full backup daily or more often in some cases. Complete backups are often used alongside incremental or differential backups.

ii. Incremental backup

Incremental backup copies or scans new or altered data. The incremental backup compares each database page to the most recent backup. Xtrabackup puts altered pages in delta files (Kim, Yeom, and Son, 2020). Incremental backups iteratively replicate updated or new files since the last full backup. This backup compares state changes since the last incremental backup. This backup is suitable for restoring recent changes in manageable portions. An organization compares the altered time stamp on files to the most recent backup's time stamp. Backup software records the date and time of backups to track file changes.

Incremental backups take less time and data. An organization can conduct incremental backups as often as needed and only store the most recent changes since they only duplicate changed data since the last backup. Incremental backups duplicate less data than full backups. This will speed up backups and save space. Full and incremental backups are needed to restore a database if all data is lost. In this scenario, we set up a weekly incremental backup schedule with level 0 on Sunday, level 1 on Wednesday, and level 2 on other days (Li and Xu, 2009).

iii. Differential backup

This backup method keeps the most recent updates since the last full backup. Differential backups include all data that has been modified since the last full backup. Differential backups improve backup and restore times. Differential backups are faster and smaller than complete database backups because they record just updated or new extents (Kadry et al., 2011). Differential backup stores accumulated changes between initial and daily transaction backups. After a differential backup reaches a specific size, a full backup should be run; otherwise, backup copies will be larger than the baseline. Because of differential backups, only a full backup is needed for restoration. This strategy requires more room and network capacity to check the most recent data.

First-time differential backups act like incremental backups, copying all changed data since the last backup. After that, it copies all data changed since the last full backup. It saves less data than a full backup but more than an incremental backup over time. Differential backups take longer and consume more space than incremental backups, but less than complete backups.

2) Database Recovery

Database recovery restores the destroyed, corrupted, or inaccessible data. Data recovery in enterprise IT means restoring data from a backup to a computer, server, or external storage system (Sharma et al., 2012). It is the process of recovering or restoring database data after a system crash, hacking, transaction errors, coincidental damage, infection, unexpected failure, wrong command implementation, etc.

Data saved in databases should always be available, despite data loss or errors. The database must provide tools for quick data recovery.

Atomicity means either the transactions exhibit the result of successful completion permanently in the database, or the transaction must have no trace of achievement in the database. Data backup and recovery might be voluntary or automatic. Postponed updates, fast upgrades, and data backups can prevent database loss.

Log-based Recovery and shadow paging can recover databases. Reusing the latest pages speeds up recovery for applications using locality. Though the system fails again during recovery, the database stays consistent because Backup List pages are still in stable memory (Choi et al., 2000). Table 1 below also shows the research Objectives and relevant motivations that were set up for the purpose of this review article.

Table 1: Research Questions and Motivation

S.No	Research Question	Motivation
RQ1	Available Feature of Database backup and Recovery	Recognize the backup and recovery functions as a benchmark for designing a database backup and recovery system that supports business needs.
RQ2	Supported technologies	Identifying the best tools to cut down on the time and money needed for backups and recoveries
RQ3	Security issues in Database backup and recovery System	Examine the causes of any backup/restore security problems and provide improved approaches if possible.
RQ4	Backup and Recovery methods of different database	To assist database users on how to effectively backup and restore their data.

Here's how the paper continues. A review identifies and describes database backup and recovery solutions. After discussing the review's findings to propose research views, we conclude our study.

II. LITERATURE REVIEW

Karina Bohora, et al. (Bohora et al., 2021) reviewed Cassandra's backup and recovery procedures. The study analyzed state-of-the-art literature on the topic and discussed Cassandra's deletion method, backup and recovery difficulties, and the study also discusses node and data center failure detection and handling. Also reviewed are

backup and recovery options, including disaster recovery.

The research of Hwajung Kim et al. (Kim, Yeom and Son, 2020) is important for database backup and recovery. The study focused on write-ahead logging (WAL) for database backup and recovery. They created a backup solution that uses existing log data without new I/O operations. Using many threads, we optimized WAL's crash recovery mechanism. MySQL is the implemented and evaluated scheme. Experiments show that the suggested technique provides instant backup by eliminating I/O processes. The suggested scheme recovers faster than existing schemes. Yongseok Son et al., (Son et al., 2017) did another comprehensive survey examined the SSD-assisted backup/recovery (Jung and others, 2019; Baek et al., 2020; Dagnaw, Hua, and Zhou, 2020) Database backup and recovery technique using flash-based SSDs (BRSSD). The backup/recovery feature employs a Samsung SM843Tn enterprise-class SATA-based SSD. They later used BR-SSDs on PostgreSQL and MongoDB (Sharma, Sharma, and Bundele, 2018; Makris et al., 2019, 2021; Zimányi, Sakr and Lesuisse, 2020; Woltmann et al., 2021), and different workloads, backup scenarios, and environments were used.

Data backup and recovery are essential to any recovery plan. Backup and recovery are strategies and methods for preserving the database from data loss and regenerating it after data loss. Infrastructure and technical solutions influence database recovery. Some recommendations bridge business-oriented studies with disaster recovery facility design (Cegiela, 2006). In the event of a database recovery, TAIL LOG is used. This option backs up the transaction log and enters recovery mode. Restore all backups. When migrations demand a minimal level of lack, this method is utilized (Gotseva, Gancheva and Georgiev, 2011). Many academics have studied offering backup and recovery across storage levels. For example, ext3cow (Peterson and Burns, 2005) and BTRFS (Rodeh, Bacik and Mason, 2013) backup and restore data using snapshots and copy-on-write (CoW) methods. In addition, numerous researchers have investigated changing the flash translation layer (FTL) of flash-based solid-state drives (SSDs) to provide backup and recovery capabilities on the storage device itself (SSDs) (Huang et al., 2012). Snapshot-based file system backup interferes with normal operations, since ordinary SSDs lack backup and recovery

functionalities. To increase recovery and run-time performance, SSDs can be used instead of hard disks (HDD) (Son et al., 2017). Flash-based SSDs provide fast throughput and low latency, making them suitable for data-intensive apps. Using WAL log data to backup databases without adding extra queries or I/O activity shortens recovery times. The suggested scheme on MySQL 8.0.15 analyzes backup and recovery using sysbench. Hwajung Kim et al. (Kim, Yeom and Son, 2020) Storage device performance was assessed for database backup and recovery. This work is crucial for database backup and recovery procedures.

III. METHODOLOGY

A. Systematic Literature Review

In order to accomplish our targets, we used a systematic methodology to conduct our research. Various learning strategies have been thoroughly investigated in order to safeguard the backup and recovery system. This study was based on research articles in the field of database management system backup and recovery techniques. Figure 04 below shows the flowchart of paper selection.
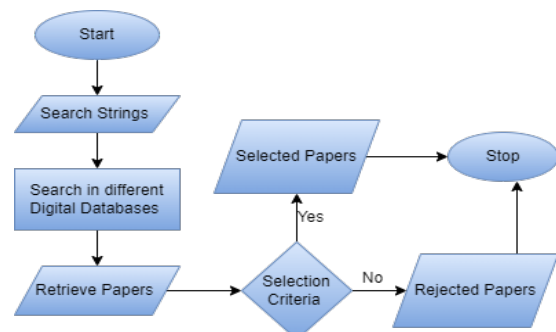
Figure 1: Flowchart for paper selection

This research examines the available literature to learn about the latest innovations and backup and recovery techniques. This technique outlines how to find, understand, and analyze research articles, making it easier to find supporting data. The search plan included expert planning and string validation. From the search results, peer-reviewed and high-quality database publications and conferences were filtered to explore database backup and recovery techniques.

The search phrases were carefully crafted in response to the research question. The search keywords were adjusted several times in order to assemble practically all the relevant papers. As a result, several search strings with different combinations of words were utilized to find relevant papers. "Database backup" AND

"Recovery Techniques" AND "Physical backup and logical backup" OR "MySQL". An automated search was conducted using these search strings using the search engines of numerous digital libraries. The paper selection criteria were then used to further filter out the most relevant research in this field. The rest of the paper discusses the database backup and recovery techniques that we derived from the review.

B. Test the Backup and Recovery methods of different database

A database backup and recovery test implementation for various databases was performed in addition to the systematic review. MySQL and NoSQL database techniques are used for the test. The backup and recovery commands of MySQL and MongoDB have been used to compare the two databases

IV. RESULT AND DISCUSSION

A. Full, Incremental, and Differential Backups

Table 2: full Vs. incremental Vs. differential Backups

Feature	Full Backup	Incremental Backup	Differential Backup
Cost	High	Low	Medium
Time	High	High	Low
Availability	High	High	High
Storage Space	High	Low	Low
Cost	High	Low	Medium

A comparison of full, incremental, and differential backups is shown in Table 02. In order to keep multiple copies of a complete file system, the full backup factor is relatively high. The cost of the backup depends on the number of locations and the size of the files being backed up. Incremental generally copies the last changes while differential copies the updated and original file system, hence those are identified as low and medium respectively.

It takes more time to do a full or incremental backup than the difference between the two. It's because of the most recent incremental upgrade and full file backup. However, there is no such problem as differential backup.

The backups' availability features can be accessed round-the-clock. As a result, all backups are readily available and highly efficient. Whenever a user needs data, they can get it instantly and without error.

Full backup uses a lot more space than the other two because it copies the complete file system. In contrast, the remaining two perform a small number of file backups

B. Backup techniques, databases, and other features

Table 3: Backup and Recovery Technique and the findings

Author(s)	Technique	Database	Findings
Karina Bohora, et al.	Typical Backup and Recovery	Cassandra NoSQL	Failure identification and management
Hwajung Kim et al.	log data for write-ahead logging (WAL),	MySQL	crash recovery procedure of WAL, throughput, latency
Yongseok Son et al.	SSD-assisted backup/recovery, BR-SSDs	PostgreSQL and MongoDB	evaluated database backup and recovery with different workloads, backup scenarios, and environments
R. Cegiela	TAIL LOG	MySQL	latest possible transaction
Many studies with many authors	ext3cow, BTRFS, copy-on-write (CoW), flash translation layer (FTL), SSD, hard disk drives (HDD)	MySQL, NoSQL	the storage stack, run-time performance
Hwajung Kim et al.	Potential Techniques	MySQL	storage device performance

Table 03 demonstrates the diverse methodologies and conclusions of different authors. A variety of methods were employed by the authors, as can be seen in table 3. The WAL, SSD, TAIL LOG, CoW, FTL, and HDD are some of the backup and recovery techniques. The authors also discovered malfunction recognition, disaster recovery, metrics of throughput and latency, backup and recovery, workload management, transactions, storage management, and run-time performance

C. Test Implementation of backup and recovery technique for MySQL and NoSQL

1) MySQL Implementation

The MySQL database's backup and recovery test implementation is depicted in Figure 03. The newly formed database schema is called "student," as can be deduced from figure 05's separate picture "01". Image 02 in Figure 03 illustrates the backup command and where the "student" backup is saved. Here the location of the student backup is "G:\Backup". In addition, once the backup command (Mysqldump) has been executed, the backup can be found in the place indicated in the figure.

"03" depicts the deletion of the database schema, whereas "04" depicts the construction of a schema with the same name, "student." The image "05" showed how the student database was being restored, and the image "06" showed the student schema tables that could be used after backup and restoration.
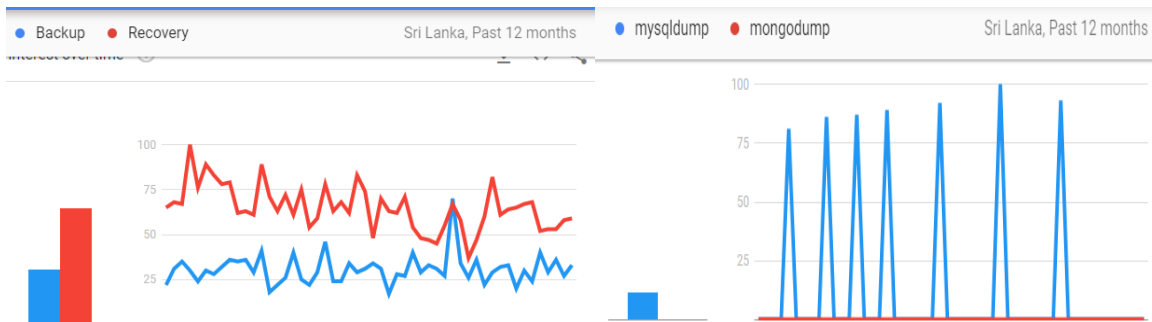
Figure 2: Google Trend search of backup, recovery, mongodump, and mysqldump

Figure 3: Backup and Recovery Process of MySQL

The test implementation allowed us to comprehend the database backup and recovery procedure. In addition, we can discover how it operates without much effort and how it gives substantial support for the MySQL database

2) NoSQL Implementation

Figure 04 illustrates the whole backup and recovery procedure of the NoSQL (MongoDB) database. It is evident from "01" that the newly formed database instance is entitled "myNewDB".

The image "02" in figure 06 demonstrates the

wiped totally. Image "04" shows the restoration operations of the NoSQL database. Once we apply that, we can get the database schema back as in the image "05". MySQL and NoSQL provide vast support and easy service to the backup and recovery process. The Google trends show that in the past 12 months, web search volume for recovery is very high when compared with the backup process. Furthermore, another noteworthy fact to notice is that MySQL backup is a more frequently searched backup process than NoSQL backup. From what it seems, most companies and organizations still rely on the MySQL database.

01

03

05

02

04

Figure 4: Backup and Recovery Process of NoSQL

NoSQL database backup procedure with the "Mongodump" command. Once we use that command, the schema is placed in the right spot. The image "03" displays the database deleting process. Once, after performing that query, we can observe that the "myNewDB" schema has been

V. CONCLUSION

In this study, we propose efficient backup and recovery techniques for database systems with reference to the extant literature available and test implementations. Some solutions for recovering

and backing up large databases have been suggested. The identified different types of database backup and recovery can be listed as full backup, differential backup, incremental backup, Log Based Recovery, and Shadow Paging. This study was able to identify the major and trending backup and recovery techniques of database systems of different databases. Most organizations do not aware of how to handle database backup and recovery. Different types of databases have a different database backup and recovery techniques. Understanding the type and working procedure of the database's backup and recovery techniques will help the organization secure the sensitive data during the calamities and will enable them to continue the service without any interruption. If the user applies the right technique and implements it correctly, this will be one of the potential remedies for database backup and recovery problems.

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State-of-Art Frameworks for Front-end and Back-end Web Development

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Abstract

Identifying software requirements, designing, coding, and testing using frameworks and technologies are all part of the web application development process. Frameworks are collections of libraries and classes that provide a wide range of capabilities. For front-end and back-end development, there are a variety of frameworks that support multiple programming languages. Front-end development employs front-end programming languages to create what the user sees on a website; back-end development employs back-end programming languages to fulfill those requests on the server side. When used together, it produces a unified look and feel. The database is where the data for web applications is stored for usage by back-end frameworks. Choosing the proper combination of front-end and back-end frameworks is the most critical component of the web development lifecycle. This paper discusses front-end and back-end frameworks. A systematic review was conducted utilizing highly cited publications, narrowed down to the most recent and relevant works in the research area. This study intends to give researchers and industry developers a brief reference to web development tools through a critical review.

Keywords: web application, front-end frameworks, back-end frameworks, angular js, Laravel

I. INTRODUCTION

The expression "web application" was initially reported in early 1999 as another technique for executing an application program from a web worker. Web applications are used to develop web applications that preserve and conduct operations using data. The framework results from aggregate knowledge, including numerous libraries and advantageous apparatuses from different engineers. They help diminish the vast majority of the monotonous undertakings and complex errands in the primary interface while implying that designers can compose less and accomplish more with the best caliber in a specific e. In this way, utilizing a dependable structure also helps bring down the improvement cost (Nguyen, 2015). Frameworks may comprise source code libraries, utilities, modules, advancement models, and a wide range of devices, the aim of which is to speed up the improvement speed of an application. Frameworks can help us carry out capacities like security, see layouts, confirmation, and approval of the information, and techniques for taking care of information in a database (Gallardo, C. 2011). MVC helps web development frameworks in detecting architectural design complexity and increase code flexibility and reuse (Cui *et al.*, 2009).
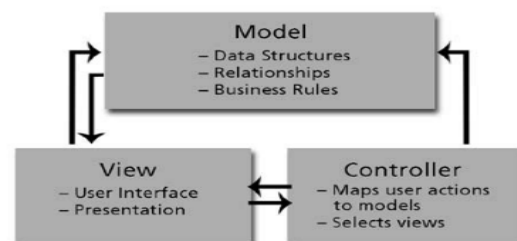
Figure 01: MVC architecture

The frontend service and the backend service are the two independent services that make up the web application. Through API calls, these two may talk to one another. While the back end of the program handles the business logic, the front end of the application manages user interaction. There are several benefits to having a distinct service handle the front end and back end independently, including quick development, simple upgrades, and high maintainability. But this also has drawbacks, one of which is the danger of running two different instances of the same program simultaneously. This interferes with the pipeline for continuous integration and deployment (Dinku, Z. 2022)

II. METHODOLOGY

This section outlines the chosen review topic and the data collection, processing, and analysis procedures. Finally, it concludes with an overview of the review framework.

Identifying product requirements, designing, coding, and testing by using frameworks and technologies are all part of the web application development process. Frameworks are collections of libraries and classes that provide a wide range of capabilities. For front-end and back-end development, there are a variety of frameworks that support multiple programming languages. Choosing the proper combination of front-end and back-end frameworks is the most critical component of the web development lifecycle. So, hopefully, this article has covered a couple of the essential front-end and back-end frameworks.

This review article referred to information from several reputed online articles and journals. It helped me to learn about the pros and cons and other details of all frameworks. This paper is mainly divided into two categories such as front-end frameworks and back-end frameworks. This framework is summarized into many main parts: introduction, advantages, disadvantages, and performance.

III. DISCUSSION

A. Front-End Frameworks

Shetty, J. *et al.* (2020), this paper discusses the front-end framework as Front End Framework is the part of an application or website where users interact with it. It incorporates all that clients run over straightforwardly, including pictures, buttons, text color, diagrams, and tables. A front-end framework creates the behavior, architecture, substance, and design of all of it visible on-screen while versatile/web apps are launched.
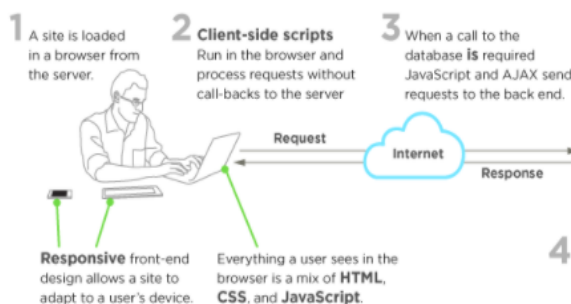
Figure 02: Front-End Development

1) Angular JS

Hutagikar, V. and Hegde, V. (2020) discuss the Angular JS introduction. This framework was first distributed in 2009 and was renamed AngularJS. This term reflects refreshes past to rendition 2.0 – the later forms are named Angular. Ollila, R. (2021), the topic of Angular js is discussed in this article. Another point is that AngularJS is one of the soonest broadly utilized web front-end systems with an express objective of empowering the explanatory programming model. AngularJS is at this point considered out of date, having been supplanted by a replacement confusingly likewise called Angular.

The first one is Right away into sees given two-way information restricting in a straightforward, viable, and natural way. Another one is Construction and engineering fabricated particularly for better adaptability of ventures.

The first disadvantage is that Angular has different structures (Injectable, Components, Pipes, Modules) in examination with React and Vue.js have just part, the previous is harder to learn. Another one is continually refreshing: new, significant upgrades are constantly made. This can cause issues for designers concerning adjusting to them Hutagikar, V. and Hegde, V. (2020)

Angular is more reasonable for Applications with dynamic substance Enterprise applications and large applications.

2) React JS

Shetty, J. et al. (2020) reviewed ReactJS. ReactJS was a JavaScript package that created a dynamic web application. It has been created and kept up via Facebook. Respond was a productive, definitive, and adaptable JavaScript package for creating web applications. Because of React's amazing highlights, Facebook delivered React as a free-source JavaScript ES6 base package to worldwide designers and organizations in 2013 Xing, Y.K., Huang, J.P. and Lai, Y.Y. (2019). ReactJS utilizes JSX to improve on composing HTML. JSX is a pre-processor that adds XML linguistic structure to JavaScript.

The first advantage is React, a virtual DOM that accomplishes ideal proficiency by redelivering hubs as wanted. Another point is that functional programming of response helps in making reusable code.

The main point is that need to import libraries for state and model, as the response does not carry Out. Another disadvantage is that react moves from class-based modules and can impede Object-Oriented Programming (OOP) for engineers to feel looser.

React is a plausible structure for applications that requires fast. Applications that require adaptability Hutagikar, V. and Hegde, V. (2020)

3) Vue

Shetty, J. *et al.* (2020) the topic of Vue explained in this section. Vue was a platform for creating singular software applications but also user interfaces. Vue intended to exit steadily versatile engineering that spotlights on standard delivery and segment piece. Vue expands HTML with HTML ascribes called "directives".

The first advantage is that Vue.js assists with generally building expansively secluded. Another point is its reactivity is perhaps the most grounded highlight of Vue.js, and Vue is treating unique two-way information restricting like nothing else at the point when the information is refreshed, the DOM ought to consistently be altered as needs be, which is ideal for SPA Hutagikar, V. and Hegde, V. (2020).

The first drawback is that compared to Respond or Angular, Vue.js just has a moderately low portion of the overall industry, which implies that data trade in this structure is just in the beginning phases. Another point is the risk of being over-adaptable while coordinating with enormous ventures because of the absence of assets.

Vue.js is more reasonable for applications such Lightweight applications, when there is a prerequisite to incorporate into existing applications, Where speed is a primary boundary.

Table 2 displays how each platform and library handles data binding.

Table 01: 2021 Related Framework Version

Frameworks	Version
Vue	3.0.7
Angular	11.2.3
React	17.0.1

Table 02: Comparison of angular js and react js

Criteria of comparison	ReactJS	AngularJS
Level	A fantastic JavaScript package	JavaScript platform with excellent performance
Why make a choice?	if the "everything is JavaScript" method	if you are coding in typescript
originators	Preserved by Facebook	Preserved by google
Learning experience.	Compared to angular, it is a lot easier to understand.	Rough learning process
design	according to virtual DOM	according to the model view controller
in writing	JavaScript	Typescript
Help from the community	excellent support from the community	excellent support from the community
popular	utilized by 75% of programmers	utilized by 20% of programmers

Table 03: Front-end frameworks with data binding

	Vue	Angular 1	Angular 2	React
Data Binding	One-way/ Two-way	Two-way	One-way & Two-way	One-way

Table 04: Performance of front-end frameworks and library memory allocation

Activity	React	Vue	Angular 2
Run memory	9.7 +_0.1 (2.6)	7.5+_0.1 (1.9)	10.9+_0.1 (2.7)
Ready Memory	4.5+_0.1 (1.3)	3.8+_0.0 (1.1)	4.8+_0.0 (1.4)

4) Next JS

With production-ready capabilities like server-side rendering, Typescript support, smart bundling, route prefetching, etc., Next.js combines developer experience. There are numerous crucial aspects to Next.js. Hot code reloads, often known as the capacity of the Next.js server to recognize updated files and immediately reload them, are the initial feature. Since the files must be placed in the pages folder and are mapped to all URLs with the option of customization, automatic routing is another feature that does away with the requirement to set up URLs for routing. For online applications that demand speedy load times, next.js is used to construct landing pages, SEO-friendly websites, e-commerce storefronts, and other web apps. Dinku, Z. (2022)

B. BACK-END FRAMEWORKS

Shetty, J. *et al.* (2020) discuss the back-end framework. Back-end platforms were assessed by their programming techniques, backed dialects, and interfaces. Likewise, platforms that give work in devices and formats assist originators after numerous web progression speedily completing projects. An excellent level back-end configuration assembles the headway speed, which saves time. These frameworks should allow originators to make interoperable applications that can build the obligation
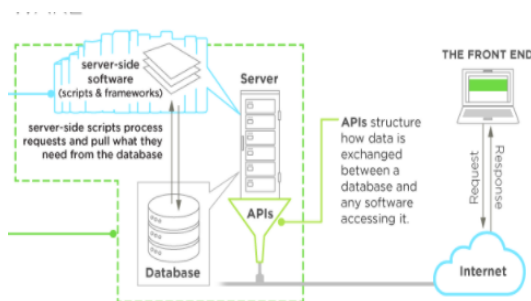
Figure 03: Back-End Development

1) Node.js

Shetty, J. *et al.* (2020) reviewed Nodejs. NodeJS is a publicly released climate with an extraordinary number of clients worldwide that add to its archive or bundles or modules. These days, Node.js is dynamically becoming a go-to innovation for various organizations. Another thing is that Node.js is an offbeat occasion-driven JavaScript runtime intended to fabricate adaptable organization applications. It upholds the treatment of numerous associations simultaneously. Get back to is set off for every association, and it sleeps if there is no work to be finished.

The first benefit is that it is tremendous respect for execution. Another one has a strong Angular-like design. The Disadvantages of Node.js is that the, absence of documentation, absence of local area support.

2) Django

Linowes, J.S. (2007) this paper discusses Django's introduction. Django is a web structure dependent on the python programming language. It deals with a large part of the battle of web application advancement, permitting engineers to zero in on composing the real business rationale of the application without expecting to waste time. It is unimaginably flexible. Django deals with numerous important undertakings of web improvement like client confirmation, website maps, content organization, and RSS (Really Simple Syndication) channels Shetty, J. *et al.* (2020). Something that Django is "popular" for is its implicit authoritative highlights. The system can produce a pleasantly planned arrangement of administrator pages to make, recover, update, and erase (CRUD) things in the model. It can likewise look, channel, and sort the rundowns. Every model presented to the admin class shows up on the administrator/landing page. Dissimilar to Rails' platform, the administrator is cleaned sufficiently that it very well may be given to end clients in a creation site.

3) Ruby on Rails.

Dawson, K. (2010)], this paper discusses Ruby on rails. The Ruby language and the Ruby on Rails framework are both free. Ruby, for the most part, alluded to as Rails for short, is much more current than the Ruby language in reality. Ruby (the language) was first delivered in 1993, while the primary rendition of Rails (the structure) was not delivered until 2004. The Rails system, including the just-delivered Rails 3.0.

4) Laravel

Laravel 5 is ideal for PHP designers who need to make a quick model just as an enormous scope project later. The learning curve is also not so steep because its documentation is very comprehensive and precise. The Laravel people group is likewise enormous, and web engineers can undoubtedly discover responses to their inquiries and assets on the web. Laravel 5 is a full-stack and rich element web structure, and it has all that web engineers may require. From advancement climate, information base movement, and MVC structure. It is worth specifying that Laravel is outfitted with the craftsman, who has an exceptionally

Table 05: Comparison of node.js and Django

Criteria of comparison	Django	NodeJS
costs	free and open sources	free and open sources
scale	lower scalability	more scalability relatively
structure	model -template - view	programming based on events
protection	It is new, and it has powered by Node.js.	Many nations use node.js, and it has a competitive advantage.
performances	Its performance is excellent.	Its performance has improved.
complexities	It is a little more complicated than Node.js.	It is a simpler version.

convenient toolset. The system additionally accompanies its ORM (Eloquent), a lovely and straightforward Active Record execution. Also, Laravel 5 is exceptionally simple to test, contrasting with Laravel 4 (Nguyen, 2015).

The first benefit is that applications requiring a dark back-end are more appropriate to make with Laravel, whether enormous or little in scale. Another one is a transient box, estate prepackaged in Laravel that made it simpler to work. And speed, security, and consistent data migration.

Table 06: In terms of MVC Architecture, there is a comparison between PHP and the .net framework.

NO	Criteria	PHP	ASP.NET
1	page load time	676	370
2	The transmission speed of response	0.101	0.612
3	time till the first byte	383	213
4	speed of transfer request	5.93	10.68
5	time till the last byte	293.47	165.69

The results of the tests are displayed in Table 6. It indicates that a web application built with.net produced better results in page load time, time to the first byte, and time to the final byte compared to a PHP-based web application. The PHP-based site, on the other hand, provides substantially better results in terms of solicitation and response time Jailia, M. (2016)

5) Spring Boot

Microservices work well with Spring Boot, but huge monolithic systems are not recommended. Direct deployment of the artifacts into Docker containers is possible. Web application development is made simpler with Spring Boot. A

cutting-edge web development paradigm that facilitates the improvement of server-side UI apps, REST APIs, and bidirectional, event-based frameworks are supplied in standard code and setup connected to web advancement. Developers may monitor and get insight into the application with the use of spring's production-ready capabilities, such as health status monitoring, metrics reporting, and tracking. Shetty, J. *et al.* (2020)

It supports a variety of widely used authentication methods, including LDAP (Lightweight Directory Access Protocol), OAuth, and SAML (Security Assertion Markup Language). Numerous relational and non-relational databases, cloud-based data services, and frameworks for map-reduce operations like Spark, Flume, etc. are supported. Java, Kotlin, and Groovy are all supported by spring.

IV. CONCLUSION

Each web framework, information base, and web framework have benefits and drawbacks. The picking of web framework ought to be done dependent on many essential components like time expected to take the item to advertise, long haul adaptability and upkeep, simplicity of writing computer programs, and engineer's capability with the advancements. So, every one of these variables is imperative to be thought of while building present-day web applications.

This paper examined the appropriateness of the front-end frameworks and back-end frameworks for creating Web applications. The front-end frameworks Angular, Vue.js, and React described their advantages and disadvantages. The back-end frameworks NodeJS, Laravel, Ruby, and Django described their advantages and disadvantages. The criteria for the selection of a specific framework were ident.

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TRACK - COMPUTING AND INFORMATION SYSTEM (CIS)

Applications of Mobile Ad Hoc Network (MANET): A Survey

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Abstract

With technological advancements, the network has also evolved to keep up with current tendencies. Mobile Ad hoc Network (MANET) is a technology that consists of a collection of mobile nodes. These nodes communicate with one another without the need for a central administrator. MANETs offer a varied range of applications in many domains such as education, sensor networks, disaster relief, and the military. The widespread of ad-hoc networking is due to the increase of wearable electronics and improvements in wireless communication. Ad-hoc networking can be used whenever there is a lack of or cumbersome usage of existing communication infrastructure. Ad hoc networking enables participants to maintain connectivity while easily adding as well as removing them from the network. MANET has a wide range of applications, from highly dynamic, mobile, and large-scale networks to static, tiny networks bound by power bases. This study used a systematic review strategy to acquire data from previously published studies from publishers, and these data were analyzed and evaluated as well. The study finds that there are numerous applications of MANET technology in various sectors. The magnitude of the dataset and the lack of quality attributes were two of the study's limitations.

Keywords: MANET, Mobile node, Mobile Ad hoc Network

I. INTRODUCTION

Smart transportation is an inevitable part of smart city development, where it is engaging with various emerging technologies considering the security of transportation (Kariapper *et al.*, 2019). This concept helps to track vehicles in real-time through smartphones (Mohamed Nafrees *et al.*, 2021), smart traffic systems (Nizzad *et al.*, 2021), etc. The architecture of Mobile Ad hoc Networks (MANETs) is seen in Figure 01. Enabling technologies, networking, application, and middleware are the three primary levels. The layer which allows technologies may be more separated into a Wireless Body Area Network (BAN), a Local Area Network (WLAN), and a Personal Area Network (PAN) depending on the coverage area (Ramphull *et al.*, 2021).

The MANET is a kind of wireless mobile communication network invented of mobile nodes with logical equivalency and wireless transceivers. It doesn't depend on any pre-existing infrastructure, but rather on cooperation among mobile nodes with restricted communication capabilities to preserve network connectivity as well as perform data transformations. It has the following characteristics: multi-hop, Mobility,
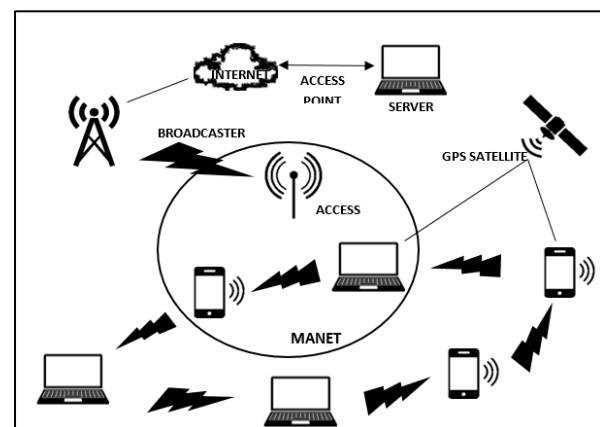
Figure 01: MANET Architecture

dynamic topology, self-organizing, wireless, distributed control, restricted connection bandwidth, as well as limited calculating capabilities, which are all features of the mobile network (Zhang *et al.*, 2019). MANETs can be used in a variety of fields, including education, sensor networks, disaster assistance, and the military (Ramphull *et al.*, 2021).

Because MANETS nodes have a limited transmission range, direct communication between the source and also destination is not possible when they are outside their transmission

zones. As a result, intermediate nodes participate in communication, and MANET's communication is divided into two types: "Single Hop Communication" and "Multiple Hop Communication." In the former, nodes within the radio range of each other interact directly, but in multi-hop communication, intermediary nodes assist in relaying messages to their destinations when the destination node is beyond the source node's radio range. Transaction data is not affected by their physical location or proximity to the foundation. In contrast to foundation structures, MANET hubs are all adaptable and their connections are dynamic. MANETS, unlike other flexible systems, do not require a solid basis. This gives the system a valuable decentralized aspect. The structure becomes more adaptive and stronger as a result of decentralization. The use of MANETS may be found in a variety of disciplines. Furthermore, ad-hoc planning is obtaining significance with the growing amount of far-reaching applications in the corporate, private sectors, and military thanks to the proliferation of mobile devices and advancements in remote correspondence. Clients can connect to Ad-Hoc Networks on the go.

Further, the paper has been organized as section II grants the literature review for attaining the applications in MANET. Section III presents the methodology used for this article. Simulation results and discussion is particularized in Section IV and the article is concluded in Section V as well.

II. LITERATURE REVIEW

In a network, each mobile device is self-contained. Mobile gadgets are permitted to roam about as well as organize themselves in whatever way they like. In other words, an ad-hoc network is a wireless network that does not rely on any fixed infrastructure. Multi-hop pathways are used in MANET communications. The MANET's nodes share the wireless medium, as well as the network's architecture, which varies irregularly but also dynamically. Because nodes in a MANET (Muruganandam and Renjit, 2021) are allowed to relocate to any location, communication links are frequently broken. The number of nodes and their density is determined by the applications in which MANET is used (Kumar and Mishra, 2012).

Any of the proposed MANET protocols must be tested and evaluated to ensure their success in a real-world application. Researchers in this field can test their MANET protocols using one of three methods: test beds, simulation tools, and emulators. The simulation tool is an application that, when given a set of controlled inputs, behaves or works like a genuine system (Hortelano *et al.*, 2010). The scale of a wireless ad-hoc network changes dramatically as the number of applications develops, from a network of a few mobile computers in a classroom to a battlefield network of hundreds of mobile units. As nodes travel about a deployed region, a network of a thousand nodes might be broken into several smaller networks of a few hundred nodes (Dhar and Jose, 2005).

Ad-hoc networks of laptops mobile nodes or PDAs that are self-monitored and self-organized and utilized for quick communication during, military operations, information exchange, disaster relief, and emergencies. MANETs have several characteristics, including changeable limited physical security, topology, power limits, and energy. Vehicular Ad-hoc Networks (VANET) is a type of MANET that allows automobiles and permanent roadside devices to communicate with each other (Singh *et al.*, 2011).

Mobile Social Software (MoSoSo) and cluster-based applications for instance emergency/rescue operations or military are widespread on MANETs. An application topology is a group that is not taken into account by present techniques. To gather resource information, there must be any query for all members individually otherwise flood queries throughout the entire network. This produces needless traffic that increases the time it takes to receive the needed source information in cluster-based applications. The prior work suffers from increasing duplicate traffic if there are numerous groups (Kwak *et al.*, 2009). MANET allocates resources for multimedia applications by both agent-based and traditional approaches. Preemptive policies, pricing policies, failure, and congestion, multi-class services with alternate pathways, spatial resolution, bandwidth, load, resource reservation, real-time control, and multilayered-stream are all examples of classic bandwidth allocation techniques. For bandwidth allocation, certain agent-based approaches were suggested. It routes packets according to bandwidth as well as latency measurements (Varaprasad, Wahidabanu and Venkataram, 2008).

