

# A<sup>STECH</sup>

**SARAWAK**

ADVANCED SUSTAINABLE TECHNOLOGY INTERNATIONAL CONFERENCE

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# 2024

## E-PROCEEDINGS

FOSTERING RESEARCH AND INNOVATION  
FOR SUSTAINABLE TVET DEVELOPMENT  
PATHWAYS TO RESILIENT FUTURE



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**Advanced Sustainable Technology International Conference 2024**  
**(ASTECH 2024)**

Kuching, Sarawak | 5<sup>th</sup> – 6<sup>th</sup> August 2024

**e-PROCEEDINGS**

“Fostering Research and Innovation for Sustainable TVET Development:  
Pathway to Resilient Future”

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# PREFACE

We are honored to present the proceedings of the "Advanced Sustainable Technology International Conference 2024" (ASTECH 2024), which took place in Kuching, Sarawak, from August 5th to 6th, 2024. This compilation of research papers represents the collective effort of numerous experts and practitioners dedicated to advancing sustainable technology and education.

The theme of ASTECH 2024, "Fostering Research and Innovation for Sustainable TVET Development: Pathway to Resilient Future" underscores the pivotal role that Technical and Vocational Education and Training (TVET) plays in addressing the global challenges of sustainability. As we navigate the complexities of the 21st century, it is imperative that we equip our workforce with the skills and knowledge necessary to foster innovation and resilience. TVET, with its focus on practical skills and real-world applications, stands at the forefront of this mission.

The proceedings encompass a diverse array of topics that align with our theme, reflecting the interdisciplinary nature of sustainable development. We are privileged to feature contributions from a distinguished array of scholars, researchers and authors who bring a wealth of knowledge and expertise to our conference. Their work not only advances academic discourse but also provides practical insights that can be applied in various contexts around the world. The depth and breadth of the content presented in these proceedings are a testament to the dynamic and rapidly evolving field of sustainable technology.

We extend our deepest gratitude to all contributors, reviewers, and organizers who have worked tirelessly to make ASTECH 2024 a success. Your dedication and enthusiasm are the driving forces behind the success of this conference. Our special thank to our main sponsor, the Ministry of Education, Innovation, and Talent Development Sarawak (MEITD) and other sponsors and partners for their unwavering support and commitment to fostering sustainable development through education and innovation.

As you delve into these proceedings, we hope that the knowledge and ideas presented here will inspire further research, collaboration, and action towards building a sustainable and resilient future. We look forward to the continued exchange of ideas and the forging of new partnerships that will emerge from this conference.

**With warmest regards,**

**The Organizing Committees**

**ASTECH 2024**





## **FOREWORD BY THE DIRECTOR POLITEKNIK KUCHING SARAWAK MALAYSIA**

It is with great pleasure that I welcome you to the “Advanced Sustainable Technology International Conference 2024” (ASTECH 2024), held in the picturesque city of Kuching, Sarawak, from August 5th to 6th, 2024. This significant event marks an important milestone in our collective efforts to advance sustainable technology and education.

The theme of ASTECH 2024, “Fostering Research and Innovation for Sustainable TVET Development: Pathway to Resilient Future” highlights the crucial role of Technical and Vocational Education and Training (TVET) in building a sustainable future. As the Director of Politeknik Kuching Sarawak, I am particularly proud to co-host this conference alongside our main organizer, Politeknik Bandung (POLBAN) from Indonesia. This collaboration is crucial not only in promoting TVET education but also in facilitating the exchange of experts and strengthening the relationship between our two countries through education. This initiative aligns perfectly with our institutions' mission to cultivate a skilled and knowledgeable workforce capable of driving sustainable development.

TVET is at the heart of our educational philosophy, providing students with the practical skills and innovative thinking needed to address contemporary challenges. This conference serves as a platform for sharing the latest research, best practices, and innovative solutions in sustainable technology. It is a gathering of minds dedicated to exploring how we can integrate sustainability into education and industry, ensuring that our development pathways are resilient and future-proof.

I am honoured to extend my gratitude to all the participants, presenters, and attendees who have travelled from near and far to be part of ASTECH 2024. Your engagement and insights are invaluable, and I am confident that the discussions and collaborations that emerge from this conference will pave the way for significant advancements in sustainable technology and education.

Lastly, I would like to express my heartfelt appreciation to the organizing committee, our main sponsor, the Ministry of Education, Innovation, and Talent Development Sarawak (MEITD), as well as all other sponsors and partners for their unwavering support and dedication in making this conference a success. Your efforts have been instrumental in bringing together this diverse and dynamic group of individuals. Together, let us continue to champion sustainable development and create a resilient future for generations to come.

**Warm regards,  
Samsudin bin Mohd Salleh  
Director  
Politeknik Kuching Sarawak**

# **FOREWORD BY THE DIRECTOR POLITEKNIK NEGERI BANDUNG INDONESIA**



Assalamu'alaikum warahmatullahi wabarakatuh  
Bismillahirrahmanirrahim

It is with immense pride and great anticipation that we welcome you to The Advanced Sustainable Technology International Conference 2024 (ASTECH 2024). This conference marks a significant collaborative milestone, representing the unified efforts of Politeknik Negeri Bandung (POLBAN), Indonesia and our co-organiser Politeknik Kuching Sarawak (PKS), Malaysia, with the support of our main sponsor, the Ministry of Education, Innovation and Talent Development Sarawak (MEITD), in collaboration with Brunei Darussalam-Indonesia-Malaysia-Philippines East Asean Growth Area (BIMP-EAGA), Malaysia National University (UKM), SIDMA College Sarawak, the Technological Association Malaysia, and the Association of Professional Technicians & Technologists (APTT), TAM Sarawak, and Iloilo Science and Technology University. Together, these esteemed institutions and associations have orchestrated an event that promises to be a beacon of knowledge, innovation, and sustainable progress. These prestigious organizations and groups have worked together to plan an event that will shine a light on innovation, knowledge, and long-term progress.

ASTECH 2024 aims to gather a distinguished assembly of global academicians, scholars, researchers, and industry experts, providing a dynamic platform for the exchange of knowledge and ground-breaking ideas. This conference is more than just a meeting; it is a fertile ground for cultivating a robust research and innovation ecosystem. We are dedicated to encouraging participants to explore and develop state-of-the-art sustainable technologies across a broad spectrum of disciplines, including engineering, technology, science, Technical and Vocational Education and Training (TVET), and education.

Aligned with the principles of Industry Revolution 4.0, ASTECH 2024 is poised to drive progress in these critical areas. The conference agenda is carefully crafted to address the latest advancements and challenges, encouraging discussions that will pave the way for future technological innovations and sustainable solutions. By integrating advanced sustainable technologies, we aim to contribute to a future where technological growth harmoniously coexists with environmental stewardship.

Presenters and participants at ASTECH 2024 can anticipate a comprehensive program featuring insightful keynote speeches, engaging panel discussions, and thought-provoking presentations. We are confident that ASTECH 2024 will be an enriching and inspiring experience for all attendees. It will provide vast opportunities for networking, collaboration, and the exchange of innovative ideas that address the pressing challenges of our time. We believe that the insights gained and the connections made during this conference will significantly contribute to the global advancement of sustainable technologies and practices.

I would like to express my profound gratitude, on behalf of the organizing committee, especially to our sponsors and to all of the attendees, speakers, and organizers for their commitment to make ASTECH 2024 a successful one. Your contributions are invaluable, and your commitment to fostering a better, more sustainable future is truly commendable. Together, we will explore new horizons and pave the way for significant advancements in sustainable technology.

Welcome to ASTECH 2024! We look forward to a successful and impactful conference.

Thank you and Wabillahitauk Walhidayah Wassalamualaikum Warahmarullahi Wabarakatuh

**Warm regards,  
Marwansyah S.E., M.SI., PH.D.  
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**SARAWAK**

**ADVANCED SUSTAINABLE TECHNOLOGY INTERNATIONAL CONFERENCE**

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## **SECTION**

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**ENGINEERING & TECHNOLOGY**

# Development Medicine Pill Box Reminder

*Ts. Nor Asiah binti Mat Yunus<sup>1\*</sup>, Mohd Fauzi bin Hassan<sup>1</sup>, and Sr. Che Zaidi bin Che Hassan<sup>1</sup>*

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**Abstract.** This project aims to address this issue by designing a comprehensive system that not only alerts patients to take their medications but also provides caretakers with real-time updates on medication consumption. With the growing population of both elderly and young individuals diagnosed with illnesses, ensuring the correct intake of medication becomes paramount for maintaining health. However, patient and caretaker face challenges in adhering to medication schedules, often forgetting to take them at the right time. The system comprises a smart pillbox equipped with visual and auditory alerts to remind patients of their medication schedule. A medicine pill box reminder is a device designed to help individuals manage their medication schedules effectively. It typically takes the form of a box or container with compartments for organizing pills according to specific times of the day or days of the week. The reminder aspect involves incorporating features to alert users when it's time to take their medications. Additionally, it incorporates a Blynk application, which notifies caretakers when medications are taken. Using a weight sensor within the pillbox, the system can accurately detect the remaining medication supply. Caretakers receive notifications if the pillbox's weight falls below 50% of its total capacity, indicating potential missed doses.

**Keywords:** blynk application, medicine pill box reminder

## 1 Introduction

Recently, many people have become highly intoxicated with several kinds of medicine. It is now common among all people. Hence it should be reminded to take the drug at the prescribed times. People are obliged to remember their medicines to be taken at the appropriate times and the appropriate medicine taken at once. Most patients will take the drugs more than once a day, and since there are various types of drugs, a patient will forget to take a few of the drugs [1] – [3]. This is most common in adults and youngsters. Thus, it is challenging if there are some situations like the time one forgets to take the medications or the mistake of eating the diabetes drug will cause a high risk to the patient.

Since an increasing percentage of old and young people are being diagnosed with diseases, improper medicating is no longer achievable for staying healthy; the priority should be taking suitable and accurate medications. Patients at home should take their medicine at appropriate times. If a patient fails to take the medicine at the correct doses regularly, therapy may be prolonged. As a result, patients should take their medications on time and in the right doses. This effort works to ensure that these folks receive their medications on time to avoid illnesses. Thus, the goals of this title are to create a system that will remind patients to take their medications while creating an application that would notify the caretaker whenever a patient has taken their medications.

An equivalent project includes an LDR sensor, a magnetic reed sensor, a motor, and a buzzer all linked to the NodeMCU microcontroller, also known as the system's core [4]. At this point, the LDR sensor detects if the patient has taken all the prescribed medication. Second, a magnetic reed sensor is employed for security considerations, acting as a switch for both the LDR sensor and the motor that operates the box's lid. Finally, a buzzer has been used to inform the patient of the right medicine periodically. Another project is an LDR sensor with a servo motor, which is known to work after the set time by the programmer. The servo motor only turns at a specific time when the patient needs to take the medication later, and the lid will stay locked at any cost, even if the patient opens it or not. This means that a patient will not be able to get medication at any cost after the buzzer alarm rings, and it does not solve the problem in some circumstances [5]. There are a few problems, if a patient is in an emergency or serious condition and wants to have the medicine before a particular time of the given medicine box, they will never help these patients to find the medicine carrier. Moreover, a pill dispenser with an Android operating system is used, which is made up of a pill dispensing slot for each intake of medication. In detail, the Android application controls the system [6]. A patient's information and insert pill storage information are in sync on the cloud, and after login, the synchronization is done. When a phone connects with the Arduino using Bluetooth and sends commands, it will call for the stepper motor and control which container will turn in rotation. By correlating the weight change in the pillbox with prescribed dosages, caretakers can ascertain the number of days patients have taken their medications. This innovative approach provides caretakers with a holistic view of patients' medication habits, enabling timely interventions if necessary. To enhance the system's functionality, future improvements may involve refining the load cell's operation to detect daily

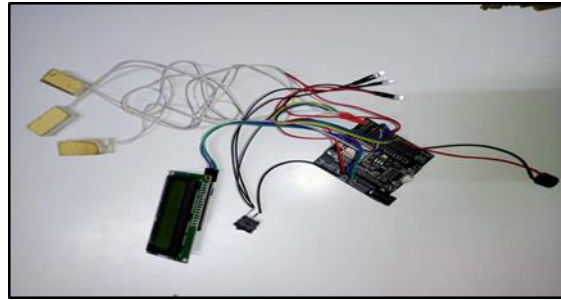
fluctuations in medication consumption accurately. By continuously evolving the system's capabilities, we strive to optimize medication management, ultimately promoting better health outcomes for patients and peace of mind for caretakers.