The MANETs have a vast area of applications, static networks, from mobile, highly dynamic networks to tiny, large-scale certain by power resources. Aside from legacy applications that migrate from old-style infrastructure to ad hoc environments, a large number of new services may and will be created for the new surroundings. Due to mobility nodes, risks from hacked nodes inside the network, changeable topology, scalability, partial physical security, as well as lack of central administration too. MANETs are more vulnerable to attacks than wired networks. MANET is more susceptible to malicious attacks as a result of these flaws (Goyal, Parmar and Rishi, 2011). Due to uninterrupted end-to-end video communication, Quality of Service (QoS) steering to support multimedia applications is critical over MANET. Nevertheless, traditional source and hop-by-hop routing protocols can't offer adequate QoS for multimedia applications due to the need to maintain state information at each node (Raji and Mohan Kumar, 2014).

The dynamic evaluation approach presented may be expanded to monitoring and assessing various distributed Trust Third Party (TTP) systems in MANET, since the dispersed Cryptographic Application (CA) is an example of the secret sharing application. This assessment methodology can assist administrators in mastering the network's dynamic security as well as taking measurements in real-time. It might be beneficial in actual network security design also construction (Mu and Changlun, 2010).

Ad-hoc networking is becoming increasingly widespread, with a growing number of applications, thanks to the increase of portable devices and improvements in wireless communication. When the current communication structure is unavailable or problematic to utilize, Adhoc networking might be employed. Ad hoc networking allows devices to keep their network connections while deleting and adding them from the network quickly and conveniently. From large-scale, mobile, and highly dynamic networks to microscopic, static networks constrained by power sources, MANET offers a wide range of applications (Bang and Ramteke, 2019). Through hardware enhancement, energy-efficient apps running in a MANET setup are tested, concentrating on issues as well as methods that are furthermost related to a decentralized ad-hoc context. When the participants' Mobile Devices (MDs) aren't conducting any meaningful action,

the extreme energy spent in MANET is equal to their idle time (Taneja, Taneja and Kumar, 2016). A fundamental challenge with MANET is arranging an acceptable amount of resources and reserving them for a lengthy period of time. Formulating techniques to support Quality of Service for individual applications is complicated. A protocol for MANETs that assigns channel resources in chronological order so that data transmission between a source and a target across a path can be and without interruption and easily. QoS can be improved to a larger extent by sharing network information across various tiers. Improved QoS has been achieved by merging network and MAC layer functionalities (Rath, Pattanayak and Pati, 2016).

III. METHODOLOGY

This study was written utilizing a qualitative method known as systematic review, which involved reviewing previously published research and review articles. Where the acquired data was examined using a qualitative manner to investigate MANET technology applications.

A. Article Selection Criteria

To shortlist the downloaded publications from publishers such as IEEE, Springer, Emerald, Inderscience, and Researchgate, the following important factors were evaluated. Figure 02 also shows a flowchart of the systematic literature review classification method.

  i.   Considered only full-length articles.
 ii.   Articles having a high index in citation databases.
iii.   Open-accesses articles
 iv.   Application of MANET technology (sensor networks, disaster management, commercial segment, education etc.)
  v.   Published in English

B. Research Question

  i.   What is defined by Mobile Ad hoc Network?

What are the applications of MANET technology?

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┌─────────────────────────────┐
│      Downloaded             │
│         50                  │
└─────────────────────────────┘
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Excluded	Not in English	→	Excluded 4
	No Clear abstract	→	Excluded 9
	No open access	→	Excluded 7
	No relevant content	→	Excluded 4
Eligibility	Publication with open access		

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┌─────────────────────────────┐
│ Article comprised for       │
│ qualitative survey          │
│         26                  │
└─────────────────────────────┘
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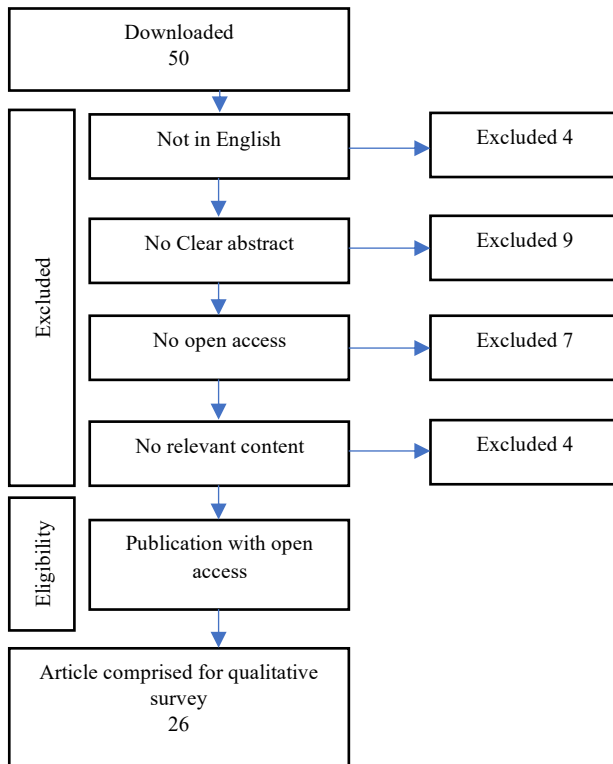
IV. RESULTS AND DISCUSSION

Figure 02: Arrangements of Research studies

Ad-hoc networking is becoming more important as a result of the rise in portable devices and advancements in wireless communication, as well as the rising number of widely used applications. Wherever there is little to no communication infrastructure, or if the infrastructure that does exist is either expensive to maintain or unpleasant to use, ad-hoc networking can be used. Ad hoc networking enables the devices to quickly add and remove devices from the network as well as retain connections to it. MANET may be used for a wide variety of applications, from tiny, static networks that are limited by power sources to big, mobile, highly dynamic networks. In a network, each mobile device is self-contained. Mobile gadgets are permitted to roam about as well as organize themselves in whatever way they like.

A. Sensor Networks

A high number of small sensors are frequently used in this sort of network. Sensors of this sort can be used to gather data from the environment, such as pressure, temperature, gas emissions, as well as pollutants. Each sensor has a finite amount of data to relay to a central computer; thus, it must rely on others. Such sensors have limited processing ability also are disposed to lose or fail too. Mobile ad-hoc sensor networks might be the

key to future home security (Nafrees, Sujah and Mansoor, 2021). Sensor networks have grown in popularity as technology such as Artificial Intelligence (AI) and the Internet of Things (IoT) has advanced. Many sensors are scattered around the environment, and each one must interact with its neighbors. As more sensors join the network, the topology changes (Ramphull *et al.*, 2021). Biological animal movement, Health monitoring, weather monitoring, and other uses (Singh and Prakash, 2020).

The network in this technology is made up of numerous tiny sensors. Sensors may be used to identify a vast range of area features. Pressure, temperature, pollution, poisons, and other variables are all checked via sensor networks. Every sensor's abilities are strictly constrained, and it should rely on others to provide data to a central computer. Single sensors have limited computational power and are susceptible to failure and loss. Future homeland security may rely on mobile ad-hoc sensor networks (Chouksey, 2016).

B. Disaster Management

Whenever rescue missions or crises, MANETs are deployed. Rescuers must be able to speak with one another to assist victims. Using inexpensive and readily available technological equipment, rescuers may construct ad hoc networks on the fly. The other organizations and government are developing reply response plans with ad hoc networks in mind, which might give rescuers relevant life-saving information as well as real-time. Disaster-related information may also be found on social media sites like Twitter and Facebook. Currently available data storage systems are unique and lack integration capabilities. To make the most of accessible data, a reliable and scalable storage system that allows for integration, reuse sharing and analysis is necessary (Ramphull *et al.*, 2021).

C. Military or Army

Ad-hoc networking permits the military to leverage the site's shared network structure to create an information network for transferring military information between troops, headquarters, and vehicles. Warfare in the future will be defined by the Network-Centric Warfare (NCW) concept. The armed community is always growing. The power of the communication network and the sharing of knowledge are increasingly appreciated in this concept. The

ideology emphasizes the need of achieving Internet-like capabilities in operating areas as well as retaining admission to an always-on network for communication (Ramphull *et al.*, 2021). There are computer devices attached to military equipment nowadays. Ad-hoc networking would enable the military to use the conventional network to maintain an information network between soldiers, military information headquarters, and vehicles (Chouksey, 2016).

PC technology is increasingly often seen in military equipment. A military might benefit from standard organized innovation by using specifically designated systems administration to maintain a data network among military headquarters, vehicles, and fighters. This sector is where the tactics of particularly assigned systems started (Chouksey, 2016).

D. Personal Area Network and Bluetooth

A personal area network (PAN) is a localized, small network in which nodes are often interconnected to individual devices. A short-range MANET, like Bluetooth, can shorten the connection with numerous moving devices, for example, laptops or mobile phones. For highly big and thick populations, a low-power operation is essential. It's critical to make the most of the device's CPU wireless bandwidth, cycles, battery capacity, and size (Ramphull *et al.*, 2021).

An Ad-hoc system can self-organize and link a temporary mixed media setup using scratch pad PCs or palmtop PCs to distribute and share data among meeting participants. Another suitable local-level use may be in home systems, where devices can connect especially to interchange data (Kumar and Mishra, 2012).

Short-extend MANET can help cell phone users communicate more effectively (for example, cell phone, tablets, and wearable computers). Remote associations replace traditional wired connections. MANET may also connect to the Internet or other systems through devices such as routers (Kumar and Mishra, 2012). Short-range MANETs can make interconnectivity between mobile devices easier. Wireless connections replace cumbersome wired connections. GPRS, UMTS, and Wireless LAN (WLAN) are examples of methods that may be used to expand access to networks or the Internet. In the future ubiquitous computing environment, the PAN might be a promising MANET application sector (Bang and Ramteke, 2019).

E. Local Level

The Ad hoc networks can connect a quick and temporary multimedia network employing palmtop computers or notebook computers to distribute and share information among classroom attendees or sessions. Another local-level use may be in home networks, where gadgets can talk straight to share data. MANET communications will have various applications in different neutral situations such as sports stadiums, taxicabs minor airplanes, and boats (Bang and Ramteke, 2019).

F. Education

The subject of education encompasses a wide range of applications based on MANET civilizations that can enhance their activities and create outcomes that benefit communication, learning, and teaching. Ad-Hoc networks allow users to create a real-time and temporary multimedia network on their device to distribute also share facts. MANETs are used in a variety of educational environments, including virtual conference rooms (Kariapper *et al.*, 2021), classrooms, and university campus wireless signals (Kariapper *et al.*, 2020). Wireless networks can expand their coverage area by communicating with a network that expands as well as mobilizes to meet the user's needs, without having to install additional access points, because the persistent link between the MANET and the wireless internet is generally sufficient. Campus networks can improve their coverage by cooperating and connecting a huge number of mobile devices (Ramphull *et al.*, 2021).

G. Commercial Segment

Ad hoc can be used in frequent cataclysms relief efforts, such as fire, surge, or seismic tremor, as part of crisis/safety operations. Where a non-existing or damaged interchanges framework, as well as speedy sending of a correspondence system, are necessary, protective actions must take place. Starting with one protected coworker, data is passed on to the next (Kumar and Mishra, 2012). During calamities, Ad-hoc Networks can be applied for emergency operations or rescue. To assist the people, rescuers must be capable of communicating. The process is made easier by immediately creating a data network with the communication tools that the rescuers previously have. Ship-to-ship ad-hoc business scenarios law enforcement, and mobile communication, are instances (Chouksey, 2016). An Ad hoc can be utilized in disaster relief energies, such as in the

event of an earthquake, flood, and fire. Where there is no damaged communications infrastructure, emergency rescue operations as well as the fast development of a communication network are required. A tiny hand-carried device is used to send information from one rescue team associate to another. Ship-to-ship ad hoc mobile communication, law enforcement, and other business scenarios are examples (Bang and Ramteke, 2019).

H. MANET-VoVoN

To allow audio streaming and user location via the JXTA virtual overlay network, a MANET-enabled version of the JXTA (Goyal, Parmar, and Rishi, 2011) peer-to-peer, modular, open platform is employed. A client can utilize MANET-JXTA to search asynchronously for a user and a call setup until a way to contact the user is provided. The program employs a proprietary signaling system based on XML messages sent across MANET-JXTA channels of communication (Bang and Ramteke, 2019).

I. Mobile Conferencing

Business customers that need to collaborate outside of their office but don't have access to a network can utilize ad hoc networks to do so. There is an increasing need for mobile computing environments in which project participants must cooperate on development and design. Documents must be shared, data must be uploaded and downloaded, and ideas must be exchanged (Dhar and Jose, 2005).

J. Other Sector

   i.   Entertainment: Virtual \classrooms, university campuses and Organizations, Meetings with wireless communications (Singh and Prakash, 2020)
   ii.   Emergency Services: In support of hospital administration (Mohamed Nafrees *et al.*, 2022), it is used for firefighting, policing, disaster management, and search and rescue operations, (Singh and Prakash, 2020).
   iii. Tactical networks: Weapons management on the battlefield, use for military applications (Singh and Prakash, 2020)
   iv.   Coverage extensive: For cellular network access scalability, using the internet of things (IoT) to connect the human body to the actual world (Singh and Prakash, 2020).

   v.   Tourism: Smart technologies and smart transportation highly increase customer satisfaction and attraction (Razeeth *et al.*, 2020; Nafrees and Shibly, 2021).

V.   CONCLUSION

Mobile nodes in a robust and challenging MANET network scenario are autonomous with self-configurable capacity due to the high frequency of topology changes and irregular rearrangement of network components through data transfer. Ad hoc mobile networks are widely employed in the business, government, and private sectors. Customers can use Mobile Ad-hoc Networks to access and exchange information regardless of where they are about infrastructure. In contrast to infrastructure networks, MANETs feature mobile, dynamically connected nodes throughout.

Moreover, there are several applications are available in MANET technology. These applications are used in several aspects as well. The study focused on the most relevant applications in Mobile Ad hoc networks such as commercial, military, education, mobile conferencing, Bluetooth, personal area network, local area, disaster management, sensor network, MANET-VoVoN, entertainment, tactical networks, coverage extensive as well as emergency services. The magnitude of the dataset and the lack of quality attributes were two of the study's limitations.

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Cyberbullying Behaviors in Anonymous Social Network

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Abstract

On a large scale, people use online social networks and mobile phones to harass victims with abusive text, images, audio, and video, resulting in a serious and growing societal problem. This study looks into unfavorable user behavior on social networks. Especially in the modern and evolving culture, cyberbullying is on the increase, and it is a phenomenon that both individuals are impacted by daily. Professionals must recognize cyberbullying, apply effective management measures that comply with regulations, and engage in proactive preventive programs. With the increased use of the world wide web, it's no surprise that young people are abusing such technologies. However, earlier research has documented the negative consequences of cyberbullying. Due to the social and cultural limits of civilizations, reporting cases of cyberbullying is also a major issue. Future studies should look into whether instructional programs reduce cyberbullying and improve reporting rates, as well as how cyberbullying affects social media etiquette. This research investigates unfavorable user behavior on a major social networking site that has resulted in several occurrences of cyberbullying, some of which have resulted in suicide conduct. We study how anonymous and non-anonymous users act in social networking and propose that obscurity is a significant source of such aggressive user behavior.

Keywords: Victims, Cyberbullying, Anonymous

I. INTRODUCTION

Despite the contemporary digitally advanced society, cyberbullying is becoming more prevalent. In recent years, technological advancements have made it possible for individuals to communicate more widely across borders. While such technical improvements undoubtedly assist individuals, the negative consequences of cyber behavior have received much attention (Wang *et al.,* 2019). Technological innovations have permitted increasing communication amongst people across geographical divides during the previous years. While such technical improvements undoubtedly assist individuals, the negative consequences of cyber behavior have received much attention (Wang *et al.,* 2019).

Bullying is a big issue in today's culture; it affects people of all ages and in various ways. Cyberbullying is a concerning tendency that has arisen as a result of enormous manufacturing use. Humans may abuse others online 365 days. Bullies who use cyberbullying get a feeling of ownership over their victims that they would not have unless they were addressed one on one. Furthermore, due

to the increased visibility, the prominence of this subject in current news and media might empower

an individual, even if he or she is the only one knowing that he or she is the bully in question. As a result, some people who have a strong grasp of technology have used these new virtual circumstances to engage in hostile conduct toward their peers (Maria *et al.,* 2020).

Cyberbullying is described as the frequent use of technology to harass someone to injure, humiliate, or injure that person (Beale Hall, 2007). This happens when flaming entails sending a person angry, harsh, or profane messages by text or email, either privately or to an online group (Watts *et al.,* 2017). Conventional bullying is considerably more widespread than cyberbullying, and a large proportion of cyberbullies' kids are also tormented by traditional methods, therefore it's only reasonable to urge organizations to concentrate their efforts on combatting harassment, especially through the use of a proven program (Zych *et al.,* 2018). Anyways bullying behaviors that are not restricted to the physical environment or face-to-face situations have emerged as a result of rapid

technological advancements. Bullying is described as a pattern of recurrent and purposeful hostile behavior directed against a helpless victim. Although interaction in online communities varies beyond seemingly popular technological communication modes, while texting still reigns supreme on social media, cyberbullying is prevalent on social media websites. This transition may have ramifications not just for how cyberbullying happens, but also for the consequences and responses that cyberbullying generates (Whittaker and Kowalski, 2014).

Bullying is already spreading beyond a small group of people thanks to modern technologies such as cell phones, social media, internet video and photographs, and so on. As horrible as fighting and bullying were before the widespread use of personal technology, the recording, and dissemination of hurtful materials have widened the scope of bullying's detrimental effects (Hosseinmardi and Ghasemianlangroodi, 2014). Media the popular press, researchers, educators, and parents have all paid careful attention to a newcomer type of cyberbullying that occurs involving adolescents as well as online bullying throughout the last decade (Olweus, 2012). On the other hand, emphasizing how the media platforms object to privacy when combined with days of continuous online networking engagement, contributes to the social learner and is a significant factor in adult cyberbullying (Lowry *et al.,* 2016).

Bullying and cyberbullying have several similarities, including the notion that almost all forms of bullying are often more probable to happen whenever an imbalance of power arises (Beringer, 2011). The purpose of cyberbullying is usually to ridicule, shame, or frighten the victim. Text, photos, voice, and/or video can all be used to perpetrate various forms of social hostility. The article (Redmond *et al.,* 2019) emphasizes that there are several sorts of cyberbullying. These categories were recognized in early studies on cyber safety, including cyberbullying.

II. METHODOLOGY

To attain our goals, we used a systematic strategy to conduct our research. In-depth research into various learning strategies has been conducted to protect against cyberbullying behaviors in certain ways. This review was based on relevant research papers on the topic of cyberbullying on social networking. The goal of this study is to look into the current literature to acquire a better

understanding of modern cyber network advances and issues. This method lays out the basic steps for identifying, interpreting, and assessing research articles, making it easier to find supporting data. As part of the search plan, rigorous professional planning and validation of search strings were carried out. The research publications are mostly current and have a lot of citations from the Scopus database. Scopus was chosen as a comprehensive research article database. To study the issues in cyberbullying behaviors, the search results were filtered to include peer-reviewed and high-quality database journals and reputable conferences such as Springer, ACM, IEEEXplore, Elsevier, Wiley, and Google Scholar. Concerning the study topic, the search keywords were carefully selected. The search terms were tweaked multiple times to get almost all of the relevant documents. As a consequence, numerous search strings including various word combinations were used to locate relevant documents. Several digital libraries' search engines were used to conduct an automated search utilizing these search terms. The criteria for selecting papers were then utilized to narrow down the most relevant research on this subject. The remainder of the article highlights the Cyberbullying behaviors that we discovered throughout the review.
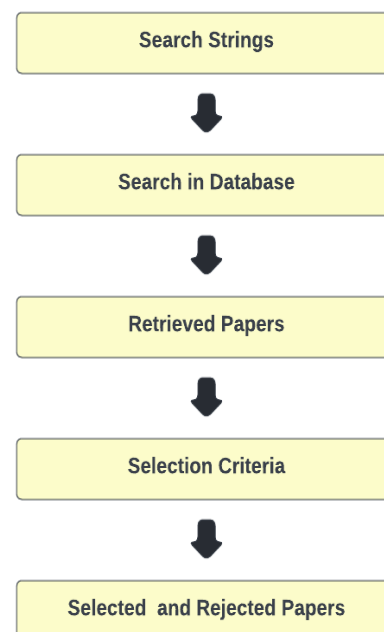
Figure 01: Methodology

III. DISCUSSION

A. Cyberbullying

There is no agreed-upon definition of cyberbullying. Traditional measures and notions typically include one factor, a list of bullying characteristics, or a comprehensive explanation of bullying.

Cyberbullying is a rapidly rising systematic issue particularly among our individuals according to the report (Albert, 2011). Cyberbullying involves the use of electronic mail, SMS, online forums, cellular phones, cell phone camera systems, and media websites. It isn't something that happens outside of school hours. Rather, it occurs at all hours of the day and night, both inside and outside of school frequently affects kids' social interactions at school, and generates situations that necessitate the intervention of teachers, counselors, and administration. Anyhow one of the issues is that people's perceptions of cyberbullying are so varied and ambiguous. When asked to explain the word, most individuals tended to associate it with "Internet bullying" or highlighted Internet activities they considered to be instances of cyberbullying. It's more difficult than it looks to transfer the features of conventional bullying to bullying using internet communication technologies. Another aspect of cyberbullying is cyberstalking (Langos, 2015), in which a victim is more likely to be subjected to a third-degree intrusion, the interest category physical integrity, as a consequence of the fear of coming damage. The threatening aspect of cyberstalking is likely to make a victim fear for his or her safety, thus this intrusion is measured by examining the anticipation of harm connected with the activity. The unique nature of textual forms of internet communication presents issues when it comes to the purposeful nature of bullying and the victim's non-provocative behavior. Email, chat, and text communications are often misunderstood because they lack the tone of voice or facial expressions. The notion that bullying occurs predominantly in recognized social groups is less evident in computer crimes. On the internet, people may interact with people they met in real life, but it also includes making unknown. Furthermore, information and communication technology help consumers conceal their identities or do business privately, which is seen to be a contributing factor to aggressive behavior.

The last component of traditional bullying is the strength differential between the attacker and the sufferer (Heidi and Katrien, 2009). In traditional bullying, this power disparity is usually centered on physical ability. Mostly on another side, because humans can't influence others in cyberspace with their body image, online authority is linked to higher technological knowledge.

As mentioned earlier, cyberbullying may be perpetrated via any technological communication device. Cyberbullies can stay anonymous due to the nature of cyberbullying, and victims can be abused for months or years. Because of the anonymity component of cyberbullying, it may be more appealing than traditional bullying. While anonymity allows the bully to attack someone he or she does not even know, it also allows the bully to quickly construct a phone identity, lowering the risk of being detected. Because of the limitless nature of the Internet, this might result in lifelong shame. The anonymity element also allows the bully to stay anonymous while engaging numerous others to see the behavior. Anyhow traditional types of bullying can have harmful repercussions for victims, but once they leave the setting, they usually get relief. Unfortunately, cyberbullying has more harmful consequences since victims may be tormented at any period, a day a week, hours a day, no matter where they are. Cyberbullies' ability to stay anonymous while scaring their victims in the quiet of their homes may mean that the perpetrators are unaware of the harmful consequences of their actions, but the consequences are real.

B. Cyberbullying-Related Aspects

1) Awareness of cyberbullying

As already formatted in this document, your paper should use a page size corresponding to A4, which is 210 x 297mm (8.27" x 11.69"). The margins should be set as follows: Pupils' knowledge of cyberbullying, participation in it, and responses to it differ. Within cyberbullying, three different roles may be played. Individuals or groups of people may play these roles. The bullying trio consists of the victim, who would be the aim or beneficiary of the harmful or vicious material; the perpetrator, who is the criminal or abuser who begins the social aggression; and the bystander, who is not an aggressor but is aware that cyberbullying is occurring (Willard, 2005). Cyberbullying research and treatment strategies should also be adopted at the societal, classroom,

and household levels (Abaido, 2019). It appears to be especially relevant in the growth and changes of mitigating in terms of the demographic of cyberbullying and survivors of online harassment: parents who are less concerned are more prone to become cyberbullied because of their poor internet use. Informing family members about new media and building a sense of their children's online activity appears to be a good starting step toward avoiding cyberbullying.

2) Cyberbullying status and mental health.

The study's objective was to see cyberbullying and its consequences status relates to teenage mental health when conventional bullying experience is taken into account, as well as to see whether there are any gender disparities. When girls are subjected to cyberbullying, their mental health appears to be significantly affected (Kaiser et al., 2020). This indicates that cyberbullies and adolescents who do not engage in every other form of cybercrime have more psychological symptoms than cyberbullies alone, as well as cyberbullies and bullies, particularly females. When you're subjected to or involved in trolling, the psychological well-being of girls appears to be more impaired than that of boys. And another fact should consider cyberbullying and cyber victimization have both been linked to mental and psychosomatic issues.

Those who are both cyber bullies and cyber victims are the most distressed (Sourander et al., 2010). A further comprehensive map collects evaluation evidence that demonstrates the significant detrimental impacts of cyberbullying on stress and psychological quality of life (Kwan, 2019). Cyberbullying may have severe consequences for victims, which are exacerbated by the problem's persistent nature. These physical and psychological consequences can leave individuals permanently scarred and even inspire them to commit suicide. In any case, by shedding insight into how and when cyberbullying is connected to anxiety, we can learn to understand more about cyberbullying's detrimental consequences (Niu et al., 2020). On the other hand, Cyberbullying on social media platforms is a serious threat to the emotional and physical health of those who are bullied (Bastiaensens et al., 2014).

3) Prevalence of Cyberbullying

The corpus of knowledge on cyberbullying is growing all the time, with costs changing depending on a variety of characteristics such as age, gender, and ethnicity. The incidence of cyberbullying varies greatly between studies, according to the way cyberbullying is characterized and the duration used to decide whether or not cyberbullying took place (Kowalski, Limber, and McCord, 2018).

According to a scoping analysis (Michele et al., 2015), commonly used communication networking venues Blogging, Tweeting, online forums, and instant messaging were all used to perpetrate cyberbullying. Web pages without additional descriptions, perhaps incorporating social media, were also reported. Therefore, speeding is increased due to these kinds of situations in society.

Considering these shortcomings, the latest research can be used as a baseline for assessing the prevalence of cyberbullying over a lifetime in culturally diverse gender populations. In actuality, the study shows that cyberbullying is a problem that has to be addressed more widely among individuals of all ages.

4) Prevention of cyberbullying

In terms of prevalence estimations, there was a lot of variation in cyberbullying research. According to the research (Brochado et al., 2017), In the prevalence investigations, cyberbullying interactions were evaluated from several viewpoints, including survivors, offenders, and both victims and perpetrators, according to our findings. The majority of the research, on the other hand, tended to focus on cyber victimization experiences. When it comes to age, different approaches to the phenomenon among adolescents in terms of age, range, recall periods, and perspectives of the cyberbullying experience, such as victimization only, perpetration only, or both, were found across studies in terms of age, range, recall periods, and perspectives of the cyberbullying experience, such as victimization only, perpetration only, or both.

At the same time, according to a recent meta-analysis, there appear to be fundamental limitations to the Prevention of cyberbullying that can be accomplished with such a technological approach (Mishna et al., 2011). To summarize,

technologically oriented researchers and numerous book writers highlight the necessity of teaching kids, parents, and educators several facets of "netiquette," including cybersecurity, and how emerging methods influence its work, along with how to act appropriately based on the internet. Most children, parents, and instructors today would benefit from acquiring some degree of basic information about modern technology.

IV. CONCLUSION

As far as we are aware, the conclusion is unquestionably consistent with the paper's overall theme. In the meanwhile, I believe we ought to take advantage of a chance to design increased awareness of trolling incidents that may result in more information on conventional bullying in the setting. Cyberbullying, as described in the literature, is a disturbing trend that affects everyone, not just teens.

This study looked at elements that are common to cyber bystander effects to see if the inconsistent results from prior studies were due to bystander number manipulation and intervention assessment. The outcomes of this study imply that additional factors, such as anonymity and the type of intervention, influence the association between bystander numbers and intentions to interfere. With limitations in mind, the study came up with four major conclusions: First, anonymity plays both cognitive and strategic aspects in determining whether or not to intervene in an online bullying situation. Second, under anonymous situations, bystander numbers were more prominent than in non-anonymous conditions. Third, there was no linear association between bystander numbers and intervention intentions. Fourth, the impacts of anonymity and bystander numbers were more pronounced on interventions that entailed actively assisting the victim or confronting the perpetrators; however, these characteristics did not affect milder interventions.

The goal of this study was to raise public awareness about the continuous problem of cyberbullying. This review defined cyberbullying as any electronic means of repeatedly persecuting, threatening, or humiliating another person; demonstrated different types of cyberbullying, such as raging, cyberstalking, and humiliation described characteristics or processes that influence cyberbullying commitment, such as confidentiality and privacy, aggressive behavior, and risks caused and looked at possible cyberbullying alternatives, such as internet bully.

Furthermore, the intense attention on cyberbullying in the media and studies may most likely be utilized to rekindle societal interest in the phenomena of bullying in general, as well as the necessity to address this serious social problem methodically. Although this is a narrow descriptive analysis that does not directly address all cases of cyberbullying, it does imply that raising awareness and understanding about new technology is insufficient to minimize cyberbullying. In this regard, future studies on cyberbullying may focus on the age at which a person first used the Internet, or a longitudinal method could be used to look at the same person's experiences through time.

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TRACK - NETWORK AND SECURITY TECHNOLOGIES (NST)

A Comprehensive Review on Lightweight Security Mechanisms to Mitigate Network Layer-Based Active Attacks

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Abstract

Node mobility, infrastructure-less network, open network boundary, and limited resources are general characteristic features of a Mobile Ad-hoc Network (MANET). These characters open MANETs to many security attacks. Network layer-based active attacks such as black-hole and gray-hole attacks are common and destructive. Proposed solutions for these attacks failed to perform well. Some mechanisms that are used in an infrastructure-based network were proposed as lightweight security mechanisms for MANETs. One hundred and two reputed journal and quality conference papers were selected for the review. In this paper, we comprehensively reviewed available security solutions, including lightweight solutions on MANET. The review proved that there is a demand for a lightweight security solution capable of operating with limited resources and mitigating active attacks without a performance drop.

Keywords: Active, Blackhole, Grayhole, Lightweight, Review, Security

I. INTRODUCTION

Mobile Ad-hoc Network (MANET) is a type of Ad-hoc Network. Node mobility is the main character in MANETs. Therefore, network topology changes frequently. Few basic characters are common to MANET. These are mobile nodes, infrastructure-less network nature, open network boundary, and limited resources. These features provide advantages such as the instant formation of the network in hostile conditions (natural disasters, war, etc) where the services of the infrastructure-based networks are unavailable. Moreover, MANETs are used for commercial purposes such as virtual classrooms. Security threats and attacks are the main drawbacks of MANETs due to these main characters. Black-hole attacks are common and destructive security attacks on MANETs. Numerous amounts of security solutions were proposed to mitigate the black-hole attacks. Moreover, lightweight security mechanisms were proposed by referring to the security techniques that were applied on infrastructure-based networks such as cryptography; nevertheless, available solutions are not effective enough to fit the MANETs. Therefore, in this paper, lightweight and proposed security mechanisms to mitigate black-hole attacks were reviewed to identify the research gap

on widespread lightweight security mechanisms to mitigate black-hole attacks. The rest of the paper is organized as follows. The available review papers were reviewed in Section II, and the methodology was described in Section III. Section IV describes the general features of MANETs in detail. Section V presents the routing protocols in MANET. The network layer-based security attacks were described in detail in Section VI. The factors that are used to evaluate the network performance are discussed in Section VII. The available security solutions were presented in Section VIII, and lightweight security solutions were presented in Section IX, and the conclusion of our research is presented in Section X.

Khanna and Sachdeva (2019) presented a comprehensive review of available security mechanisms for black-hole attacks and their variants. The paper contained a review, summary, and discussion in it. The authors identified a few research gaps, and the main research gap was a lightweight mechanism. They failed to consider existing lightweight security mechanisms in their study. In separate two different research (Gurung & Chauhan, 2017: Kahn & Jamil, 2017) presented an analysis and a summary of available black-hole attack mechanisms. The review was based on a limited amount of literature. In 2014, Mitchell & Chen surveyed intrusion detection in wireless

network applications. The survey presented a quality analysis and review of the available security mechanisms. The concepts of lightweight security mechanisms have been proposed for the last few decades, though these mechanisms are not reviewed. These types of mechanisms are based on the compatible modification of infrastructure-based security mechanisms applied to MANETs. Therefore, these mechanisms should be reviewed to find a suitable solution for network layer-based active attacks.

II. METHODOLOGY

The research articles were searched on the official websites of reputed journals and conferences. "Active attacks", "MANET", "Mobile Ad-hoc Network", Mechanism", "Review", "Security", and "Survey" were a few keywords that were used to search articles. Individual or combination of keywords used for the searches. The full papers of the relevant articles were downloaded from the search results based on the research title. The following reasons were used to filter downloaded articles from the review as illustrated in Figure 1.

- Article language – not English
- The contradiction between the theory and the presented results
- Unclear results
- Articles with duplicated works
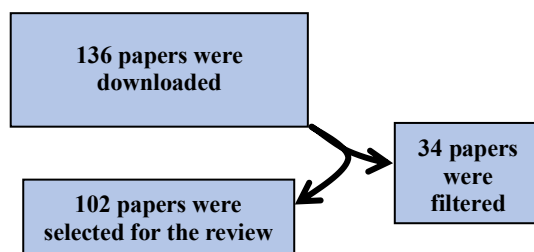
Figure 1: Filtering of articles for the review

III. RESULTS AND DISCUSSION

A. General Features of A MANET

Few features are general to a MANET. These features are being considered as the main factors that are listed as follows.

1) Mobility

The most unique feature and the critical factor (Rangaraj & Anitha, 2017) in the MANET is node mobility. This will decide the network topology. Though a source node is managing the maintenance of the network connectivity by

allowing mobile nodes to join the route after existing links are broken, the node mobility creates an opportunity for the source node to find the shortest path to the destination node after the breakage of the existing route (Ahamed & Fernando, 2021).

2) Infrastructure-less network

MANET follows the peer-to-peer networking concept to establish communication. Therefore, it does not depend on any network infrastructure. The source node selects any neighbour node that helps to find a route to the destination node. Nodes are capable of restoring network connectivity when a node is left from the network. Then source node initiates to reestablish the connectivity by selecting other nodes. Therefore, the infrastructure-less nature of the network helps to stay connected.

3) Limited Resources

Nodes are designed to allow nodes to be mobile. Therefore, nodes are designed with limited resources: energy source, computing or processing power, memory, storage capacity, node size, and weight. Another important limited resource is the wireless radio range. Therefore, the source node is forced to depend on the help of the neighbour nodes for communication.

4) Open network boundary

The limited radio range of nodes enforces the source node to depend on the help of the neighbour nodes to communicate. Node mobility disrupts communication by breaking the link between nodes. A route reconstruction mechanism is used to prevent communication loss. Therefore, MANET maintains an open network boundary to overcome this issue. Therefore, a node can join or leave the network without any constraints. This concept helps restore collapsed networks.

B. Routing Protocols

Routing protocols are used to find the route between source and destination nodes when these nodes are unreachable within their radio transmission range (Ahamed & Fernando, 2020). A routing protocol is one of the protocols operating on the network layer (Dawoud et al., 2011) in the OSI model. Generally, routing protocols can be divided into two broad categories based on their operational mechanism. Those are Proactive and Reactive Routing Protocols.

1) Proactive Routing Protocols

In proactive routing protocols, the route details are updated periodically to maintain the route information in a table which is called a routing table. This periodic updating of the route details continues even when there is a demand for a route or not. Therefore, these types of routing protocols consume more node energy to operate. These protocols are only suitable for networks in which node energy is not considered a critical factor such as wireless sensor networks with few nodes. Examples of these types of protocols are:

Ex.:
Destination-Sequenced Distance Vector Protocol (DSDV),
Cluster-head Gateway Switch Routing (CSGR).