## 2 Materials and Methods

The project utilizes a broad spectrum of components and technologies to develop a system that would realize the functional complexities of a medication reminder alert. First and foremost, the project's microprocessor, Arduino Uno, is responsible for connecting different parts and components of the project. It utilizes the ESP8266 WiFi module to relay information to the programmed Blynk app, allowing the patient's caretakers to receive notifications and alerts of the patient's medication adherence. Moreover, with the ESP8266 Wi-Fi module, the test results are also sent to a Blynk app, and a tweet is displayed. The LED and buzzer serve as a warning and alerting system for the patient to take their medication effectively. This project also includes a load cell to effectively measure the amount of drug left in the device medication box, allowing the patient to keep track of the remaining daily medication quantity with precision. The RTC DS3231 aids in timekeeping and helps the patient set an alarm to notify them via the LED and buzzer. Pushbuttons are included in the model to set the time, and date to permit the patient to interact with the display by navigating the menu interface.

### 2.1 Hardware development

This section describes the specifications and attributes of the materials, equipment, and other resources employed in the project. Figure 1 illustrates the RTC DS3231 IC that was used in this project. The IC maintains all of the project's tracking time functions, including the date and time set by the user. It also has a 3V extra battery to keep track of the date and time in the event of a power outage. A 1kg load cell transforms a force into a measurable electrical signal, with the frequency of the signal changing proportionately to the force applied. This project uses the weight of each type of medicine to measure them on the pillbox. The ESP8266 WIFI module updates the caretaker about the condition of the pill box. If the condition of the pillbox is less than 50% of the total weight of the pills, the caretaker is notified via the Blynk mobile application.



**Fig. 1.** Hardware connection

The Arduino Uno is considered the system's heart; all of the devices' functionality is measured and tweaked using this microcontroller. All input and output devices are connected to the appropriate pins on the Arduino, allowing it to perform as designed. The system's output consists of an LED, a buzzer, and an LCD. The LCD will display the date and time, as well as where the patients may set their alarm, while the LED and buzzer signal to them when the alarm is active.

Figure 3 illustrates the system's flowchart, including the date and time configuration feature, that enables patients to enter an accurate day and time. Following that, the patients may program the system to notify them of a specific alarm, allowing them to take their medications when they hear the alert. The caretaker will adjust the load cell to ensure that the load cell weight sensors accurately gauge the total weight of medicines in the pill box. The data from the load cell will then be communicated to the Blynk application, where the carer may receive notifications and track the weight of the drugs in the pill box. Finally, if the load cell detects that the total weight of the drugs is less than 50%, the carer will be advised that their patients have taken the medications.



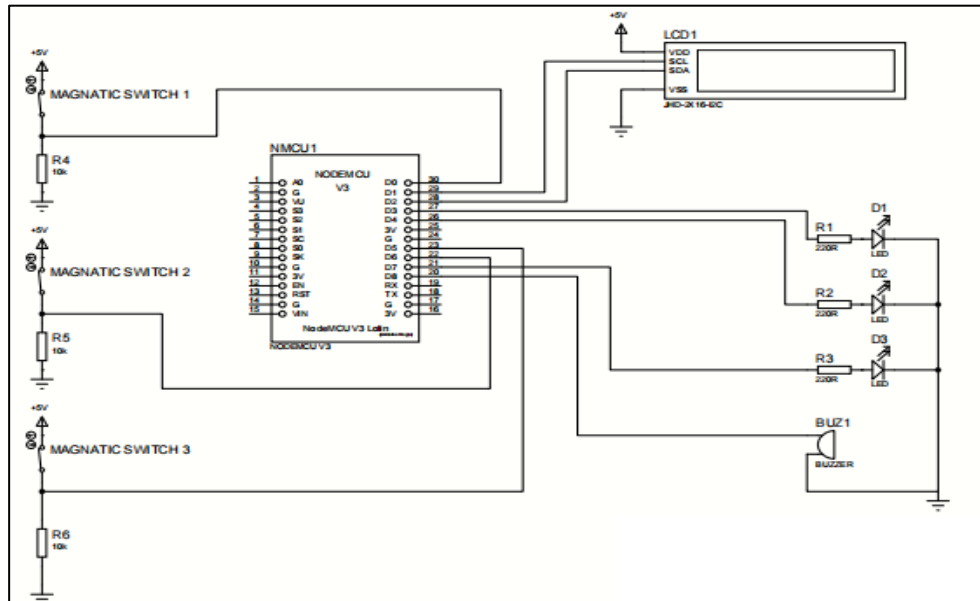


Fig. 2. Schematic circuit

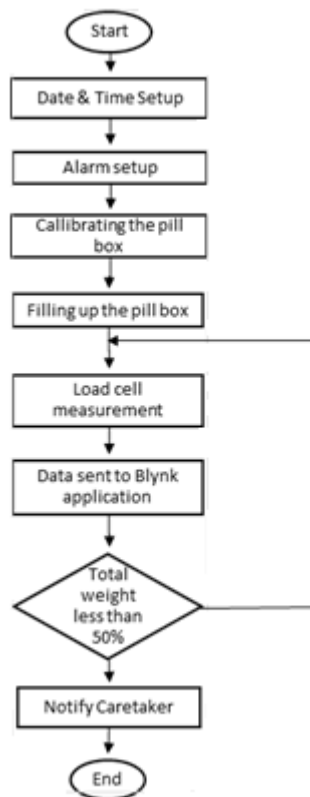
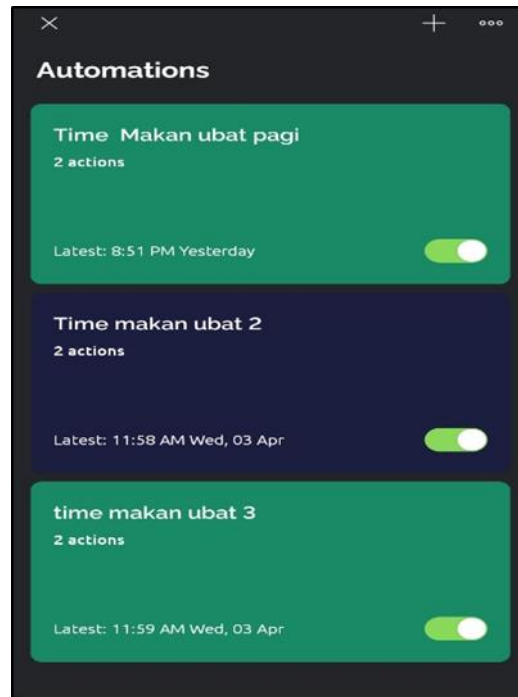


Fig. 3. Flow chart of the system

## 2.2 Time and date setup

Patients may set their precise time and date on the RTC DS3231 by clicking on the "Set Time / Date" button. By hitting this button, the LCD will flash and the patients can set the time and date. To modify the time and date, the patient may use the "Up" and "Down" buttons to either increase or decrease the date and time values. When the patient hits the "Set Time / Date" button, the blinking effect shifts to the hour, minute, and second sections of the time. To set the right hour, the patients must push the "Set Time / Date" button until the flashing display on the LCD reaches the hour section.



**Fig. 4.** Time and date setup

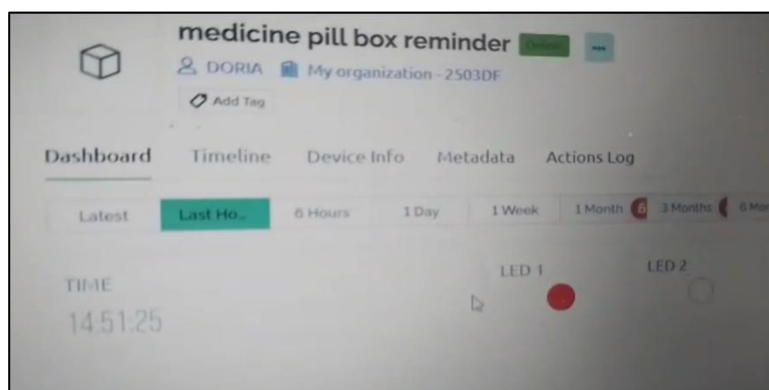
### 2.3 Setting up the alarm

By hitting the "Set Alarm" button, the LCD will display an alternate arrangement on the screen, which provides the patients with a chance to turn on or off their alarm. This allows the patients to set up the alarm that they prefer to use. Once users have decided whether to turn on or off the alarm, pushing the "Set Alarm" button once more will trigger the LCD to display a flashing effect, which then moves on to the hour section of the alarm. Every time the patient presses the "Set Alarm" button, the flashing effect of the LCD will shift from the hour section to the minute section, and then finally to the second section. The process will continue until the second section is reached. The purpose of the LCD's flashing is to indicate the precise unit of time that the patients would like to set on the alarm.

### 3 Result and discussion

The Smart Medicine Pill Box Reminder's alerting method comprises of an LED and a buzzer, which will only sound when the alarm has gone off. According to Figure 5 , the buzzer within the box will pulse and the green LED will light up when the alarm is set off. Only when the medication's overall weight falls below 50% will the carer be informed via the Blynk app. This implies that the carer will receive a notification on their phone letting them know that their patient has taken their medication when the total weight of the medications drops to less than 10g.

These findings indicate that patients will need to take their medications three times to achieve 50% of the total weight of the prescribed medications. This will let the carers know that their patients have been taking their medications for the last four days. It is also evident from this study that the pill box's size is restricted. This implies that only medications with the same size and form can fit within the pill box.



**Fig. 5.** Alarm is activated

An intelligent pill box is proposed and implemented in this paper. It informs the patient to take medicine. It efficiently controls the time of patient to take medicine. It also reduces the ratio that patient misses and delays taking medicine. Caretakers receive notifications if the pillbox's weight falls below 50% of its total capacity, indicating potential missed doses. The design architecture is also suitable for the drug packages. In the future, we hope that the energy saving and portable can be considered. So, missing and delaying taking medicine can be completely eliminated.

## 4 Conclusion

The Smart Medicine Pill Box Reminder is intended to not just remind patients to take their medications at the right times for them, but it can also send a notification to the caretakers that their patients have already taken their medications. Therefore, the goals of this study have been accomplished, and the data that were acquired have been analyzed along with them. The carer can receive notification on the state of the pill box through the installation of the Blynk application. This allows the carer to track whether or not their patients have taken their medications all over the next week. Through the installation of the Blynk application, the carer will be alerted if the percentage of the total mass of the medications contained within the pillbox is less than fifty percent. In addition to that, the Smart Medicine Pill Box Reminder comes with a notification system that notifies patients using a buzzer and an LED light that displays a light. If the patients have enabled their alarm, this will occur. As a result of the LED and buzzer being activated if the alarm is triggered, the patients will be informed that they need to remember to take their medication right now.

## References

1. Keram, S., & Williams, M. E. *J. AGS*, 36(3), **198-201** (1988)
2. Joan J. Branin MBA and MA. Home Health Care Serv. Q. **1- 16** (2001)
3. Roth, G. A., Fihn, S. D., Mokdad, A. H., Aekplakorn, W., Hasegawa, T., & Lim, S. S. *BWHO*. **89, 92-101** (2011)
4. P. A. Harsha Vardhini, M. S. Harsha, P. N. Sai and P. Srikanth, *CICN*. **182-186** (2020)
5. O. Al-Mahmud, K. Khan, R. Roy and F. Mashuque Alamgir, *INCET*. **1-6** (2020)
6. W. Antoun, A. Abdo, S. Al-Yaman, A. Kassem, M. Hamad and C. El-Moucary, *MECBME*. **20-23** (2018)
7. Wu, H. K., Wong, C. M., Liu, P. H., Peng, S. P., Wang, X. C., Lin, C. H., & Tu, K. H. (2015, October). A smart pill box with remind and consumption confirmation functions. In 2015 IEEE 4th global conference on consumer electronics (GCCE) (pp. 658-659). IEEE.
8. Najeeb, P. N. J., Rimna, A., Safa, K. P., Silvana, M., & Adarsh, T. K. (2018, July). Pill care-the smart pill box with remind, authenticate and confirmation function. In 2018 International Conference on Emerging Trends and Innovations In Engineering And Technological Research (ICETIETR) (pp. 1-5). IEEE.
9. Sree, V. B., Indrani, K. S., & Latha, G. M. S. (2020). Smart medicine pill box reminder with voice and display for emergency patients. *Materials Today: Proceedings*, 33, 4876-4879.
10. Cu, G., Chan, D., Chua, A. G., & Ramin, E. G. A Smart Medicine Pill Box for Improving Medication Adherence.

# Fabrication of Extra Virgin Olive Oil Alginate Beads: A Study on The Effect of Concentration and Distance Towards Beads' Characteristics

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**Abstract.** Extra virgin olive oil (EVOO), renowned for its health benefits, is now emerging as a trending and convenient health supplement. Despite its nutritional advantages, the bitter taste and the limited availability of soft gelatin capsules in the market often reduce treatment compliance. Thus, this study aimed to encapsulate EVOO in alginate beads with consistent size and spherical shape by optimizing the EVOO concentration and the extrusion distance. The research was conducted using varying concentrations of 1% (w/v), 2% (w/v), and 3% (w/v) while extrusion distances at 5 cm, 10 cm, and 15 cm. The size and shape of the beads were assessed through image analysis using Image J software. The spherical beads were successfully fabricated with a uniform size below 2.5 mm at 1% (w/v) EVOO concentration and the extrusion distance between the nozzle tips and the gelation bath solutions was optimized at 5 cm. The resulting beads exhibited an average diameter of  $1.844 \pm 0.02$  mm with a sphericity factor of  $0.005 \pm 0.002$ . The study demonstrated that both the concentration and extrusion distance significantly influenced the size and shape of the beads...

**Keywords:** olive oil, alginate beads, extrusion, palatability, sphericity factor

## 1 Introduction

EVOO is widely recognized for its health benefits and is one of the organic foods that consumers perceive as a healthier option [1]. EVOO is becoming popular in dietary food and supplements as an alternative for people to seek health benefits. This is due to EVOO has therapeutic effects such as antioxidant [2], anti-inflammatory [3], cardioprotective [4], and antiatherogenic activity [5]. However, EVOO has certain limitations such as its prominent oily flavor and the restricted options for consuming it primarily in its raw state. In order to improve the efficacy of EVOO as a nutritional supplement, the encapsulation technique has come up as an alternative solution. Encapsulation is a process to protect the inner bioactive compound from environmental degradation by surrounding the compound with the coating material [6]. Sodium alginate is utilized as a coating material in this study due to its properties in encapsulating bioactive materials such as drugs and foods [7]. Nevertheless, there is a lack of research on the encapsulation of EVOO using sodium alginate as coating material and the utilization of the extrusion dripping technique for the fabrication of EVOO alginate beads. Therefore, this study focuses on the formulation, and parameters involved to produce and develop the spherical EVOO beads in uniform size below 2.5 mm.

Currently, EVOO in the market has seen an increase in demand from consumers, especially those who are more likely to prefer supplements made from natural sources. However, EVOO in the market is mostly attainable in the form of big soft gelatin and bottled oil which cause some difficulty for children and elders to consume. Other than that, the fluid form of EVOO supplement potential leads to several problems which are, the possibility of leaking, transportation, and difficulty in handling. The taste and texture of EVOO are also challenging for consumers who find the taste of EVOO unpleasant due to the presence of the phenolic compound such as oleuropein aglycon and ligstroside aglycon which are primarily attributed to the bitter and pungent taste of EVOO [8].

EVOO is one of the alternatives for people to consume to enhance their health due to its beneficial properties that derive from its natural form and unique characteristics [9]. The encapsulation of EVOO will be performed by optimizing the formulation and extrusion distance of the alginate bead to discover the health benefits and increase compliance among consumers. The encapsulation increases consumer compliance by covering the bitter taste and texture of its oil. Apart from that, the encapsulation makes it easy to carry anywhere and to handle with a size below 2.5 mm which is convenient to consume. This ensures accurate and consistent EVOO intake, promotes compliance, and makes it easier for them to

incorporate EVOO into their diet. Moreover, due to its small nature, it does not take much space which makes it easier to transport. Thus, this study aims to evaluate the formulation of EVOO concentration on the fabrication of EVOO-alginate beads as well as determine the optimal extrusion distance for producing uniform-size spherical beads.

## 2 Materials and Methods

### 2.1 Materials

EVOO was purchased from Mahnaz Food (Selangor, Malaysia). Sodium alginate was purchased from Sigma-Aldrich (M) Sdn Bhd (Malaysia). Tween 80 and calcium chloride dihydrate were purchased from Evergreen Engineering & Resources (Malaysia).

### 2.2 Methodology

#### 2.2.1 Preparation of EVOO emulsion

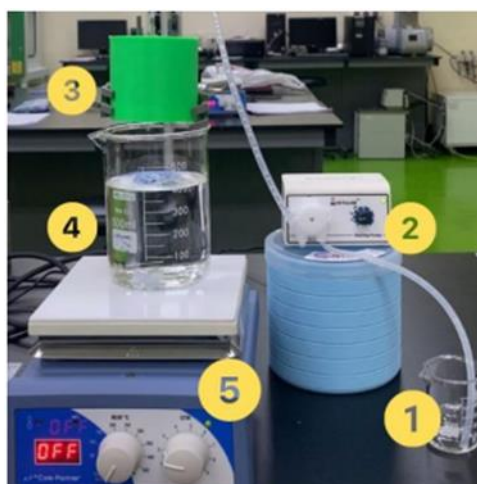
EVOO emulsion was prepared up to 30 mL. Firstly, the 2% (w/v) sodium alginate solution (SAS) was prepared by gradually adding sodium alginate into distilled water and stirred using a magnetic stirrer at 400 rpm until completely dissolved [10]. Then, 2% (w/v) of tween 80 was prepared and poured into SAS. After that, 1% (w/v) of EVOO was added into a mixture containing 2% (w/v) SAS and 2% (w/v) tween 80 and kept stirred until the emulsion was formed. Lastly, the produced emulsion was sonicated at a 20% power rate for 25 seconds using the Q700 Sonicator® for optimal mixing [11]. The step was repeated with 2% (w/v) and 3% (w/v) of EVOO concentration.

#### 2.2.2 Preparation of 2% (w/v) CaCl<sub>2</sub> solution

The 2% (w/v) CaCl<sub>2</sub> solution was prepared up to 500 mL [12]. About 10 g of CaCl<sub>2</sub> was weighed and transferred into the beaker. Approximately 490 mL of distilled water was measured and poured into the beaker. The solution was stirred thoroughly until complete dissolution was attained.

#### 2.2.3 Fabrication of EVOO-alginate beads

The extrusion dripping method was set up as shown in Figure 1. Initially, 30 mL of EVOO emulsion was extruded through the peristaltic pump at a fixed flow rate of 1.28 mL/min through the nozzle at an extrusion distance of 5 cm into 2% (w/v) CaCl<sub>2</sub> solution while stirred at 400 rpm. The fresh beads immediately formed and were kept in a gelation bath for 20 minutes [12]. Thereafter, the beads were collected by a metal mesh, rinsed with distilled water, and then filtered. This process was repeated with 2% (w/v) and 3% (w/v) of EVOO concentration.



**Fig. 1.** The extrusion dripping process involves the use of EVOO emulsion (1), a peristaltic pump (2), the nozzles (3), a gelation bath containing 2% (w/v) CaCl<sub>2</sub> (4), and a magnetic stirrer (5)

#### 2.2.4 Optimization extrusion distance of EVOO-alginate beads

The optimization of extrusion distance was carried out after the formulation of the EVOO emulsion was determined. The optimized EVOO emulsion was then extruded with the same process as described in section 2.2.3. During this step, the extrusion distance underwent variation, at 5, 10 and 15 cm. Then, the bead diameter and SF were measured.



### 2.2.5 Determination of bead diameter

Firstly, 30 randomly wet beads were captured by using MS5 Wifi Digital Microscope. Then, the captured images were imported into image analysis (Image J, National Institutes of Health, Bethesda, Maryland) [13]. The size of each bead was measured using Image J and then was calculated according to Equation 1.

$$\text{Average bead diameter} = (d_{\max} + d_{\min})/2 \quad (1)$$

where  $d_{\max}$  is the maximum bead diameter and  $d_{\min}$  is the minimum bead diameter.

### 2.2.6 Determination of sphericity factor

The shape of the beads was determined by the SF value. The following equation was utilized to calculate the SF:

$$SF = (d_{\max} - d_{\min}) / (d_{\max} + d_{\min}) \quad (2)$$

The value of SF under 0.05 will be considered spherical [14]

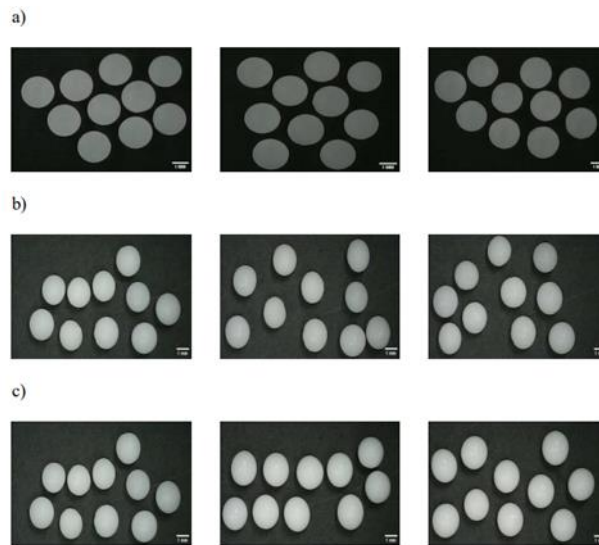
## 2.3 Statistical analysis

The optimisations of EVOO concentration and extrusion distance were performed in One-way analysis of variance (ANOVA) and presented as mean  $\pm$  SD ( $n = 30$ ) to assess the significance of EVOO concentrations [1%, 2% and 3% (w/v)] and extruding distances (5 cm, 10 cm, and 15 cm) on bead diameter and SF, with a significance level of ( $p < 0.0001$ ).