Ex.:
Ad hoc On-Demand Distance Vector (AODV),
Dynamic Source Routing (DSR),
Temporally Ordered Routing Algorithm (TORA),
Scalable Source Routing (SSR)

According to the summary in Table 1, reactive routing protocols are more suitable for MANETs than proactive routing protocols. Out of available reactive routing protocols, AODV and DSR perform well as stated in Table 2. In DSR, the route information is maintained in the source node. Similarly, each data packets hold the entire route details on it. Therefore, DSR fails to operate at the higher numbers (Sharma et al., 2015, Kanthe et al., 2012) of nodes in the network. Moreover, node mobility changes network topology frequently in a MANET. Therefore, a routing protocol should be capable of handling the failure of links between

Table 1: Comparison between proactive and reactive routing protocols

	Proactive Routing Protocols	**Reactive Routing Protocols**
Mobility	Network collapse (Sharma & Kumar,2016).	Capable to manage (Ahamed & Fernando 2021: Schellenberg, 2020)
Number of nodes in the network	Only suitable for a few nodes (Bai et al., 2017)	Scalable from few to higher numbers (Sharma & Kumar 2016)
Network Overhead (NO)	Periodic communication causes high NO (Chavan et al., 2016)	Lower than proactive (Semary & Diab, 2019: Rangaraj & Anitha, 2017)
RO	Periodic acknowledgements cause high RO(Reddy, 2018: Bai et al., 2017: Chavan et al., 2016: Sharma & Kumar, 2016)	Nodes are idle when there is no communication (Perking et al., 2003).
Energy Consumption	Require uninterrupted energy (Reddy, 2018: Rangaraj & Anitha, 2017)	Only active for communication (Boukerche et al., 2011: Perking et al., 2003).
Network Performance	High only in a lower number of nodes. (Bai et al., 2017: Boukerche et al., 2011: Nand et al, 2010)	Fair in a lower number of nodes on high in a higher number of nodes, (Bai et al., 2017: Chavan et al., 2016: Sharma & Kumar 2016)
Connectivity	Initiation is quick (Semary & Diab, 2019: Boukerche et al., 2011)	Start to initiate when there is a demand (Perking et al., 2003)

2) Reactive Routing Protocols

These types of protocols establish a route from a source node to the destination node only when there is a demand for a route. The source node starts to broadcast routing request packets to find a route to the destination node when there is a demand. Routing request packets are sent to the neighbour nodes, and if a routing request is received from a node, it will retransmit the packets until the request is received by the destination node. After a successful route discovery, the source node starts communication with the destination node by forwarding data packets. Examples of these types of routing protocols are:

nodes and node mobility (Shahzamal, 2018). AODV uses only the destination IP address and sequence number to locate the destination node. Moreover, the AODV routing protocol is equipped with features to overcome link failures due to node mobility through local route repair mechanisms.

Table 2: Reactive routing protocols comparison (Reddy et al., 2018: Sooriyaarachchi, 2016: Kaur et al., 2013)

Protocol	Route Selection	Route	Method	Loop free
AODV	Shortest and most updated path	Multiple	Unicast	Yes
TORA	Shortest path	Multiple	Broadcast	No
DSR	Shortest and most updated path	Multiple	Unicast	Yes
SSR	Associativity and Stability	Single	Broadcast	Yes

(Perking et al., 2003). Therefore, AODV performs well in MANET than DSR (Reddy et al., 2018: Bai et al., 2017: Sooriyaarachchi, 2016: Sharma, and Kumar, 2016: Sharma et al., 2015: Kanthe et al., 2012).

C. SECURITY ATTACKS

Security attacks are not only from outside the network; compromised nodes also engage in different types of attacks in the network (Reddy et al., 2021: Teodoro et al., 2014) even after a successful route formation. The most common network layer-based security attacks on a MANET can be categorized into two: Active attacks and Passive attacks.

1) Active attacks

Active attacks are a type of attack which disrupts the network operation. These types of attacks impact the network performances seriously. Finally, it will collapse the network. These types of attacks are possible from the outsiders of the network as well as from the compromised nodes. Therefore, for the fair operations of the network, these types of attacks should be handled. Examples of these types of attacks are the Black-hole and Grayhole attacks. These attacks can be simulated (Ahamed & Fernando, 2021b) in network simulators.

1) Black-hole attack

A Black-hole attack is a type of denial-of-service attack. These attacks drop data packets in an abnormal amount than normal nodes in the

network. A Black-hole attack is classified as a network layer-based Active attack. During the route-finding process of a routing protocol, the attacker node waits to receive a request from a
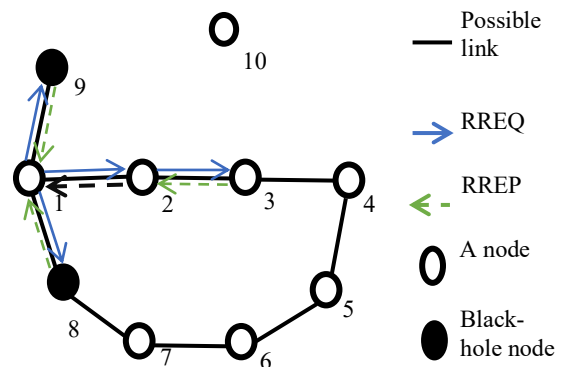
Figure 2: An example of black-hole attacks

source node. Then it starts replying by advertising itself as it has the destination node as its neighbour. A malicious node injects false information (Dorri et al., 2015: Casado et al., 2014), claiming that it has the shortest and newest route to the destination node. As illustrated in Figure 2, a black-hole node is possible to establish a route to the destination node or no possible route. The reply from the malicious node reaches the source node at first other than a reply from a non-malicious node is reached.

Table 3: A description of NPMs

	PDR	AEED	Throughput
Description	the ratio between the total number of packets sent by the source node and the total number of packets received by the destination node	an average amount of time that is taken by a data packet to reach the destination node from the source node	a ratio between the total number of packets received by the destination node and the total time to receive all packets
Unit	Percentage	Seconds	Bytes per seconds

The source node misleads to consider the reply of the malicious node. Finally, the source node is considered the reply from the malicious node because it seems to be the shortest and newest

Therefore, it starts to send the RREP packet to the source by increasing the destination sequence number by one. Then 2 retransmits the same RREP packet to the destination node by increasing

Table 4: Summary of security mechanisms and the publications

Mechanisms based on	Description	Examples
Trust	It is used to evaluate the neighbour nodes. It is updated based on the performance of a node.	Mahamune & Chandane, 2021: Mukhedkar & Kolekar, 2019: Movahedi & Hosseini, 2017: Sethuraman & Kannan, 2017: Khanna, 2016: Xia. et al., 2015: Hinge & Dubey, 2016: Vijayakumar et al., 2015: Subramaniyan et al., 2014
Validation of threshold value	Sequence numbers or other values related to the routing or data in the network were validated to detect the attacker.	Reddy et al., 2021: Elmahdi et al., 2020: Shrestha et al., 2020: Hammamouche et al., 2018: Gurung & Chauhan, 2017: Poongodi & Karthikeyan, 2016: Panos et al., 2016: Patel & Chawd 2015: Kumar & Kumar, 2015: Salunke & Ambawade, 2015: Jhaveri & Patel, 2015: Casado et al., 2015
Detection and prevention	Behavioural patterns, filters, fuzzy logic, or logical inference are used on a neighbour node to differentiate attackers from other nodes.	Pandey & Singh, 2020: Kalkha et al., 2019: Moudni et al., 2019: Hammamouche et al., 2018: Rmayti et al., 2017: Khanna. N., 2016: Usha et al., 2016: Arthur & Kannan, 2015: Balan et al., 2015: Nadeem & Howarth, 2014: Casado et al.: 2014: Nadeem & Howarth, 2013: Olmos et. al., 2012: Joseph et al., 2010: Sen et al., 2007:
Collaboration	Data-link layer and network layer or all the nodes on the network or set of nodes in the network or set of groups in the network are worked collaboratively to identify attackers based on the routing and data packet information.	Usha et al., 2016: Singh & Singh, 2016: Subba et al., 2016: Arathy & Sminesh, 2016: Arthur & Kannan, 2015: Funde & Chandre, 2015: Poongodi & Bose, 2015: Sharma, 2015: Shi et al., 2014: Deb et al., 2014: Zadeh & Kabiri, 2014
Separate packets	Separate acknowledgement packet or modification on available routing packets used to collect information to detect attacker node.	Pathan et al., 2019: Dorri et al., 2017: Chavan et al., 2016: Dorri, 2016: Babu & Usha, 2016: Patel & Chawd, 2015: Ahmed et al., 2015: Rana et al., 2015: Dhaka et al., 2015: Basabaa et al., 2014: Shakshuki et al., 2013: Sun et al., 2012
Special hardware	Special hardware components are used to collect the information to detect attacker nodes.	Song et al., 2008
Collective mechanisms	Two or more mechanism works together to detect an attacker.	Ourouss et al., 2020: Singh et al., 2018: Anusha & Sathiyamoorthy, 2017: Akbani et al., 2012

route. It assumes that it can create a route to the destination node through the malicious node. Therefore, the source node starts the communication by sending data packets to the malicious node. The malicious node drops all.
Data packets (Semary & Diab, 2019: Casado et al., 2014) that are received from the source node, though it allows only routing packets. For example, if 1 is a source node that needs to send data packets to destination node 4, it starts to send RREQ packets. The packets will reach neighbour nodes of the 1. According to Figure 2, nodes 9, 2, and 8 are neighbours of 1. The 2 does not have 4 as its` neighbour. Therefore, it rebroadcasts the RREQ packet to its neighbours by increasing the source sequence number by one. Then, 3 receives the RREQ packet, and it has 4 as its` neighbour.

the destination sequence number by one. This is the formal process of the AODV routing protocol in a MANET, nevertheless, black-hole nodes act differently than usual. When 8 and 9 receive the RREQ packet, they replace the destination sequence number with a higher possible integer value and send the RREP, though there is a possible route to the destination node (via 9 or not).

2) Grayhole attack

The grayhole attack can be described as an extension of the Black-hole attack (Jain & Raghuwanshi, 2014). A grayhole attack is classified as a network layer-based Active attack. A malicious node can maintain states during a communication either by behaving as a genuine

node or by behaving as a malicious node. Malicious nodes use true data to reply to a route request during the route-finding process of the routing protocol. Though, during communication between a source node and a destination node, the attacking node acts as a genuine node by delivering or retransmitting what it received. After some period, it starts to drop all the data packets that it receives (Ibrahimet al., 2015). In some other cases, a malicious node drops all the data packets from a specific node in the route and forwards or retransmits data packets from other nodes. As an example, in Figure 2, if 8 and 9 are normal nodes, then the route between 1 and 4 will be 1, 2, 3, and 4. If 2 is a grayhole node, then it will cooperate to find the route. The grayhole node starts to drop all data packets after some period, or it will drop all the data packets from a specific node.

D. NETWORK PERFORMANCE MATRICS

Network Performance Metrics (NPM) is a set of measurements of a network that is used to understand the performances of a network. The values of these NPMs are based on the packets that are transmitted through the network during communication between nodes. PDR, AEED, and Throughput are some examples of formal NPMs as described in Table 3.

E. AVAILABLE SECURITY SOLUTIONS

Researchers proposed a huge number of security mechanisms, as presented in Table 4 to detect or prevent or mitigate black-hole attacks in a MANET. Some mechanisms are capable of performing all of these operations. Most of the mechanisms are based on the specific routing protocol. Some researchers proposed individual mechanisms for each security attack, though some researchers proposed a system to handle a single attack or else to handle the number of attacks at once. The taxonomy of the available security mechanisms can be categorized as follows based on the available review studies (Khanna & Sachdeva, 2019: Khan & Jamil, 2017: Gurung & Chauhan, 2017: Dubey & Saxena, 2016: Mitchell & Chen, 2014: Boukerche et al., 2011).

F. LIGHTWEIGHT SECURITY SOLUTIONS

The fundamental features of the MANET prevent the usage of the quality security countermeasures that are used in infrastructure-based networks, such as cryptography and IDS. Some researchers proposed (Shukla et al., 2021: Pandey & Singh, 2020: Moudni et al., 2019: Khanna. N., 2016) these mechanisms for MANETs. As presented in Table 5, these mechanisms are capable of handling security threats in only some instances due to their complex nature.

Table 5: Lightweight security solutions

Author/s	Description	Advantages of the lightweight concept
Ahamed & Fernando, 2022	Lightweight Security Mechanism to Mitigate Active Attacks in a Mobile Ad-hoc Network	Relatively same performance compared to the network without an attack
Liu et al., 2021	A computing model based on a lightweight framework is proposed to reduce the computing pressure of edge nodes.	More secure edge node environment and guaranteed security of the user's privacy data
Batra et al., 2021	A new hybrid lightweight (key size, and mechanism) logical security framework for offering security in IoT	Comparatively fast making the compromise of keys
Lee & Chen, 2021	Lightweight cryptographic operations, including a one-way cryptographic hash function, the Barrel Shifter Physically Unclonable Function	Provide more security than related schemes but also are more efficient.
Wang et al., 2021	A lightweight blockchain-based secure routing algorithm for swarm UAS networking	Reduce the routing consumption
Gaurav & Singh, 2021	A secure lightweight backbone construction approach for MANET	A high degree of detection rate without bringing in any significant traffic
Santos et al., 2020	Proposed a Federated Lightweight federated identity authentication protocol exclusively tailored to IoT	Reduced data exchange overhead, storage, memory, and computation time
Jamshidi et al., 2020	A lightweight algorithm using watchdog nodes	False detection probability and imposing ignorable processing and memory overhead.
Kumar et al., 2020	A lightweight signcryption (hash function) scheme for perception layer devices in IoT	Reduced communication cost and energy consumption, less complex and fast performance
Wen et al., 2020	Proposed aggregate signature schemes for lightweight devices (Healthcare Wireless Medical Sensor Networks)	Quick verification of multiple messages

Ayobi et al., 2020	A lightweight blockchain-based decentralized trust model for preserving the privacy in VANET	Deal with imprecise data in VANET
Conti et al., 2019	A lightweight mechanism and practically feasible countermeasures against two different types of DDoS attacks	Adequate reduction in bandwidth consumption and processing delay of new request
Hammamouche et al., 2018	A lightweight reputation-based approach to detect single and cooperative black-hole attacks	High delivery and the detection rates of packets and low communication overhead
Shahzamal, 2018	Lightweight Mobile Ad-hoc Network Routing Protocols for Smartphones	Node mobility causes high control overheads.
Xia et al., 2016	A lightweight routing protocol to provide a feasible approach to choosing an optimal two-way trusted route	Consumes limited computational resources and reduces the RO
Suraj et al., 2015	A novel approach to mobility prediction using movement history and existing concepts of genetic algorithms	A faster rate of mobility prediction
Martirosyan & Boukerche, 2015	A new encryption scheme which is lightweight in computation by leveraging network coding	Minimal energy consumption and low encryption time
Wang et al., 2014	A lightweight Proactive Source Routing protocol that can maintain more network topology information than DSR	Smaller overhead and better data transportation performance
Cheng et al., 2014	Delivery-guaranteed location-free routing protocol with a lightweight construction cost	Good performance in construction message overhead, the maintenance time and message overhead, and the great PDR
Zhang et al., 2013	New encryption scheme which is lightweight in computation by leveraging network coding	Reduce energy consumption, lower encryption time of P-Coding
Marchang & Datta, 2012	A lightweight IDS is used for estimating the trust of nodes	Consumes limited computational resources
Zhang et al., 2012	A group-based lightweight authentication scheme	The authentication time is minimized and the fast MAC layer handoff is achieved, no extra overhead is introduced.
Malekzadeh et al., 2011	A lightweight non-cryptographic security solution is proposed to prevent wireless DoS attacks.	It prevents wireless DoS attacks, and the security cost is not remarkable with the simplicity of the overall computation.
Babu & Selvan, 2010	A lightweight and Attack Resistant Authenticated Routing Protocol for MANETs	A high PDR with reduced the delay and overhead and detects the malicious nodes quickly
Tran et al., 2009	A Bloom filter-based beaconing mechanism to aggregate and distribute information for presence detection	Minimized communication overhead, and speedy information propagation
Song et al., 2009	The proposed protocol has strengths such as light computational load, backward compatibility, and dependable operation.	Minimal computational overhead, low computational cost and minimal delay
Wool, 2005	A lightweight solution to the host-revocation problem	Simple, very efficient, uses well-understood key transport protocols and cryptographic primitives, requires no additional equipment

These mechanisms require high computational power, higher storage, uninterrupted battery backup, and infrastructure-based network topology. Therefore, these mechanisms barely fit MANET. If these mechanisms need to be applied in MANET, then those mechanisms should undergo serious modifications that enable them to fit into the MANETs. Then these modified mechanisms are called lightweight mechanisms in terms of specific concern as summarized in Table 5. The processing time or delivery time or delay or EED or AEED and the performance of the other relevant factors such as throughput, and PDR are used to consider the mechanism as a lightweight mechanism.

IV. CONCLUSION

The following research gaps were identified by reviewing the works of literature.

- Active attacks are destructive and commonly available among the reactive routing protocols. AODV is a suitable routing protocol for MANETs. Routing protocols should undergo serious modification to handle data security including routing.

- Available security solutions for the active attacks failed to perform well than the performance of the

network without the attack. Therefore there is a demand for a lightweight security solution that is capable of operating with limited resources and mitigating active attacks without a performance drop in common NPSs.

Network layer-based active attacks are common and destructive in action. Black-hole attacks are a general example of these types of security attacks. Many solutions to mitigate black-hole attacks have been proposed in the last few decades. Some solutions were oriented to the mechanisms that were used for the infrastructure-based security mechanism. These mechanisms were modified to apply to MANETs as lightweight mechanisms though these were performance dropped the same as standard security mechanisms do. Moreover, some of these lightweight mechanisms introduced new NPSs that decrease the network performance such as more energy consumption and false detection. Therefore, the routing protocol should be modified to handle network layer-based security attacks too, or proposed lightweight security solutions should be widespread and capable of operating in minimum resources without a performance drop.

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TRACK - MULTIMEDIA AND GAMING TECHNOLOGIES (MGT)

Microfinance Interest Rate Prediction and Automate the Loan Application

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Abstract

In the Sri Lankan context, microfinance is the main banking service provider for the 'unbankable' people who live in rural areas. Due to the informal nature and high-interest rate, microfinance continues to operate in a falling field. In addition, in the appraisal stage, rural borrowers tend to make mistakes while filling out loan applications causing default situations. As a result, microfinance institutions demotivate and people shifting away from traditional forms of borrowing to informal forms is socially problematic. Therefore, in order to address those issues, the researchers collected primary data through ABC bank and analyzed data relating to 10000 random borrowers' records and set of loan forms. The purpose of this research is to automate paper-based loan applications to recognize handwritten characters with the use of information technology through image processing techniques and analyze customers' determinant factors to predict interest rates for microfinance facilities. The finding of our study shows that Regression analysis models can gain the best result in predicting the interest rate. Together Ridge regression analysis and XGBoost regression models gave the most accurate results compared to other models in interest rate prediction. By using this interest rate prediction, microfinance institutions can offer a suitable interest rate that is convenient for the loan borrower. The application automation reduces the paperwork and the manual effort needed to process and increases data accuracy. The developed model can enhance the repayment performance of microfinance firms and prevent defaults by borrowers at the loan appraisal stage.

Keywords: Microfinance, Interest Rate, Handwritten character recognition, Information Technology

I. INTRODUCTION

Microfinance is widely recognized that the exclusion of the poorest lenders, particularly in rural areas from the traditional financial banking system is one of the main obstacles to poverty reduction. Microfinance is also called microcredit. It allows people to take on reasonable small business loans safely and consistently with ethical lending practices. Through the provision of responsive and specific financial services, microfinance institutions (MFIs) allow the financial inclusion of poor entrepreneurs who, for economic reasons, are excluded from the traditional banking system. All around the world, there are several institutions involved in providing microfinance facilities. But in Sri Lanka, this microfinance continues in the descending field because of its risk and the high loan repayment rate. The survival of most MFIs depends entirely on a successful lending program that revolves on funds and loan repayments made to them by the clients. According to that, have to be concerned about the accuracy of the loan application form with accurate data gathering. In this research, we have compared some machine learning models and image processing models to quantify the models' estimation accuracy when measuring individuals' interest rates. Here, the machine learning model type is regression. Moreover, the machine learning target is the interest rate. In the development environment Jupyter Notebook, google colab, and various libraries were used. To find the repayment of a borrower, models such as logistic regression, GradientBoost and CatBoost models were adapted. Furthermore, to predict interest, used the Ridge regression model and Lasso regression model. To identify character recognition, the pre-processing stage consists of applying multiple methods such as grayscale, thresholding, and morphological operations. Consequently, the research study has suggested that to predict the interest rate of the loan per borrower individually. The rest of the paper consists of a literature review, methodology, results, discussion and conclusion.

II. LITERATURE REVIEW

Researchers have found various factors, which are affected by MFIs, to be determinants of interest rates. To predict the interest rate, microfinance services, play an important role in identifying low-income groups and providing them with the confidence to start their own businesses while also stabilizing the borrowers' socioeconomic condition.

A. Interest rate prediction using macroeconomic factors and repayment borrowers

Microfinance institutions provide lending facilities depending on the borrowers' payback promises. Borrowers have the option of applying for a loan as an individual or as a group (Munene and Guyo, 2013). The repayments of borrowers have a greater impact on the process of granting Microfinance loans. The majority of loan applicants are urban and rural residents who are unable to obtain collateral loans from other banks (Gudde Jote, 2018).

Microfinance institutions become opaque as a result of persistent loan repayment defaults, restricting the availability and accessibility of financial help. Because of that, the government tends to regulate financial acts. The success of a microfinance institution is determined by the efficiency with which loans are collected. Identifying the borrower's background before approving the loan strongly managed the decision-making process to reduce the bank's repayment default cases. Furthermore, research shows that various determinant factors have an impact on loan repayment default. Based on that, the microfinance interest rate is predicted.

In the context of Sri Lanka, there was little Microfinance loan repayment-based research conducted to identify the determinant factors. Current literature reviews have divided factors that affect Microfinance into different categories. (Gudde Jote, 2018) have identified repayment factors as demographic, loan, and institutional categories. (Nanayakkara and Stewart, 2015) classified factors that affect the repayment as lender, borrower, and loan characteristics. Microfinance institutes offer their loans and decide the interest rate in groups and individually. In Sri Lanka, the popular loan type is group lending. Microfinance officers visit village-wise and identify the individuals, group them and grant loans (Nanayakkara and Stewart, 2015). From the side of loan characteristics, the interest rate has been identified as a determinant factor. According to the current situation of microfinance institutes, demand has increased compared to supply. Therefore, the interest charged for the small-size loan has been increased. Indirectly, borrowers' information is asymmetric, and the low repayment frequency has affected the behavior of interest rates (Nanayakkara and Stewart, 2015). (Priyankara and Sumanasiri, 2019) also mentioned as a major factor that affects repayment of the loan. Increased interest rate adversely affects loan repayments. Microfinance Institutes are not the same in interest levels.

In Sri Lanka, the central bank imposes a range where the interest rates can move. No one can violate that range, but microfinance institutes can decide which rate they are going to be followed within that range. Therefore, the interest rate has a significant relationship with loan payments in Sri Lanka. According to the research findings, there are a number of factors that affect loan repayment. Some of the factors mentioned above are some of them.

According to the researchers, it is important to consider the Microfinance Institutions ensuring access to financial services. To generate fair interest rates using technological changes with macroeconomic determinants that are affected positively and negatively. Namely GDP growth rate, unemployment rate, rural population, inflation etc. (Janda and Zetek, 2014). Themistocles Polit off and Dan Ulmer describe how to predict interest rates by comparing the performance of ANN models with that of simple multivariate linear regression (SMLR) models (Priyankara and Sumanasiri, 2019). A variety of factors, both internal and external to MFIs, have been identified as predictors of interest rates charged by MFI researchers. According to Hudon (2007), competition is a key element in influencing interest rates. MFI interest rates are influenced by funding costs, loan size, and efficiency levels, according to Cotler and Almazon (2013), who studied MFIs in a variety of countries. Cost of money, operating costs, provision for bad debts, tax charges, client credit rating, profit, inflation, competition, and customer financial literacy are all factors that influence interest rates, according to Fehmeen (2010). Nirav A. Desai and MBA I.T.Manik Bhatia (Munene and Guyo, 2013) have built a multi-variable regression model to predict the GDP growth rate using key

macroeconomic indicators. Inflation, crude oil price, interest rates, services and manufacturing PMI are used as predictors in a multivariable linear regression model to forecast the GDP growth rate (Munene and Guyo, 2013).

Identifying the factors that affect the interest rate of MFIs can be divided into two categories. Such as Microfinance Institutional factors and Macroeconomic factors. Microfinance institutional factors are operating expenses, cost of funds, loan loss expenses, and profit. Operating cost depends on the loan size, age, location and the client's ratings (Janda and Zetek, 2014). The other factor is the cost of funds. When determining a borrower's loan repayment capacity, macroeconomic factors such as pricing levels and economic growth are key considerations (Goncu, 2019). The goal of obtaining a low loan default rate in order to maintain a healthy loan portfolio will lead to MFIs' long-term viability. Interest rates on loans will be unaffected by the size of the microfinance institution and Interest rates on loans will be unaffected by the type of microfinance institution. Another institutional factor is profit. Researchers believe that a higher rate of profit leads to an increase in the interest rate of investors. Loan losses because of borrower default have an effect on MFIs interest rates. Macroeconomic factors which are mainly affected by interest rates are GDP, unemployment rate, inflation rate, agricultural value and rural population (Janda and Zetek, 2014). Basically, MFI interest rates may be caused by increased poverty or an accidentally increase in inflation. In rural areas, the population are highly considerable credit supporters. Therefore, it is also an important factor.

B. Handwritten character recognition of the loan application

In the character recognition process, it detects and recognizes the character from the input image. Then it converts into a machine-editable form like ASCII (Kai Ding *et al.*, 2007). The Handwriting Recognition System is a computerized system that can recognize the characters and the symbols written by hand in natural handwriting. There are two types of handwritten recognition known as Offline Handwriting Recognition which scans the image and is recognized by the computer and Online Handwriting Recognition which recognizes the characters while writing on the touchpad (Ayush and Singh Chauhan, 2016).

1) Hidden Markov Models (HMM):

To recognize cursive handwriting and online handwriting, Hidden Markov Model is used and can identify isolated characters. This model processes two main sections: preliminary classification and recognition using HMMs (Hewavitharana, Fernando and Kodikara, 2002).

2) Kohonen Artificial Neural Network (KANN):

The address identification process of Sri Lankan posts continues manually and most of the time, the address is written in natural handwriting. The aim of automating this separate letter into divisions is to identify the address in the envelope, Kohonen Artificial Neural Network is used. Using 32x32 input neurons and one output neuron were used to build this network. After pre-processing, the data characters are recognized by using the character group. These groups can be customized based on user requirements. Then the system creates a pattern for the received characters. After that, it recognizes the received characters such as the city name by retrieving the city name from the database (Ifhaam and Jayalal, 2019).

3) Thinning Algorithm:

The combination of Thinning Algorithm and character recognition process can identify the Sinhala handwritten characters. This research uses the curvature histogram-based method to identify the characters. In the pre-processing stage, the Sinhala character set is scanned using a Red Green Blue (RGB) color space scanner and converted to Grayscale. Here the characters to identify are in vertical or horizontal projection. After that, resize and find the effective area of the character and convert it to a color image in Grayscale and apply binarization. After that, apply the thinning algorithm to remove the pixels which are not contributing to the character horizontally and vertically. After that, the proposed method identifies the curvature by considering the pixel contribution by the predefined curvature patterns. The pre-processing stage in this method enhances the accuracy of the character recognition (Madushanka, Bandara and Ranathunga, 2017).

Many researchers around the world stated that recognizing a handwritten character achieved a higher level of accuracy as a result of deep learning techniques rather than other character recognition algorithms (Chaudhuri Arindam et al., 2016). Among the classification methods, CNN has the ability to extract the most suitable features

from the image and recognize the object among the other patterns (Saqib et al., 2022).

The Work (Ebrahimzadeh and Jampour, no date) proposed system has been generated in three steps. These are, 1) Pre-processing, 2) HOG features extraction and 3) Support vector machine classification. Pre-processing includes some basic image processing to separate numbers from real samples or preparing data from a dataset (reshaped data from images to vectors) and then extracting HOG features, which is a very distinguishable descriptor for digit recognition that divides an input image into 99 cells and computes the histogram of gradient orientations, which represents each digit with a vector of 81 features. Finally, a linear multiclass support vector machine was used to categorize digits in the third stage. The use of HOG features with SVM is the model's key contribution. HOG is a descriptor that can execute distinguishing characteristics quickly and accurately.

In work (Jiang and Zhang, 2020) proposed a system including two novel deep learning models, named EdgeSiamNet and Edge-TripleNet, for handwritten digit recognition. First, use the canny edge extraction method to extract the edge photos according to their model. They propose employing a Siamese/Triple network topology to extract features from both the original input image and the edge image rather than using edge features as residual connections. The strategy increases the network's performance in recognizing distinct numbers without introducing more parameters than EdgeNet. To extract edge pictures, they employ the Canny function provided by OpenCV.A technique for off-line recognition of handwritten Devanagari numbers is proposed in this study (Lakshmi, Jain and Patvardhan, 2007). This research offers a new approach for recognizing handwritten Devnagari numerals utilizing edge histogram features on images that have been pre-processed with splines to improve their quality. Splines have proven effective in a variety of signal-processing applications. PCA is then used to improve the results. For their study, they used 9800 samples of handwritten data. They present a novel strategy for solving the problem of images with thin edges based on detecting edges in continuous domain images via cubic spline interpolation in this study.

"An Improved Algorithm for Segmenting and Recognizing Connected Handwritten Characters"

(Zhao, Chi and Feng, 2010) research paper proposed a solution for the segmentation and recognition of handwritten character strings. The proposed method includes a gradient descent mechanism employed in the approach to weight the distance measure while applying KNN for segmenting/recognizing connected characters (numerals and Chinese characters) in the left-to-right scanning direction. A high-quality segmentation technique is required for recognizing related characters. In many circumstances, traditional approaches attempt to segment the string into individual characters without recognition and then apply a recognition algorithm to each isolated character, resulting in incorrect segmentation and poor recognition results. This suggested method mimics the human process of identifying related character strings, in which segmentation and recognition are combined. The technique is resilient and efficient, as evidenced by experimental results on 1959-character strings from the USPS database of postal envelopes.

III. METHODOLOGY

The methodologies used in this work contain two parts. Those are as follows, 1). Loan interest rate prediction 2). Handwritten character recognition of the loan application. The solution is used to predict the interest rate using an approved loan request and look to correctly extract Ref.No, NIC and name of the application and display it and write it into the CSV file. Figure 1 shows the flow of interest rate prediction and loan application recognition in a process diagram.
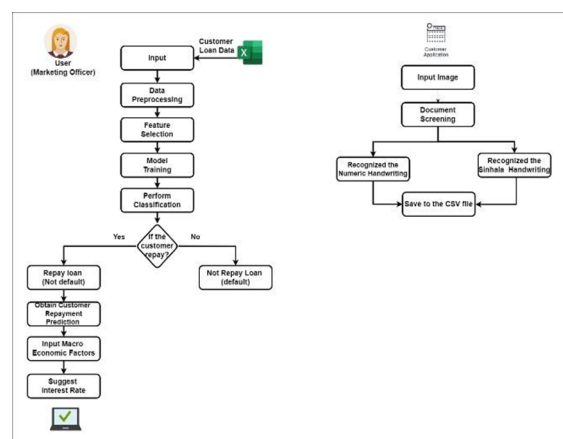

Figure 01: Process Diagram.

A. Predict the interest rate using macroeconomic factors and repayment borrowers.

Every year hundreds of loans are granted to different borrowers. Some loans will be repaid and

settled correctly; some loans are not. Many factors affect deciding loan repayment or default. The dataset contained 10000 applicants and 10000 applicant-relevant records between the years 2014 to 2020 from island-wide branches in the ABC bank.

The key novelty in this work is to take into account several factors such as loan amount, repayment mode, population density (to identify potential market), income, and expenses that were overlooked in previous studies. In that case, the factors that have a significant impact on loan repayment were identified. Those variables were only used in model development.

1) Data Extraction

The initial dataset used was collected from 10000 loan datasets from ABC bank. Among the dataset, we selected only Microfinance loans. This facility is given to low-income generating people who have minimum access to banking services for borrowing for consumption purposes and also who work as entrepreneurs. Extract only microfinance-relevant loans as Microfinance from 10000 datasets for research purposes. After extraction, the dataset appears to contain 5933 records.

2) Data pre-processing

In the bank, these data were entered by microfinance marketing officers who are working in the field. According to the discussion we had with top management, "they told us these staff members are not well educated and while they enter data, they make a lot of mistakes". In that case, in the pre-processing stage, recognize that there are many custom details that do not have all data attributes available. Such as GENDER, MARITAL STATUS and EFFECTIVE_RATE. These missing data are replaced using missing value imputation with the "mode" of the relevant column. Because removing rows of data-frame could affect the data set. Also, perform basic data cleaning dealing with categorical variables using the dummies approach. Because dummy encoding allows to encode as many category columns as there are in the data frame and choosing how to label the columns, Dataset mainly consists of more than four categorical columns such as DUE_FREQUENCY (Payment mode), MARITAL_STATUS, and GENDER. Also, perform basic data cleaning dealing with data types and converting categorical to numeric using a dummy. Dataset mainly consists of more than

five categorical columns such as due frequency, gender, marital status and loan cycle.

3) Data analyzing

This data set has different attributes. This data analysis process tries to identify the correlation between those features. Specially Correlation with the LOAN _STATUS column. Because of having contained more than 50 columns after doing a dummy. During the data analysis process, multicollinearity among independent factors in the data frame was discovered. IBM statistical tools were also used to determine the significance of the factors influencing loan repayment. Also, the multicollinearity among independent variables was identified using a correlation map.

4) Perform Classification

This data set contains so many factors which affect the repayment of loans which are identified based on significance and previous research. But every value is not important to predict the output. The classification process tries to identify feature significance. To predict microfinance repayment, a few machine learning models have been implemented because various studies suggest the best models as different models based on context and input variables. The Boosting algorithms show significant improvement. So, in the beginning, to find the most accurate model for the prediction of repayment, Logistic regression, Gradient boosting, and CatBoosting algorithms are used with true data. The research about loan default prediction conducted in 2019 shows that the XGBoost algorithm has the best performance compared to other algorithms like AdaBoosting, ANN and Support vector. In that case, as a based model, choose XGB and evaluate with other models After comparing the accuracy of models and finding the most suitable model. Then the output of this model sends for use of the interest prediction module. The accuracy of the model was measured using the following equations and the summary of the models shown in Table 01. Among the selected models, the best accuracy scores were recorded in the XGB model. In order to achieve a swap between losing money on default customers, this study examined how various methods affect sensitivity, F1 and precision.

- Accuracy $=(TP+TN)/(TP+TN+FP+FN)$
- F1-score $=2TP/(2TP+FP+FN)$

- Precision =TP/(TP+FP)

Table 01: Models accuracy, f1 -score and precision

Model	Accuracy	F1-score	Precision
Logistic Regression	0.70	0.70	0.70
CatBoost	0.88	0.88	0.89
XGBoost	0.91	0.91	0.91
GradientBoost	0.90	0.92	0.92

In this model, the F1 and Precision values appear to be the same. The accuracy column was used to evaluate the model in that case. In comparison to the other three models, the XGBoost model accurately predicts loan repayment with 91 % accuracy.

By identifying the loan approval data and macroeconomic data, the model is developed. To predict the interest rate of the borrowers, various regression models can be used. Among them, for evaluation purposes, the lasso regression model and ridge regression model have been used. Ridge regression is used as the extension of linear regression. To determine the average of the absolute difference between the actual and predicted values in the dataset Mean Absolute Error (MAE) was suitable for that. It measures the average of the residuals of the dataset. When the models are predicting the loan approval data and macroeconomic data, build and evaluate the model by applying Classification and Regression Machine Learning Algorithms. If the loan is approved, Predict the interest rate according to the macroeconomic factors of the country. For the dataset classification, the following steps are being used.

Minimizing the prediction error of all data points is important. The Mean Absolute Error rate is performed. In the Lasso Regression model, the Mean Absolute Error rate is -1.091. In the Ridge Regression model, the Mean Absolute Error is -1.615, and the summary is shown in Table 02. To evaluate the module, one way is to identify the error of all data points, and the Mean Squared Error can be used to compare regression models.

Table 02: Summary of Lasso Regression and Ridge Regression

Methods	Lasso Regression	Ridge Regression
MAE	-1.091	-1.615
MSE	19.79	15.50

When considering the above error data points, a low error rate exists during Ridge Regression.

B. Handwritten character recognition of the loan application

The loan borrower's data is gathered from the loan application form. This form contains both text and numeric data related to the loan borrower. Also, the loan borrower must write in the given format. The form format is in a traditional way that it does not allocate the data-filled boxes to add the text data and only allows for numbers. So before proceeding, need to identify the particular areas separately. Before going to that required to train the model. For the model, use VGG19 Convolutional Neural Network. This recognition process will continue in two phases. The first phase is to train the model and the second one is the recognition part. In the model, training generates the dataset and the labels and train.