## 3 Results and discussion

### 3.1 Optimization of EVOO concentration on bead diameter and sphericity factor

The physical appearance of the EVOO-alginate beads, as illustrated in Figure 2, displayed a size perspective in which they exhibited consistency for each concentration. However, a notable difference was observed in Figure 2(a), where the beads presented a visually pleasing rounded appearance. In contrast, those depicted in Figures 2(b) and (c) exhibited a slightly elongated form, resembling an egg-like shape

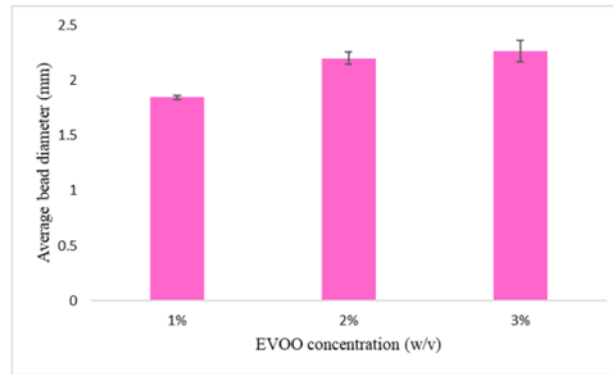


**Fig. 2.** The appearance of EVOO-alginate beads at different EVOO concentrations: 1% (w/v) (a), 2 % (w/v) (b), 3% (w/v) (c)

#### 3.1.1 Effect of EVOO Concentration on Bead Diameter

Figure 3 shows the diameter of beads  $1.884 \pm 0.020$  mm at 1% (w/v),  $2.199 \pm 0.056$  mm at 2% (w/v), and  $2.265 \pm 0.097$  mm at 3% (w/v) which indicates that higher EVOO concentrations result in slightly increased bead diameter. ( $p < 0.0001$ ), emphasizing the significant role of EVOO concentration in the diameter of the beads. This finding is crucial for understanding the impact of varying concentrations on the structural properties of the beads. The effect of increasing EVOO concentration on the diameter of beads may be related to the viscosity of the mixture. According to Zhang et al. (2024), the viscosity increases as the oil concentration increases, influencing the fluid dynamics during bead formation. This alteration in fluid dynamics subsequently influences the coalescence and cohesiveness of the sodium alginate structure contributing to an

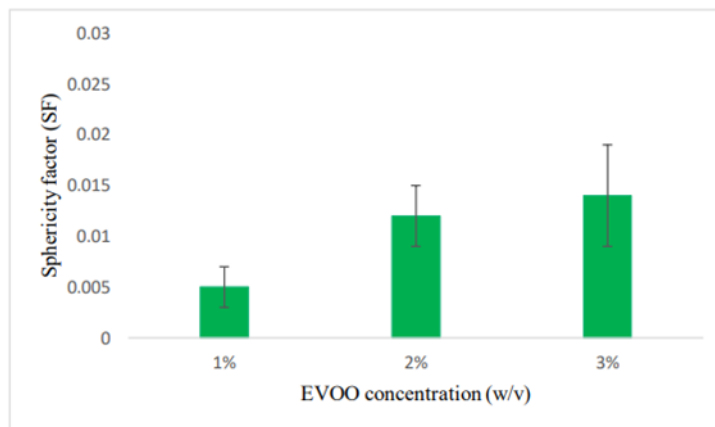
increase in bead diameter (Zhang et al., 2017). These observations align with the findings of other researchers (Mazza et al., 2023) who also have found that changes in viscosity are associated with variations in bead size



**Fig. 3.** Effect of EVOO concentration on bead diameter

### 3.1.2 Effect of EVOO concentration on sphericity factor of beads

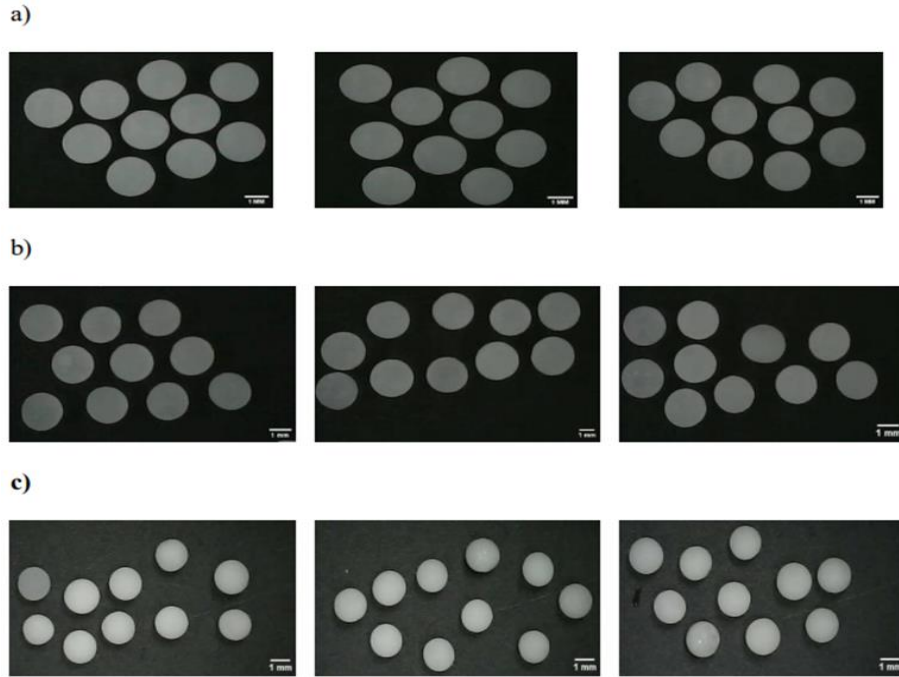
Figure 4 illustrates the SF for 1% (w/v), 2% (w/v), and 3% (w/v) EVOO concentrations were  $0.005 \pm 0.002$ ,  $0.012 \pm 0.003$ , and  $0.014 \pm 0.005$ , respectively. Based on the results, all three concentrations of EVOO are considered a spherical shape due to SF values being below 0.05. However, the increasing trend in SF values as the concentration of EVOO increases suggests a potential correlation between EVOO concentration and sphericity factor with a remarkable ( $p < 0.0001$ ). The correlation between different concentrations of EVOO and the SF values may be explained by the increase in emulsion surface tension with increasing EVOO content. The droplet forms egg-like beads due to sticking to the tip of the nozzle before impacting the surface of the CaCl<sub>2</sub> Solution. (Davarci et al., 2017). Hence, the 1% (w/v) EVOO concentration emerged as the optimal choice for subsequent parameter investigations in this study. This selection is supported by the beads at 1% (w/v) exhibiting diameters below 2.5 mm, aligning with the study 0 0.005 0.01 0.015 0.02 0.025 0.03 1% 2% 3% Sphericity factor (SF) EVOO concentration (w/v) objective and the sphericity factor being the closest among the concentrations to the ideal value of 0 which closeness signifies a shape that approaches perfect sphericity [14]. Moreover, according to Azad et al. (2020), a lower SF value indicates a greater symmetrical sphere, which can contribute to better flow properties and packing characteristics of the beads [15].



**Fig. 4.** Effect of EVOO concentration on SF

## 3.2 Optimization of Extrusion Distance on Diameter Bead and Sphericity Factor

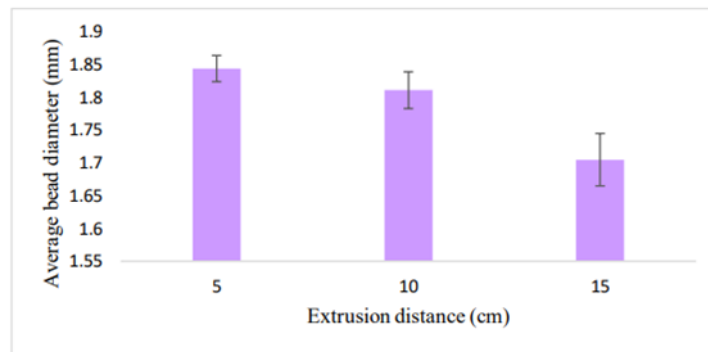
The appearance of EVOO-alginate beads, as shown in Figure 5, highlights notable physical characteristics. In Figure 5(a), the beads appear more uniformly 28 rounded with consistent sizes among the 30 wet beads. Meanwhile, Figure 5(b) reveals rounded beads with slight variations suggesting elongation. Subsequently, Figure 5(c) displays beads with noticeably smaller sizes and a distinct egg-like shape. These results were in alignment with the results found by another study [13] in which the extrusion distance affects the alginate beads' sphericity factor.



**Fig. 5.** The appearance of EVOO-alginate beads at extrusion distance: 5 cm (a), 10 cm (b), 15 cm (c)

### 3.2.1 Effect of extrusion distance on bead diameter

Figure 6 illustrates the impact of varying extrusion distances on the diameter of produced beads. The trends shown in Figure 6, which depicts the diameter of the beads as influenced by different dripping distances, show a constant reduction. Specifically, extrusion distance at 5 cm, 10 cm, and 15 cm yields bead diameter measures of  $1.844 \pm 0.020$  mm,  $1.811 \pm 0.056$  mm, and  $1.705 \pm 0.040$  mm, respectively ( $p < 0.0001$ ) statistically significant changes in bead diameter with varying dripping distances. The decrease in bead diameter with increasing extrusion distance can be attributed to several factors. One possible explanation is the influence of kinetic energy and air resistance over the distance of the droplets during the extruding process due to droplets traversing a greater distance which may contribute to a diminution in bead size [16]. Additionally, the longer travel time of droplets before reaching the CaCl<sub>2</sub> could lead to increase evaporation, potentially affecting bead dimensions [17, 18].

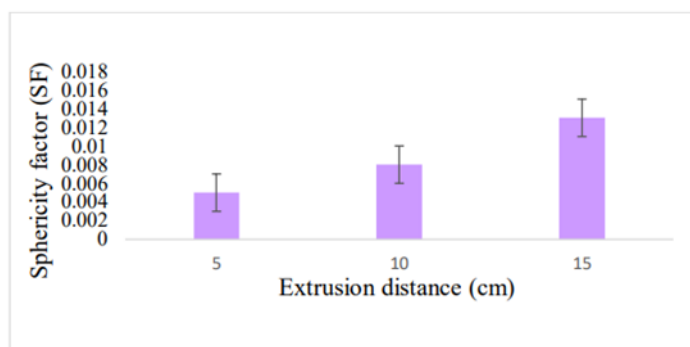


**Fig. 6.** Effect of extrusion distance on bead diameter

### 3.2.2 Effect of extrusion distance on sphericity factor

Figure 7 illustrates a comparative representation showcasing the relationship between differences in three specific extrusion distances at 5 cm, 10 cm, and 15 cm and the SF of the beads. The data reveals a trend that the SF for the respective distances is  $0.005 \pm 0.002$  at 5 cm,  $0.008 \pm 0.002$  at 10 cm, and  $0.013 \pm 0.002$  at 15 cm ( $p < 0.0001$ ) indicating a significant difference. This finding aligns with the understanding that a shorter distance during bead formation leads to a more compact and rounded structure, indicating the decreased value of SF which may be associated with alterations in droplet coalescence and solidification dynamics during flight [18]. Moreover, according to Davarci et al. (2017), increasing the distance leads to the deformation of beads [17]. Thus, the extrusion distance of 5 cm was taken as the optimal distance in this study. This may be explained by the SF at 5 cm being significantly smaller than those at greater distances, implying that beads formed at a closer dripping distance exhibit a

distance (cm) 30 more spherical morphology. According to Weibel et al. (2018), the SF near zero signifies a move toward achieving a perfect spherical shape [19].



**Fig. 7.** Effect of extrusion distance on SF

## 4 Conclusion

In conclusion, the EVOO-alginate beads were successfully fabricated through the optimization of extrusion dripping parameters, specifically on EVOO concentration and extrusion distance by using Image J software. This study emphasized the significant impact of EVOO concentration and extrusion distance on the physical properties of the resulting beads. The optimized parameters were determined at a 1% (w/v) concentration of EVOO and an extrusion distance of 5 cm, resulting in a bead diameter of  $1.844 \pm 0.020$  mm and an SF of  $0.005 \pm 0.002$ . These findings not only contribute to the successful fabrication of beads but also provide essential insights into the precise control of parameters for optimized bead production in diverse applications

## References

1. A. Lopez-Yerena, J. Lozano-Castellon, A. Olmo-Cunillera, A. Tresserra-Rimbau, P. Quifer- Rada, B. Jimenez, M. Perez, A. Vallverdu-Queralt. *Molecules*, **24**(10), 1986 (2019)
2. M. J. Oliveras-Lopez, G. Berna, E. Jurado-Ruiz, H. L. G. De La Serrana, F. Martin, *J Funct*, **10**, 475-484 (2014)
3. S. De Santis, M. Liso, G. Verna, F. Curci, G. Milani, M. F. Faienza, C. Franchini, A. Moschetta, M. Chieppa, M. L. Clodoveo, P. Crupi. *Antioxidants*, **10**(7), 1016 (2021)
4. A. Romani, F. Ieri, S. Urciuoli, A. Noce, G. Marrone, C. Nediani, R. Bernini *Nutrients*, **11**(8), 1776 (2019)
5. H. Yanai. *J Endocrinol Metab*, **9**(1-2), 1-2 (2019)
6. N. K. Mohammed, C. P. Tan, Y. A. Manap, B. J. Muhiadin, A. S. M. Hussin. *Molecules*, **25**(17), 3873 (2020)
7. N. Choudhury, M. Meghwal, K. Das. *Food Front*, **2**(4), 426-442. (2021)
8. M. Cui, B. Chen, K. Xu, A. Rigakou, P. Diamantakos, E. Melliou, D. E. Logothetis, P. Magiatis. *Sci Rep*, **11**(1), 22340 (2021)
9. X. Li, S. C. Wang. *J Food Qual*, **2018**, 1-15 (2018)
10. M. M. Ahmed, S. Abd El-Rasoul, S. H. Auda, M. A. Ibrahim. *Saudi Pharm J*, **21**(1), 61-69 (2013)
11. P. Paximada, E. Tsouko, N. Kopsahelis, A. A. Koutinas, I. Mandala. *Food Hydrocoll*, **53**, 225-232 (2016)
12. H. Alkhatib, E. Assadpour, A. S. M. Sabere, F. Mohamed, S. M. Jafari. *J Food Eng*, **328**, 111065 (2022)
13. M. F. Azhar, M. S. Haris, I. Mohamad, M. N. S. Ismadi, A. A. H. Yazid, S. R. Rahman, N. H. Azlan, *Int Food Res J*, **28**(4), 860-870 (2021)
14. B. B. Lee, P. Ravindra, E. S. Chan. *Chem Eng Tech*, **36**(10), 1627- 1642 (2013)
15. A. K. Azad, S. M. A. Al-Mahmood, B. Chatterjee, W. M. A. Wan Sulaiman, T. M. Elsayed, A. A. Doolaanea, *Pharmaceutics*, **12**(3), 219 (2020)
16. G. Ciarleglio, F. Cinti, E. Toto, M. G. Santonicola, *Gels*, **9**(9), 714 (2023)
17. F. Davarci, D. Turan, B. Ozcelik, D. Poncelet, *Food Hydrocoll*, **62**, 119-127 (2017)
18. E. Martins, D. Renard, Z. Adiwijaya, E. Karoglan, D. Poncelet. *J Microencapsul*, **34**(1), 82-90 (2017)
19. M. I. Weibel, , L. N. Mengatto, J. A. Luna, I. Rintoul. *Iran Polym J*, **27**, 161-170 (2018)

# Improving Work Efficiency in the Sabah Manufacturing Industry: Leveraging Lean Tools for Optimization and Performance Enhancement

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**Abstract.** This paper explores Sabah manufacturing industry's perspective on enhancing work efficiency by implementing lean tools. It aims to analyse the correlation between environmental factors, job performance, manager-employee relationships, and work efficiency in Sabah's manufacturing companies. The study employs a quantitative approach using a survey-based questionnaire distributed to 50 companies that operates throughout Sabah. Of these, 25 responses were received, yielding a 50% response rate. Data analysis utilized SPSS software, including Cronbach's Alpha for reliability, descriptive statistics for mean comparisons, and Pearson correlation analysis for regression and path analysis. Results show that 68% of respondents are aware of lean tools, yet only 64% have implemented them. Among lean tools, 5S and Kaizen are most prevalent. Respondents generally agree that lean tools positively impact productivity, waste reduction, lead time, inventory management, and safety enhancement, suggesting their effectiveness in improving work efficiency.

**Keywords:** manufacturing industry, work efficiency, lean tools

## 1 Introduction

Efficiency always being confused with terms such as productivity and effectiveness. Efficiency emphasizes the optimization of resources such as time, money, and energy to achieve specific outcomes, aiming to minimize waste and maximize output. Effectiveness measures the success of achieving objectives or goals, assessing the impact and relevance of actions taken within a given context. Productivity quantifies the output generated relative to the input expended, providing insights into the overall efficiency and effectiveness of processes and systems [1]. Employee efficiency can be described as the state of being efficient or competent to do a particular work [2]. Employers should prioritize employees' work efficiency as it directly impacts costs and product quality. High efficiency typically results in lower labor expenses while maintaining or improving product standards, contributing to the company's bottom line. By fostering a culture of efficiency, businesses can achieve greater profitability and competitiveness in the market [3].

This study is important to identify lean tools that might help a company in increasing work efficiency. Lean is a principle, concept, techniques, methodologies, and a set of tools that can be seen and applied at various levels and commitment as an improvement process, which has a direct impact on health, income, productivity, and efficiency of the organization [4]. The utilization of Lean tools is crucial for minimizing waste across various industry sectors. Additionally, they serve as recommended methods for identifying and implementing potential improvements within a company's operations. Incorporating Lean principles can lead to enhanced efficiency, reduced costs, and increased competitiveness in the market [5]. There are more than 50 types of lean tools and techniques being used widely, depending on industry size. The ten main lean tools and techniques used in Malaysian industry are 5S, cellular manufacturing, kaizen (continuous improvement), Poka-Yoke (mistake proofing), standardized work, value stream mapping (VSM), Jidoka (autonomation), Kanban (pull system), Plan-Do-Check-Act (PDCA) and total productive maintenance (TPM) [6] while in other studies, there are 17 activities that might be considered feasible and important to the characteristics of Small Medium Enterprises (SMEs) [7]. Employee is a key component to achieve company's mission and vision. A company productivity is influenced by employees' effort and engagement [8]. Performance of employee is a crucial element in ensuring a company runs efficiently and successfully [9]. Employees must meet the company's requirements to ensure the quality of their work. This ensures alignment with organizational standards and objectives [10].

The efficiency of employees within a company can be influenced by a multitude of factors. These factors encompass the working environment, managerial behaviours, company culture, personal circumstances, task quality, and financial incentives [11]. Understanding and addressing these variables can contribute to optimizing workforce productivity and

overall organizational performance. Therefore, by doing research and questionnaire survey on a company, it is possible to gather the factors that might affect work efficiencies such as working environment, manager-employee relationship, working hours and job performance. Hence, to know the implemented lean tools of companies in Sabah.

## 2 Methodology

The method used for this study is quantitative method. A questionnaire was design to collect data for this study which consist of three parts: (A) company's background information, (B) factors affecting work efficiency and (C) the lean tools assessment as well as correlation between lean tools implementation and work efficiency of a company. The questionnaire was designed using a five-point Likert scale, multiple choice answer and close-ended answer to select from in order to make ease of answering. The questionnaire was pilot tested as the pilot test is essential to modify and eliminate the number of variables [12].

The questionnaire, distributed via official email using Google Forms, was the primary method for data collection, complemented by phone call interviews to boost response rates. Samples for the study were sourced from the contact information available on the official websites of the Federation of Sabah Industries (FSI) and Federation of Malaysian Manufacturers (FMM). The data collection process spanned approximately six weeks to accommodate companies' responses to the questionnaire.

The data are gathered based on the companies' responses and analysed by using Statistical Package for the Social Sciences (SPSS) software. A frequent first step in data analysis is to summarize the information of variables, such as measure of central tendency and measure of dispersion as they related to each other. Measure of central tendency is related to the measure of average value of the sample. It consists of mean, median and mode. While dispersion refers to the spread of the value around the central tendency, specifically the mean value [13]. The reliability of the questionnaire was measured by using the common measurement used to measure reliability for Likert scale form which is Cronbach's Alpha. The general accepted reliability value of Cronbach's Alpha is 0.6 to 0.7, which shows that items are reliable and considered good. When value of alpha is  $\geq 0.8$ , it shows that it is very reliable [14]. Descriptive statistics tool was used to study the respondents' demographics [15]. Using Pearson correlation analysis, the correlation between lean tools implementation and work efficiency among companies in Sabah was analysed. The bivariate relationships between variables that are measured at an interval or ratio level are indicate by using Pearson correlation [16]. The correlation value which 0.1 to 0.4 is classed as weak correlation and the value above 0.5 is classed as strong correlation [17]. Meanwhile, stated that the value of significance  $p = 0.05$  in social science research is the widely accepted conventional level, which implies it can be sure there is a significant correlation between the two variables [18]. All data were presented in table form, pie chart and frequency plots.

## 3 Result and discussion

There was a total of 25 responses. This gives a total of 50% response rate, considered satisfactory. This study managed to be carried out at 4 divisions out of 5 which is division of Kudat, Sandakan, Tawau and West Coast. Majority of the respondents' position in companies are engineers with percentage of 32%. The distribution of manufacturing companies involved in this study were 20% from agriculture, 12% was from oil and gas and 4% was from constructions material. Food and automotive component manufacturer, both share the same percentage value which was 8%. The total remaining of 48% are from other manufacturers which include electronics, textile and furniture. 60% of the respondents are from big companies with total number of more than 100 employees. Only 40% of the respondents are from small or medium companies with range of less than 50 and 50-100.

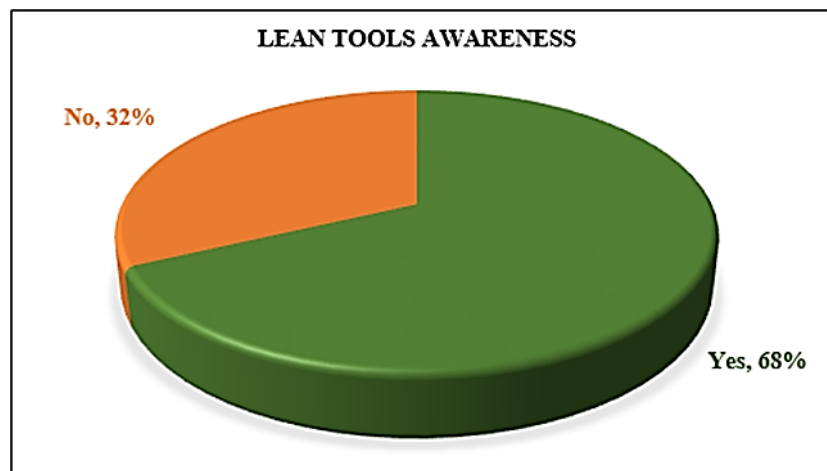
To achieve the first objectives of this study, the respondents were asked to rate their agreement on how far environmental factors, job performance and manager-employee relationship affect work efficiency, by using Five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree.). Table 1 below shows the value of Cronbach's Alpha coefficient for all the questions which is 0.691. According to the accepted reliability value, all questions are reliable and have a decent measurement of internal consistency. In addition, for the right column in the table which is Cronbach's Alpha if item deleted shows the prediction value of Cronbach's Alpha if that specific question being removed. Shown that some of the values are more than 0.7. Therefore, the questions can be eliminated in order to improve the internal consistency.

**Table 1.** Reliability Test by Using Cronbach's Alpha (N=25)

No	Questions	Cronbach's Alpha	Cronbach's Alpha if item deleted
Factors Correlation of Environment with Work Efficiency			
1	Exposing employees to noisy working place affect work efficiency.	.691	.739
2	Teamwork affects towards employee behaviour and work effectiveness.		.668
3	Lighting effects on employee focus which then affects work efficiency.		.698

4	The facilities provided by the company affect employee efficiency.		.684
5	Hazards hinder employees productivity rate and lead to a low morale.		.684
Factors Correlation of Job Performance with Work Efficiency.			
6	Crowded working condition decreases employees job performance.	.691	.710
7	Ergonomics furniture affects employees performance and efficiency.		.645
8	External stress such as work duration affect employees job performance.		.699
9	Employee failure to utilize his skill will have poor job performance.		.661
10	Goal setting help employees improve job performance.		.669
Factors Correlation of Manager-employee Relationship with Work Efficiency.			
11	Communication leads to a strong relationship with employee work efficiency.	.691	.651
12	Better communication reduces miscommunication which leads to productivity.		.659
13	Supervisor's support increases employee's performance which leads to self-confidence.		.631
14	Supervisor's motivation and encouragement affect employee's performance.		.663
15	Good relationship with employee makes them feel secure in sharing good and innovative ideas.		.667

Table 1 shows the percentage of lean tools awareness among employees. Shown that 17 respondents stated they have general knowledge on lean tool. This gives a total percentage of 68%. Hence, 8 respondents admit they never know about lean tools, which gives a total percentage of 32%. According to the survey results, from the 8 respondents who never know about lean tools, 3 of the respondents' company did actually apply lean tools in their organization. The company where these 3 respondents working at are considered as a big company, with total number of employees more than 100. This can be concluded that a big or growing company are still lack of lean tools knowledge or exposure among their employees.