VGG19 is combined with 19 layers and contains 16 convolution layers and 3 fully connected layers. The 16 convolutional layers work for feature extraction and 3 fully connected layers 37 specialize in image classification. Those can classify 1000 object categories. When considering the Sinhala language, a total of 736 characters (Chamikara *et al.*, 2014) are available in the language. So that to separately identify their categories can use this. Another thing is that can add a million images to the model. Also, in the Sinhala language because of the writing style, the shape of the character varies. for that also can be addressed in this model (Bansal *et al.*, 2021).

In the pre-processing stage, the scanned image is made in a computer to a readable format. This directly affects the performance of the system.

A convolutional matrix is used here because the shape, thickness and writing style of the Sinhala language are similar to the letters and their technical methods of edge recognition and

sharpening help to recognize correctly. Then the image is converted to grayscale because the RGB type of image contains a lot of data and when processing it takes more time, and most of the time, it loses the information. Then do the Thresholding to identify the shape of the image.

In the character recognition phase, to segment, the characters take the sliding window, and it has a fixed value to segment the image. This value is decided by considering the space available for writing. Here, the segmented characters match the classes and their predicted values, which satisfy the conditions assigned to the class value. Finally, after finishing this recognition process, save the recognized field to the CSV file.

Through this part, identify numbers of data from the loan application and increase the accuracy of those data. The application has NIC, DOB, Telephone Number, number of the address, registration number of the business place (if available), duration with year and month etc., with different formats. This module aims to recognize handwritten numbers and increase the accuracy of those data. The after-effects of probably the most broadly utilized tesseract OCR technology. Sensitive information about related banking customers was difficult to get during data collection because the bank's policies only permitted loan applications with no associated data. In order to reduce accuracy difficulties in the data set, the research was carried out using little data that was developed by us and with the help of a bank marketing officer. In that case, use only Name, NIC number, Date of Birth, and application reference number. This module has mainly four stages: pre-processing, segmentation, feature extraction, classification, and recognition (Rosebrock, 2018). The pre-processing step's job is to execute a variety of activities on the supplied image (Ebrahimzadeh and Jampour, no date). It essentially improves the image by making it segmentation friendly. Pre-processing is primarily motivated by the desire to extract a fascinating example from the backdrop. This stage mostly consists of noise filtering, smoothing, and standardization. After the input photos have been pre-processed, the sequence of images is divided into sub-images of individual digits. Individual digits are assigned images and are divided into sub-image of individual digits. Each digit gets resized into pixels on its own. The dataset photos are segmented using an edge detection algorithm in this step. Then, the pre-processing and

segmentation stages are completed, and the pre-processed images are represented in the form of a matrix that contains pixels from very large images. In this approach, representing the digits in the photos that carry the necessary information would be beneficial. Feature extraction is the term for this activity. Redundancy in the data is removed during the feature extraction stage.

The flow of both Sinhala and numeric character recognition models is shown in Figure 02.
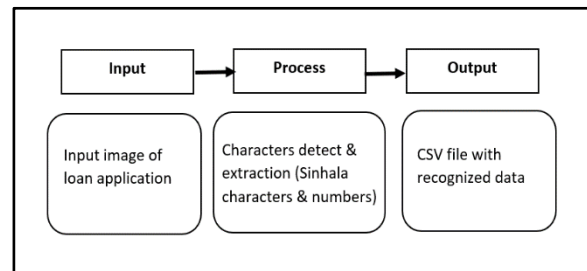
Figure 02: Flow of the character recognition model

IV. RESULTS AND DISCUSSION

This study aims to predict the interest rate according to repayment determinant factors and macroeconomic factors for each customer. Through this work, we were able to achieve the core of the aim. Firstly, the collected dataset from the ABC bank was used for data extraction. Missing data is replaced by using missing value imputation. During data analyzation multi correlation was identified to obtain the best relationship among the variables. And evaluated the regression models using various models to identify the better way to repay and the interest rate. For the loan approval, an accuracy column was used to evaluate the model. In comparison to the other three models, the XGBoost model accurately predicts loan repayment with 91 % accuracy. By analyzing the error rate of the Ridge Regression Lasso Regression models, the least error was identified in the Ridge Regression model.

According to the findings, we are predicting the interest rate for each customer considering several factors that affect the interest rate and ability to loan repayment. The regression models actually suggest a better interest rate in prediction with the help of the Boost algorithm results. However, we are currently obtaining a high-interest rate for each customer via prediction as a result of the sample data acquired. Another part of this work is loan

application automation through character recognition. In loan application automation, the research focuses on both Sinhala handwritten characters and number recognition in an equitable manner to obtain more accuracy. In the Sinhala details, the recognition form recognizes the name of the applicant from the filled form. Then, number recognition modules recognized the application number and NIC details. After that, all the details recognized by the system will display in the data entry and save as a CSV file as evidence. For this work, we used a sliding window method for character recognition and Tesseract OCR technologies. According to the findings, identified that using Tesseract OCR is more accurate for character recognition than the sliding window method.

The proposed methods under this study are the system that can be implemented for the predicted interest rate separately for the individual customer and recognize the customer details from the handwritten application form. For this study, we needed a bulk of data for both the interest prediction part and the character recognition part. The ABC bank is given their past data and their loan application form without filling data. The first step of the flow is to identify the loan repayment determinants relevant to the data set in the context of Sri Lanka and then use those determinant factors to perform binary classification to predict whether the loan applicant will be able to repay the loan. Then interpret approved repayment data and macroeconomic factors by applying linear regression models to predict the interest rate for repayment borrowers. The next step is to proceed with the loan application form. In the Sinhala details, the recognition form recognized the name of the applicant from the filled form by using the CNN methodology. With the limited data, accuracy was less compared to other research works. Also, here used the sliding window technique to separate the characters from the given text. That was not a success compared to object detection. Then number recognition modules recognized the application number and NIC details. After that, all the details recognized by the system will display in the data entry and save as a CSV file as evidence. The development of this system uses data mining techniques. Image processing and convolutional neural network, among other techniques.

V. CONCLUSION

This study seeks to find the determinants of credit default in microfinance institutions with the help of Information Technology. The proposed system is mainly concerned with predicting the interest rate for lending money and assuring the data accuracy of the process. For the interest prediction process, evaluate the customer applicability to request a loan and evaluate the interest rate that the system supports for the loan repayment process which does not negatively affect both customers and the bank. When considering the data accuracy, because of the unclear handwriting data entry operator sometimes may fail to update the bank database with accurate data. By identifying the basic details, the bank can give the loan to the customer and continue, but in case something happens related to the Judiciary, the bank has no accurate evidence to prove that the transaction happened via their bank. So in the past few years, microfinance institutions had a lot of bad experiences in proving the data and proving that.

So that this proposed system can provide the processed accurate data which customers write on the loan application form to maintain the accuracy of the process. Loan repayment was predicted using the XGBoost algorithm, and the results were 91 per cent accurate. GridSearchCV and SMOTE techniques were made to improve model performance. XGB produced the best results when compared to the other classifications. The accuracy scores for Gradient Boosting, Logistic Regression, and CatBoost Classifier are all less than 91 per cent. This model will be useful for predicting loan repayment and reducing default cases in the microfinance industry. Predicting the interest rate by identifying the impact of macroeconomic factors is used to do a comparison between regression models to predict the interest rate for non-default borrowers. To obtain a better solution, it was compared regression models by checking the Mean Absolute Error of each model.

It can be chosen the model that has the lowest error. If the model has the lowest mean absolute error, that is the best model for the prediction. In character recognition, here only focus on non-overlapping characters in the field and only one field is recognized. The main input to the program is the scanned image of the loan application form. So, the quality of the image has a higher impact on the process. Because depending on the quality of the image, pre-processing steps may cause some problems, and because of that incorrectly

identifying and did not predict the correct results. Another thing is that because of the similarity of the characters, the prediction failed. When it comes to number recognition using tesseract OCR can get high accuracy of character recognition.

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TRACK - BIOSYSTEMS ENGINEERING (BSE)

A Review on the Development, Mechanism and the Applications of the Tidal Flow Constructed Wetland Systems

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Abstract

Wetlands are an assortment of water bodies that give an environment to aquatic and terrestrial species and act as a distinct ecosystem flooded by water, where this water cover may occur seasonally or permanently. These may vary depending on various reasons, such as; the differences in the soils, topography, climate, hydrology, water chemistry, vegetation, etc. Constructed wetlands are being constructed by humans for the purpose of wastewater treatment specifically. These can be classified based on various parameters including the characteristics of the wastewater components and the wetland system itself, where they differ in their performance as well. The treatment wetland system technology has been developed so far, in terms of treatment efficiency, various types of contaminant removal capability, and the usage of land. Hybrid technologies have been developed to enhance these performance terms. The current study focus on the development, mechanism, and applications of the tidal flow constructed wetland systems, which possess a rhythmic cycle of filling and draining and enhanced treatment performance. The findings of the studies done with regard to various constructed wetland systems could be integrated to further enhance the treatment efficiency of the tidal flow constructed wetland system, having critically considered the role of oxygen in the treatment mechanism.

Keywords: Constructed wetlands, Wastewater treatment, Tidal flow, Nitrification, Denitrification

I. INTRODUCTION

Wetlands can be considered as a variety of water bodies that provide a habitat for aquatic vegetation and possess a biofiltration capability. They can be either natural marsh and swamp environments or artificially constructed storage basins and ponds. Wetland systems are located in the places where the water table is normally lying near the soil surface or at places of a permanent shallow-water cover. Constructed wetlands for wastewater treatment, sometimes referred to as treatment wetlands, are manmade systems that use natural processes to remove contaminants from polluted water in a more regulated setting (Faulwetter *et al*., 2009; Vymazal, 2009).

There are numerous methods and strategies used in wastewater treatment using the constructed wetlands, thus making it difficult to distinguish each and every method. However, studies have shown that they can be categorized based on their loading pattern (continuous or intermittent flow), vegetation (rooted emergent, floating, or submerged macrophyte-based system), wastewater characteristics (municipal, agricultural or industrial), or soil hydraulics and materials (Borkar and Mahatme, 2015).

Kathe Seidel in the 1960s (Seidel, 1961) and Reinhold Kickuth in the 1970s have significantly contributed to the development of wastewater treatment technology using constructed wetlands (Du *et al*., 2014). By then the usage of constructed wetlands has been primarily employed for the treatment of typical tertiary and secondary domestic and municipal wastewater (Kivaisi, 2001). By the time the usage of constructed wetlands has been extended to purify the agricultural effluents (Zhao, Sun and Allen, 2004; Wood *et al*., 2008), tile drainage waters (Borin and Toccheto, 2007; Kynkäänniemi *et al*., 2013), acid mine drainage (Wieder, 1989), industrial effluents (Mbuligwe, 2005; Calheiros *et al*., 2007) and landfill leachates (Justin and Zupančič, 2009; Istenič *et al*., 2012). Table 1 represents the road map of CWs.

Table 1: History of the development of CWs

Year	Innovation	Reference
1901	U.S. patent issued for the construction of distributed vertical flow, a fluctuating water level, and aeration of the wastewater.	(Monjeau, 1901)
1953	Vegetation-based designs for the improvement of inland waterways that suffered from overfertilization, pollution from sewage, and siltation.	(Seidel, 1953)
1952-1956	Research on the use of wetland plants for sanitation purposes. Also pointed out that "There are many questions about these systems and many limitations.	(Vymazal, 2011)
1970	Following a series of national conferences aimed at the use of wetlands for wastewater treatment in the United States.	(Brinson, 1984; Greeson et al, 1979)
1980	International exchange of knowledge by organizing conferences in various countries. Europe was mostly focused on Horizontal Flow CWs.	(Geller et al, 1992)
1985	The first two Horizontal Flow (HF) CWs were built in the United Kingdom and by the end of 1987 more than 20 HF CWs were designed.	(Cooper and Boon, 1987)
1990	The European Guidelines for constructed wetlands were introduced.	(Cooper, 1990)
1997	Austria accepted constructed wetlands as a certified technology by issuing official guidelines.	(Austrian Standards International, 1997)
1999	Denmark accepted constructed wetlands as a certified technology by issuing official guidelines.	(Danish Environmental Protection Agency, 1999)
2000	Australia and US EPA accepted constructed wetlands as a certified technology by issuing official guidelines.	(Sinclair, 2000; Queensland Department of Natural Resources, Brisbane, Australia, 2000; U.S. Environmental Protection Agency, 2000)
2000	The International Water Association issued its "Scientific and Technical Report" on the performance, design, and operation of constructed wetlands.	(Kadlec et al, 2000)
2000 - 2003	Increased demand for ammonia-N removal from sewage has resulted in the more frequent use of hybrid constructed wetlands, which are better suited to meet this goal than a single CW unit.	(Mander et al., 2003; Brix, Koottatep and Laugesen, 2007)
2005	Built wetlands have been used to treat not only municipal wastewater but also effluent from tanneries, wineries, compost leachate, and shrimp aquaculture.	(Calheiros, Rangel and Castro, 2007; Kucuk, Sengul, and Kapdan, 2004; Grismer, Carr and Shepherd, 2003; Masi et al, 2002; Reeb and Werckmann, 2005; Lin et al., 2005)
2005	The tidal flow CWs have been developed.	(Cooper, Griffin and Cooper, 2005)
2008	Numerical models of different complexities have been developed for describing various processes in subsurface flow CWs.	(Rousseau, Vanrolleghem and De Pauw, 2004; Langergraber, 2008)

Contaminant removal in constructed wetlands is complicated and reliant on a number of mechanisms such as; sedimentation, filtration, precipitation, volatilization, adsorption, plant uptake, and a range of microbiological activities (Vymazal, 2007; Kadlec and Wallace, 2008; Faulwetter et al., 2009).

Constructed wetlands have traditionally been used to remove suspended solids and organic matter, and they have shown to be effective in achieving these aims (Dordio and Carvalho, 2013; Vymazal, 2009). Advanced wastewater treatment in terms of total nitrogen (TN) removal has become a mandatory requirement across the world to prevent the eutrophication of aquatic bodies (Wendling et al., 2013).

However, none of the traditionally constructed wetlands such as; Surface flow constructed wetlands, Horizontal subsurface flow constructed wetlands, or Vertical subsurface flow constructed wetlands can remove TN effectively on their own, as they lack the ability to provide alternate aerobic and anoxic conditions for the subsequent nitrification/denitrification processes (Kadlec and Wallace, 2008; Vymazal, 2007, 2011). As an example, Surface flow constructed wetlands and

Horizontal subsurface flow constructed wetlands do provide favorable circumstances for denitrification, but nitrification is impeded by the lack of oxygen transfer. Conversely, the Vertical subsurface flow constructed wetlands, generate an aerobic environment that promotes nitrification while preventing denitrification (Vymazal, 2007). As a result, advanced process designs, such as hybrid or staged systems (Cooper et al., 2005; Cui et al., 2012; Seo et al., 2008; Vymazal, 2007), are becoming an unavoidable trend in the future development of constructed wetlands to accomplish successful TN removal (Vymazal, 2009).

Hence, the technology of wastewater treatment in constructed wetlands proceeded so far could be summarized as; Combining various types of constructed wetlands in hybrid systems to improve treatment performance; particularly for nitrogen, treatment of specific compounds present in wastewaters, search for suitable media with high capacity for phosphorus removal in subsurface flow constructed wetlands, identification of bacteria that assist in the treatment processes and the displaying of the pollution removal and the hydraulics of the various types of constructed wetlands (Zhi et al., 2015).

Further, the hybrid constructed wetlands have been demanded as a more suited approach in lieu of the single constructed wetlands in response to the necessity of removing the ammonia-N from sewage. Extra capital investment and a set of complex operating procedures are required by the hybrid systems of constructed wetlands and the Tidal flow constructed wetlands have been presented as an inclusive and cost-effective modification of enhanced removal of nitrogen, ammonium (NH_4^+), and TN (Zhi et al., 2015).

In this review, the mechanism, applications, and efficiency of the tidal flow wetland system are described with regard to the other wetland treatment designs.

II. DISCUSSION

Tidal flow constructed wetlands provide a rhythmic sequential cycle of a "filled/wet" phase and a "drained/dry" phase that enhances both nitrification and denitrification in a single reactor, reducing the costs of extra land use and initial capital (Borkar and Mahatme, 2015).

Tidal flow constructed wetlands are a somewhat new innovation that uses a new oxygen transfer operational strategy (Wu et al., 2014). They produce a musical successive pattern of a flood/wet stage and a channel/dry stage, which increments both the nitrification and denitrification in a single reactor. High TN removal rates were accomplished in Tidal flow constructed wetlands when the C/N proportions were higher than 10. Various researches have shown a restricted denitrification process in Tidal flow constructed wetlands, resulting in the accumulation of NO_3^--N and NO_2^--N because of the degradation of organic matter during the aerobic stage. The flood and drain (F/D) pattern of Tidal flow constructed wetlands is a critical parameter influencing the hydraulic loading rate (HLR) and aerobic/anoxic conditions for greatest nitrogen removal (Wu et al., 2015).

In tidal flow constructed wetland systems, the wastewater is fed to the aeration pipes at the bottom of the bed. It then percolates upward, flooding the surface. The pump is turned off when the surface is entirely inundated, and the wastewater is retained in the bed, in contact with the microorganisms growing on the medium. After a certain amount of time has passed, the wastewater is drained downward, air diffuses into the spaces in the bed, and the treatment cycle is complete after the water has drained from the bed (Cooper et al., 2005).

Ammonium removal in constructed wetlands is complicated, including a variety of sequential or concurrent physical, chemical, and biological interactions inside the substrates (Vymazal, 2007). The process of biological nitrification-denitrification is widely recognized as the most common method of ammonium removal. However, nitrification frequently comes before denitrification and is a rate-limiting phase in most classical constructed wetlands due to the lack of oxygen supply (Maltais-Landry et al., 2009; Hu et al., 2014). Accordingly, oxygen in wetland beds is significant for nitrification and ought to be expanded. In most horizontal subsurface flow constructed wetlands, oxygen transport to saturated media is restricted, with just a little amount of net delivery through macrophyte roots (1–8 $gm^{-2}d^{-1}$) (Kadlec and Wallace, 2008; Garcia et al., 2010). Artificially aerated constructed wetlands can enhance the oxygen transfer rate to 160 $gm^{-2}d^{-1}$ by compressing air from the atmosphere into the wetland bed through a blower

(Kadlec and Wallace, 2008). Therefore, the removal of nutrients could be enhanced and the required area would also be reduced significantly. However, this extra aeration could consume a lot of energy and the air diffusers could get dirt quickly leading to malfunctioning, hence their cleaning mechanism plus their replacement systems have to be decided carefully (Wu *et al*., 2014).

Tidal flow constructed wetlands are consistently loaded up with wastewater and the drained, going about as uninvolved siphons that repel and draw air from the atmosphere into grids (Sun *et al.*, 2006). Subsequently, the oxygen transfer rate comes to up to 450 $gm^{-2}d^{-1}$ (Wu *et al*., 2012). Also, the treatment limit of ammonium and organic matter fundamentally improves (Hu *et al*., 2014). By Fick's law, the half-time of oxygen diffusion from the air-water interface across thin biofilms, which is less than 100 μm is on the order of a second or less. In this way, the diffusion benefits the oxygen transfer in the drained phase to quickly nitrify adsorbed ammonium ions (McBride and Tanner, 1999). In the next flood cycle, nitrate (NO_3^-) anions as a result of ammonium oxidation are desorbed into bulk water. And they fill in as terminal electron acceptors for denitrification utilizing the organic carbon in the feeding water (Wu *et al.,* 2015).

However, it should be noted that for the treatment wetlands, oxygen is a vital natural parameter that controls nitrification and biodegradation of organic materials. Especially, when constructed wetlands are utilized to treat high-strength wastewaters, the oxygen transfer limitations act as a crucial factor affecting the performance of the treatment process (Wu *et al*., 2011). Accordingly, another tidal flow operation approach; also named the fill-and-drain operation has been proposed. Here, as the constructed wetland is being filled and drained, its bed of it is being saturated sporadically and when the air draws into the aggregate oxygenates the biofilms (Jiang et al. 2014). Hence, the operation has been researched as a method of improving treatment efficiency in various studies (Zhao, Sun and Allen, 2004; Jiang *et al*., 2014).

A study done on the oxygen transfer capacity and the removal of NH_4^+-N and organic matter utilizing a laboratory scale tidal flow constructed wetland has reported that the maximum removal of BOD, NH_4^+-N, and TN for various pollutant loadings (BOD loading 174–330 g/m^2/day) was

91, 82, and 43 %, respectively (Wu *et al*., 2011). Sun *et al*. (2006) studied a pilot-scale constructed wetland for high-strength piggery wastewater treatment utilizing tidal flow operation, where the study concluded of the system that shows a cleaning impact, and the removal efficiencies of COD, BOD, TSS, NH_4^+-N, and TP were 80, 82, 78, 58, and 45%, respectively. This is significantly higher than the ordinary subsurface flow systems. However, the performance of removal utilizing this methodology relies upon many factors such as; flood channel proportions, C/N proportion, and substrate qualities. Another study has covered the impact of utilizing various medium arrangements in tidal flow constructed wetlands by treating the wastewater emitted from a pig farm and the outcomes exhibited that utilizing coarse substrates in the upper layer of the constructed wetland system could enhance the removal of organic matter and suspended solids due to the minimized effect of clogging (Sun *et al*., 2006). Furthermore, another study has explored the impact of various flooded/drained (F/D) time proportions on nitrogen transformations in tidal flow constructed wetlands, where it has been indicated that the extended drained periods and shorter flooded periods have shown a positive impact on the nitrification in the wetlands, whilst the F/D time proportions had a little impact on the Phosphorous removal (Chang *et al*., 2014; Zhi and Ji, 2014) has revealed that high COD (83–95 %), NH_4^+- N (63–80 %), and TN (50–82 %) removal efficiencies were accomplished in a tidal flow constructed wetland under the C/N ratios ranging from 2 to 12. They further reveal that a C/N ratio of greater than 6 (>6) is needed to achieve complete denitrification.

Apart from these promising results, further full-scale and real-world research are being needed to receive a better understanding of the tidal flow operation and its practicability in applications.

Added to that, the construction solid waste (solid waste generated from the construction fields/materials) -based tidal flow constructed wetland system would facilitate a high rate removal of Phosphorous, ammoniacal-nitrogen and organic matter from the domestic. Also, this strategy would enable us to utilize construction solid waste as a useful material. Hence, the construction solid waste could be used as the main substrate material in the constructed wetland systems and the usage of coal ash-based construction solid waste particularly would yield

benefits in reusing and disposal of the construction solid waste, while stepping to an improved Phosphorous removal out of the domestic wastewater. Sorption in the construction of solid waste-based media has been suggested to be the main mechanism of Phosphorous removal. This usage eases the pressure on construction solid waste management and disposal. TCOD and NH4+ -N removal performance could be enhanced in a significant manner through the increased oxygen supply capacity via the tidal flow operation strategy (Yang *et al*., 2012).

The removal of COD, BOD, N, and P from rejected water of a municipal wastewater treatment plant utilizing a new alum sludge-based multi-stage vertical subsurface flow constructed wetland system has been investigated, where the results indicate that a critical decrease of up to 99.5% of P-input through the reject water recycling to the principle wastewater treatment stream can be accomplished by utilizing such alum sludge-based constructed wetland. The alum sludge has shown that it contains a few metal ions that identify with P-metal adsorption and precipitation. Particularly, the aluminum ion is the predominant constituent in the alum sludge. And it could potentially contribute to adsorption and chemical precipitation of P onto the alum sludge. Different studies show different results on the reported Phosphorous adsorption capacity of the alum sludge, as per their experimental method and the other conditions. However, a range of 1.1 to 150.0 mg-P/g-sludge could be observed in the results of the studies (Kim *et al*., 2002; Dayton and Basta, 2005; Novak and Watts, 2005; DeWolfe, 2006). A recent study has employed an Irish alum sludge as the wetland media, and its long-term lab-scale operation has depicted a strong association with phosphorousimmobilization. Also, the lifetime of the constructed wetland for Phosphorous adsorption saturation has been estimated to be 9-40 years (Zhao *et al*. 2011)

A novel tidal vertical flow constructed wetland has been developed to treat secondary effluent with low COD/ total nitrogen (C/N) ratio raw sewage as a carbon source. The tidal zone has been described by the presence of unclassified Xanthomonadaceae, Nitrospira, and Rhodanobacter, while Candidatus Brocadia and Denitratisoma, which includes anammox and denitrification, dominated the community composition in the saturated zone. These outcomes have additionally been affirmed by the

relating functional genes (amoA, nxrA, nirS, and anammox). Hence, the halfway denitrification-anammox (PDN/AMX) and denitrification were proposed as the significant pathways identified with nitrogen removal (Zhan *et al.,* 2020).

The purification limit of a research center scale tidal flow reed bed system with final effluent recirculation at a proportion of 1:1 has been investigated. The normal removal efficiencies obtained for COD, BOD5, SS, NH4+-N, and P have been 77%, 78%, 66%, 62%, and 38%, respectively (Zhao, Sun and Allen, 2004).

The beneficial effect of effluent recirculation on the performance of wetlands, particularly on the removal of inorganic nitrogen, has been reported in the literature. Kantawanichkul *et al*. (2001) investigated the effect of varying the recirculation ratio (recirculation flow rate: feed flow rate) in a vertical flow wetland system treating pig farm wastewater from 0:1 to 2:1. The optimum ratio was discovered to be 1:1, which allowed the system to achieve the highest nitrogen removal, 93 percent Total Nitrogen. A column-scale trial of a tidal flow constructed wetland system treating diluted piggery wastewater resulted in significant removal of organic matter, ammoniacal nitrogen, and suspended solids. Recirculating final effluent at a 1:1 ratio improved pollutant removal percentages (Sun, Zhao and Allen, 2005).

Accomplishing viable total nitrogen (TN) removal can be considered one of the major challenges faced by constructed wetlands. Including multiple tides in a single-stage tidal flow constructed wetland has been proposed in addressing this issue (Hu, Zhao and Rymszewicz, 2014). This has resulted in a very high value of 85% (average) on TN removal under a high nitrogen loading rate (NLR) of around 28 gNm^{-2}/day. This makes this system an optimum advanced wastewater treatment method for peri-urban and rural communities. This method has also, shown greater adaptability to tidal flow constructed wetlands. However, the contact/rest plan on the bed should be optimized as per the adsorption/nitrification kinetics. These findings will provide a new foundation for the design and modeling of nitrogen removal in tidal flow-constructed wetlands.

III. CONCLUSION

Oxygen is the crucial factor for continuous nitrification and denitrification processes. Conventional wetland systems do not have proper oxygen transferring processes via the substrate and wetland water. Tidal flow constructed wetlands possess special flow cycles, which proceed with the fill and drain. Oxygen can fill into the system during the drain cycle. The "Fill" part of the cycle enhances nitrification, while the "drain" part accounts for the enhancement of the denitrification. By combining and integrating various treatment technologies, followed by the particular specifications to the substrate and wetland water, Nitrogen and Phosphorous removal rates could be developed.

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Characterization of the Drinking Water Sludge for Agricultural Usage

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Abstract

Water treatment plants generate large quantities of sludge resulting from treatment processes. "Konduwatuwan" water treatment plant located in Ampara in Sri Lanka, generates a huge amount of sludge annually and is disposed directly to the adjacent environment. Concerns have been raised by various authorities regarding the potential risk of the sludge on human and environmental health. This study was conducted to characterize the sludge and to evaluate the potentials to utilize it for soil application in agriculture. Physical and chemical parameters were analyzed using sludge samples in the laboratory. The result showed that the average moisture, total solid, ash and organic matter contents present in the sludge were 79.44%, 20.55%, 60.73% and 39.27% respectively and the monthly mean values of ash and organic matter contents did not significantly vary with time during the study period. The pH, electrical Conductivity, levels of cadmium, chromium, iron, lead and nitrogen were promising in the sludge when compare with aluminium based water sludges used for comparison in this study. Further, the levels of pH, electrical conductivity, nitrogen and phosphorous present in the sludge were within the suitable range for land application and the concentrations of cadmium, chromium and lead were far below the threshold values for composting according to Sri Lankan standards. Thus, the sludge can be utilized for the cultivation of non-food crops. However, further studies are recommended to investigate the effects of sludge on long-term application over the metal loading on cropping lands.

Keywords: sludge characters, metals, analysis, composting

I. INTRODUCTION

Treatment of water for drinking is one of the essential services worldwide. A large quantity of drinking water sludge (DWS) is generated during the water treatment processes. Konduwatuwan water treatment plant (WTP) is one of the large-scale plants operated by the National Water Supply and Drainage Board in Sri Lanka. According to our preliminary assessment, it was estimated that during the treatment about 25-30 m^3 of sludge is generated and disposed of daily which fluctuates depending on the climate. The Gal-Oya river, which is feeding the Konduwatuwan tank, passes through many agricultural areas on its way crossing from Badulla district to Ampara district carrying a huge load of potential agrochemical residues causing an increased algal population in its water. The sludge is rich in clay particles and residual chemicals (Uwimana *et al.*, 2010). Our estimate suggests that about 5% (W/W) of Poly Aluminium Chloride, 0.3 % (W/W) of powder activated carbon and 0.04% (W/W) of Polyacrylamide are used in the water treatment process as a coagulant, for the removal of taste, odor & toxic chemicals and to treat the sludge respectively. Disposal of drinking water sludge has become a serious problem not only in Ampara but also in many other districts where such treatment plants operate.

Figure 01: Sludge dumping site of the Water treatment plant in Ampara

II. LITERATURE REVIEW

Direct discharge of DWS into rivers and water bodies might cause metal pollution, such as contamination with aluminum (Barakwan et al., 2019). Al movement into surface water has

potential plant Al toxicities and damage to the aquatic environment (Ippolito, Barbarick and Elliott, 2011). Further, the heavy metal residues may be toxic to humans, resulting in central nervous system failure, dementia, memory loss, lethargy, and severe trembling (Ahmad, Ahmad and Alam, 2016). The simple method of discharging sludge directly into nearby water bodies or dumping in the landfill sites is not a sustainable solution, therefore, suitable sludge management strategies need to be formulated for sustainable development (Ahmad, Ahmad and Alam, 2016). As a way for the disposal of DWS, research studies in other countries suggested that DWS can be utilized as building and construction material (Odimegwu *et al.*, 2018), to produce brick (Hegazy, Fouad and Hassanain, 2012. Further, sludge can be used as a good candidate material for P adsorption (Hou *et al.*, 2018), as a cement material (Pan, Huang and Lin, 2004), to remove heavy metal pollutants such as Hg, Se, and As (Ippolito, Barbarick and Elliott, 2011). DWS also utilized to adsorb pollutants in wastewaters (Feria-Díaz, Polo-Corrales and Hernández-Ramos, 2016); Yang et al., 2006), and for wastewater treatment in constructed wetland systems (Zhao *et al.*, 2011) and as a coagulant to remove the turbidity, Chemical oxygen demand (COD) and anionic surfactants (Jangkorn *et al.*, 2011).

Appropriate application of this sludge will not pose any negative effect on the soil properties or plant when they are used as soil fertilizer with appropriate sludge content (Odimegwu et al., 2018; Caniani et al., 2013) and it can be considered suitable for agricultural use (Caniani *et al.*, 2013). Therefore, the reuse of the DWS as fertilizer is considered a sustainable form of disposal method (Odimegwu *et al.*, 2018). Investigations on sludge toxicity did not find acute toxicity effects in a variety of situations, the heavy metal concentrations were less than regulatory levels and pose few environmental risks (Maiden *et al.*, 2015). Water treatment sludge can be used as an organic matter stabilizing agent with active adsorption surfaces (Haynes and Zhou, 2015). Water treatment sludge is made up of inorganic and organic compounds varies in physical and chemical characteristics depending on the chemicals used in the treatment process and the water source (Odimegwu *et al.*, 2018). The characterization of sludge samples showed that their organic matter content would open up the possibilities for application in soil improvement

(Hidalgo *et al.*, 2017). Therefore, land application of sludge generated from water treatment plant is possible with non-food crops, mine reclamation areas, and in forestlands (USEPA, 2011).

III. PROBLEM STATEMENT

Drinking water sludge disposal has become a serious problem in Ampara because a large quantity of sludge is disposed directly in to the nearby environment daily as no alternative solutions are put forwarded to utilize it in a safe manner (Figure 01). Public, health and environmental authorities are concerned regarding the potential risk of the sludge on human and environmental health. Even though a number of investigations on potential industrial reuse and recycling of DWS are available, studies on its agricultural utilization are limited (Dassanayake *et al.*, 2015). Scientific characterization of DWS is necessary for safe agricultural uses locally owing to its source of generation. However, literature on the characteristics of the sludge for agricultural uses, which influence the growth and development of agricultural crops, are limited. As such the present research work was carried out to characterize the DWS based on the physical and chemical properties with the purpose of utilizing the sludge as an ingredient in plant growth media which in turn is expected to be a green solution for its disposal.

IV. METHODOLOGY

Sludge samples were collected in plastic containers from the centrifugal dewatering outlet of the Konduwatuwan water treatment plant during 10.00 am to 11.00 am in the morning at weekly intervals. A total number of 12 samples collected during March to May were used for the analysis of moisture content, total solid content, organic matter content and ash content (Ramirez and Possan, 2018), Whereas a total number of 16 samples collected weekly during March to June were used for analysis of pH, electrical conductivity, total nitrogen, phosphorous, potassium and metals concentration levels. Immediately after collection, the samples were dried at 105 °C for 24 hours until constant weight was reached. The dried sludge samples were ground and sieved using a 75 μm (200 mesh) metal sieve and stored at 4 °C for further analysis of physical and chemical characters (Zhang, Qin and Yi, 2020).

The moisture content (MC) was determined by the weight loss after the sample dried at 105 °C for 24 hours in an electric oven, total solid content (TS) was calculated from the residuals. The oven dried sample was subjected for combustion at 550 °C for 5 hours in the furnace to determine the organic matter content (OM) by weight loss (Bożym and Siemiątkowski, 2018). Ash content (AC) was calculated by the final weight after ignition (Ahmad, Ahmad and Alam, 2016). Analysis of inorganic parameters was performed according to the Standard methods for examination of waste and wastewater (Brandi and Wilson-Wilde, 2013). The pH and the electrical conductivity (EC) were determined by using a professional pH meter (model-BP300) and a conductivity meter (model-ST300C-B) respectively in 1:5 (W/V) sludge: distilled water ratio. Total nitrogen was determined by Kjeldahl digestion method whereas total phosphorous & potassium were determined using dry ash method (Brandi and Wilson-Wilde, 2013). Concentrations of aluminum, iron, lead, arsenic, cadmium and chromium were determined using Thermo Scientific iCAP 7000 plus series ICP-OES. Sample analyses were carried out in the laboratory of the department of biosystems technology of the Faculty of Technology, South Eastern University and in the Central soil testing laboratory of the Horticultural crop research & development institute in Sri Lanka. The data analysis was carried out using MINITAB statistical software version 18. Analysis of variance (ANOVA) was performed to find out whether the mean values of studied parameters are significantly different within the studied months.

V. RESULTS AND DISCUSSION

A. *The mean values of the moisture content, total solid content, organic matter content and ash content for the sludge samples collected from March to May in 2021.*

Table 3: ANOVA for monthly mean values of moisture content, total solid content, organic matter content and ash content.

Sampling Month	Moisture content (%)	Total solid content (%)	Ash content (%)	Organic matter content (%)
March	78.7 (77.2, 80.2)	21.2 (19.7, 22.9)	60.9 (59.1, 62.2)	39.3 (37.8, 40.9)
April	81.1 (79.5, 82.6)	18.9 (17.4, 20.5)	60.7 (59.4, 62.5)	39.0 (37.4, 40.6)
May	78.5 (76.9, 80.0)	21.5 (19.9, 23.0)	60.5 (58.9, 62.1)	39.5 (37.9, 41.0)
P- value	0.04*	0.04*	0.92	0.92

Note: 1. All data represent the mean values and 95% CI values (n = 4).
2. *Monthly mean values are significantly different at p<0.05.

B. *The mean pH value, electrical conductivity, total nitrogen, total phosphorous, total potassium, level of aluminum, iron, lead, arsenic, cadmium and chromium for the samples collected from March to June in 2021.*

Table 4: ANOVA for monthly mean values of pH, electrical conductivity, total nitrogen, total phosphorous and total potassium.