**Fig. 1.** Lean Tools Awareness (N=25).

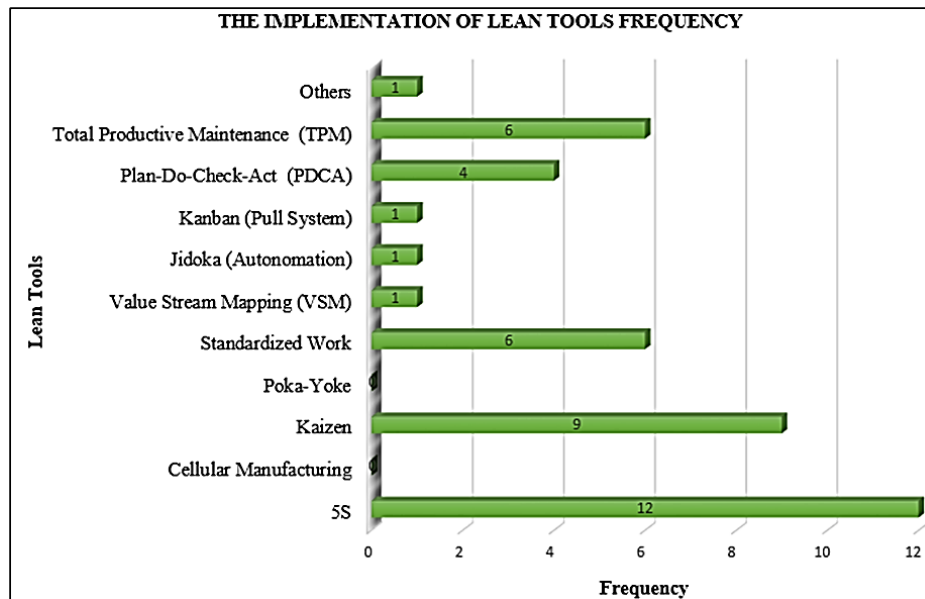
From the data collected, 16 or 64% of the companies have implemented lean tools in their organization. 9 companies located at West Coast division, 2 at Kudat division, 1 at Sandakan division and 4 at Tawau division. The remainder of 9 out of 25 or 36% of the respondents stated that their companies does not apply lean tools in their organization. 5 of the companies are located at West Coast division and another 4 located at Tawau division. The location distribution is shown in Table 2.



**Table 2.** Reliability Test by Using Cronbach's Alpha (N=25).

Location	Yes	No
Kota Kinabalu	8	4
Kudat	2	0
Lahad Datu	3	0
Papar	0	1
Penampang	1	0
Tawau	1	4
Telupid	1	0
<b>Total</b>	<b>16</b>	<b>9</b>
<b>Cumulative Percentage (%)</b>	<b>64</b>	<b>36</b>

The frequency of lean tools applied in 16 companies can be found in Figure 2 below. Based on the figure, 5S is the most commonly used tool with a total of 12 companies followed by Kaizen with total number of 9 companies, standardized work and TPM with total number of 6 companies for each tool and PDCA with a total number of 4 companies. Note that majority of the company have implemented 2 lean tools.

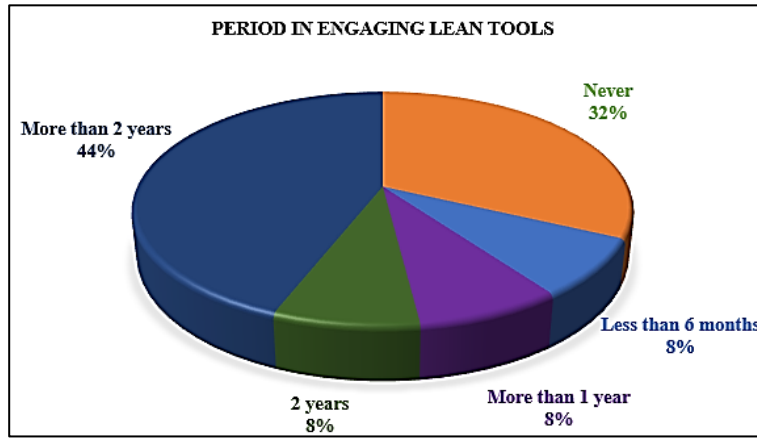


**Fig. 2.** Implementation of Lean Tools Frequency (N=16)

Known as the simplest system to implement, 5S can be applied across all areas of a company, regardless of its background. Its versatility makes it accessible and effective for improving organizational efficiency and effectiveness [19]. All of the respondents totally agree by applying this tool, it helps the companies to strengthen its competitive position where the emphasis is on reducing lead time and improving efficiency. The 5S, Kaizen, TPM and Standardized Work tools are technique used by most companies in their way to develop lean system. Kanban, Jidoka and VSM are among the least lean tools applied. Even though VSM focuses on waste-free generation for overall performance, VSM were not evaluated by factors such as environmental, social, and economic [20]. For a company to establish competency in some of the basic lean techniques, it took about three years. Hence, five years are required for employees to master the tools [21]. This source clarifies the continuous journey needed in implementing lean tools.

The period of lean tools engagement in a company are investigated through the number of years. As shown in Figure 3 below, 44% of the companies had applied lean tools for more than 2 years, 8% of the companies had applied for exactly 2 years, 8% had applied approximately more than 1 year but less than 2 years and 8% had applied less than 6 months in their organization. A total of 32% or 8 respondents admitted their company never involved in lean tools. Based on the result, larger companies are more prone to lean tools compared to smaller companies. Usually, smaller companies are less likely to adopt lean tools because of constraints and obstacles [22].





**Fig. 3.** Period in Engaging Lean Tools (N=25).

In this study, Pearson's correlation analysis served as a statistical tool employed to fulfil the third objective, which aimed to investigate the relationship between the implementation of lean tools and the level of work efficiency among companies in Sabah. Table 3 below shows the result for correlation coefficient of lean tools implementation and environment factor affecting work efficiency.

**Table 3.** Correlation Coefficient of Lean Tools Implementation and Environment Factor Affecting Work Efficiency.

		Noise	Teamwork	Lighting	Facilities	Hazards
Positive Impact	Pearson Correlation	-.648**	.072	.173	.188	.274
	Sig. (2-tailed)	.007	.790	.521	.485	.304
	N	16	16	16	16	16
Eliminate waste and improve process operation	Pearson Correlation	-.234	.099	.237	-.059	.022
	Sig. (2-tailed)	.383	.715	.377	.827	.935
	N	16	16	16	16	16
Reduce lead time	Pearson Correlation	.078	.425	.174	.206	-.036
	Sig. (2-tailed)	.775	.101	.519	.444	.896
	N	16	16	16	16	16
Inventory reduction	Pearson Correlation	-.475	-.021	.022	-.021	.313
	Sig. (2-tailed)	.063	.940	.935	.940	.238
	N	16	16	16	16	16
Safety improvement	Pearson Correlation	-.593*	.197	.398	.197	.052
	Sig. (2-tailed)	.016	.465	.127	.465	.848
	N	16	16	16	16	16

From the result above, shown that even though most of the results show a weak positive correlation, there are still high possibilities this factor affects employee's work efficiency. When employees feel comfortable and have positive perception with their working environment, they will be more productive in their job.

Table 4 below shows the results analysis between lean tools implementation and job performance affects work efficiency. From the results obtained, it could be seen that stress has the highest agreeability compared to the other variables. Stress may cause emotional response if the job exceeds employees' capabilities [23]. According to this researcher, positive stress is also a good influence in motivating employees to carry out their duty. In terms of this study, job performance is found to have an impact on work efficiency although some of the results show negative correlation and weak positive correlation. The percentage chance of the relationship does not exist for those with negative correlation results are high. This means that there are still possibilities this factor gives an impact towards employees' performance.

**Table 4.** Correlation Coefficient of Lean Tools Implementation and Job Performance Factor Affecting Work Efficiency.

		Crowded work conditions	Ergonomics furniture	External stress	Failure to utilize skill	Goal setting
Positive Impact	Pearson Correlation	.093	-.074	.021	.189	-.051
	Sig. (2-tailed)	.732	.785	.939	.483	.852
	N	16	16	16	16	16
Eliminate waste and improve process operation	Pearson Correlation	.202	.259	-.153	.137	.152
	Sig. (2-tailed)	.452	.333	.571	.613	.573
	N	16	16	16	16	16

Reduce lead time	Pearson Correlation Sig. (2-tailed) N	.160 .554 16	.601* .014 16	-.382 .144 16	-.053 .846 16	.393 .132 16
Inventory reduction	Pearson Correlation Sig. (2-tailed) N	.005 .986 16	-.035 .897 16	-.006 .983 16	.047 .862 16	.244 .362 16
Safety improvement	Pearson Correlation Sig. (2-tailed) N	.301 .258 16	.080 .768 16	-.105 .699 16	.151 .576 16	-.059 .828 16

Table 5 below shows the result analysis for the last factor which is manager-employee relationship. Based on the outcomes that have been analysed, most of the result shows a positive weak correlation. There are some items gives a negative value of r. However, there are certain percentage chance where relationship between these variables does not exist. It can be concluded that, dissatisfaction in workplace occurs when the employees feel that management are not being supportive towards employees. Therefore, employees would feel less motivated in performing their duty. This clearly can be supported by one of the previous researcher's statements where two-way communication, respect, concern from managements for employees' well-being and provide more opportunities for employees to grow are the main driver for employee engagement in their job [24].

**Table 5.** Correlation Coefficient of Lean Tools Implementation and Manager-employee Relationship Factor Affecting Work Efficiency.

		Communication	Better communication	Supervisor's support	Supervisor's motivation and encouragement	Good relationship
Positive Impact	Pearson Correlation Sig. (2-tailed) N	-.122 .651 16	.093 .731 16	-.281 .292 16	-.043 .873 16	.188 .485 16
Eliminate waste and improve process operation	Pearson Correlation Sig. (2-tailed) N	.076 .780 16	-.042 .876 16	-.055 .840 16	-.218 .418 16	.099 .715 16
Reduce lead time	Pearson Correlation Sig. (2-tailed) N	.411 .114 16	.147 .587 16	.342 .195 16	-.014 .960 16	-.123 .649 16
Inventory reduction	Pearson Correlation Sig. (2-tailed) N	.110 .684 16	.220 .412 16	-.057 .834 16	.144 .595 16	.308 .246 16
Safety improvement	Pearson Correlation Sig. (2-tailed) N	-.194 .471 16	-.060 .824 16	-.389 .136 16	-.253 .344 16	-.141 .604 16

In the manufacturing industry, implementing lean tools such as 5S and Kaizen (based on Figure 2) significantly enhances work efficiency across multiple fronts. Firstly, through 5S, the workspace is organized and maintained, promoting a clean and efficient environment conducive to productivity, while Kaizen ensures continuous improvement, refining processes to optimize efficiency further. This structured approach not only improves job performance by reducing downtime and streamlining workflows but also fosters a positive manager-employee relationship by involving staff in decision-making and improvement initiatives, ultimately driving overall work efficiency and effectiveness in the manufacturing sector.

## 4 Conclusion

The study indicates several factors influencing a decline in work efficiency, including the level of awareness regarding lean tools among employees and the effectiveness of their implementation within companies in Sabah. Among the key factors impacting work efficiency are the working environment, job performance, and the quality of manager-employee relationships. Notably, the successful implementation of lean tools has been shown to significantly mitigate declines in work efficiency across these areas. Specifically, within the environmental factor, teamwork and facilities emerge as primary contributors to decreased work efficiency, while external stressors such as work duration are highlighted in affecting job performance. Additionally, respondents emphasize the importance of effective communication in improving manager-employee relationships and reducing miscommunication, ultimately enhancing productivity. Despite variations, there is considerable agreement among respondents regarding the significance of factors like communication leading to strong relationships, supervisor support, motivation, and maintaining positive relationships within the workplace.