Month	pH	EC (dS/m)	N (ppm)	P (ppm)	K (ppm)
March	6.6 (6.5, 6.8)	0.72 (0.66, 0.78)	14800 (14304, 15296)	1465 (1358.1, 1571.9)	275 (216.2, 333.8)
April	6.5 (6.4, 6.6)	0.62 (0.56, 0.68)	16500 (16004, 16996)	1337.5 (1230.6, 1444.3)	250 (191.2, 308.8)
May	6.5 (6.3, 6.6)	0.65 (0.59, 0.70)	17375 (16879, 17871)	1572.5 (1465.6, 1679.4)	275 (216.2, 333.8)
June	6.5 (6.4, 6.6)	0.68 (0.61, 0.73)	14700 (14204, 15196)	1307.5 (1200.6, 1414.4)	250 (191.2, 308.8)
P-value	0.377	0.093	0.001*	0.009*	0.0835

Note: 1. All data represent the mean values and 95% CI values (n = 4).
2. *Monthly mean values are significantly different at p<0.05.

Table 5: Comparison of the mean values of chemical parameters with nutrient requirements for compost.

Parameters	Mean values for the entire study period	Nutrient requirements for compost according to Sri Lankan standard specification (SLS 1246: 2003)
pH	6.5	6.5-8.5
EC dS/m	0.67	0.5-3.0
N (ppm)	15798	>10000
P (ppm)	1414	>500
K (ppm)	257.7	>10000

Table 6: ANOVA for monthly mean values of aluminum, iron, lead, arsenic, cadmium and chromium.

Month	Aluminum (000, ppm)	Iron (000, ppm)	Arsenic (ppm)	Cadmium (ppm)	Chromium (ppm)	Lead (ppm)
March	120.7 (120.1, 121.3)	103.2 (101.9, 104.5)	1.162 (1.142, 1.182)	0.029 (0.027, 0.030)	5.875 (5.298, 6.451)	ND
April	120.7 (120.1, 121.3)	102.2 (100.9, 103.5)	1.13 (1.110, 1.149)	0.040 (0.038, 0.041)	5.950 (5.374, 6.526)	ND
May	120.2 (119.6, 120.8)	985.1 (972.1, 998.1)	1.13 (1.110, 1.149)	0.032 (0.030, 0.033)	7.100 (6.524, 7.676)	ND
June	121.2 (120.6, 121.8)	101.3 (100.0, 102.6)	1.14 (1.122, 1.162)	0.033 (0.032, 0.035)	7.500 (6.924, 8.076)	ND
P-value	0.163	0.001*	0.081	0.001*	0.002*	-

Note:
1. All data represent the mean values and 95% CI values (n = 4).
2. ND-Not detected.
3. *Monthly mean values are Significantly different at $p<0.05$.

Table 7: Comparison of the Mean values of metal with threshold values for compost.

Parameters studied	Mean values for the entire study period	Limit for heavy metals threshold values according to Sri Lankan standard specification for compost (SLS 1246: 2003).
Cadmium (ppm)	0.0335	< 10
Chromium (ppm)	6.55	< 1000
Lead (ppm)	ND	< 250
Aluminium (ppm)	120745	NA
Iron (ppm)	10134	NA
Arsenic (ppm)	1.141	NA

Note:
1. NA-Not available.
2. ND- Not detected

Table 6: Comparison of physicochemical characteristics of DWS from Konduwatuwan WTP with previous studies.

Parameter	Mean values of present study	Average values of Aluminium based water treatment sludge as calculated by Ippolito et al. (2011)	Values from ASCE et al. (1996) based on 12 WTR (U.S. EPA, ASCE and AWWA., 1996)
pH	6.5	6.5 ± 0.3	7.0
EC dS/m	0.67	1.6	0.6 ± 0.5
Total N (ppm)	15798	4,065 ± 7404.06	4950 ± 2560
Total P (ppm)	1414	2,157 ± 361	2,260 ± 2,480
Total K (ppm)	257.7	3,547 ± 582	2,250 ± 3,170
Cadmium(ppm)	0.0335	0.12 ± 0.02	5.15 ± 11.7
Chromium(ppm)	6.55	20 ± 7	50 ± 56
Lead (ppm)	ND	22 ± 12	80 ± 100
Aluminium(ppm)	120745	118700± 24260	60,100± 52,100
Iron(ppm)	10134	37,000±19,740	52,75± 63,64
Arsenic (ppm)	1.141	NA	NA

Note:
1. NA-Not available.
2. ND- Not detected

Analysis of variance (ANOVA) showed that, the ash content and organic matter content during the studied months were not significantly different($p<0.05$) whereas monthly mean values of moisture content and total solid content are significantly different($p<0.05$), which may be due to the difference in the dewatering operation in the plant (Table 1). The average moisture content and the total solid content of sludge samples were 79.44% and 20.55 % respectively which are almost similar to the values reported by Ramirez and Possan (2018) where the average moisture content and total solid content were recorded as 76.36% and 23.63% respectively for DWS. The reason for obtaining similar moisture and solid contents in the present study compared to previous studies may be due to plant operation as predetermined by the dewatering plant operator and also due to the similar dewatering procedures adopted by different dewatering units in different treatment plants.

The average ash content was 60.73 % during the sampling period, this is almost similar to the value

reported by Awab, Paramalinggam and Mohd Yusoff (2012) where, the ash content was 66.67%. The ash content in the present study indicated that the WTP sludge presented similar characteristics throughout the study period as reported by Ramirez and Possan (2018) may be due to minimum climatic variation prevailed during the study period. The average organic matter content of the sludge sample over the study period was 39.27 % which highly deviated from the previous studies. Gmurkowska (2019) reported in a study, that the organic matter content is 69% in sludge samples collected at the ZUW Raba water treatment in Poland. Further stated that this may be due to the accumulation of organic compounds in summer (Gmurkowska, 2019). According to Odimegwu *et al.* (2018) the organic matter content of alum sludge differs from treatment plant to plant based on the origin of water source. The organic matter present in the water sludge will help to improve the physical and chemical characteristics as well as the nutrient availability of the agriculture soil. (Jamil Khan, Qasim and Umar, 2006 ; Bozkurt, Yarılgaç and Yazıcı, 2010).

The analysis of variance (ANOVA) showed that the monthly mean values of pH, electrical conductivity and the level of potassium were not significantly different ($P<0.05$) throughout the study period but significant differences were found in levels of nitrogen and phosphorous (Table 2). The mean pH value obtained as 6.5 in the present study is similar to the value found in a study conducted by Ahmad, Ahmad and Alam in 2016. The mean values of total nitrogen (15 843ppm) and total potassium (262.5 ppm) identified in the present study were higher than the values obtained by Feria-Díaz, Polo-Corrales and Hernández-Ramos,in 2016 which are 4000-4800 ppm and 148ppm respectively. However, the level of total phosphorous (1420.6 ppm) is lower than the value (3001-3500 ppm) obtained in the said study (Feria-Díaz, Polo-Corrales and Hernández-Ramos, 2016). The chemical characteristics of DWS are influenced by water source used for it and the cultivation practices in the surroundings. Further the catchment areas and climatic factors influence the characteristics of water source. Therefore, the variations of pH, electrical conductivity, N, P and K in DWS from different treatment plants fed by different water sources are anticipated.

The mean values of pH, EC, total nitrogen and total phosphorous present in the sludge are within the suitable range of nutrient requirements for compost as determined by Sri Lankan standards for nutrient requirements for compost (Table 3) indicating the suitability of DWS for agricultural usage.

According to Table 4, the analysis of variance (ANOVA) of metals showed that the monthly mean values of aluminum and arsenic were not significantly different($P<0.05$), whereas iron, cadmium and chromium concentrations showed significant difference($p<0.05$) between months in the sludge. The heavy metals content in the DWS may vary with time due to variations in leaching of the heavy metals into the reservoir and agricultural runoffs (Dahhou *et al.*, 2017). According to a study conducted by Yiew *et al.* (2018) in Malaysia the concentration aluminum and iron were recorded as 170 000 ppm and 49 900 ppm respectively and these values are much higher than the values obtained in the present study (Table 4). A study conducted by Uwimana *et al.* (2010) in Rwanda on characterization of the sludge generated at Kadahokwa WTP found that the concentrations of cadmium, chromium and iron were 1.1 ppm, 29.9 ppm and 45, 007 ppm respectively and these values are comparatively higher than the concentrations of the said elements found in the present study (Table 4).

According to Table 5, the concentrations of cadmium and chromium were found as 0.0335ppm and 6.55pm respectively in the sludge. Further, these values are far below than the toxicity threshold level for land application set according to SLS standards (SLS 1246: 2003) hence it is found to be safe for land application as well as for making compost (Central Environmental Authority Sri Lanka, 2003). However, the limit for threshold values of aluminum, iron and arsenic are not available in Sri Lankan standards for comparisons. The concentration of lead was not found up to detectable level. According to Uwimana *et al.* (2010) WTP sludge possess no serious detrimental properties and in particular no soluble aluminum. Further, according to Caniani *et al.* (2013) the chemical composition of the drinking water sludge does not show substances that could be dangerous for the environment, as it is found with a low risk of contamination for human beings and low concentrations of transfer of pollutants to soil and groundwater. On the other hand, a number of beneficial properties were found in DWS such as low bulk density, high infiltration rate, available

nitrogen and a neutral to alkaline pH which are favorable for plant growth. Further Ippolito, Barbarick and Redente (1996) observed a linear relationship between increasing WTP sludge application rate and crop yield. Hence, the beneficial physical and chemical properties of the WTP sludge make it a good plant growth medium. However, loading effects of heavy metals as a result of continuous application on cultivation field should be considered and investigated.

When compare the physicochemical characteristics of sludge from Konduwatuwan WTP with the average values of aluminium based water treatment sludge as calculated by Ippolito, Barbarick and Elliott (2011) the pH and the Level of aluminium are comparable whereas the level of cadmium, chromium, lead and iron are lower while the total nitrogen level is higher in the studied sludge (Table 6).

A comparison between the present sludge with the values found by the American Society of Civil Engineers (ASCE) *et al.* (1996) based on 12 water treatment residuals reveals that the electrical conductivity and the pH values are comparable while the level of iron, cadmium, chromium and lead are comparatively lower in concentration (Table 6) in the present study with higher level of total nitrogen and aluminium.

VI. CONCLUSION

Based on the evaluation of the physical and chemical characteristics of the Konduwatuwan sludge, it is concluded that the sludge contains a higher percentage of organic matter content up to 39% throughout the period studied without significant fluctuation. The levels of pH, EC, total nitrogen and total phosphorous present in the sludge is within the suitable range for land application as it complies with the nutrient requirement for composting as per Sri Lankan standards. Further the concentrations of cadmium, chromium and lead are found far below than the threshold values for heavy metals for composting. Further, the pH, EC, levels of cadmium, chromium, iron, lead and nitrogen were promising in the sludge when compare with the characteristics of aluminium based water sludges used for a comparative analysis in this study. Though, the level of aluminum is higher in the DWS, the sludge can be recommended for land application and as an ingredient in making compost for non-food crops. However, further studies are necessary to evaluate the effects of

aluminium and iron on crop growth and development on long term basis.

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TRACK - FOOD SCIENCE AND TECHNOLOGY (FST)

Development of Biscuits using Composite Flour of Wheat, Finger Millet and Kohila (*Lasia Spinosa)* Supplemented with Garlic Flavor

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Abstract

The consumption of cereal snack food such as biscuits, cookies and shortbread has become very popular in Sri Lanka especially among children because of their variety in taste, crispiness, and digestibility. Composite flours have higher nutritional quality and would be ideal for making nutritious cookies. A study was conducted to evaluate the quality characteristics of biscuits made from finger millet (Eleusine coracana), kohila (Lasia spinosa), and wheat (Triticum aestivum) flour. Various composite blends of wheat, finger millet, and Kohila flours were mixed in the following ratios: 100: 00: 00, 80: 10: 10, 50: 10: 40, 50: 40: 10, and 20: 40: 40 with 1 g of garlic powder in all treatments. The diameter and spreading ratio of the biscuits expanded from 5.90 – 5.95 cm and 14.51-15.59, respectively, while the thickness decreased (4.07 -3.80) as the composite finger millet and Kohila flour increased. Chemical parameters such as protein (4.25 % -5.76 %) and ash (0.66 % -0.83 %) increased, while fat (8.74 % - 7.25 %) and moisture content (2.58 % - 1.88 %) decreased significantly (p < 0.05) with the addition of composite finger millet and Kohila flour to the biscuits. When compared to other treatments, the biscuits supplemented with 50 g wheat flour, 40 g finger millet, and 10 g Kohila (T4) were well acceptable in terms of color, texture, taste, flavor, and overall acceptability. As a result, T4 with a combination of 50g wheat flour, 40g crabgrass and 10g Kohila enriched with 1g garlic powder was successful in formulating composite biscuits with improved nutritional and organoleptic properties.

Keywords: Composite flours, finger millet, kohila, Qulaity characters, Wheat flour

I. INTRODUCTION

Millet feeds one-third of the world's population and is an important food source in developing countries. The nutritional value of finger millet [*Eleusine coracana* (L.)] is superior to that of other common cereals. Millets are high in minerals such as iron, magnesium, phosphorous, and potassium. It has the highest calcium content, approximately ten times that of paddy rice or wheat (Bhoite et al., 2018).

Lasia spinosa (L.) is a native vegetable that is high in nutritional and medicinal value. It is a member of the Araceae family. It is widely grown in South and South-East Asian countries, including Sri Lanka (Kumari et al., 2017). It had a lot of phenolic and flavonoid compounds. Its antioxidant constituents, such as vitamin E, vitamin C, flavonoids, and polyphenols, can combat oxidative stress via the free radical scavenging mechanism of phytochemicals (Men et al., 2021). In addition to its use as food, *L. spinosa* plays a significant role in indigenous medicine.

Due to its strong flavor, garlic is frequently used as a flavoring or condiment around the world(Bhoite et al., 2018)

Bakery products produced with wheat flour (WF) are a main food in many countries and thus play an important role in global nutrition. WF contains essential carbohydrates and some proteins, but it lacks minerals, particularly calcium and iron. The addition of food groups such as pulses, oilseeds, herbs, and so on can often improve the nutritional quality of WF-containing baked foods. Incorporating such ingredients into bakery products such as biscuits will not only improve nutritional quality but also provide novel textural properties and improved sensory acceptability (Agrahar-Murugkar, 2020). Biscuits are a ready-to-eat, inexpensive, and convenient food for people of all ages. It is regarded as a good product for protein fortification and other nutritional improvements due to its acceptability in all age groups and longer shelf life.

As a result, the current study was conducted in order to assess the chemical and sensory quality of newly made biscuits made of a composite flour of wheat, finger millet, and *Kohila*, along with garlic flavor.

II. MATERIALS AND METHODS

A. Procurement of materials

The Agronomy farm in Nikaweratiya provided high-quality finger millet seeds. Premature *Lasia spinose* rhizome of high quality was purchased from a local market in Anamaduwa. A supermarket in Anamaduwa provided the wheat flour, garlic, sugar, margarine, baking powder, egg, and packaging materials. The finger millet garlic and cloves were cleaned, washed, dried, and ground with a grinder (Senator Dx-2000) then, sieved (60 mesh). *Lasia spinose* rhizomes were washed and cut into small pieces. The mixture was then oven dried at 60 ° C for 15 minutes before being ground with a commercial grinder (Senator Dx-2000) and sieved (250 mesh).

B. Preparation of biscuits

Initially, the sugar (50 g) and margarine (50 g) were thoroughly creamed. The sieved composite flour, baking powder (2 g), and garlic powder (1 g) were gradually mixed into the creamy mixture. The dough was then kneaded to a smooth consistency with water. The dough was refrigerated for 30 minutes. Small balls of dough were formed to make biscuits, placed on a tray, and baked at 180^0 C for 15 minutes.

Table 01: Treatments combinations

Treatments	Wheat (g)	*Lasia spinosa (g)*	Finger Millet (g)	Garlic Powder (g)
T_1	100	00	00	1
T_2	80	10	10	1
T_3	50	40	10	1
T_4	50	10	40	1
T_5	20	40	40	1

C. Quality analysis

Moisture (oven drying method), carbohydrate (phenol-sulfuric acid method), protein (Kjeldahl Method), fat (AOAC 935.38), and ash (AOAC 900.02) were measured. Physical parameters; thickness, diameter, and spread ratio were measured.

D. Sensory evaluation

The sensory quality of the developed products was judged by 20 trained panelists using a 9-point hedonic scale in terms of color, flavor, texture, taste, and overall acceptability.

E. Statistical evaluation

In the experiments, each formulation was replicated in a completely random design (CRD). The chemical, physical, and organoleptic data were analyzed using analysis of variance (ANOVA) ($\alpha = 0.05$). Duncan's multiple range test was used to compare mean differences through Minitab 17 version.

III. RESULTS AND DISCUSSION

A. Physical parameters

Table 02 indicated that when the concentration of composite finger millet and Kohila was increased, the thickness of the biscuits decreased. T1 had the highest mean thickness value (4.07cm) and T5 had the lowest mean thickness value (3.80cm). Both the diameter and spread ratio increased. T1 had the lowest value and T4 with 50 g wheat, 40 g finger millet, and 10 g Kohila flour had the highest value for both diameter and spread ratio.

Table 02: Physical parameters of the wheat, finger millet and Kohila composite flour biscuits enriched with garlic flavor

Treatment	Thickness (mm)	Diameter(cm)	Spread ratio
T1	4.07 $\pm$ 0.03ᵃ	5.90 $\pm$ 0.03ᵃ	14.51 $\pm$ 0.12ᵃ
T2	4.03 $\pm$ 0.08ᵃ	5.93 $\pm$0.08ᵃ	14.72 $\pm$ 0.32ᵃ
T3	3.97 $\pm$ 0.06ᵃ	5.91 $\pm$ 0.07ᵃ	14.90 $\pm$ 0.24ᵃ
T4	3.93 $\pm$ 0.08ᵃ	5.98 $\pm$ 0.28ᵃ	15.32 $\pm$ 0.26ᵃ
T5	3.80 $\pm$ 0.20ᵃ	5.95 $\pm$0.23ᵃ	15.59 $\pm$ 0.94ᵃ

The values are means of triplicates $\pm$ SE

Mean values with the same superscript letters within the same column do not differ significantly at 5% level

B. Nutritional parameters

1) Fat content

With the substitution of finger millet and Kohila flour, the fat content of freshly made biscuits was reduced. The biscuits made from 100 % wheat flour had the highest fat content (8.74 %). This could be that Kohila and finger millet flours have low fat content whereas wheat flour has the high

fat content. The fat content of biscuits was reduced from 8.11 % to 6.37 % by reducing the proportion of wheat flour from 100 percent to 20%. The similar outcomes were observed in the study of finger millet in cookies (Sinha & Sharma, 2017).
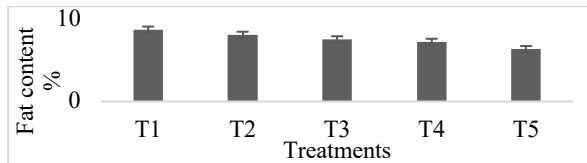

Figure 01: Fat content of the wheat, finger millet and *Kohila* composite flour biscuits enriched with garlic flavor

2) Protein content

Figure 02 described that T5 had the highest protein content (5.76 %) and T1 had the lowest mean value (4.25 %). All of the treatments were significantly different from each other. The protein content of newly made biscuits was increased from 4.25 % to 5.76 %. It could be because the concentration of finger millet flour has increased. This results were comparable with the study of biscuits prepared from finger millet seed coat based composite flour (Krishnan et al., 2011).
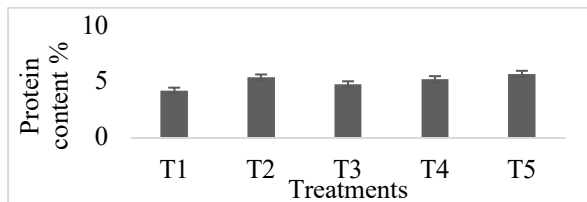

Figure 02. Protein content of the wheat, finger millet and *Lasia spinosa* composite flour biscuits enriched with garlic flavor

3) Ash content

Figure 03 depicted the ash content of freshly baked biscuit samples. T1 had the lowest mean value (0.66 %) for ash content, while T5 had the highest mean value (0.83 %) with 20 g wheat, 40 g finger millet, and 40 g *Kohila*. With increasing finger millet concentration, there was a significant increasing trend (0.71 % to 0.85 %). This results were comparable to that of finger millet cookies (0.64 to 1.00 %) (Bhoite et al., 2018).
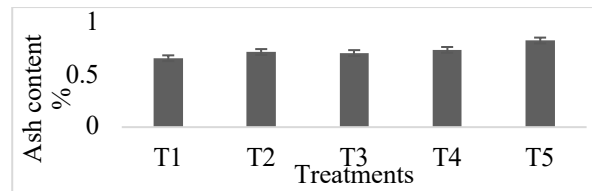

Figure 03: Ash content of the wheat, finger millet and Kohila composite flour biscuits enriched with garlic flavor

4) Moisture content

Figure 4 demonstrated that there were significant differences between the treatments. T1 with 100 g wheat flour had the highest mean value (2.58 %) for moisture content, while T5 with 20 g wheat, 40 g finger millet, and 40 g *Kohila* had the lowest mean value (1.88%). The moisture content of freshly made biscuits was reduced from 2.58 % to 1.88 %, while the concentration of wheat flour was reduced from 100% to 20%. It may be that higher moisture level in wheat flour than finger millet and *Kohila* flour.
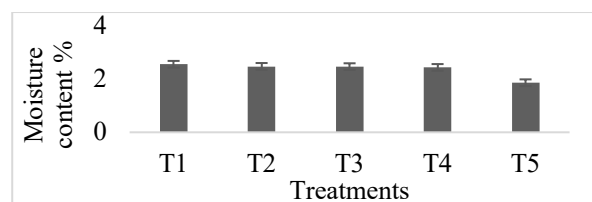
Figure 04: Moisture content of the wheat, finger millet and *Kohila* composite flour biscuits enriched with garlic flavor

C. Sensory analysis

The sensory evaluation of the biscuits revealed significant differences ($p < 0.05$) in texture, flavor, taste, color, and overall acceptability between the treatments (Table 03). The biscuits' color changed from very light brown to dark brown. The dark color could be due to the concentration of finger millet. T3 and T4 had the highest color value (5.13), while T1 (control) had the lowest value (3.63). Taste is the primary factor that determines the acceptability of any product, and it has the greatest impact on the product's market success. The taste of all sample were excellent with the addition of garlic powder. T4 with 50 g wheat, 40 g finger millet, and 10 g *Kohila* received the highest taste rating (5.4), while T5 received the lowest rating (4.4). (2.93). Texture analysis is the process of measuring the properties that affect how a food feels in the mouth (initial bite). T5

contained T1, which had the highest texture score (5.3) and the lowest value (2.73). Flavor is primarily determined by the chemical senses of taste and smell. T4 had the highest value for flavor. The overall acceptability, which is an important parameter in organoleptic estimation, included many implications. The biscuits from treatment T4, which contained 50 g wheat flour, 40 g finger millet, and 10 g *Kohila*, had a higher mean value for overall acceptability than the other composite biscuits.

IV. CONCLUSION

A protein-rich biscuits could be made from a composite flour of wheat, finger millet, *Kohila*, and garlic powder. The use of finger millet and *Kohila* flour in baking could significantly reduce wheat flour imports. The study's findings revealed that wheat flour was high in fat. The combination of finger millet and *Kohila* with wheat flour for the

Table 03: Sensory analysis of composite flour of wheat, finger millet and *Kohila* enriched with garlic flavor freshly made biscuits prepared

Treatment	Colour	Taste	Texture	Flavor	Overall acceptability
T1	3.63 ± 0.01^b	4.13 ± 0.19^b	5.30 ± 0.03^a	3.76 ± 0.01^c	4.76 ± 0.01^c
T2	3.43 ± 0.01^c	3.80 ± 0.03^c	4.50 ± 0.00^b	3.56 ± 0.01^c	3.86 ± 0.01^e
T3	5.13 ± 0.01^a	3.70 ± 0.03^c	3.50 ± 0.03^c	4.30 ± 0.03^b	5.16 ± 0.01^b
T4	5.13 ± 0.01^a	5.40 ± 0.03^a	3.80 ± 0.03^c	5.10 ± 0.03^a	5.90 ± 0.03^a
T5	3.76 ± 0.01^b	2.93 ± 0.19^d	2.73 ± 0.06^d	3.26 ± 0.01^d	4.20 ± 0.03^d

production of biscuits had a higher protein and ash content. When compared to other tested combinations, biscuits made with 50 g wheat, 40 g finger millet, and 10 g *Kohila* flour were highly acceptable in terms of nutritional, and organoleptic qualities. The findings could also be useful in making decisions for industries that want to use finger millet and *Kohila* flour as a nutritional alternative or supplement to cereal flours.

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Analysis and Comparison of Peanut Shell's Cellulose Content

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Abstract

The peanut shell is a waste product of peanut cultivation and is available throughout the year in Sri Lanka. The peanut consists of cellulose and microcrystalline cellulose in its shell, which can be utilized to produce a biodegradable packaging material. As a result, the current research was focused to estimate the ash content, extractives, total solid content, hemicellulose, cellulose and lignin of peanut shells. For that purpose, peanut shell was collected in the Mullaithivu district in the Northern province of Sri Lanka. Further, it was dried in a cabinet dryer, ground using the grinder and sieved into 1mm and 90 µm particle size powders. The composition of the peanut shell was analyzed using standard methods as 'Klason' method for lignin determination and drying methods for other components. Further, the cellulose content was compared with the chemical extraction method which is related to the removal of all the major components except cellulose, and with the literature review which was analyzed by the above standard method. The total solid content of the peanut shell is 92.038 ± 0.0037 % which comprises 4.58 ± 0.0005 % ash, 2.93 ± 0.015 % extractives, 18.1 ± 2.423 % hemicellulose, 32.24 ± 0.081 % lignin and 34.183 ± 0.012 % cellulose. According to the extraction process, the cellulose content was, 32.9 % whereas from the literature review it was 35.7 %. As a by-product, the peanut shell is a valuable source of cellulose that may be utilised to make cellulose-based goods.

Keywords: - Compositional analysis, peanut shell, cellulose content, cellulose-based packaging

I. INTRODUCTION

The extraction of the peanut seed from its pods produces peanut shells as a by-product. It is a common agro-industrial waste product that degrades very slowly in nature. Groundnut shells on the other hand contain a variety of bioactive and functional compounds that are helpful to humans. It is used as a feed, food, fertilizer component and carrier for bio-filters in the commercial world. The bulk of abandoned groundnut shells, on the other hand, are burnt or buried contaminating the environment (Adhikari *et al.*, 2019).

The huge quantity of agro-waste produced by the food industry has been a major source of concern, as it produces massive volumes of inedible residues coming from processed edible crops and grains all over the world (Gonçalves de Moura *et al.*, 2017). Peanut shells contribute to around 20% of the weight of dried peanut pods, meaning that there is a large amount of shell residue after processing. Rising peanut production leads to an accumulation of peanut shells, which are either burnt or buried because they are not utilised. Due to their high content of functional components including cellulose, hemicellulose, and lignin, groundnut shells may be utilised in a variety of ways (Duc *et al.*, 2019).

Peanut hulls are bulky trash that is produced in enormous quantities. In peanut-producing countries, peanut shells are routinely burnt, discarded or left to decay naturally. Peanut shells are being used for several purposes, including biofuel, compost, chemical and fertiliser transporters, cow and poultry bedding, pet litter, soil conditioners, and so on (Heuzé *et al.*, 2016). Even though its high fibre content makes it inappropriate for monogastric animals, peanut shells are fed to livestock, namely grazing animals and rabbits (Hill, 2002).

II. LITERATURE REVIEW

The nut (79–71%) is surrounded by a shell (21-29%) on the outside of the peanut fruit (Hamm and Hamilton, 2013; Davis and Dean, 2016). Peanut hulls are a by-product of the peanut processing industry. Shelling peanuts is often the second (after washing) step in the peanut processing process. Peanut shells are frequently fractured and contain varying percentages of entire or broken kernels (Hill, 2002).

The microfibrils in peanut shells are organised similarly to those in other cellulosic materials. In a conclusion, employing groundnut shell (shell) as a filler material in polyolefin would pave the way for new ways to transform agro-waste into useful resources for the plastics industry. This contributes to the general need for greater environmental sustainability by reducing municipal solid waste and generating "waste to riches" (Obasi, 2015). The chemical constituents of peanut shells are shown in Figure 01 and described below.

A. Lignin

Lignin is a biological polymer found in plants that serve as a structural support material. During cell wall formation, polysaccharides such as cellulose and hemicellulose are laid down initially, with lignin filling up the gaps between the polysaccharide filaments and binding them all together. This mechanism stiffens cells and protects the carbohydrate against physical and chemical destruction (Mohanty *et al.*, 2000). The uneven binding or insertion of monomers provides natural lignin. The quantity of lignin found in different tissues or cell walls varies a lot. The amount of lignin in various tissues or cell walls varies significantly. Environmental factors such as plant growth, temperature, nutrition, and light have an impact on the chemical composition of lignin. One of the most challenging problems in the field of natural polymers is lignin's chemical structure. Because lignin molecules and their breakdown products have numerous asymmetric centres. They are not formed by a single key-type connection. Between the structural components, there are many carbon-carbon bonds (Huang *et al.*, 2019).

B. Hemicellulose

Hemicellulose is divided into three types based on the primary sugar residue in the backbone: xylenes, mannans and glucans, with xylenes and mannans being the most common. The cellulose, hemicellulose and pectin classes make up the bulk of polysaccharides found in plant cell walls. The stiffness of the cellulose microfibril is enhanced inside a matrix of hemicellulose, regardless of the fact cellulose serves as the rigid, load-bearing component of the cell wall. Hemicelluloses, also known as cross-linking glycan are thought to be involved in the control of wall elongation and modification. Hemicelluloses are non-cellulose, non-pectin cell wall heteropolysaccharides made

up of multiple polymers with different monosaccharide and glycosidic linkage compositions, substitution patterns and polymerization degrees. Chemical structure and structural properties are influenced by species, subcellular location, and developmental phases. Between cellulose and hemicellulose, there are likely no chemical connections, but hydrogen bonds and Van Der Waals forces give reciprocal adhesion (Wyman *et al.*, 2005).

C. Cellulose

The most prevalent polymer on the planet is cellulose. It may be used to make high-value chemicals, biofuels, polymer composites and a variety of other products. Biodegradable, durable, non-toxic and thermally stable are the benefits of cellulose (Galiwango *et al.*, 2019). Cellulose has strong film properties and is chemically stable and cellulose derivatives are simple to synthesise. However, due to its insolubility in water and the overwhelming majority of organic solvents, cellulose's use in edible films is limited. These disadvantages can be addressed by derivatization, which enhances not only cellulose's water solubility but also its thermoplastic behaviour (Radovanovi, 2020). Biodegradable, tasteless, odourless, flexible, fairly strong, translucent, impermeable to lipids, water-soluble and relatively transparent to humidity and air, cellulose films have good film-forming characteristics (Kocira *et al.*, 2021).
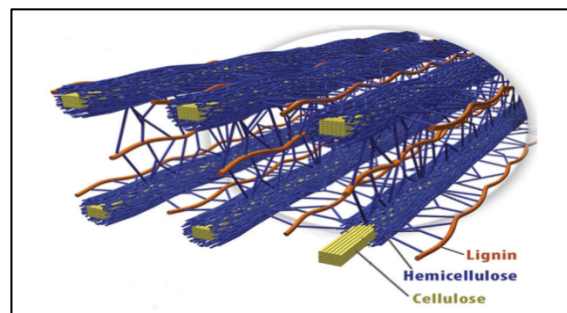
Figure 01: Spatial pattern of lignocellulosic biomass in the cell wall (Source: Brandt et al., 2013)

III. PROBLEM SPECIFICATION

The most prevalent biopolymer in the universe, cellulose, is known for its ultimate tensile strength. Because of its renewable and biodegradable nature, it is an important natural filler. The capacity of the three hydroxyl groups present in the structure of cellulose to form hydrogen bonds is responsible for cellulose's diverse applications due to its improved physical and mechanical

qualities. In recent years, the creation of cellulose-based biological scaffolds has attracted a lot of interest. The removal of hemicellulose and lignin, which form the matrix for cellulose micro fills, is used in the cellulose extraction process. Cellulose has been isolated and characterized from several sources, including maize stalks, rice husks and sugarcane bagasse. But the peanut shell, a readily available and plentiful source, has yet to be documented. Hence, this paper is targeted at the isolation of cellulose from peanut shells.

IV. METHODOLOGY

Peanut shells were gathered from the Murikandy area, Mullaithivu. To eliminate dirt and debris, the shells were cleaned and rinsed with tap water many times. The method described by Punnadiyil, Sreejith and Purushothaman (2016) was used with slight modification. Washed peanut shells were allowed to dry at $60^{\circ}C$ for 18 hours using a cabinet dryer (MINI II UF750, Japan). Dried shells were ground using the grinder (Vita-Mix Blender, Absolute 3, Japan) and sieved into less than 90 μm and 1 mm particles. Peanut shell powder was stored in an airtight container for further analysis.

A. Analysis of cellulose content by chemical extraction method

Peanut shell powder of 90 μm particles was taken. The 50g of peanut shell powder was weighed (HR – 250AZ, Japan). In a conical flask, peanut shell powder was placed. The 500 mL of 1.5% NaOH (Jung *et al.*, 2018) was added to that conical flask. The solution with peanut shells was heated in a water bath for 1 hour at $75^{\circ}C$ (Yamato – BT200, Japan). The treated solution was washed and filtered until the filtrate was clear. In the oven, it was dried at $60^{\circ}C$ for 24 hours (ISUZU- CAP, Japan). The end product is called an "Alkali treated sample" (Oliveira *et al.,* 2015). The 1g of Alkali treated sample was refluxed with 25 mL of HNO₃: Ethanol mixture (1:4) ratio. It was carried out at boiling temperature for one hour. This process is called "Refluxation". It was then rinsed in cold distilled water and filtered via the vacuum pump. The final product was dried at $90^{\circ}C$ for one hour with slight modification. The end product was "Cellulose" (Chen *et al*., 2018).

B. Analysis of cellulose content by standard method

For this standard method analysis, 1 mm particle size peanut shell powder was taken.
1) Determination of ash

As defined by Ayeni *et al.* (2015) the weight of an empty crucible was measured (W1). The weight of peanut shell powder was measured with a crucible (W2) in a weighing balance. It was ignited in a muffle furnace for 4 hours at $600^{\circ}C$. The final weight was measured with a crucible (W3).

$$Ash\ \% = \frac{(W3-W1)*100}{(W2-W1)}$$

2) Determination of total solids

According to Sluiter *et al.* (2008), the peanut shell powder (1g) was weighed in the moisture can and was kept at $105^{\circ}C$ for 4 hours in an oven. The empty moisture can (W3), the initial weight of moisture can with sample (W2) and the final weight of moisture can with sample (W1) were measured.

$$Total\ Solids\ \% = \frac{(W1-W3)}{(W2-W3)}*100$$

3) Determination of extractives

It was done according to Ioelovich (2015), and Li *et al.* (2015) with slight modifications. The thimble was filled with dried peanut shell powder (W1). The weight of the glass used to hold the solvent was measured (W2). The Soxhlet extractor (BUCHI – B811, Japan) was set up for 3 hours for the extraction using 100 mL of ethanol as the extraction solvent. The material was dried at room temperature after extraction. The glass used as the solvent holder was dried for 24 hours in an oven at $80^{\circ}C$ to measure the dry weight (W3). The difference in weight between the empty glass and the glass containing extractives was used to calculate the extractive content percentage (w/w).

$$Extractive\ \% = \frac{(W3-W2)*100}{W1}$$

4) Determination of hemicellulose

It was described by Ioelovich (2015). Extracted free dried sample (1 g) (W1) was transferred into 500 mL of the Erlenmeyer flask. 150 mL of 0.5 mol/L NaOH was added to the mixture. In a water bath (Yamato – BT200, Japan), the mixture was boiled for 3.5 hours. It was vacuum filtered through and washed until the pH level was neutral. In an oven, the residue was dried for 4 hours at $105^{\circ}C$ (ISUZU CAP, Japan) and weight was measured (W2). The hemicellulose concentration (%w/w) of dry biomass is the difference between the sample weight.

$$Hemicellulose\ \% = \frac{(W1-W2)*100}{W1}$$

5) Determination of lignin

It was continued as described by Dence (1992) with slight modification. Dried extracted peanut shell powder (0.3 g) was weighed in a 100 mL conical flask and 3 mL of 72% of H_2SO_4 was added. For full hydrolysis, the sample was maintained at $30°C$ for 1 hour with shaking in a water bath (Yamato –BT200, Japan). Following the initial hydrolysis, 84 mL of distilled water was poured. The second phase of hydrolysis was completed in an autoclave (ALP, Japan) at $121°C$ for 1 hour. At room temperature, the slurry was chilled. The vacuum pump was used to filter the residues. By drying the leftovers at $105°C$ and compensating for ash by burning the hydrolyzed sample at $575°C$ in a muffle furnace, the acid-soluble lignin was measured. By measuring the acid hydrolyzed specimens' absorbance at 300 nm, the acid-soluble lignin fraction was measured. The summation of acid-insoluble and acid-soluble lignin was used to compute the lignin content in a peanut shell.

6) Determination of cellulose

This was described by Ioelovich (2015) and Jin *et al.* (2017). By subtracting extractives, hemicellulose, lignin and ash from the total solids, the cellulose content (%w/w) was determined.

Cellulose % = Total Solids - (extractives % + Ash % + Lignin % + hemicellulose %)

analysis. By the extraction process, the obtained amount of cellulose was 32.9 g/100g. These results vary from the results of Obasi (2015). It's because of some factors which influence the preparation of the sample and processing of the analysis. As well as the ash, extractives, cellulose, hemicellulose, lignin and total solids in the peanut shell powder was measured. The total solid content of peanut shell powder was 92.038 ± 0.0037 g/100g. The ash content of peanut shell powder was 4.585 ± 0.00056 g/100g. Extractives are composed of fats, fatty acids, fatty alcohols, phenols, terpenes, steroids, resin acids, waxes, and a range of other minor organic compounds (Mansor *et al.*, 2019). As a result, the peanut shell has 2.93 ± 0.015 g/100g of extractives. The colour, aroma, and durability of the biomass are all due to the extractives. (Rowell, 2012). Hemicellulose is a sugar-based material that is sometimes referred to by the sugars it contains. Hemicellulose and lignin are a kind of cellulose that contributes to the structural components of plants (Rowell, 2012). The content of hemicellulose and lignin are 18.1 ± 2.423 % and 32.24 ± 0.081 % respectively. These results were approximately the same as the results of Obasi (2015).

VI. CONCLUSION

This research has shown a straightforward method for determining the cellulose content of peanut shells by standard analysis. Comparable results were obtained for the examined raw materials and

Table 01: Compositional analysis of peanut shell

Composition	Value (%) (By extraction)	Value (%) (By standard)	Reported Composition (%) (Obasi, 2015)
Ash	-	4.585 ± 0.0005	5.9
Extractives	-	2.93 ± 0.015	-
Total solids	-	92.038 ± 0.0037	90.5
Lignin	-	32.24 ± 0.081	30.2
Hemicellulose	-	18.1 ± 2.423	18.7
Cellulose	32.9	34.183 ± 0.012	35.7

The values are means of duplicates ± standard deviation for duplicate analysis

V. RESULTS AND DISCUSSION

Lignocellulosic compounds of peanut shells are given below in Table 01.

A plant cell's major structural component is cellulose. The peanut shell has 34.183 ± 0.012 g/100g of cellulose according to the standard

those published in scientific literature. The cellulose, hemicellulose, and lignin content of the peanut shell are all within the range of lignocellulosic components, according to the findings of this study. It has the potential to become a replacement for cellulose-based products due to its high cellulose, hemicellulose, and lignin content. The significance of the

lignocellulosic study is dependent on a result collected from a comparable field and may change somewhat from prior studies due to other factors influencing it, such as specimen preparation and the analysis procedures.

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Awareness of Anaemia and Educational Level of Pregnant Women: A Baseline Assessment at Kattankudy in Batticaloa District, Sri Lanka

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Abstract

Anaemia in pregnancy is a common public health concern globally. It is linked to sociodemographic factors of individuals. There is a need for up-to-date information on awareness of anaemia among pregnant women. As a result, the study was conducted to determine pregnant women's awareness of anaemia and to investigate the relationship between educational level and awareness of anaemia. This study was done in the Kattankudy area in Batticaloa district, Sri Lanka. According to the consecutive sampling, 352 pregnant women who have registered at antenatal clinics (ANC) were interviewed through a semi-structured questionnaire that focuses on key aspects such as respondents' educational level, awareness of anaemia in terms of signs and symptoms, nutritionally balanced diet and treatment to prevent anaemia. The SPSS statistical software was used to analyse the data. According to the findings, 71.9%, 52% and 52% of the pregnant women were familiar with signs and symptoms like fatigue, tiredness/weakness and dizziness respectively. The majority of them had replied incorrectly for the other symptoms. The correct answer on nutritionally balanced diet and treatment to prevent anaemia was given by the majority of respondents. Meanwhile, 59.9% of pregnant women don't know about treating hookworm infection to prevent anaemia. There was a significant association (p<0.05) between the educational level of pregnant women and awareness regarding signs and symptoms of anaemia, nutritionally balanced diet and treatment to prevent anaemia. As a result, during antenatal visits, awareness programmes should be done through adequate dietary counselling for pregnant women to mitigate the adverse effect of anaemia during pregnancy.

Keywords: Anaemia, Awareness, Educational level, Pregnant women.

I. INTRODUCTION

Anaemia in pregnancy is one of the most important causes of the global burden of disease, with iron deficiency anaemia accounting for more than half of the cases (Siteti *et al*., 2014). The fight against anaemia appears to be a difficult effort all around the world, particularly in underdeveloped nations. The severe effects of anaemia may have a considerable impact on national economies. In underdeveloped nations, 58% of pregnant women are anaemic. Furthermore, anaemia is associated with 50% of all maternal fatalities (Galloway *et al*., 2002). Anaemia is seen as threatening and persuasive as infectious illness outbreaks (Mannar, 1991). Anaemia can affect anybody, but babies, school-aged children, and women of reproductive age are the most vulnerable (Hurrell, 1997). According to a study conducted in eight countries, women are aware of the majority of the effects of anaemia during pregnancy (Gallowaya *et al*., 2002).

Anaemia in pregnancy is common globally, according to WHO criteria for designating anaemia as public health risk (WHO, 2008). While pregnant anaemia is a global public health concern, underdeveloped nations are the most hit, with the majority of the anaemia burden falling on them. At both the individual and population levels, anaemia is linked to socioeconomic characteristics such as education, income, and cultural habits. WHO classifies anaemia as a moderate public health problem when it affects 20-39.9% of the population (The World Bank, 2007). In Sri Lanka, anaemia in pregnancy has long been recognized as a serious maternal morbidity condition, and anaemia has evolved into a moderate public health concern among children, nonpregnant, and pregnant populations, with prevalence rates of 33%, 39%, and 34%, respectively (Department of Census and Statistics, 2011).

Various risk factors influence the causes of anaemia during pregnancy. Anaemia in pregnancy is linked to sociodemographic factors such as

family income, educational level, parity (Rai *et al*., 2016; Gogoi *et al*., 2016), types of occupations, pregnancy visits, not taking iron supplementation (Titilayo *et al*., 2016; Xu *et al*., 2016), and a large number of families (Titilayo *et al*., 2016; Xu *et al*., 2016; Bekele *et al*., 2016). An increase in the incidences of anaemia during pregnancy can also be attributed to a lack of vitamin consumption. The most common cause of anaemia in pregnant women is iron deficiency anaemia, which accounts for more than half of all cases (Stevens *et al*., 2013). Anaemia affects around a third of pregnant women due to a lack of micronutrients such as iron, folic acid, and vitamin B_{12} (Lee and Okam, 2011).

Pregnant women, whose risk of anaemia is enhanced by other variables such as gravidity, the time between pregnancies, and early pregnancy, might be classified as having anaemia based on their socioeconomic standing (Anorlu *et al*., 2006; Ndukwu and Dienye, 2012). More than half the world's pregnant women have levels of haemoglobin that are indicative of anaemia. It is assumed that you are aware of the present condition of affairs in our area. This knowledge would encourage prenatal healthcare providers to diagnose and treat anaemia in pregnant women as soon as possible (Cyril and Hyacinth, 2005). Various studies have confirmed that anaemia in pregnant women is still one of the major public health concerns in developing countries, owing to many socio-cultural issues such as poor education, low income, lack of awareness, cultural and religious taboos, poor dietary habits, and a high prevalence of parasitic infestation (Karaoglu *et al*., 2010).

To combat anaemia in pregnancy, several efforts should be made, including education and awareness campaigns, vitamin supplements, and parasitic infection control and prevention. However, the extent to which such interventions impact the awareness of anaemia towards signs and symptoms, nutritionally balanced diet to prevent anaemia and treatment to prevent anaemia is unknown. In this research area, there is a need for up-to-date information on anaemia awareness among pregnant women. As a result, the study was to determine pregnant women's awareness of anaemia and to investigate the relationship between educational level and awareness of anaemia among pregnant women in this study area.

II. METHODOLOGY

The cross-sectional study was conducted in the Kattankudy area in Batticaloa district, Sri Lanka. According to the consecutive sampling, 352 pregnant women who have registered at antenatal clinics (ANC) during the study period from September 2020 to February 2021 were interviewed through the administration of a semi-structured questionnaire. After examining the literature, a semi-structured survey questionnaire was created and the questionnaire's content validity was determined by consulting with a subject matter expert and a supervisor. Before being given to the research participants, the questionnaire was pretested on 20 pregnant women from a nearby region who had comparable characteristics to the study participants to see if any changes were needed. The semi-structured questionnaire consisted of respondents' educational level, awareness of anaemia in terms of signs and symptoms, nutritionally balanced diet and treatment to prevent anaemia. The administrative approval was obtained from the Medical Officer of Health, Kattankudy and consent was obtained from each respondent by reading the information contained in the consent form. The statistical software for social science (SPSS) version 25.0 was used to analyse the obtained data. The relationship between educational level and awareness of anaemia in terms of signs and symptoms, nutritionally balanced diet to avoid anaemia, and treatment to prevent anaemia was determined using a Chi-square test.

III. RESULTS AND DISCUSSION

A. *Awareness of Anaemia on Signs and Symptoms*

Most of the study respondents were more familiar with signs and symptoms like fatigue 253 (71.9%), tiredness/weakness 183 (52.0%) and dizziness 183 (52.0%). The majority of them had replied incorrectly for the other symptoms like pale or yellowish skin (240 i.e. 68.2%), brittle nails (281 i.e. 79.8%), irregular heartbeats (196 i.e. 55.7%), shortness of breath (240 i.e. 68.2%), headache (156 i.e. 44.3%), loss of appetite (198 i.e. 56.3%) and cold hands and feet (183 i.e. 52.0%). Respondents had replied don't know for the symptoms like pale or yellowish skin (14 i.e. 4.0%), dizziness (14 i.e. 4.0%), brittle nails (28 i.e. 8.0%), irregular heartbeats (57 i.e. 16.2%), shortness of breath (42 i.e. 11.9%), headache (42 i.e. 11.9%), loss of appetite (56 i.e. 15.9%) and cold hands and feet (42 i.e. 11.9%) (Table 1).

Table 01: Awareness of signs and symptoms of anaemia

Variables		Frequency	Percentage (%)
Fatigue	Yes	253	71.9
	No	99	28.1
	Don't Know	0	0.0
Tiredness/weakness	Yes	183	52.0
	No	169	48.0
	Don't Know	0	0.0
Pale or yellowish skin	Yes	98	27.8
	No	240	68.2
	Don't Know	14	4.0
Dizziness	Yes	183	52.0
	No	155	44.0
	Don't Know	14	4.0
Brittle nails	Yes	43	12.2
	No	281	79.8
	Don't Know	28	8.0
Irregular heartbeats	Yes	99	28.1
	No	196	55.7
	Don't Know	57	16.2
Shortness of breath	Yes	70	19.9
	No	240	68.2
	Don't Know	42	11.9
Headache	Yes	154	43.8
	No	156	44.3
	Don't Know	42	11.9
Loss of appetite	Yes	98	27.8
	No	198	56.3
	Don't Know	56	15.9
Cold hands and feet	Yes	127	36.1
	No	183	52.0
	Don't Know	42	11.9

The data reveals that most women know only the sign and symptoms of anaemia like fatigue, tiredness/weakness and dizziness. Most of them don't know about other symptoms like pale or yellowish skin, dizziness, brittle nails, irregular heartbeats, shortness of breath, headache, loss of appetite and cold hands and feet. According to Gies *et al*. (2003), the majority of pregnant women are unaware of the signs and symptoms of anaemia. Except for the previously reported signs

and symptoms of anaemia, the current study found that awareness of signs and symptoms is below average. Raksha and Shameem (2016) found that awareness about the signs and symptoms of anaemia was lacking. Detecting signs and symptoms early will significantly reduce moms' need to seek medical help. As a result, anaemia progresses to a more advanced state, resulting in worse pregnancy and neonatal outcomes (Chang *et al.*, 2013). An understanding of the signs and symptoms of anaemia during pregnancy is essential for early detection and treatment of anaemia and it is also required to have biochemical confirmation for anaemia in these women.

B. Awareness of a Nutritionally Balanced Diet to Prevent Anaemia

The correct answer on a nutritionally balanced diet to avoid anaemia was given by the majority of respondents (Table 2). A well-balanced diet during pregnancy prevents anaemia, according to 254 (72.2%) of respondents. 338 (96.0%) answered green leafy vegetables and sprouted grains are high in iron, whereas 282 (80.1%) stated meat is an excellent source of iron, 338 (96.0%) said dates and dry grapes contain a rich source of iron, 254 (72.2%) said orange and lemon juice promotes the absorption of iron, 211 (59.9%) said tea and coffee inhibit the absorption of iron. 225 (63.9%) said fasting or missing meals must be avoided during pregnancy.

According to this study, people were more knowledgeable than the average about the effect of tea and coffee on iron absorption. This result was consistent with the findings of Kdivar *et al* (2007). Anaemia can affect anybody, but babies, school-aged children, and women of reproductive age are the most vulnerable (Mannar, 1999). Our findings were in line with those of Chacko *et al* (2016). Further, they stated that the majority of pregnant women were aware of the diet they must follow during their pregnancy. Other study findings suggested that the relationship between awareness of anaemia and food may be lacking. Anaemia was recognized as a concern connected to food by less than 1% of respondents in a nationwide lifestyle study. They also discovered that anaemia was more likely in people who ate meat infrequently or never (Baines *et al.*, 2007). This clearly shows that majority of mothers had average knowledge regarding diet.

Table 02: Awareness of nutritionally balanced diet to prevent anaemia

Variables		Frequency	Percentage (%)
A well-balanced diet during pregnancy prevents anaemia	Yes	254	72.2
	No	70	19.9
	Don't Know	28	8.0
Green leafy vegetables and sprouted grains are rich in iron	Yes	338	96.0
	No	14	4.0
	Don't Know	0	0.0
Meat, fish, liver and eggs are rich sources of iron	Yes	282	80.1
	No	42	11.9
	Don't Know	28	8.0
Dates and dry grapes contain a rich source of iron	Yes	338	96.0
	No	14	4.0
	Don't Know	0	0.0
Orange and lemon juice promotes the absorption of iron	Yes	254	72.2
	No	28	8.0
	Don't Know	70	19.9
Tea and coffee inhibit the absorption of iron	Yes	211	59.9

	No	71	20.2
	Don't Know	70	19.9
Fasting or missing meals must be avoided during pregnancy	Yes	225	63.9
	No	98	27.8
	Don't Know	29	8.2

C. Awareness of Treatment to Prevent Anaemia During Pregnancy

According to Table 3, most of the respondents knew that regular medical checkup i.e., 295 (83.8%), daily intake of iron and folic acid i.e., 281 (79.8%) and vitamin C tablet is taken along with iron tablet i.e., 296 (84.1%) are necessary during pregnancy to prevent the anaemia. Meanwhile, most of the pregnant women i.e., 211 (59.9%) don't know about treating hookworm infection to prevent anaemia. This result is much compatible with the findings of the study done by Kulkarni (2015), the role of deworming was known to only 16 women out of 250 participants. According to Chacko *et al*. (2016), the participants are unaware of the value of antenatal appointments and therapy during pregnancy. But according to this study, most of the women were having a higher level of awareness regarding treatment to prevent anaemia during pregnancy.

Table 03: Awareness of treatment to prevent anaemia

Variables		Frequency	Percentage (%)
A regular medical checkup is necessary during pregnancy	Yes	295	83.8
	No	42	11.9
	Don't Know	15	4.3
Daily intake of iron and folic acid is necessary	Yes	281	79.8
	No	71	20.2
	Don't Know	0	0.0
Adequate treatment is necessary to treat hookworm infection to prevent anaemia	Yes	70	19.9
	No	71	20.2
	Don't Know	211	59.9
Vitamin C tablet is taken along with iron tablets	Yes	296	84.1
	No	14	4.0
	Don't Know	42	11.9

A. Association between the Education Levels of Pregnant Women with the Awareness of Pregnant Women Regarding Anaemia

According to the findings, there was a significant association between the educational level and awareness regarding signs and symptoms of anaemia at a $p < 0.05$ significance level. According to the Pearson Chi-Square analysis, sign and symptoms of anaemia such as fatigue ($x^2 = 83.08$, $p < 0.05$), tiredness/weakness ($x^2 = 53.74$, $p < 0.05$), pale or yellowish skin ($x^2 = 73.95$, $p < 0.05$), dizziness ($x^2 = 51.20$, $p < 0.05$), brittle nails ($x^2 = 87.85$, $p < 0.05$), irregular heartbeats ($x^2 = 80.20$, $p < 0.05$), shortness of breath ($x^2 = 50.72$, $p < 0.05$), headache ($x^2 = 44.65$, $p < 0.05$), loss of appetite ($x^2 = 54.43$, $p < 0.05$) and cold hands and feet ($x^2 = 51.24$, $p < 0.05$) had significant association with education levels of pregnant women (Table 4).

Table 04: Association between the women's education level and the awareness regarding signs and symptoms of anaemia

	Women's Education	Yes Frequency	No Frequency	Don't know Frequency
Fatigue	Primary education	26	52	0
	O/L	84	15	0
	A/L	101	32	0
	Graduate and above	42	0	0
	$x^2 = 83.08$ p < 0.05			
Tiredness/weakness	Primary education	26	52	0
	O/L	42	57	0
	A/L	73	60	0
	Graduate and above	42	0	0
	$x^2 = 53.74$ p < 0.05			
Pale or yellowish skin	Primary education	13	65	0
	O/L	14	85	0
	A/L	43	76	14
	Graduate and above	28	14	0
	$x^2 = 73.95$ p < 0.05			
Dizziness	Primary education	39	26	13
	O/L	56	43	0
	A/L	74	58	1
	Graduate and above	14	28	0
	$x^2 = 51.20$ p < 0.05			
Brittle nails	Primary education	0	78	0
	O/L	28	57	14
	A/L	1	118	14
	Graduate and above	14	28	0
	$x^2 = 87.85$ p < 0.05			
Irregular heartbeats	Primary education	28	52	0
	O/L	28	56	15
	A/L	45	46	42
	Graduate and above	0	42	0
	$x^2 = 80.20$ p < 0.05			
Shortness of breath	Primary education	26	52	0
	O/L	14	71	14
	A/L	30	75	28
	Graduate and above	0	42	0
	$x^2 = 50.72$ p < 0.05			
Headache	Primary education	26	39	13
	O/L	42	57	0
	A/L	58	46	29
	Graduate and above	28	14	0
	$x^2 = 44.65$ p < 0.05			
Loss of appetite	Primary education	13	39	26
	O/L	28	71	0
	A/L	43	60	30
	Graduate and above	14	28	0
	$x^2 = 54.43$ p < 0.05			
Cold hands and feet	Primary education	26	39	13
	O/L	28	71	0
	A/L	59	45	29
	Graduate and above	14	28	0
	$x^2 = 51.24$ p < 0.05			

The study found that there was a significant association between the educational level and awareness regarding a nutritionally balanced diet to prevent anaemia at a p<0.05 significance level. According to the Pearson Chi-Square analysis, awareness regarding a nutritionally balanced diet such as a well-balanced diet during pregnancy prevent anaemia ($x^2 = 71.53$, p<0.05), green leafy vegetable and sprouted grains are rich in iron ($x^2 = 24.01$, p<0.05), meat, fish, liver and eggs are a rich

source of iron (x^2 = 91.0, p<0.05), dates and dry grapes contains a rich source of iron (x^2 = 42.35, p<0.05), orange and lemon juice promote the s absorption of iron (x^2 = 95.04, p< 0.05), tea and coffee inhibits the absorption of iron (x^2 = 20.08, p<0.05) and fasting or missing the meals must be avoided during pregnancy (x^2 = 72.03, p<0.05) had a significant association with education levels of pregnant women (Table 5).

The study found that there was a significant association between the educational level and awareness regarding treatment to prevent anaemia at a p<0.05 significance level. According to the Pearson Chi-Square analysis, awareness regarding treatment to prevent anaemia such as regular medical checkups is necessary during pregnancy (x^2 = 48.99, p<0.05), and daily intake of iron and folic acid is necessary (x^2 = 65.19, p<0.05), adequate treatment is necessary to treat hookworm infection to prevent anaemia (x^2 = 71.64, p<0.05), vitamin C tablet is taken along with iron tablets (x^2 = 187.84, p<0.05) had a significant association with education levels of pregnant women (Table 6).

Table 05: Association between the women's education level and the awareness regarding a nutritionally balanced diet to prevent anaemia

	Women's Education	Yes Frequency	No Frequency	Don't know Frequency
A well-balanced diet during pregnancy prevents anaemia	Primary education	52	13	13
	O/L	71	28	0
	A/L	103	29	1
	Graduate and above	28	0	14
	x^2 = 71.53 p < 0.05			
Green leafy vegetables and sprouted grains are rich in iron	Primary education	78	0	0
	O/L	99	0	99
	A/L	119	14	0
	Graduate and above	42	0	0
	x^2 = 24.01 p < 0.05			
Meat, fish, liver and eggs are rich sources of iron	Primary education	78	0	0
	O/L	85	14	0
	A/L	105	14	14
	Graduate and above	14	14	14
	x^2 = 91.0 p < 0.05			
Dates and dry grapes contain a rich source of iron	Primary education	65	13	0
	O/L	99	0	0
	A/L	132	1	0
	Graduate and above	42	0	0
	x^2 = 42.35 p < 0.05			
Orange and lemon juice promote the absorption of iron	Primary education	65	0	13
	O/L	85	14	0
	A/L	90	14	29
	Graduate and above	14	0	28
	x^2 = 95.04 p < 0.05			
Tea and coffee inhibit the absorption of iron	Primary education	52	13	13
	O/L	57	28	14
	A/L	74	30	29
	Graduate and above	28	0	14
	x^2 = 20.08 p < 0.05			
Fasting or missing meals must be avoided during Pregnancy	Primary education	65	13	0
	O/L	56	28	15
	A/L	90	43	0
	Graduate and above	14	14	14
	x^2 = 72.03 p < 0.05			

Table 06: Association between the women's education level and the awareness regarding treatment to prevent anaemia

Women's Education	Yes Frequency	No Frequency	Don't know Frequency
A regular medical check-up is necessary during pregnancy			
Primary education	65	13	0
O/L	70	14	15
A/L	118	15	0
Graduate and above	42	0	0
$x^2 = 48.99$ p < 0.05			
Daily intake of iron and folic acid is necessary			
Primary education	78	0	0
O/L	56	43	0
A/L	119	14	0
Graduate and above	28	14	0
$x^2 = 65.19$ p < 0.05			
Adequate treatment is necessary to treat hookworm infection to prevent anaemia			
Primary education	26	0	52
O/L	14	42	43
A/L	16	29	88
Graduate and above	14	0	28
$x^2 = 71.64$ p < 0.05			
Vitamin C tablet is taken along with iron tablets			
Primary education	78	0	0
O/L	71	14	14
A/L	133	0	0
Graduate and above	14	0	28
$x^2 = 187.84$ p < 0.05			

IV. CONCLUSIONS

According to the findings, there was a significant association (p<0.05) between the educational level of pregnant women and knowledge regarding signs and symptoms of anaemia, nutritionally balanced diet to prevent anaemia and treatment to prevent anaemia. As a result, during antenatal visits, awareness programs should be done through adequate dietary counselling for pregnant women to mitigate the adverse effect of anaemia during pregnancy.

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Development and Quality Evaluation of Ash Gourd and Banana Pseudo-Stem Tender Core Blended Jam Alternative

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Abstract

Ash gourd and banana pseudo-stem tender cores contain more fiber and other nutrients that benefit human health. This study was carried out to compare the formulated jam alternative with ash gourd and banana pseudo-stem tender core and to evaluate its physio-chemical content against the control. The jam alternative was produced with five treatments (T1: Ash gourd only, T2: Banana pseudo-stem tender core pulp only, T3: Ash gourd pulp 50%: Banana pseudo-stem tender core pulp 50%, T4: Ash gourd pulp 30%: Banana tender core pulp 70%, T5: Ash gourd pulp 70%: Banana tender core pulp 30%) with different formulation incorporating ash gourd and banana tender core. The moisture, ash, fiber, pH, and titratable acidity were analyzed for the different jam alternative treatments. The results ranged from 5.10-7.14 % fiber, 0.26-0.37% ash, 2.81-2.92 pH, 1.08-1.58 mg per 100g as citric acid titratable acidity, and 19.01-21.53 % moisture content. Significant differences (p<0.05) were observed between the treatments for moisture, ash, fiber, pH, and titratable acidity of jam alternative. Further, the sensory evaluation was conducted for the five different formulas with 20 untrained panelists using a nine-point Hedonic scale for taste, texture, color, odor, and overall acceptability. According to the sensory test, 100% banana tender core jam alternative (Treatment 2) was selected as the preferable sample out of the five samples. Conclusively, the jam alternative developed with a banana tender core was favored by the sensory panel.

Keywords: Jam alternative, Banana pseudo-stem Tender Core, Ash Gourd, Quality Evaluation, Sensory Evaluation

I. INTRODUCTION

Banana is an herbaceous plant of the family Musaceae (Ranjha, 2022). In terms of overall production, banana are in second place after citrus, accounting for about 16% of the world total fruit production. Currently, nearly 50,000 ha of land is under banana cultivation in Sri Lanka, and the annual banana production is around 450,000 metric tons (Hirimburegama et al., 2004). The stem of the banana plant, called the pseudo stem, produces a single bundle of bananas before it starts its reproductive growth. The soft core of the banana pseudo-stem is thickly pressed in the middle (core) of the banana pseudo-stem, tube-like shape with a width of roughly 5–6 cm (Hirimburegama et al., 2004).

Each banana plant produces only one bunch of bananas because this crop generates a large amount of residue. After the harvest, the stem is cut and usually left on the plantation or burned, which could ultimately cause environmental issues (Ranjha, 2022). After each cluster of developed banana natural products (usually 10-12 months), four times of banana waste (e.g., banana pseudo-stem, leaves, organic product bundle, spoiled organic product, and rhizomes) are deserted to the environment (Khatun et al., 2019). Banana waste materials are rich in minerals and nutrients. Recently, some studies on the banana pseudo-stem (*Musa acuminata* Colla and *Musa sapientum*) have been reported, focusing on the chemical contents, such as monosaccharides, fibre composition, and mineral contents (Mukhopadhyay et al., 2008; Oliveira et al., 2007). Ash gourd, also known as a *Benincasa hispida*, is in the Cucurbitaceae family. It comprises 96% water and is low in calories, fat, protein, and carbs (Pradhan, 2020). Its inner side has a thick white, delicious, and fresh tissue. It has the name ash gourd because its seeds build up a waxy matter of gray on development (Pradhan, 2020). The biochemical activity of the fruit includes antioxidative, anti-inflammatory, anti-angiogenic, detoxicant, and curative effects in treating various ailments. The essential minerals Ca, Mg, Fe, Cu, Zn, and Se are present (Gupta et al., 2019).

Natural products are critical in human nutrition. Be that as it may, due to their short-lived nature and occasional accessibility, they are prepared into more stable structures, for example, jams, juices, pickles, and some more items. Jam is a prepared natural product item with a middle-of-the-road moisture content set up by bubbling homogenized natural product mash with sugar, corrosive, and gelatin. It might have different fixings like additives, seasoning, or shading compounds. It ought to have an appropriate consistency so that it could spread without much of a stretch and should be firm enough, so it doesn't stream like a liquid (Garg et al., 2019).

Jam is thought to contain 68.5% absolute dissolvable solids (TSS) at any rate, and the organic product ought to contribute 45% of the all-out weight of jam. Sugar in a jam decreases its water action, bringing about longer rack life. Around the world, a few kinds of organic products have been utilized for making jams. Since customer decisions provide the food items, improving new things is significant for the natural product businesses (Garg et al., 2019). Therefore, this study aims to develop jam from underutilized plant products such as banana tender core and ash gourd.

II. METHODOLOGY

A. Experimental site

The experiment was carried out in the Food Science and Technology laboratory, Department of Biosystems Technology, Faculty of Technology, South Eastern University of Sri Lanka.

B. Procurement of raw materials

Fresh and matured ash gourd was collected from the local market in Akkaraipattu. The banana pseudo-stem was collected from an Embul banana cultivar at the stage before the fruiting stage, nearby the University premises. Pectin and citric acid were purchased from Colombo, and other ingredients were purchased from local stores in Oluvil.

C. Extraction of pulps

1) Extraction of ash gourd pulp

Undamaged ash gourd fruit was selected, and the peel was removed. Then it was cut into small pieces and washed using potable water. Afterward, ash gourd pieces were boiled for 2 hours at the ratio of 1:1 ash gourd and water. And 0.5g citric acid was added to the ash gourd to prevent the enzymatic browning. After heating, it was kept for cooling, and then it was blended to make pulp. The pulp was strained through a 100-mesh strainer.

2) Extraction of banana pseudo-stem tender core pulp

The fresh banana pseudo-stem was collected, and the outer layer was removed to collect the core of the banana. Then, it was cut into sliced and washed using potable water. The sliced banana core was boiled for two and half hours at 1 cup of the sliced core: 1 cup of water. Then, 0.5g of citric acid was added to the sliced core. After heating, it was kept for cooling, and then it was blended to make pulp. The pulp was strained through a 100-mesh strainer.

D. Experimental design

Treatments:
Treatment 1 (T1); Ash gourd pulp only
Treatment 2 (T2); Banana tender core pulp only
Treatment 3 (T3); Ash gourd pulp 50%: Banana tender core pulp 50%
Treatment 4 (T4); Ash gourd pulp 30%: Banana tender core pulp 70%
Treatment 5 (T5); Ash gourd pulp 70%: Banana tender core pulp 30%

E. Preparation of jam alternative

For the preparation of the jam alternative, the pulp mixture was heated at 100 °C. When the pulp mixture reached 100 °C, it was turned off, and sugar and pectin were added to it while stirring it continuously to prevent the pectin from clotting. The pectin powder was mixed with a small amount of sugar taken out of the total sugar in the recipe.

Table 1. Ingredients of the different jam alternative treatments per 100 g

Ingredients (g)	T1	T2	T3	T4	T5
Ash gourd pulp	35.00	-	17.5	10.5	24.5
Banana core pulp	-	35.00	17.5	24.5	10.5
Sugar	60.00	60.00	60.00	60.00	60.00
Pectin	3.00	3.00	3.00	3.00	3.00
Citric acid	2.00	2.00	2.00	2.00	2.00

Then, again mixture was allowed to boil, and the temperature was increased to 100 °C, and the mixture was allowed to cook for several minutes while stirring occasionally. The heat was turned off, and citric acid was added. The endpoint of jam alternative preparation was determined by cooling a small amount of sample and testing for its TSS (62-650Brix) pH (3.1-3.5 pH) and skin wrinkle. Upon reaching the consistency of 65o Brix value and pH 2.9-3.00, the heat was turned on and allowed to cool down for a few minutes. The jam alternative sample was immediately filled into clean and pre-sterilized glass jars and was allowed to cool at ambient temperature. The jars were closed with their lids and were stored at room temperature.

F. *Proximate* characteristics of jam alternative

The sample's crude fiber and ash content were determined by the methods described by AOAC (2000).

1) Determination of ash content

The crucible was placed in an oven at 105°C for 30 minutes. The crucible was cooled in the desiccators for 30 minutes and weighed. The sample (5.0 g) was weighed into the crucible (W1). The crucible was placed in a muffle furnace and heated at 600°C for 5 hours. Then, it was cooled in the desiccators. The ash with crucibles was weighed after cooling (W2).

$$Ash\ content\ \% = \frac{Weight\ of\ the\ ash(g)}{Initial\ sample\ weight(g)} \times 100$$

2) Determination of crude fiber

The samples (5.0g) were taken into the beakers, and 0.2 M H_2SO_4 solution 200ml were added to the samples, and the mixture was boiled under reflux for 30 minutes. The hot solution was filtered using a muslin cloth, and insoluble matter was washed with hot water until free of acid and transferred into the beaker. Then, 0.2 M NaOH solution 200ml was added and boiled under reflux for 30 minutes, and the solution was filtered,

washed with hot water, weighed, and dried in an oven for 2 hours, cooled in a desiccator, and weighed in a crucible (W1). The crucible and its content were incinerated in a muffle furnace at 550°C for 3 hours and the crucible was cooled in a desiccator and weighed.

$$Fiber\ (\%) = \frac{Wt\ of\ insoluble\ matter\ (g) - \ Wt\ of\ ash\ (g)}{Weight\ of\ sample\ (g)} \times 100$$

3) Determination of moisture content

The empty dish was dried in an oven at 105°C for 3 hours, transferred to desiccators to cool, and then weighed. The sample (5g) was put into the dish. The sample was dried in an oven for 3 hours at 105°C. After drying, the dish was transferred to desiccators to cool and weighed (AOAC 2000).

$$Moisture\ content\ \% = \frac{Initial\ weight(g) - Final\ weight(g)}{Initial\ weight(g)} \times 100$$

4) Determination of pH

The pH of the jam alternative was measured using calibrated digital pH meter (PHS-25, China).

5) Determination of titratable acidity

The sample (5.0g) was mixed with 100ml of distilled water. Estimating the titratable acidity of the jam alternative was done by the Automatic Titrator (WT-TT-3A, China).

$$Titrable\ acidity\ = \frac{S * N * 90}{V * 1000} \times 100$$

Where:
S = ml 0.1 NaOH used
N = Normality of 0.1 N NaOH
V = ml solution used

G. Sensory evaluation

The samples were evaluated for sensory attributes, including color, flavor, texture, taste, odor, and overall acceptability. The ranking of the samples

using a nine-point hedonic scale from 1 (dislike extremely) to 9 (like extremely). Sensory evaluation was carried out with 20 untrained panelists.

H. Statistical analysis

The Analysis of Variance (ANOVA) was used to find significant differences and means were compared using Tukey's range test at 95% significant level using SPSS (IBM SPSS Statistics

III. RESULTS AND DISCUSSION

1) Moisture content

The moisture content of the jam alternative had a significant difference (p <0.05) within the treatments. According to the results, the moisture content of different jam alternative treatments ranges from 19.01 % to 21.53 %. Treatment 4 had the lowest moisture content of 19.01 %, while the highest content (21.53

Treatment	Moisture	Ash	Fiber	pH	Titratable Acidity
1	21.52±0.55b	0.21±0.02a	6.16±0.05b	2.83±0.02a	1.28±0.04bc
2	19.59±0.50ab	0.59±0.03b	7.14±0.07c	2.92±0.03a	1.08±0.02a
3	20.05±0.31ab	0.19±0.03a	5.10±0.04a	2.81±0.02a	1.58±0.03d
4	19.01±0.46a	0.16±0.01a	6.18±0.02b	2.83±0.02a	1.16±0.06ab
5	20.93±0.21ab	0.18±0.02a	6.16±0.04b	2.83±0.06a	1.43±0.03cd
F, (DF)	5.69, (4)	60.11, (4)	258.49, (4)	1.382, (4)	27.52, (4)
	*	*	*	NS	*

Version 25).

Table 2. Physio-chemical composition of each jam alternative treatments
Different letters below the mean values within the column indicate the significant difference, *= significant and NS= non-significant at 0.05.

%) was that of the T1 control sample. It is prominent that the higher the banana tender core content, the lower the moisture content. The jam is considered a self-stable food, so the moisture content is low in jams. James et al. (2015) reported that mixed fruit jam moisture content was 18.64 to 22.14 %. Therefore, we can argue that the moisture content of the developed jam alternative is in the standard range.