Throughout this study, 68% out of 100% respondents have awareness on lean tools. Therefore, it can be concluded that

most companies in Sabah have been exposed to lean tools technique. However, only 64% of the companies have implement lean tools technique. Most respondents express a consensus regarding the beneficial effects of lean tools on work efficiency, acknowledging their positive impact on productivity, waste reduction, lead time minimization, inventory reduction, and safety enhancement. Particularly noteworthy is the overwhelming agreement regarding the positive influence of lean tools on safety, which is seen as crucial for enhancing work efficiency. Additionally, analysis of collected data suggests that 5S and Kaizen are the most widely utilized lean tools among manufacturing companies in Sabah. While correlations between lean tools implementation and environmental factors, job performance, and manager-employee relationships generally exhibit weak positive or negative associations, the overall findings suggest that implementing lean tools contributes to improvements in work efficiency across these areas.

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## References

1. F. S. Cakir, Z. Adiguzel, Analysis of Leader Effectiveness in Organization and Knowledge Sharing Behavior on Employees and Organization, *SAGE J.* **10**(1), 1-14 (2020)
2. M. Wankhede, R. Gujarathi, Training Effectiveness: An Evaluation, *Asian J. Manag. Sci.* **2**(2), 1-7 (2014)
3. G. Zhenjing, S. Chupradit, K. Y. Ku, A. A. Nassani, M. Haffar, Impact of Employees' Workplace Environment on Employees' Performance: A Multi-Mediation Model, *Frontiers in Public Health*, 1-13 (2022)
4. P. Atkinson, *Change Management* (Management Services, Spring, 2005)
5. S. Manikandaprabu, S. P. Anbuudayasankar, Productivity Improvement through Lean Manufacturing, *Int. J. Eng. Adv. Technol.* **8**(5), 2657–2660 (2019)
6. M. S. Yahya, M. Mohammad, B. Omar, E. F. Ramly, H. Atan, Awareness, implementation, effectiveness and future use of lean tools and techniques in Malaysia organisations: a survey, *J. Phys.: Conf. Ser.* **1150**, 1-6 (2019)
7. M. Adzrie, M. A. S. M. Armi, The Awareness of Lean Manufacturing Implemented Practices in SME in Sabah State: TQM And TPM Practices Approach, *J. Phys.: Conf. Ser.* **1878**, 1-8 (2021)
8. S. Osborne, M. S. Hammoud, Effective Employee Engagement in the Workplace, *Int. J. App. Manage. Technol.* **16**(1), 50-67 (2017)
9. E. E. Ezeanyim, Ufoaroh, E. Theresas, Ajakpo, The Impact of Job Satisfaction on Employee Performance in Selected Public Enterprise in Awka, Anambra State, *Global J. Manage. Bus. Res.* **19**(7), 1-11 (2019)
10. M. Adzrie, B. Chagat, R. L. Arechinan, S. T. Naidu, U. A. Karim, A Study of the Effect of Industrial 4.0 on Improving the Manufacturing Performance: A Case Study in Miri and Bintulu, *Technol. Adv. in Instrument. Human Eng., LNEE* **882**, 113-120 (2023)
11. J. Wokalada, School Management and its Effectiveness in Lower Secondary Education in Uganda: Examining Perceptions of the Practitioners, *Adv. Res. J. Soc. Sci.* **3**(1), 141-154 (2016)
12. N. Nordin, B. M. Deros, D. A. Wahab, A survey on lean manufacturing implementation in Malaysian automotive industry, *Int. J. Inno. Manage. Technol.* **1**(4), 374-380 (2010)
13. M. Adzrie, K. Elcy, R. M. Joselyn, Na Mohd-Lair, F. O. Chai, Implementation Selected Tools of Lean Manufacturing, *J. Phys.: Conf. Ser.* **1529**, 1-9 (2020)
14. N. Y. M. Hom, *A Study of The Factors That Influencing on Job Satisfaction of Private Bank in Myanmar* (MBA thesis, Bangkok University, 2019)
15. A. Y. S. Ali, A. A. Ali, A. A. Adan, Working Conditions And Employees' Productivity In Manufacturing Companies In Sub-Saharan African Context: Case Of Somalia, *Edu. Res. Int.* **2**(2), 67-78 (2013)
16. U. Sekaran, R. Bougie, *Research Methods for Business: A Skill-Building Approach* (Wiley, New York, 2013)
17. J. Cohen, *Statistical Power Analysis for the Behavioral Sciences* (Lawrence Erlbaum Associates, New York, 1988)
18. E. W. Walker, *A 5s Implementation Plan for the Shipping Department at Helical Products Co.*, (bachelor's degree thesis, California Polytechnic State University, 2011)
19. C. Kirani, R. L. Isnaini, A. A. Sholichin, A. N. Gumilang, Fitrianiingsih, 5S Culture of Excellence in Facilities and Infrastructure Management in Higher Education Institutions, *Didaktika: Jurnal Pendidikan* **12**(4), 547-556 (2023)
20. A. Batwara, V. Sharma, M. Makkar, A. Giallanza, Towards smart sustainable development through value stream mapping – a systematic literature review, *Heliyon* **9**(5), 1-19 (2023)
21. K. A. Uz-Zaman, A methodology for effective implementation of lean strategies and its performance evaluation in manufacturing organizations, *Bus. Process Manage. J.* **19**(1), 169-196 (2013)
22. A. Alkhoraif, H. Rashid, P. McLaughlin, Lean implementation in small and medium enterprises: Literature review, *Op. Res. Perspectives* **6**, 1-19 (2019)

23. S. K. Vallasamy, S. U. Muhadi, S. Kumaran, Underlying Factors that Contributed to Job Stress in an Organisation, *J. Bus. Soc. Sci. Res.* **13**(5), 1239-1250 (2023)
24. B Sypniewska, M. Baran, M. Kłos, Work engagement and employee satisfaction in the practice of sustainable human resource management – based on the study of Polish employees, *Int. Entrepre. Manage. J.* **19**, 1069-1100 (2023)

# Smart Vehicles Tracking System Using IoT

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**Abstract.** This project presents the "Smart Vehicle Tracking System Using IoT," a technology designed to prevent vehicles from being lost. The system utilizes advanced methods and technologies to monitor and track vehicles effectively. One of the primary methods involves using the Neo6m GPS, which provides accurate vehicle detection and location tracking. The system also employs an MCU Node to control and manage the tracking processes. The project includes a detailed analysis of the annual number of lost vehicles and incorporates user feedback collected through interviews to refine the system's functionality. The system is designed to be lightweight and can be easily installed on any vehicle. In the event of a lost vehicle, the application provides real-time location updates directly to the user. As a result, the implementation of this system has shown potential in significantly reducing vehicle theft incidents, thereby enhancing vehicle security for consumers.

**Keywords:** smart vehicle tracking system, neo6m gps, node mcu control

## 1 Introduction

The transportation system is an integral part of human activity that cannot be ignored. People have become increasingly dependent on it in recent years. Despite its many opportunities, the transportation system also faces significant challenges, particularly concerning security. The security standards, such as alarm-based systems provided by vehicle manufacturers, are often ineffective in preventing vehicle theft [1]. Vehicle tracking systems represent a new technology designed to detect and locate stolen vehicles, offering significant help to vehicle owners in such situations [2]. Traditionally, finding a stolen vehicle has been challenging. However, tracking systems are designed to simplify this process by providing real-time location data, allowing vehicle owners to locate their vehicles automatically.

In this project, the Neo-6m GPS was utilized to transmit GPS coordinates to a mobile device through a designated application. This system aims to keep users alert even when their vehicles are parked in secure areas, such as fenced-off zones. This is particularly important as vehicle theft cases are becoming increasingly difficult to prevent in our country. Without proactive measures to prevent theft, the risk of loss remains substantial. Therefore, the purpose of our project is to provide an efficient method for locating stolen vehicles. Specifically, the goal is to design a system that automatically detects and reports the location of vehicles. In conclusion, while it may be impossible to completely prevent vehicle theft, taking the right steps—such as implementing a hidden Neo-6m GPS and Arduino Node MCU in vehicles—can significantly enhance our ability to locate and recover stolen vehicles quickly.

### 1.1 Issues

In contemporary society, the demands of work, household responsibilities, social activities, and other engagements contribute to an irregular lifestyle. This busy schedule often leads to the neglect of personal safety and vehicle security, especially with the rising crime rates. Numerous incidents involve vehicle theft when owners leave their vehicles unattended, even when locked. Additionally, negligence, such as forgetting to lock the vehicle, can result in theft. Current vehicle security systems are often inadequate, leaving vehicles vulnerable to theft [2]. Traditional security systems are cumbersome and time-consuming, leading to a lack of diligence among vehicle owners regarding their vehicle's safety [2]. To address this issue, a new system has been developed to assist vehicle owners and authorities in locating lost vehicles efficiently [3]. This user-friendly system is designed for use anytime and anywhere, providing significant advantages to its users.

The primary objective of this system is to enhance the ability to locate lost vehicles by continuously tracking their location. It facilitates authorities in pinpointing the vehicle's location, thereby aiding in crime prevention. This system aims to assist rental car companies in Kuala Terengganu by enabling the recovery of stolen or lost vehicles, whether taken by renters or thieves. Features include notifications through the Blynk app upon hardware connection and the continuous transmission of live GPS data, ensuring real-time location tracking [4-5]. Ensuring vehicle security without robust measures is challenging, and vehicle malfunctions can result in substantial losses if the vehicle is not recovered [6]. This project aims

to help companies locate their vehicles using mobile devices. The system involves installing an Arduino Node MCU and Neo-6m GPS unit hidden within the vehicle. This setup allows companies to detect the vehicle's presence in case of problems or theft. The application, accessible via a mobile device, displays the GPS location in real-time, including longitude and latitude, and sends GPS data to real-time web servers like Google Maps.

The smart vehicle tracking system using IoT is a cutting-edge technology designed to assist vehicle owners in tracking their vehicles effectively [2]. Studies on the components used in vehicle tracking systems highlight the importance of commitment to vehicle safety. This system alleviates concerns by providing the exact location and time needed to locate a lost vehicle. A significant issue in vehicle theft is the lack of effective control over vehicle security systems and owner negligence in locking their vehicles [3]. To address these challenges, the propose a vehicle tracking system that ensures easy location of the vehicle. The project's high-level goals are to safeguard vehicle security and reduce vehicle theft. This paper also identifies the problems encountered and discusses the methods employed in the project development.

## 1.2 Arduino Node MCU

The Arduino Node MCU is an open-source Internet of Things (IoT) platform comprising hardware based on the ESP-12 module and firmware running on Espressif Systems' ESP8266 Wi-Fi SoC. By default, the firmware is referred to as "Node MCU," distinct from the development kits. Node MCU was developed shortly after the release of the ESP8266, which Espressif Systems began producing on December 30, 2013. The ESP8266, widely used in IoT applications, combines a Wi-Fi SoC with a Tensilica Xtensa LX106 core. On October 13, 2014, the initial Node MCU firmware file was uploaded to GitHub by Hong, marking the inception of Node MCU. The project expanded into an open-hardware platform two months later when developer Huang R contributed.