2) Ash content

Ash content of the jam alternative treatments had a significant difference (p<0.05) within the treatments. The lowest ash content was that of (T4) 0.16 %, and the highest ash content was T2, 0.59 %. Garg et al. (2019) reported that the Ash content of mixed fruit jam alternatives ranged from 0.26% to 0.37%. This present study had ash content varied between 0.16 % and 0.59 %. The mineral content of both ash gourd and banana tender core is contributed to the total ash content of the developed jam alternative.

3) Fiber content

Crude fiber contents ranged from 5.10 % to 7.14 %. Treatment 3 had the lowest fiber content (5.10%), while Treatment 2 had the highest one (7.14 %). Garg et al. (2019) reported that the crude fiber content of the mixed fruit jam alternatives was in the range of 0.44 to1.61%. The present study had the highest fiber content compared to the other

jams. We may argue that the fiber content of jam is higher due to the incorporation of tender banana core since tender banana core has a higher amount of fiber content (Aziz et al., 2011).

4) pH content

pH is an important factor in the formation, jelling property, and stabilization of jams (Awolu et al., 2018). The pH value of the jam alternatives varied between 2.81 and 2.92.

5) Titratable acidity

Acidity is one of the physicochemical properties responsible for a longer shelf-life of food products as it associates with a certain degree of acidity and prevents the food products from microorganism growth (Tifani et al., 2018). In the present study, titratable acidity varied from 1.08 to 1.58 mg per 100g as citric acid.

6) Sensory properties of jam alternative

The mean scores for consumer preference in terms of color, texture, taste, order, and overall acceptability are presented below (Figure 1). According to the sensory panel response, the overall acceptability of jam alternative in T2 was the highest. The jam alternative developed with the 100 % banana tender core secured higher

scores for all the sensory attributes, including color, texture, taste, order, and overall acceptability.
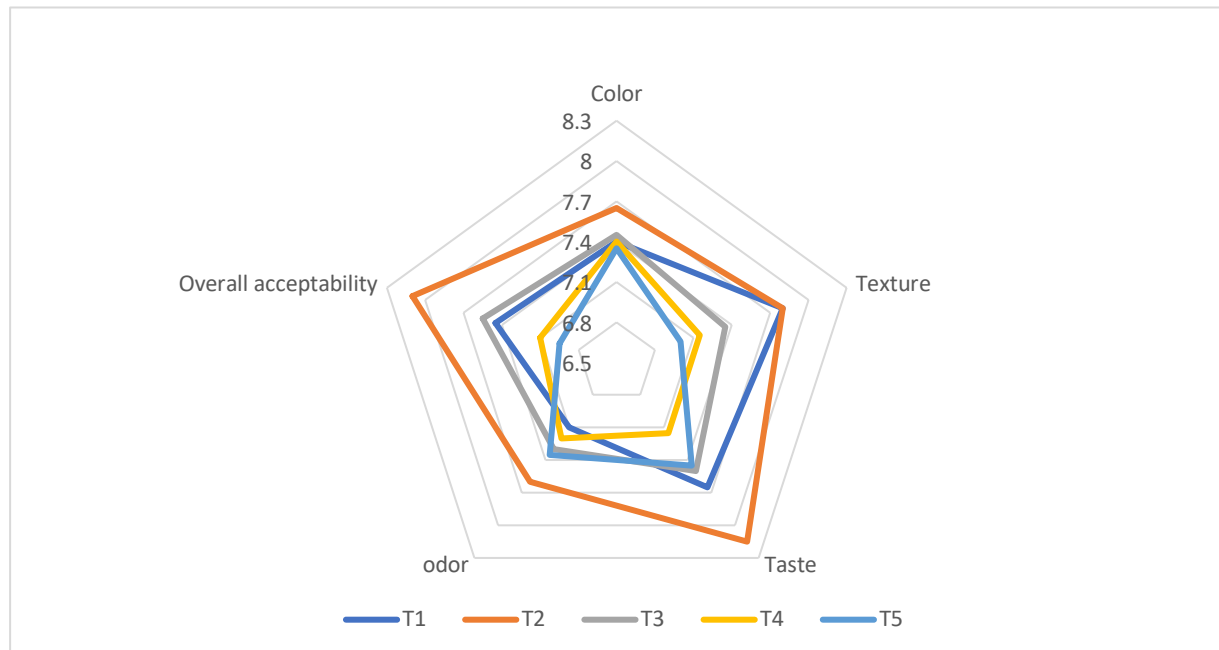
Figure 1. Sensory profile of different jam alternative formulations

IV. CONCLUSION

The banana tender core and ash gourd are underutilized agricultural by-products and produce. The jam alternative was produced with a different formulation of banana tender core and ash gourd. According to the results, the moisture, ash content, fiber content, pH value, and titratable acidity of the jam alternative aligned within the range of standard range. Further, the sensory analysis resulted in the panelists favoring a jam alternative developed with 100 % banana tender core. Therefore, in the future, jam alternatives could be produced with tender banana core alone.

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TRACK - CROP SCIENCE AND TECHNOLOGY (CST)

Effect of Copper Grafted Graphite Loading on Cure Characteristics of Natural Rubber Composites

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Abstract

Metal-coated graphite-based materials are important to effectively transmit and control heat for different electrical and electronic applications. In this study, copper grafted graphite (Cu-g-graphite) was synthesized according to a chemical process and, six natural rubber (NR) composites were prepared by varying the Cu-g-graphite loading from 2 parts per hundred parts of rubber (phr) to 10 phr at 2 phr intervals. Maximum torque and delta cure results indicated high cross-link density for the composites prepared with Cu-g-graphite. In contrast, the stock viscosity of the composites decreased with the increase of the Cu-g-graphite loading. Further, the composite prepared with 10 phr loading of Cu-g-graphite showed the highest scorch time indicating the highest processing safety. However, cure time slightly increased with the increase of Cu-g-graphite loading and, slower cure rate was indicated at higher Cu–g-graphite loading. Overall, the composite prepared with 10 phr loading of Cu-g-graphite which exhibited higher scorch safety and crosslink density compared to the others would be suitable for particular dry rubber-based applications.

Keywords: Cu-g-graphite, natural rubber, minimum torque, cure time, cure rate index

I. INTRODUCTION

Modified graphite incorporated polymer-based materials are a major topic today due to their excellent chemical, physical, rheological and mechanical properties. Generally, rubber-based polymeric materials are limited to many applications in many industries due to their inherent properties. However, rubber-based materials are shown in good demand for mechanical applications due to their high visco-elastic properties, as well as their durability and ease of processing (Nasir et al., 2015). In contrast, the thermal conductivity of rubber is poor and, hence it has poor heat diffusion through rubber matrix. Therefore, most of the research is focused on developing rubber-based materials with high thermal stability and high mechanical properties as a solution to the problems stated earlier (Allaoui et al., 2002; Zou et al., 2009). Literature suggests that, the thermal conductivity of rubber-based materials could be increased by adding certain additives. There are different types of fillers that have been used for such composite processing. Some of them are carbon black (CB), graphite, carbon fiber, carbon nanotube (CNT), pure metal, metal-coated inorganic particles, metal powders, etc. (Das et al., 2000, 2002; Zou et al., 2009). However, the most commonly used material for rubber is CB as it provides better chemical, physical, rheological and mechanical properties as well as good reinforcement to the rubber matrix (Roland, 2016). In this study, copper grafted graphite was used as a filler material since natural graphite poorly disperses in the rubber matrix and, raw graphite particles are chemically inert with the polymer matrix (Ulfah et al., 2015). Further, air voids will be formed around the graphite particles. Additionally, to achieve higher thermal conductivity at lower loading, metal-coated graphite-based materials such as copper-coated, silver-coated and nickel-coated graphite-based filler may be a better choice than raw graphite. Further, metal grafted graphene was used to improve electron field emission and increase the density of the end composite (Kaushik et al., 2013). Metal-coated graphite-based materials are very important to effectively transmit and control heat for application performances (Jang et al., 2017). In this study, Cu-coated graphite powder was fabricated according to a chemical-reaction process (Jang et al., 2017) and, the study

concentrates on the cure characteristics of Cu-g-graphite powder-filled NR composites.

II. METHODOLOGY

A. Preparation of Cu-g-graphite/ NR composites

A series of NR composites was formulated by varying the Cu-g-graphite loading from 2 phr to 10 phr at 2 phr intervals. The NR composite prepared without Cu-g-graphite was considered as the control. The formulation of the composites is given in Table 1. The composites were prepared by melt mixing using a Brabender Plasticorder operated at room temperature, at a rotor speed of 60 rpm. Total mixing time was kept constant at 10 min.

Table 1: Formulation of the Cu-g-graphite/ NR composites

Ingredient	Function	Phr
Natural rubber	Rubber	100
ZnO	Inorganic activator	5.0
Stearic acid	Organic co-activator	2.0
TMQ	Antioxidant	1.0
Cu-g-graphite	Filler	0,2,4,6,8,10
ZDC	Accelerator	1.5
Sulphur	Vulcanizing agent	2.0

B. Cure characteristics

Cure characteristics of Cu-g-Graphite/NR composites, such as minimum torque, maximum torque, scorch time, optimum cure time (T_{90}), cure rate index (CRI), and extent of cure or delta cure (M_H - M_L), were obtained by a Dynamic Rubber Process Analyzer (D-RPA 3000- MonTech, Germany) at 150 ºC.

III. RESULTS AND DISCUSSION

A. Cure characteristics of Cu-g-graphite/ NR composites

Rheographs provide important characteristics namely, scorch time, cure time, minimum torque, maximum torque, delta cure and cure rate of a rubber composite. The scorch time (t_{s2}) is usually defined as the onset of vulcanization of a composite at a specific temperature, which represents the time limit available for processing. Cure time (t_{90}) is the time required for 90% vulcanization of the composite to achieve the

required degree of cross-linking to yield the desired properties. The minimum torque (M_L) is mainly related to the processability and viscosity of the unvulcanized stock. The rheographs of Cu-g-graphite/ NR composites are shown in Figure 1. According to these curves, the composites prepared with 6 phr, 8 phr and 10 phr Cu-g-graphite show similar patterns, but they differ from the curves of the other three composites.
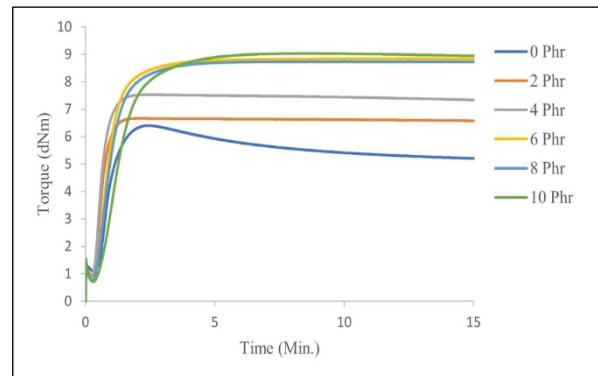

Figure 1. Rheographs of Cu-g-graphite/NR composites

B. Minimum Torque (M_L)

Minimum torque is an indication of stock viscosity and processability of rubber composites (Ismail et al., 2002). As shown in Figure 2, the minimum torque values of the composites decrease with the increase of the Cu-g-graphite loading. The results obtained show the highest value for the control (without Cu-g-graphite) composite and the other composites show significant similarities from 2 phr to 10 phr. The main reasons for this may be wettability and the low density of graphite-based material (Ismail et al., 2011). Further, lower minimum torque indicates a lower viscosity and it may be due to better dispersibility of filler and low force requirement for the torque generated initially (Ismail et al., 2011). Hence, the composite prepared with 10 phr loading of Cu-g-graphite shows the lowest minimum torque and indicates the lowest viscosity in comparison to the other composites.
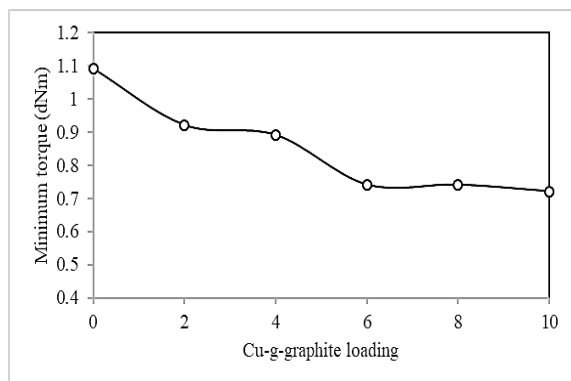

Figure 2. Variation of minimum torque of Cu-g-graphite/NR composites

C. Maximum Torque (MH)

Maximum torque is an indication of the state of cure (Surya et al., 2018). Further, maximum torque may give an idea of the maximum extent of curing such as crosslink density and the static/shear modulus or the hardness of the fully vulcanized compound (Charoeythornkhajhornchai et al., 2017). As shown in Figure 3, the maximum torque values of the composites increase with the increase of the Cu-g-graphite loading and the highest M_H value is exhibited by the composite prepared with 10 phr Cu-g-graphite. It can be due to the improved reinforcing efficiency, better dispersion and distribution of filler in the NR composites and greater cross-link density (Teh et al., 2004). Furthermore, the gradual addition of Cu-g-graphite loading facilitates the generation of cross-linkers, which in turn increases the rigidity or toughness of the composite.
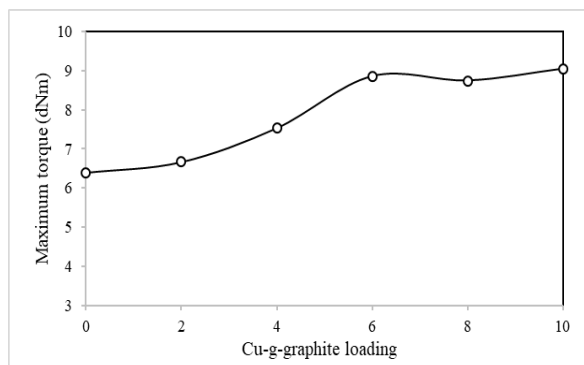
Figure 3. Variation of maximum torque of Cu-g-graphite/NR composites

D. Delta Cure (MH- ML)

M_H- M_L torque is an indication of the cross-link density of rubber compounds (Surya et al., 2018). As shown in Figure 4, when the loaded amount of Cu-g-graphite powder increases, the delta cure value increase compared to the control composite

and the highest torque value is shown by the composite prepared with 10 phr loading of Cu-g-graphite. This indicates that the incorporation of filler into the rubber matrix leads to higher viscosity and modulus of rubber composites (Ngamsurat et al., 2011). The increase of this torque value is consistent with the known behavior of increasing viscosity with the addition of carbon. Delta cure is generally related to the cross-link density of NR composites. An increase in the value of delta cure indicates an increase in cross-link density (Surya et al., 2013). Hence, an increase in cross-link density with the increase of Cu-g-graphite loading may have caused the delta cure values of the composites to increase as shown in Figure 4.
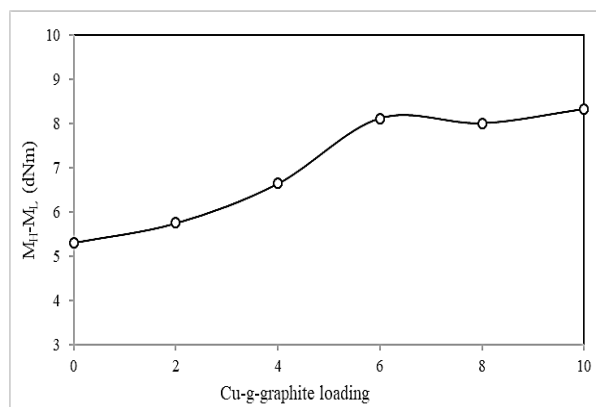

Figure 4. Variation of M_H- M_L of Cu-g-graphite/NR composites

E. Scorch Time (ts2)

The variation of scorch time of the composites with Cu-g-graphite loading is shown in Figure 5. These values give information about the premature cure for processing safety. According to Figure 5, the addition of Cu-g-graphite from 2 phr to 10 phr shows an increasing trend in the scorch time. This improvement may result as a consequence of the change in filler parameters such as higher surface area, surface reactivity, particle size, and moisture content (Ismail et al., 2011). When compared with the control composite, only the composite prepared with 10 phr loading of Cu-g-graphite shows a higher scorch time. In general, scorch time decreases due to the restriction of mobility and deformability of the matrix with the introduction of mechanical restraints (Pornprasit et al., 2016). Therefore, the lower values obtained for the composites prepared with 2 phr to 8 phr Cu-g-graphite could be attributed to the above reasons.
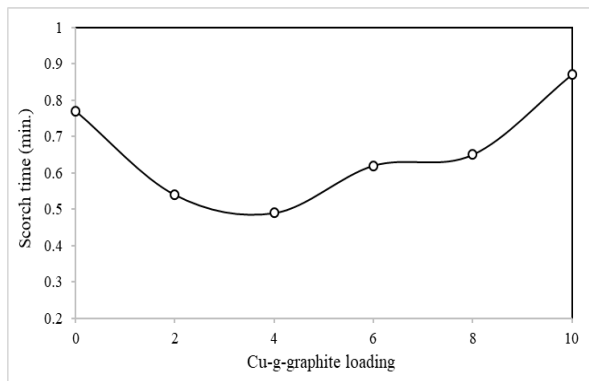
Figure 5. Variation of scorch time of Cu-g-
graphite/NR Composites

F. Cure Time (t90)

The cure time (t_{90}) is the required time during the step of vulcanization for need the required amount of cross-linking to occur, yielding the desired properties. Figure 6 shows the 90% curing time of Cu-g-graphite/ NR composites. According to Figure 6, by adding Cu-g-graphite from 2 phr to 10 phr, the cure time is increasing gradually. Most of the time, this improvement is a consequence of filler parameters such as higher surface area, surface reactivity, particle size, and moisture content (Ismail et al., 2011). However, according to Figure 6, when adding Cu-g-graphite powder at 2 phr and 4 phr, shows a lower curing time compared to the control composite. These results could be caused due to the increasement in viscosity of former composites (Pornprasit et al., 2016).
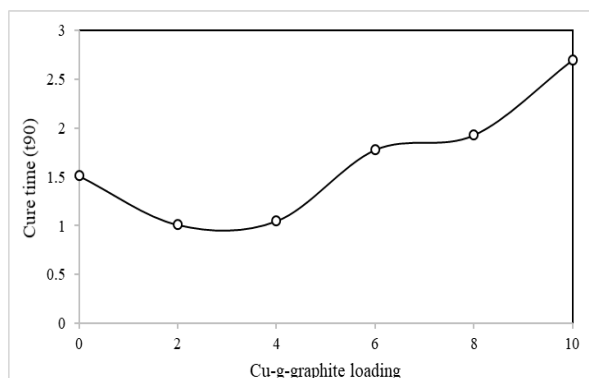
Figure 6. Variation of cure time of Cu-g-
graphite/NR composites

G. Cure rate index (CRI)

The Cure Rate Index (CRI) is a measurement of the cure rate of composite based on the difference between the optimal cure time (t_{90}) and the initial scorch time (t_{S2}). According to Figure 7, The CRI values of the Cu-g-graphite filled NR composites

are lower than that of the control composite. However, there is no significant variation between the cure rate of composites prepared from 6 phr to 10 phr loading of Cu-g-graphite as the variation is between 12.01 min $^{-1}$ and 12.32 min^{-1}. A faster cure rate index has been reported for fillers having lower surface area (Nair et al., 2012). A Moderate increment of the cure time with the loading of graphite indicates a slight increase in production time. In addition, the slight delay in vulcanization at higher filler loadings is a known effect in rubber vulcanization (Shanmugharaj et al., 2019).
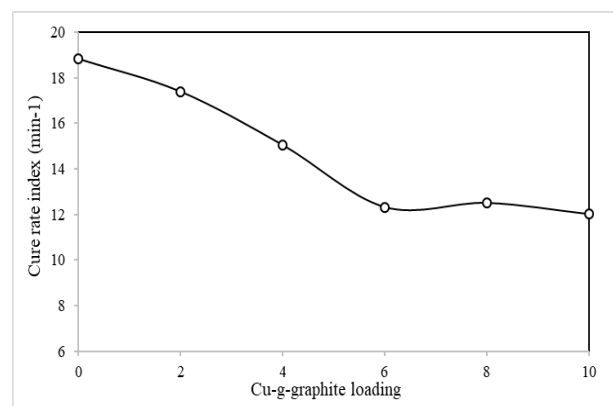

Figure 7. Variation of cure rate index of Cu-g-
graphite/NR composites

IV. CONCLUSIONS

The composite prepared with 10 phr loading of Cu-g-graphite shows better cure characteristics in terms of maximum torque, delta torque, scorch time, etc. The finding of this study is Cu-g-graphite powder could have a retarding effect on the accelerator, which in turn can slow down the sulphur vulcanization process leading to an increase in cure time. Further, the composites prepared with Cu-g-graphite indicate low energy combustion due to the low cure time exhibited. Hence, results suggest that the reduction of cure time of Cu-g-graphite incorporated NR composites would be an advantage for high-energy combustion rubber-based processes such as in the case production of solid tires.

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Farmer Awareness and Adoption on Good Agricultural Practices (GAP) in Sri Lanka

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Abstract

Good Agriculture Practices (GAP) are more important to get higher income in crop production. GAP involves economic viability, social acceptability, sustainability of environment and food safety and quality factors. Most of farmers are not aware of the advantages of GAP At Present, some farmers involved in GAP certification programme. Officials of the department of agriculture are conducting awareness programmes on GAP all over the Island. The study based on a survey which was carried out in Batticaloa, Ampara, Polanaruwa, Monaragale and Anuradhapura district to find out hundred respondents registered commercial fruits cultivation farmers were randomly selected and a primary survey was conducted during January – May 2020 using a structured questionnaire. Farmer's knowledge on GAP program, and its elements perception and adaption GAP by farmers, factors affecting farmer's eligibility to apply for GAP certification measured. A probity model was estimated to identify determinants of a farmer being eligible for GAP certification. In determining the variables affecting the GAP eligibility a value of 1 is assigned for farmers who were eligible and a value of 0 was assigned for farmers who were not eligible. The results of the estimation showed that there is not statistically significant relationship between eligibility and age, perception score, land ownership, and farming experience. Farmers' knowledge of GAP certification and land extent positively and significantly on farmer eligibility. It was revealed that commercial farmers have good awareness of GAP. More attention should be paid to their knowledge on soil test-based fertilizer application. Specific area such as fertilizer use Integrated Plant Nutrient System but Raise adaptation, perception on ownership of land, Farming experience and farmers knowledge on GAP certification and provision of subsidy will lead to more adaptation of GAP.

Keywords: Environmental Safety, Agricultural Extension Adopting, Farmer Perception, Farming Experience.

I. INTRODUCTION

Good Agriculture Practices considered to environment, economics and human resource. Demand for quality, safe and healthy food, produced in environmentally friendly and socially acceptable manner is increasing globally and there is a requirement of introducing an acceptable certification system for value agriculture products for the betterment of consumers as well as producers (Ajzen I. and Fishbein.1980). Good Agriculture practices programe was introduced in 2015 as an initiative by the Department of Agriculture Sri Lanka with the purpose of providing safe agriculture commodities to consumer overcoming the technical barriers in crop production, and for facilitating farmers to gain good income. Presently GAP is being implemented by the Division of Agribusiness Counseling of the Extension and Training Center while the certification is carried out by the GAP certification unit of the Seed certification Services, Department of Agriculture. GAP programme in Sri Lanka is still in its initial stages. Identification of barriers and constraints in GAP program would be beneficial for the successful implementation it in the future. The present study was carried out to identify problems GAP procedure, understanding level (GAP) of farmers, adaptation of farmers and idea about cultivation of special farm practices (Pongthong, Yamao and Hosono.2014).

A. Problem Identification of Gap Implementation

Good agricultural practices inspection procedure, ineffective market conditions and limitations of extension activities were the major reasons behind the inefficiency of GAP implementation problems

II. MATERIALS AND METHODS

The study (survey) was carried out in Batticaloa, Ampara, Polanaruwa, Monaragale and Anuradhapura districts. Hundred respondents were randomly selected registered commercial fruits cultivation farmers and a primary survey was conducted during January – May 2020 using a structured questionnaire. According to the Theory of Planed Behavior (TPB), individual behavior is determined by evaluation of object intension, attitudes, perceived behavioral control (that is ease or difficulty to perform) and social norms .TPB was used as the theoretical framework for the study (Policy Brief, 2018) Based on TPB, farmers' behavior towards adopting/intensions to GAP in the future would be guided by their knowledge and understanding of GAP, attitude towards GAP, and ease and difficulty   in
adopting GAP, influence of external factors and control factors such as marketing, and price for the produce. Data were analyzed using   Table for descriptive statistics correlations and a probity model were prepared. Farmers' perception in GAP was analyzed by developing perception scores for each individual using seven positive statements on GAP given in five-point scale.

A model analysis are used and estimated to identify determinants of a farmer being eligible for GAP certification. In determining the variables affecting the GAP eligibility a value of 1 is assigned for farmers who were eligible and a value of 0 was assigned for farmers who were not eligible (Development of Locally Appropriate GAP., 2016).

III. RESULTS AND DISCUSSION

A. Farmers knowledge on GAP Program

Based on the results 65 % farmers were aware of GAP while others 35% were not aware GAP programe. Most of the farmers are mentioned that the GAP programe support healthy, economically earning farm productions and developments. Farmer have become aware of GAP programme in various ways. Most of the respondents (60%) awareness on GAP from the officials DOA. while (15%) from media, (10%) from neighboring framers, (5%) from private sector, and (10%) from the internet made them aware of the GAP Program (A Practical Manual, 2019).

B. Perception and adopting GAP by farmers

Farmer sensation for whole sampling area populations was more than 75% value are mention

the farmers are proper management attitude toward practices of GAP but table 1 show the percentage value of farmers adaptation practice of GAP.

Table 1: Adoption of GAPs by farmers (percentage)

Practices	Adaptation	
	Yes	No
Water source and drainage		
Natural or irrigation water source (Mahaweli, irrigation department)	87	13
Used irrigation water of efficiency (sprinkler, drop)	50	50
Proper water management	58	42
Cultivation site		
Use of soil conservation practice	90	10
Pest and disease management		
Use of recommended pesticides by DOA	74	26
Use of recommended dosages of pesticides by (DOA)	71	29
Fertilizer Application		
Use of recommended amount of fertilizer (DOA)	55	45
Harvest and Post-harvesting		
proper harvesting method (time of harvesting,tool)	65	35
Use of proper handling for harvest and transport	55	45
Recode keeping/documentation		
Farmer keeps records	65	35
Worker health and society		
Concern about farmers health condition	63	37
Use of safety kit when working	55	45
Keep first-aid box in farm-site	80	20

Farmers poorly adapted to most of management practices proper systems of water managements, efficiency of water usage, proper way for the water management, use of recommended pesticides, use of recommended dosages of pesticides, use of recommended amount of fertilizer, use of proper

harvest and post-harvest practices record keeping (previews crops records, chemical records financial records), concern about farmers health conditions (understood health issues),use of safety kit when working since the adaptation was less than 75% (table 1) (Food and Agriculture Organization, 2007).

C. Farmers' knowledge of GAP elements

Farmers knowledge are depended on the own experience but normally all farmer are following some special idea or practice of cultivation cropping systems, escape cultivation, seasoning cultivation but some commercial cultivation farmers they will used advance practices and recommendations fertilizer and chemicals used for the cultivations. 35% farmers use recommended amount of fertilizer, 20% apply fertilizer by their experience. However, more than half of farmers 55% had applied recommended amount of fertilizer while others (45%) used overdose of fertilizer More than 70% followed recommendations of DOA for proper land preparations, used pheromone trap, use of cropping systems, use of biological control agents (predators) and others didn't follow. Most of farmers used recommended pesticides (74% farmers) with recommended dosages (71% farmers) while others (26-29%) use unrecommended pesticides with over dosages (figure 04). over chemical application. No one soil test-based fertilizer application. Proper harvest and post-harvest practices were used by more farmers (65% and 55% farmers respectively) compare to non-users meanwhile, a considerable percentage (45%) didn't know about proper handling of harvest and transport (Punyawardena, 2007).

D. Eligibility requirements of GAP and Estimation of Probity Model

More than half of farmers (55%) full filled the requirements of GAP and others should improve farm management practices and awareness of GAP (figure 09). but we are used quality and quantity parameter eligibility criteria of farmer. A probity model was estimated to identify determinants of a farmer being eligible for GAP certification. The results of the estimation of probity model are shown in table 2. Result show that there is not statistically significant relationships between eligibility and farmer age, perception score, land ownership, and farming experience. Farmers' knowledge on GAP

certification and land extent were positively and significantly affected on farmer eligibility.

Table 2: Factors affecting farmer's eligibility to apply for GAP certification

Description	Coefficient	P-value
Farmers knowledge on GAP certification	1.289	0.008
Farmers age	-0.002	0.843
Land ownership	0.18	0.619
Perception score	0.13	0.659
Farming experience (year)	0.008	0.508
Log if land extent(Ac)	0.205	0.081
Log likelihood value 43.767		
No, of observation 100		

Figure:1 showed detail about to the farmers how tacked idea to GAP knowledge from the resources. But most of the farmers/respondents (60%) knew detail from department of agriculture.
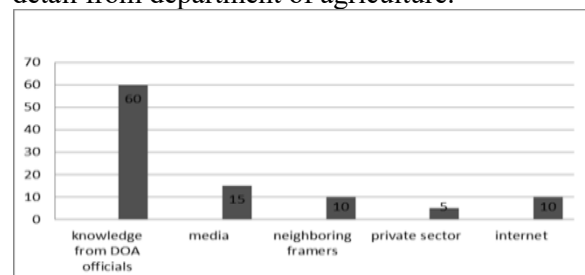

Figure 01: Farmers knowledge on GAP Program

Figure 2 explains most of the farmers (87%) received water from Natural or irrigation water source supplied by the (Mahawali Authority or irrigation department) other depended on the rainfall and various systems of irrigations.
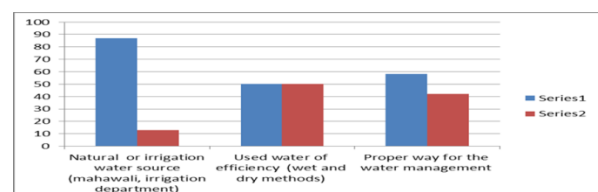

Figure 02: Water source and

Figure 3 showed detail most of the farmers (90%) practiced soil conservation management and others (10%) don't have ideas about soil conservation
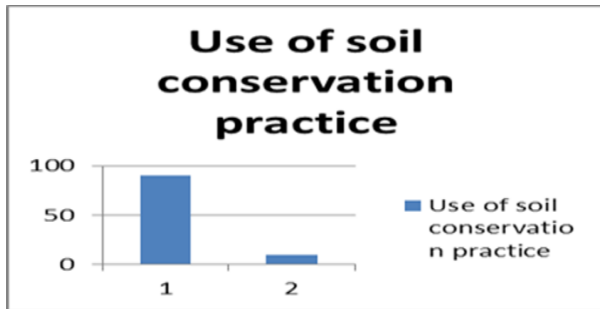

Figure 03: Use of soil conservation

Figure 4 showed column (1) 74% Used of department of agriculture recommended pesticides but others percentage of farmers used chemicals over applications or some of the farmers are by experiences.

Column (2) Shown use of recommended dosage of pesticides (Plant production division) department of agriculture but most of the farmers (71%) followed department of agriculture instructions other percentage of farmers over dosage or by experience applications.
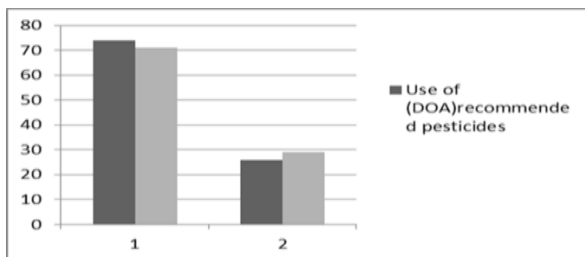
Figure 04: Pest and disease management

Figure 5 describe first column (1) shown More than 50% farmers use of the department of agriculture recommended fertilizer. Column (2) 45% percentage of farmers they applied fertilizer by experiences.
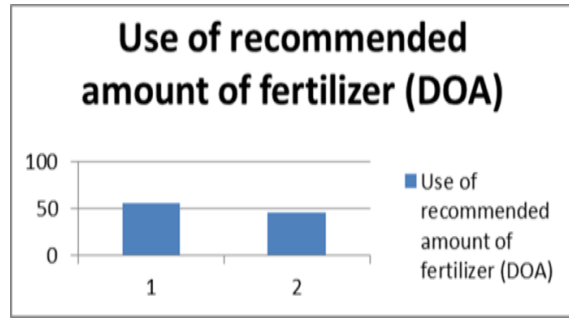

Figure 05: Use of recommended amount of fertilizer (DOA)

Figure 6 showed to first column shown 65% Proper harvesting method is practiced but 35% they don't know about the post harvesting methods. Column (2) 55% of farmers use of proper Handling for harvest and transport but 45% of farmers they don't about post harvesting technologies.
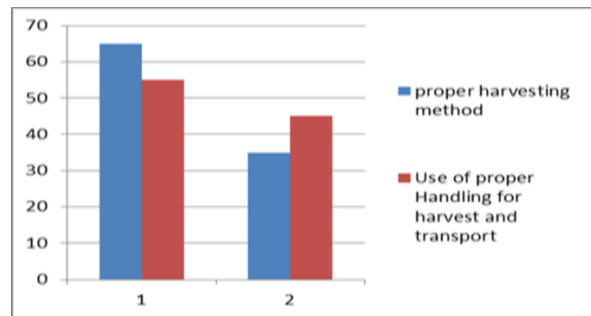

Figure 06: Post-harvesting

Most important part of the GAP this record keeping or documentation of farm practices. Majority of farmers (64%) have kept records on farming practices and others didn't keep records (figure 07).
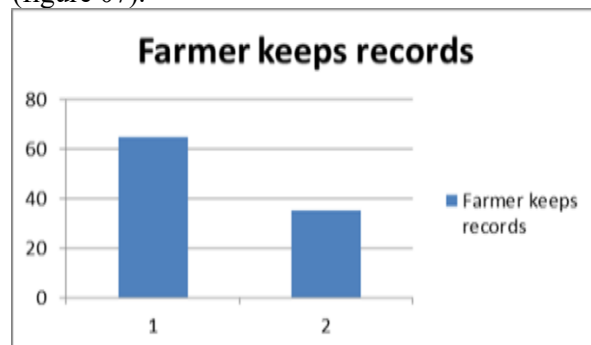

Figure 07: Recode keeping/documentation

Figure 8 described 63 % Concern about farmers health condition but 37% farmer they didn't considering health condition to the during the work.55% of farmers use of safety kit when

working 45% of farmer they not wearing safety kit or safety practices. Most of the farmers (80%) have keep first-aid box in farm-site and others have not.
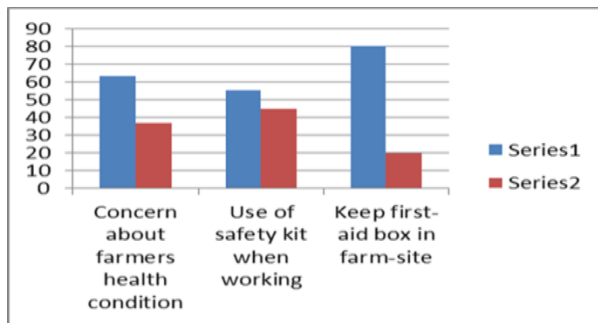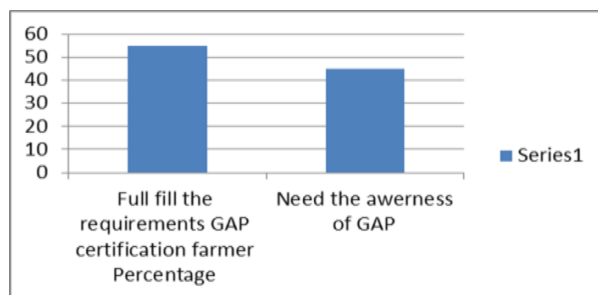

Figure 08: Worker health and society

Figure 09: Eligibility requirements of GAP and Estimation

IV. CONCLUSION

Commercial cultivation farmers have good awareness towards good agriculture practice. More attention should be paid to their knowledge on some soil test-based fertilizer application (Use of recommended amount of fertilizer DOA), Proper water management, and used irrigation water of efficiency (wet and dry methods), Use of proper handling for harvest and transport, Use of safety kit when working, will lead to more adaptation of GAP. GAP registered commercial farmers are taking special subsidies, insurance of department of agrarian.

Indicated that knowledge on GAPs, non-economic benefits such as appropriate farming techniques, economic incentives of GAP and improving income and profitability led to successful GAP implementation.

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Analysis of Leaf Characteristics of Local Moringa (*Moringa oleifera* Lam.) Germplasms in Sri Lanka

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Abstract

Moringa (Moringa oleifera Lam.) is one of the most popular vegetable crop species cultivated throughout the tropics with a high medicinal and nutritive value. However, there were no evidences regarding crop improvement, breeding or germplasm evaluation programmers reported for this valuable crop. Hence, this study was conducted in Grain Legume and Oil Crop Research and Development Center, Angunakolapelessa to identify the best Moringa *accessions with desirable morphological characteristics. Twenty accessions representing 4 districts which were maintained in field plots with 3 replications per accessions, were arranged in a Randomized Complete Block Design (RCBD). At 90 days after field planting, the 4 leaf morphological characters were recorded and hierarchical cluster dendrogram was generated to reflect their relatedness using cluster analysis. Our results revealed that the leaf dry matter content ranged between 22.1% and 26.4%. The maximum value of 26.4% was recorded in the M94 accession, which was collected from the Kurunegala district. Mean tripinnate leaf length ranged between 62.5±0.5 mm and 82.0± 4.68mm whilst the tripinnate leaf width ranged between 52.3 mm and 69.3 mm. Accordingly, the highest leaf dimensions were recorded in accession no. M14 and M97 collected from Batticaloa and Jaffna districts respectively. According to the dendrogram, accessions M14 and M97 were resulted as the most distinctive accessions in the study. Conversely, M14, M94 and M97 were clustered in one group depicting that the moringa leaf traits subjected to vary according to the geographical location within the country.*

Keywords: Moringa, Accessions, leaf characters, dry matter

I.   INTRODUCTION

Moringa (*Moringa oleifera* Lam.) is belonging to the family Moringaceae (Paikra and Gidwani, 2017). It is a common vegetable species cultivated throughout the tropics, and a fast-growing perennial plant with high medicinal value (Sarkar, 2021). It is commonly referred as "Horseradish tree", or "Radish tree "or Drumstick tree" (Obuobi, 2012). The fruits (pods) are long and slender which look like "drumsticks" and hence, it is denoted as with the popular name.

Moringa is rich in nutrition owing to the presence of a variety of essential phytochemicals in its leaves, pods and seeds. Specifically, seeds and leaves of the plant contain unsaturated fatty acid where oleic is prominent among the saturated fatty acids (Mahmood *et al.,* 2010) According to Khawaja *et al.* (2010), the Moringa is claimed to be the most nutrient-rich plant yet discovered. The leaves are rich in vitamins A, C, B1 (thiamin), B2 (riboflavin), B3 (niacin), B6 and Folate. Moreover rich in magnesium, iron, calcium, phosphorus, and zinc (Sarkar, 2021). The extracts from the leaves are used to treat malnutrition, augment breast milk in lactating mothers (Fahey, 2005). It is used as potential antioxidant, anticancer, anti-inflammatory, antidiabetic and antimicrobial agent (Ijarotimi *et al*., 2013).

The moringa plant is usually very slender, with an average height of about 10 meters. The tree has softwood and produces yellowish-white fragrant flowers (Chand *et al.*, 2012). The leaves are bipinnate or more commonly tripinnate, grow up to 45 cm long, alternate and spirally arranged on the twigs. The leaflets are finely hairy, green. The fruits are pendulous, linear, three-sided pods with nine longitudinal ridges, usually 20 to 50 cm long. The tree esquires an annual rainfall of between 250 and 3000 mm. It is drought-resistant, though in drought conditions it may lose its leaves (Akther *et al.,* 2014).

Although, there are no moringa commercial growers are reported in Sri Lanka, the crop has been cultivated in home gardens and used as a vegetable for a long period due to the unavailability of identified or developed moringa varieties/accessions for local farmers. Hence, this raises the crucial question of how to assess the local moringa germplasm, enhance it, and develop new breeding techniques and use it in addressing current food crisis. Hence, for the improvement of such crop, germplasm collection, analyzing of morphological, physical and molecular characteristics are needed. As the first step, investigating leaf-based characters of locally grown moringa is vital to unveil the latent potentials. In germplasm management, morphological characterizations are usually employed as markers to deter the variations either within or between species, varieties or accessions (Acquaah, 2007). These markers called descriptors of the crops (Esen and Hilu, 1989). Such information through basic plant features is vital and provides the breeder with the information on the genetic closeness of the accessions. Information acquired from these markers aid breeders in the selection of accessions with desirable traits for both farmers and consumers. Therefore, this study was conducted to characterize the local moringa germplasms based on leaf characteristics and to identify the best performing accessions for future moringa breeding programmers.

II. METHODOLOGY

Twenty *Moringa oleifera* accessions were collected from Batticaloa, Kurunegala, Kandy, and Jaffna and cultivated at Grain Legume and Oil Crops Research and Development Centre, Angunakolapelessa,SriLanka<https://www.latlong.net/place/kandy-sri-lanka-1085.html>The geographical coordinates are 6° 27' 0" North, 81° 1' 0" East. Each moringa accession was maintained as individual field plots with 3 replications in a Randomized Complete Block Design (RCBD). Stem cuttings with the length of 45 cm were planted in 30 cm x 30 cm x 30 cm size holes provided with 3 m x 3 m spacing. Then the crop management practices were done according to Department of Agriculture standards, regular irrigation, fertilizers (compost), weeding were practiced. At 90 days after field planting, moringa leaves qualitative and quantitative characters was observed in different 20 accessions in collected from the four districts of Sri Lanka.

Table 01. Details of Moringa olifera accessions collected from the four districts of Sri Lanka

Batticaloa	Jaffna	Kurunegala	Kandy
M02	M47	M72	M94
M13	M50	M74	M97
M14	M55	M78	M98
M25	M58	M84	M106
M05	M61	M86	M06

A. Leaf and leaflet measurements

Five leaves were taken from each moringa accessions from each field plots. Then the tripinnate leaf length and width, tripinnate leaflet length and width were measured using ruler and vernier caliper in mm (Zhigila *et al*, 2015).

B. Qualitative characters of moringa leaves

Leaf type, leaf and leaflet arrangements, leaflet shape, leaf color, growth habit, petiole pigmentation and stem bark color were recorded (Zhigila *et al*, 2015).

C. Moisture and dry matter content of moringa leaves

Moisture content of the sample was determined using the method described by (Prajapati.*et al*., 2003). One gram of sample in pre-weighed crucible was placed in an oven (105 °C) for 24 h, cooled, and reweighed. The moisture content was calculated as follows:

$$Moisture\ (\%) = (W_2 - W_3 / W_2 - W_1) \times 100$$

Where, W1 is the weight of the crucible, W2 is the weight of the crucible after drying at 105 °C and the sample, and W3 is the weight of the crucible and the sample after cooling in airtight desiccators.

Dry matter content of the sample was obtained using the following formula,

$$Dry\ matter\ content = 100 - [moisture\ (\%)].$$

D. Statistical analysis

Quantitative data was analyzed using the analysis of variance (ANOVA) using IBM SPSS software by using Tukey's post-hoc version 25. Dendrogram was generated by using IBM SPSS software to reflect their relatedness using cluster analysis.

III. RESULTS AND DISCUSSION

A. Morphological analysis

There were significant (p<0.05) differences among the accessions of *M. oleifera* for the leaf measurements determined in this study. Mean tripinnate leaf length ranged between 62.5 mm and 82.0 mm whilst the tripinnate leaf width ranged between 52.3 mm and 69.3 mm (Table 02). For both parameters, the maximum values were recorded in accession no. M14 collected from Batticaloa district while the minimum values of tripinnate leaf width were recorded in accessions

no. M74 collected from Kurunegala district, as well as minimum tripinnate leaf length was recorded M25 originated from Batticaloa.

Tripinnate leaflet length and width ranged from 25.8m to 34.2 mm and 14.5 mm to 23.1 mm respectively. M14 Accessions collected from the Batticaloa district had the highest tripinnate leaflet length and width values of 34.2 cm and 23.1 mm respectively. M74 Accessions from Kurunegala district had the lowest tripinnate leaflet length (25.8 mm) and tripinnate leaflet width (15.3 mm).

Table 02: Variation in leaf and leaflet dimensions of Moringa olifera accessions

Acc. No	Tripinnate leaf length (mm)	Tripinnate leaf width (mm)	Tripinnate leaflet length (mm)	Tripinnate leaflet width(mm)
M 02	70.1 ± 3.79^a	60.5 ± 4.11^{ab}	30.4 ± 2.24^a	18.2 ± 1.59^{ab}
M 06	69.7 ± 2.95^b	62.3 ± 2.33^a	31.5 ± 1.18^b	19.7 ± 2.24^b
M05	70 ± 3.85^a	62.6 ± 2.34^b	30.9 ± 1.80^c	18.7 ± 0.98^a
M 106	67.0 ± 4.41^{ab}	61.2 ± 4.67^a	29.9 ± 2.28^{ac}	17.9 ± 1.54^{bc}
M 13	74.8 ± 4.99^b	59.1 ± 5.11^b	30.4 ± 2.34^{ad}	16.1 ± 1.36^c
M 14	$\underline{82.0 \pm 4.68^c}$	$\underline{69.3 \pm 4.90^c}$	$\underline{34.2 \pm 2.35^a}$	$\underline{23.1 \pm 0.99^{ac}}$
M 25	62.5 ± 2.72^{ac}	54.4 ± 3.40^d	27.6 ± 1.60^b	$14.5 \pm 0.69b$
M 47	$64.7 \pm 0.75b^c$	58.7 ± 1.36^{cd}	28.5 ± 1.21^{ab}	17.3 ± 0.59^{bd}
M 50	70.3 ± 1.79^c	58.6 ± 2.23^d	29.0 ± 1.01^c	15.9 ± 0.42^a
M 54	$65.7 \pm 2.14b^c$	56.5 ± 2.51^d	27.7 ± 1.35^{bc}	16.1 ± 0.47^{ad}
M 55	$66.1 \pm 0.93b^c$	61.8 ± 2.57^c	31.0 ± 0.99^{cd}	16.8 ± 0.28^{cd}
M 58	$65.2 \pm 3.85b^c$	54.8 ± 4.77^{ad}	27.1 ± 2.33^{bd}	18.5 ± 1.53^c
M 61	64.5 ± 3.17^c	54.0 ± 2.69^c	27.9 ± 1.29^{cd}	15.9 ± 0.76^{cd}
M 72	76.4 ± 3.53^d	62.9 ± 3.47^d	31.2 ± 1.79^{ac}	18.3 ± 0.70^d
M 74	63.6 ± 3.47^b	52.3 ± 3.95^e	25.8 ± 1.80^b	15.3 ± 0.38^c
M 78	68.7 ± 5.58^d	57.7 ± 4.85^e	28.2 ± 2.30^d	17.6 ± 1.51^d
M 84	66.1 ± 3.90^c	53.9 ± 3.29^{ae}	32.2 ± 1.88^{cd}	15.7 ± 1.19^{ed}
M 86	72.2 ± 1.61^d	63.3 ± 2.25^d	26.8 ± 1.09^b	18.6 ± 0.98^e
M 94	62.2 ± 0.60^c	52.4 ± 1.19^d	34.0 ± 0.93^c	14.9 ± 0.47^{ce}
M 97	78.5 ± 2.19^{ed}	68.3 ± 1.92^{ae}	31.3 ± 1.11^{cd}	21.3 ± 0.44^{de}
M 98	72.4 ± 1.91^{ec}	63.0 ± 1.98^e	29.6 ± 0.43^e	19.3 ± 0.22^c
P	0.003	0.027	0.034	0.01

Mean (±SD) followed by the same superscript letter in each columns are not significantly different (p>0.05)

B. Moisture content and Dry matter content of Moringa oleifera accessions.

There was significant (P<0.05) variation in the dry matter content of *Moringa oleifera* accessions. However there was significant variation in the moisture content. The moisture content ranged between 77.9% and 73.6%. The maximum value of 77.9% was recorded on the accessions of M54 and M58. Both accessions were collected from the Kandy district. The minimum value of moisture content was recorded on the accession of M94. The dry matter content ranged between 26.4% and 22.1%. The maximum value of 26.4% was recorded on the M94 which was collected from the Kurunegala district. Accessions of M54 and M58 had a minimum value of 22.1%. Those were collected from the Jaffna district (Figure 1).
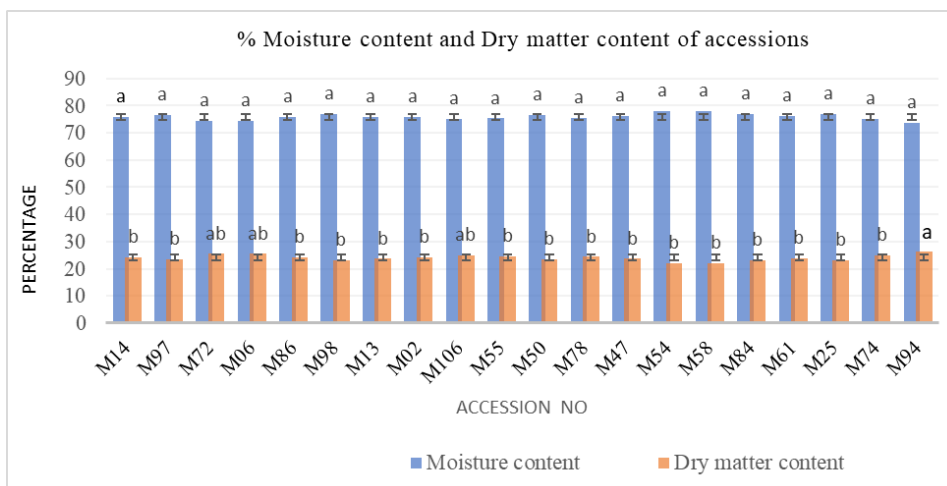

Figure 1: Moisture content and dry matter content of accessions.

C. Qualitative attributes of the Moringa oleifera accessions

The investigated *Moringa oleifera* accessions showed variance in the qualitative characteristics (supplementary Table 2). The compound leaves produced by all of the studied moringa accessions had alternate leaf configurations, and the leaflets were also placed alternately. As a result, the accessions' leaflet arrangement and shape seemed to be monomorphic for the characteristic. The hues of the leaves ranged from pale green to dark green and were all different shades of green. Since the leaf petiole's pigmentation ranged from dark green to light purple to purple, the pigmentation level of the various germplasms seemed to vary.

D. Cluster analysis for Quantitative of the Moringa oleifera accessions.

Cluster analysis resolved the quantitative data for moringa accessions into two major clusters A and B at a similarity level of 25 %. Major cluster-A further separated into two sub-clusters at a similarity level of 10 %. Sub-cluster I contained the accessions of M86, M98, M06, M72, M13, M106, M55, M50, M78, M02. Sub-cluster II contained; accession of M14 and M97. These two accessions had a high value for quantitative traits such as tripinnate leaf length, tripinnate leaf width, tripinnate leaflet length, tripinnate leaflet width.

Then major cluster B separated into only one subcluster (cluster III) at a similarity level of 10 %. That contained the accessions of M74, M47, M54, M25, M74, M84, M61, M58 (Figure 2).

According to our findings, it was noteworthy to mention that there were variations in leaf traits among the germplasms collected from the four districts of Sri Lanka. Typically, the germplasms from drier regions (Batticaloa and Jaffna) and intermediate climatic zone (Kurunegala) tend to display improved leaf traits including dry matter accumulation and leaf dimensions. Conversely, the wet zone (Kandy) germplasm consisted of smaller leaf characteristics. The lowest percentage of dry matter among the accessions was observed in the accessions from the Kandy district, meaning fresh leaves derived from such germplasms may prone to deterioration since leafy vegetables with high moisture content tend to be more prone to perishability. Moreover, the accessions from the Kurunegala district were less prone to deterioration since they have the least amount of moisture content as such post-harvest handling and packaging, processing this data can be effectively utilized.
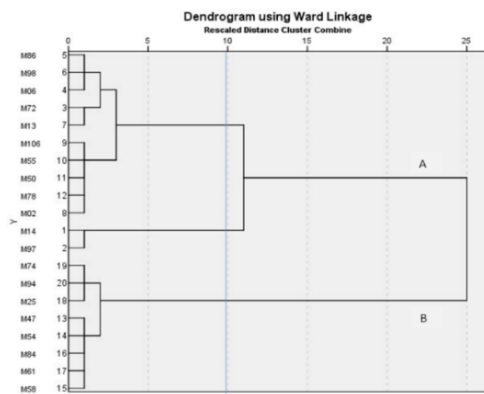
Figure 2: Dendrogram based on quantitative and qualitative of the Moringa oleifera accessions

IV. CONCLUSIONS

According to our research, the 20 evaluated moringa accessions varied in their tripinnate leaf and leaflet characteristics. According to the findings, *Moringa oleifera* accession from districts in the dry zone (Batticaloa and Jaffna) and intermediate zone (Kurunegala) displayed better leaf characteristics than those from wet zone (Kandy). Therefore, the M14, M94, and M97 are initially suggested for extensive field tests to back up the recent findings. For future research projects, suggest thorough characterization of leaf, flower, fruit, plant height and structure, sensory qualities, and nutrient analyses to have a clear grasp of the diversity that is accessible and their potential uses. It is also suggested to use molecular techniques, such as DNA marker assisted selection, to find variations in leaf characteristics among the moringa species.

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Supplementary table

Table 2 : Qualitative attribute of moringa accessions

ACC. No	Leaf arrangement	Leaflet arrangement	Leaflet shape	Leaf colour	Leaf type	Petiole Pigmentation
M 02	Alternate	Opposite	Compound	Green	Compound	Light Purple
M 06	Alternate	Opposite	Compound	Green	Compound	Dark Purple
M 106	Alternate	Opposite	Compound	Dark Green	Compound	Dark Green
M 13	Alternate	Opposite	Compound	Green	Compound	Dark Green
M 14	Alternate	Opposite	Compound	Light Green	Compound	Light Purple
M 25	Alternate	Opposite	Compound	Light Green	Compound	Dark Green
M 47	Alternate	Opposite	Compound	Light Green	Compound	Purple
M 50	Alternate	Opposite	Compound	Dark Green	Compound	Dark Purple
M 54	Alternate	Opposite	Compound	Light Green	Compound	Dark Purple
M 55	Alternate	Opposite	Compound	Green	Compound	Light Purple
M 58	Alternate	Opposite	Compound	Light Green	Compound	Dark Purple
M 61	Alternate	Opposite	Compound	Green	Compound	Dark purple
M 72	Alternate	Opposite	Compound	Green	Compound	Light Purple
M 74	Alternate	Opposite	Compound	Dark Green	Compound	Dark Purple
M 78	Alternate	Opposite	Compound	Green	Compound	Brown
M 84	Alternate	Opposite	Compound	Green	Compound	Brown
M 86	Alternate	Opposite	Compound	Dark Green	Compound	Dark Green
M 94	Alternate	Opposite	Compound	Green	Compound	Purple
M 97	Alternate	Opposite	Compound	Light Green	Compound	Green
M 98	Alternate	Opposite	Compound	Green	Compound	Purple

TRACK - ANIMAL AND AQUATIC SCIENCE AND TECHNOLOGY(AAT)

Factors Affecting the Performance of Artificial Insemination in Cattle at the Kalmunai Veterinary Range

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Abstract

Artificial insemination has created a great deal of interest in genetic circles during the last few years. The objective of this study was to find the success rate, and factors affecting the AI performance of the smallholder, and to expand the efficiency of AI services. The research revealed that in the last five years the total number of AI was 65 to 70 and it's covering the average 55 of the total cattle population of the government veterinary range Kalmunai. And the total conception rate was 79.4%, with crossbreeds having a higher conception rate. The frequency of repeated AI was relatively low, and no-repeat AI performance was observed in 2017. Last five years, most AI performed with Jersey (34.2 %), Sahiwal (32.8 %) and Friesian (27.4 %). Further, the overall success rate of AI and its impact on genetic variation of the breed-able cattle population were low in the studied area. Performance and efficiency were influenced by poor infrastructural facilities, low motivation and mobility of field staff, inadequate veterinary coverage and resources and farmers' ignorance and low motivation. These results suggested the need for farmer awareness, training, and extension in this region. This is a result of farmers' lack of knowledge of the significance of the proper time of service and inadequate communication across smallholding farms. Therefore, emphasis must be placed on resolving these defects

Keywords: Artificial insemination, Cross breed cattle, Conception rate, Farmer awareness

I. INTRODUCTION

Food and nutritional security; climate change; sustainable consumption, production, and development; rural livelihoods; human health; animal welfare; and the environment are all positively impacted by Sri Lanka's cattle sector. To improve resilience, food security, and rural livelihoods while reducing negative impacts, the cattle sector must be included in Nationally Determined Contributions (NDCs), National Adaptation Plans (NAPs), and policies. The livestock industry in Sri Lanka is mostly structured on smallholder farming, especially dairy and poultry. The dairy industry contributes significantly to the economy of both developed and developing nations. The preponderance of cattle in Sri Lanka is crossbred, with crosses primarily between indigenous *Bos indicus* (Zebu) cattle and improved Zebu strains from the Indian subcontinent, or between Zebu and *Bos taurus* (European/American) dairy breeds. Sindhi and Sahiwal are the major improved Zebu breeds utilized in dairy production in Sri Lanka, whereas Holstein/Friesian and Jersey are the main European breeds adopted (Alexandratos and

Bruinsma, 2012). The National Livestock Development Board (NLDB) was mandated to supply superior breeding stock to farmers, but it covers only 20 % of the demand due to the lack of organized livestock markets for farmers to sell and buy animals (Hitihamu and Epasinghe, 2015). Meanwhile, artificial insemination (AI) serves only 10% of breed-able cows and 2% of breed-able bulls; Because there was a dearth of natural services for reproduction in regions without access to artificial insemination (Demetrio *et al*., 2007).

Although AI has been regarded the main tool for cow breeding in the dairy sector, it still only accounts for around 10% of yearly calving in Sri Lanka and just 20% of the breed-able cattle population (Chebel *et al*., 2004). Since only half of all newborn calves are female and male calves are known to be lost at a high rate, the national cow herd does not get a very large dose of new genetic material. Although the AI service is available across the whole island, this service has acquired traction and established itself as the dominant breeding method in just a few provinces. Only

around 10% of the projected breed-able cattle population (about 600,000 animals) is given with more than 50% coverage. The remaining ninety percent of the population is supplied with very limited coverage, and more than two-thirds are still bred spontaneously, mostly by scrub bulls (Alexandratos and Bruinsma, 2012). This poor level of coverage on a national scale and in some regions of the country seems to be the result of a many of issues. And it is acknowledged that AI is the major instrument for genetic advancement in dairy cattle breeding. In order to evaluate the coverage and effectiveness of AI at the national, provincial, and district levels, as well as the success rate and variables influencing in Wet Country Intermediate Zone (WCIZ) with several research context available but very rear in dry zone's cattle management. Therefore, the current study will take corrective actions and/or identify future research needs to enhance the effectiveness of AI services in Kalmunai veterinary range.

A. Background of the Study

In Sri Lanka, the increased milk production appears mainly due to the upgrading of dairy cattle through the national artificial insemination (AI) program (Demetrio *et al.,* 2007). The national AI program for dairy cattle was carried out according to the national breeding policy. The type of semen according to the agro-climatic zone, management system, and the breed of the cow is recommended. Therefore, continuous maintenance of different breeds of semen donor bulls is essential. This is a challenge for AI services since their intended farmers are sometimes unmotivated to use them and, as a result, fail to notice heat symptoms in their

animals on time. This demonstrates that farmers need education (Chebel *et al.,* 2004).

However, owing to the limited resources that these relatively few veterinarians have access to in terms of qualified staff, mobility, and operating finances, they are unable to complete this work. This is the case since there are so few veterinarians in these locations. When comparing the intermediate zone with the dry zone, relatively better infrastructural facilities were observed in that zone, but the dry zone lack from resources. Development employees in the cattle industry are faced with a challenging issue because of the variance in coverage as well as the poor performance of AI in the various agro-ecological zones (Alexandratos and Bruinsma, 2012). But AI has been designated as the prime breeding tool in genetic up-grading efforts, and it will boost production efficiency and raise the dairy industry's economic profit. This approach may need to be reconsidered in light of persistently inadequate coverage and performance, notably in the majority of dry and intermediate zones. This problem has also been voiced in a large number of earlier consulting reports. Due to logistical, administrative, and budgetary restrictions, inadequate heat detection, and wrong timing of insemination, the country's AI service is inefficient.

II. METHODOLOGY

The study was conducted from November 2016 to May 2021 in Government veterinary range Kalmunai, Ampara district of the Eastern province, it covers approximately 222 m^2 of land area and consists of 29 Grama Niladari Divisions. A cross-sectional study was conducted to determine the risk factors of AI service efficiency
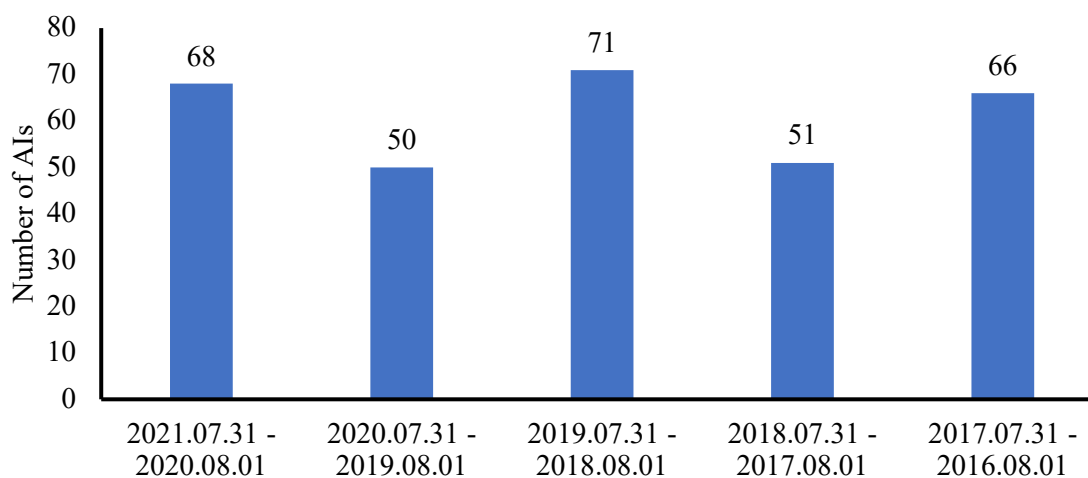

Figure 1. Number of Ais from 2016 to 2021

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through random sampling technique using registered farm list in veterinary range, the sample size was 29 to 35 along the years. The secondary data was collected from the Kalmunai veterinary office's livestock statistical detail based on Ampara district from census and Department of Animal Production and Health (DAPH) and from the annual report. The following information was gathered from the records of the Government veterinary office in Kalmunai: I) The quantity of AI Services ii) the total number of cattle in the region, and iii) the number of successful AI and calving record. All data were input into a Microsoft Excel 2018 spreadsheet, coded, and analyzed using descriptive illustrations.

III. RESULTS AND DISCUSSION

The study reveals that in the last five years the total number of AI was 65 to 70 (Figure 1) and it's covering the average 55 of the total cattle population of the government veterinary range Kalmunai. In the present research, the total conception rate was 79.4 %, and crossbreeds had a higher conception rate. This variance in conception may be attributable to genetics, the precision of heat detection, and farmers' desire to handle crossbred cattle better than native cattle (Alexander et al., 1997). A Zebu cow does not display obvious estrus signals like crossbred cows, which may contribute to the reduced percentage of indigenous animals who conceive at first insemination. Cows who were inseminated in the

midst of estrus had a greater conception rate. Estrus symptoms have been known to be brief, unpredictable, and generally less visible or quiet heat, necessitating careful monitoring and early insemination for a healthy pregnancy (Anzar et al., 2003)

The discrepancy may be related to changes in the handling of the sperm and the inseminator's capacity to appropriately fertilize the egg. To enhance the likelihood of conception, cows should be inseminated within six hours after the onset of heat. Late insemination may impact conception rates (Douphrate et al., 2013). Researcher found that null ratio recorded from 2018 to 2019 in repeat AIs (Figure 2) and high number of AI (n=71) preformed (Figure 1) in the same period; which indicating that AI success rate is 100%. From this repeating AI and PD farmers spent additional cost in dairy production at this veterinary range. Abeygunawardena et al. (2001) found that the owner's profit dropped when the cow required more than three attempts at insemination before giving birth to a calf. The repeat AI ratio highly (4) recorded from 2020 to 2021 year (Figure 2). The present study found that in last five years most of the AI performed with Friesian (27.4 %), Sahiwal (32.8 %) and Jersey (34.2 %) and semen types. According to Figure 3, in 2018 to 2019 period mostly Jersey (46 %) semen used to preform AI, Sahiwal 30 % and Frisian 24 %.
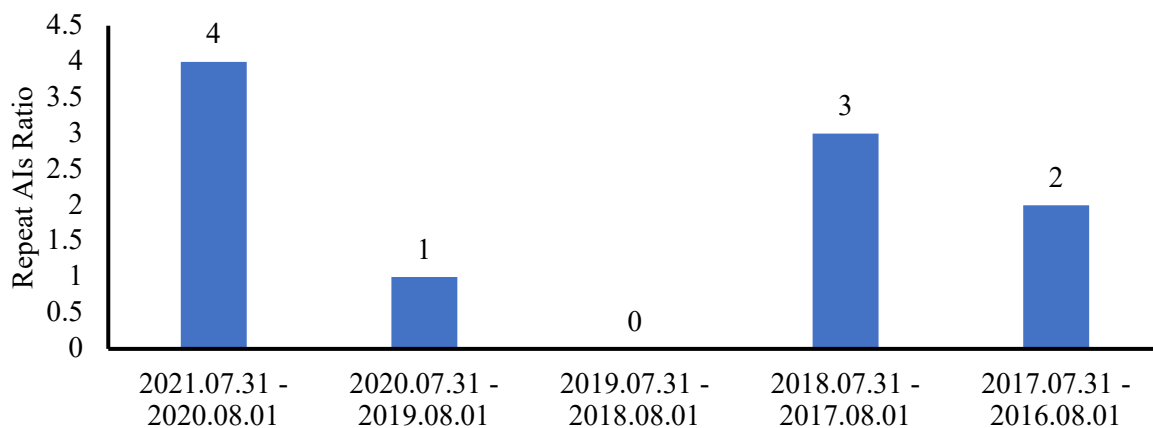

Figure 2. Repeat AIs Ration from 2016 to 2021

The animals that are raised on the smallholder farms are almost exclusively *Bos taurus* genotypes, and the management types may either be extensive or semi-intensive. The majority of farmers in studied area used AI to breed their cows. This is either because they are aware of the sustainable diary production in a particular area. The time between calving and the first service was well over four months, and this might most certainly be attributed to the lack of information that farmers have about the reproduction planning of the cattle (Jeganathan, 1955). Due to the
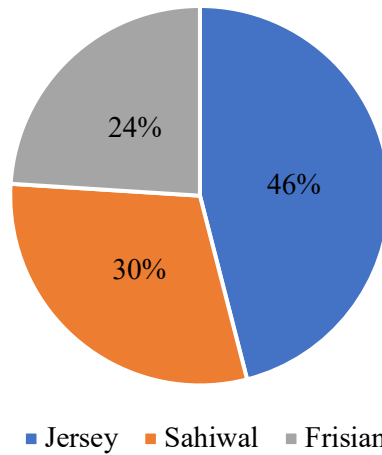

Figure 3. Used Semen Types from 2018 to 2019

benefits of AI for getting a calf with a greater dairy potential or because there is a lack of stud bulls of sufficient quality in their localities (Marshall *et al.*, 2020). According to the findings of the current research, the majority of farmers had no special preferences for breeds or types of sperm, showing a lack of understanding of the relative benefits and appropriateness of various breeds for their unique farming area (Figure 5). This highlights the critical need of educating farmers on breeding objectives and the proper use of AI to accomplish and widespread belief that early re-breeding harms both the milk production of the cow and the development of the calf, the majority of farmers waited many months (06 to 08 months) following the birth of their calves before mating (Mohamed *et al.,* 1990). It is probable that farmers did not breed cows even they returned to estrus early in the postpartum period due to the aforementioned misconceptions. The long average time from calving to first service in this research may be attributed to the presence of postpartum estrus
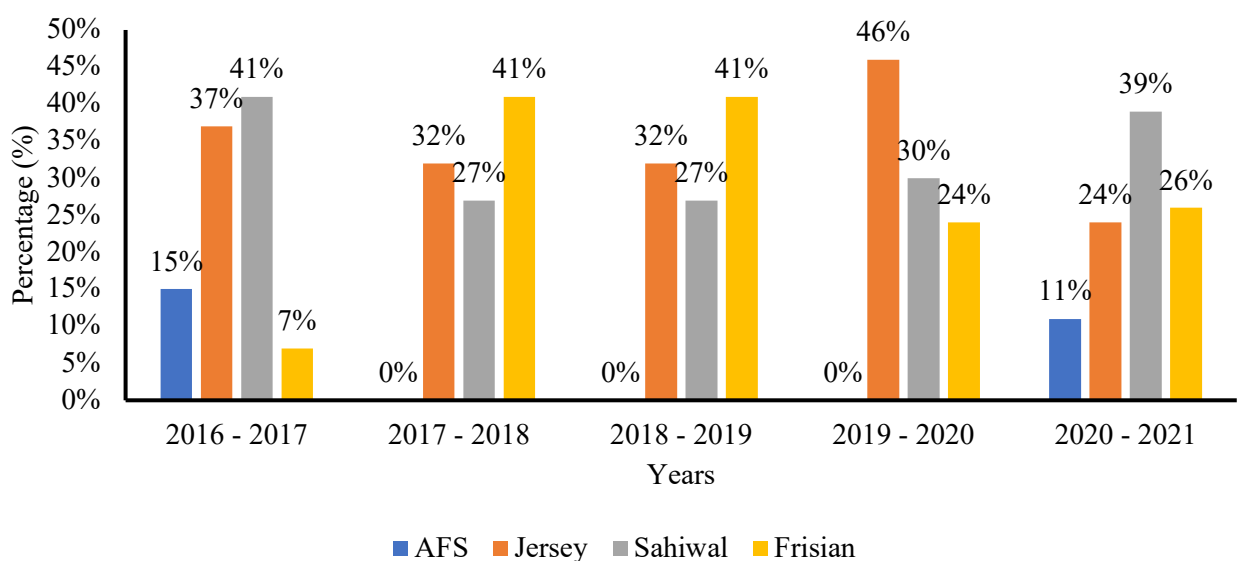

Figure 4. Defferent types of Semen used for AI from 2016 to 2021

cycles. These inaccuracies in estrous identification would have contributed considerably, without a shadow of a doubt, to the poor success rates of artificial insemination that were seen in this investigation. These results lend credence to the findings and highlight the need of providing education, training, and extension services to farmers in this sector.

These findings give insight into how the fertility of cattle in this area and the AI service may be enhanced. Animals given concentrates as a supplement to roughages tended to have a greater Conception Rate (CR) than those not fed concentrates. The previous study shows that cows with a strong Body Conditional Score (BCS) had a propensity to exhibit greater CR than those with low BCS is another piece of data that demonstrates the significance of proper feeding (Alexandratos and Bruinsma, 2012). Therefore, better nutrition will not only shorten the postpartum anestrous phase, as several studies have shown, but it will also lead to an increase in CR (Douphrate *et al.*, 2013). This may involve improved feeding and heat detection, which would allow for the cow to be milked at the optimal time concerning her estrous cycle, leading to increased fertility (Chebel *et al.*, 2004). It is well known that the time of insemination relative to the initial detection of heat is crucial for getting a high CR (Anzar *et al.,* 2003). The delay lengthened from six to twenty-four hours, then started to go shorter again. In principle, 12 to 18 hours following the beginning of "standing" heat is the best time to begin providing service (Jeganathan, 1955).

IV. CONCLUSION

In conclusion, the study's results show that the percentage of breed-able cattle serviced by AI and the overall success rate of AI are insufficient to have a discernible effect on the genetic makeup of the government veterinary range Kalmunai cow population. Numerous reasons, such as farmer ignorance and a lack of drive, insufficient infrastructural facilities, inadequate veterinary coverage and resources, poor motivation, and field worker mobility, have all contributed to this low level of performance and efficiency. The overall success rate of artificial insemination on small-holder farms within the government veterinary range Kalmunai is within the lower limit of tolerance, with a significant degree of inter-locational variability. Inadequate heat detection and delays in completing AI stand out as the most significant contributing causes. These findings

support and highlight the need for farmer education, training, and extension in this area. This is due to farmers' lack of knowledge about the necessity of service scheduling and inadequate communication amongst smallholding farms. As a result, priority on reproductive record keeping must be focused on resolving these inadequacies.

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