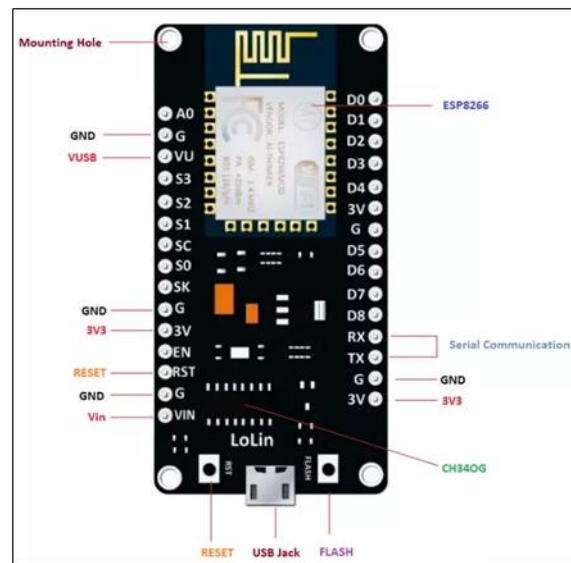
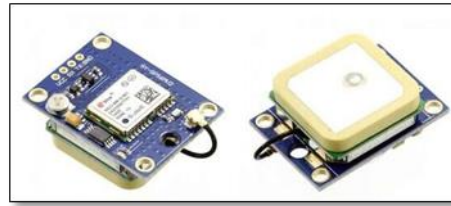


Fig. 1. Arduino Node MCU pinout

As shown in Figure 1, the module includes a USB to UART converter, transforming USB data into UART data primarily for serial communication. The module features a Micro USB port, which serves a dual purpose: programming the board and supplying power. A compatible micro-USB cable connects the board to a computer, indicated by an LED lighting up upon connection. If the computer does not recognize the Node MCU board, necessary drivers can be downloaded from the provided source. The Arduino IDE software is recommended for programming this module. It is important to note that the pin configuration on the board differs from the one used in the software. For instance, coding for pin 16 in the Arduino IDE corresponds to the D0 pin on the module. The pinout diagram indicates that the board has five ground pins and three 3V3 pins. The board can be powered in three ways: 1. USB Power: Ideal for program loading unless a separate interface is required. 2. 3V Supply: Effective for powering the module, especially with an off-board regulator providing a stable power source and 3. Power Vin: A voltage regulator supporting up to 800 mA and capable of handling voltages between 7 to 12 V, although it cannot power devices operating at 3.3 V.

## 1.3 NEO-6M GPS

The u-blox NEO-6M GPS module is a widely used, affordable, and high-performance GPS module. It features a ceramic patch antenna, an in-built memory chip, and a backup battery, making it compatible with a variety of microcontrollers. Two popular versions of the NEO-6M GPS module are the GY-GPS6MV2 and the GY-GPSV3-NEO.



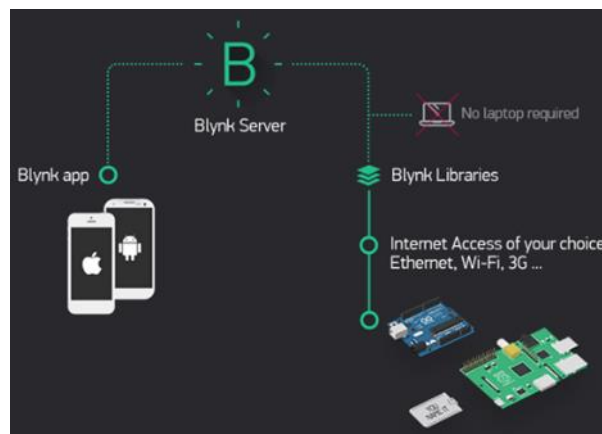
**Fig. 2.** Neo-6m GPS

These modules are equipped with the u-blox NEO-6M GPS engine, known for its excellent sensitivity in indoor applications. They include an MS621FE-compatible rechargeable battery for backup and an EEPROM for storing configuration settings. The module operates efficiently with a DC input ranging from 3.3 to 5 volts. The GPS modules are based on the u-blox NEO-6M-0-001 model, with ROM/FLASH version ROM 7.0.3 (UBX-TN-11047-1). Proper antenna positioning is critical for optimal GPS receiver performance. The patch antenna should be aligned parallel to the geographic horizon with an unobstructed view of the sky to maintain a direct line of sight with as many visible satellites as possible.

The NEO-6M can track up to 22 satellites across 50 channels and offers high sensitivity of -161 dB tracking while consuming only 45mA of supply current. It provides up to 5 location updates per second with a horizontal position accuracy of 2.5m. The u-blox 6 positioning engine features a Time-To-First Fix (TTFF) of less than 1 second. A notable feature is the Power Save Mode (PSM), which reduces system power consumption by selectively switching parts of the receiver on and off, lowering the module's power consumption to just 11mA, ideal for power-sensitive applications such as GPS wristwatches. The data pins of the NEO-6M GPS chips are broken out to 0.1" pitch headers, including pins for UART communication with a microcontroller. The module supports a baud rate ranging from 4800bps to 230400bps, with a default baud rate of 9600.

#### 1.4 Blynk Apps

Blynk is a platform designed for the Internet of Things (IoT), enabling remote control of hardware, sensor data visualization, and data storage among other features. The platform consists of three main components: 1. Blynk App: Allows users to design interfaces for their projects using various widgets. Blynk Server: Manages all communication between the smartphone and the hardware. Users can utilize the Blynk Cloud or run a private Blynk server locally, which is open-source, capable of managing thousands of devices, and can be hosted on a Raspberry Pi. 2. Blynk Libraries: Compatible with all popular hardware platforms, facilitating communication with the server and processing all commands and 3. Blynk operates via the Internet, requiring hardware with internet connectivity. Boards like the Arduino Uno need an Ethernet or Wi-Fi Shield, while others like the ESP8266, Raspberry Pi (with a Wi-Fi dongle), Particle Photon, or SparkFun Blynk Board come with built-in internet capabilities. Without a shield, a USB connection to a laptop or desktop can be used, although this may be more complex for beginners. The Blynk App, compatible with both iOS and Android, serves as an interface builder for smartphones.



**Fig. 3.** Diagram that Blynk process with another component.

As indicated in the above figure, Blynk operates via the Internet, implying that your chosen hardware should have internet connectivity. Certain boards, such as the Arduino Uno, require an Ethernet or Wi-Fi Shield for communication, while others like the ESP8266, Raspberry Pi with a Wi-Fi dongle, Particle Photon, or Spark Fun Blynk Board are already equipped with Internet capabilities. Even without a shield, you can establish a connection via USB to your laptop or desktop, although this might be slightly more complex for beginners. Interestingly, the range of hardware compatible with Blynk is extensive and continually expanding. For smartphones, the Blynk App serves as an excellently designed interface builder, compatible with both iOS and Android platforms.

## 2 Materials and methods

The iterative model initiates the development process with a basic implementation of a small set of software requirements. This initial implementation is then iteratively enhanced based on feedback and additional requirements until the complete system is ready for deployment. Unlike other models, the iterative life cycle does not necessitate a full specification of requirements at the outset. Instead, development begins with a partial implementation, which is reviewed to identify further requirements. This process repeats, producing new software versions at the end of each iteration. The iterative methodology in the System Development Life Cycle includes several phases: planning, design, analysis, implementation, development, testing, and maintenance.

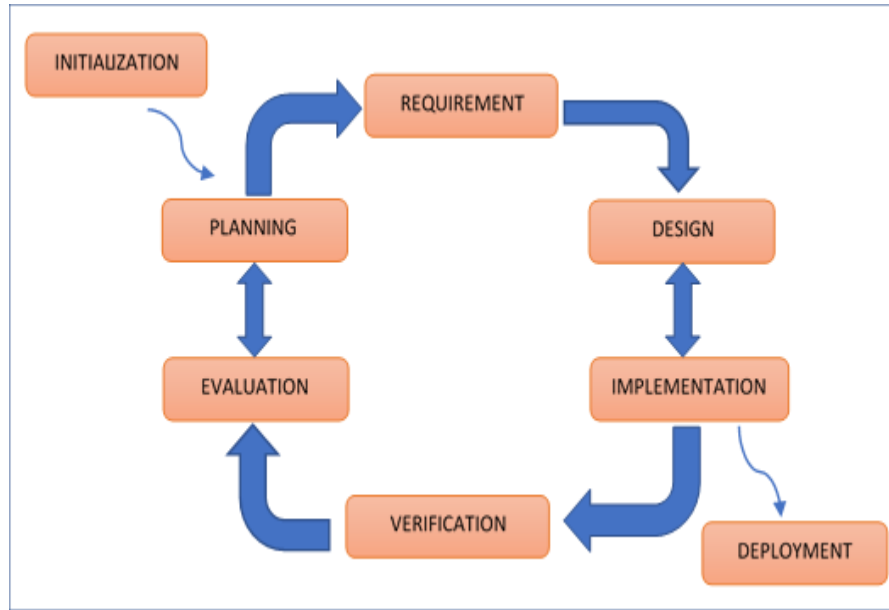


Fig. 4. Iterative model

### 2.1 Requirement Gathering and Analysis

In this phase, all system requirements are identified and documented. Tools necessary for vehicle detection, such as the Arduino Node MCU, Neo-6m GPS, and jumper wires, are specified. This phase ensures that the objectives of the project are aligned with the required performance standards.

### 2.2 System Design

In this phase, all system requirements are identified and documented. Tools necessary for vehicle detection, such as the Arduino Node MCU, Neo-6m GPS, and jumper wires, are specified. This phase ensures that the objectives of the project are aligned with the required performance standards.

### 2.3 Implementation

The system is developed into small units based on the system design inputs. Each unit undergoes Unit Testing to verify functionality. For vehicle tracking systems applicable to motorcycles, cars, or bikes, all modules are implemented according to the design and objectives. The process involves connecting the Arduino Node MCU and Neo-6m GPS, inputting commands using Arduino software, programming in C++, and utilizing the Blynk software on a mobile device.

### 2.4 Integration and Testing

In this phase, all units developed during the implementation phase are integrated and tested for defects and failures. Modules such as the Arduino and sensors are inspected to ensure the system meets its objectives. Any issues identified are addressed to ensure proper functionality.

### 2.5 Deployment of System

Once testing is complete and the system is verified to function as expected, it is deployed in the customer environment or released to the market. The vehicle tracking system is distributed for use, with maintenance conducted as needed. This includes releasing patches to resolve issues and upgrading the product to accommodate changes in the customer's



environment. Maintenance includes preventive measures to avoid issues and corrective actions when errors occur. Detailed information is provided in the user manual for user convenience

### 3 Result and discussion

#### 3.1 Unit testing plan

The unit testing plan involved three key test cases. First, for the login functionality, users needed to fill in the username and password fields to access the system. They were required to register or create an account beforehand. Upon successful login, a notification was expected to appear. Second, the "Button Play" functionality required users to click the play button to obtain longitude and latitude information. There were no pre-conditions for this test, and the expected result was the display of the longitude and latitude. Third, for the notification functionality, connecting a USB was supposed to trigger an automatic notification indicating that the GPS was activated. The pre-condition was that the USB needed to be connected before the notification appeared. This would inform users about the GPS tracker's activity.

**Table 1.** Unit Testing Plan

UNIT TESTING PLAN (UTP)						
No.	Test Case Name	Test Procedure	Pre-condition	Expected Result	Tester	Result (Pass / Failure)
1.	Login	Users must fill in the username and password field before access the system	Users need to register or create new account before login	Prompt Notification successful login.	Encik Fathi	Pass
2.	Button play	Users must click button play to get the longitude and latitude.	none	user will get the longitude and latitude	Encik Fathi	Pass
3.	Notification	When the user connects to the USB it will automatically pop up the notification that gives the information about GPS is activated.	Users need to connect the USB first before notification pop-up.	Users will get information about the activity of the GPS tracker.	Encik Fathi	Pass

#### 3.2 Integration Testing Plan

The integration testing plan comprised three main test cases. The first test case focused on the login functionality, where users needed to click the submit button. There were no pre-conditions for this test, and the expected result was that the user would be directed to the homepage after clicking the submit button. The second test case involved the "Button Play" functionality, where users were required to click the play button. Again, there were no pre-conditions, and the expected outcome was that users would immediately receive the longitude and latitude information. The third test case tested the notification feature, where users needed to click on the pop-up notification indicating that the GPS was activated. There were no pre-conditions for this test, and the expected result was that the user would activate the GPS tracker directly.

**Table 2.** Integration Testing Plan

<b>Integration Testing Plan (ITP)</b> <b>UNIT TESTING PLAN (UTP)</b>						
<b>No.</b>	<b>Test Case Name</b>	<b>Test Procedure</b>	<b>Pre-condition</b>	<b>Expected Result</b>	<b>Tester</b>	<b>Result (Pass / Failure)</b>
1.	Login	User must click submit button	None	User will directly go to homepage after done click submit button.	Encik Fathi	Pass
2.	Button play	Users click the button play.	None	User will directly be getting the longitude and latitude	Encik Fathi	Pass
3.	Notification	Users click the pop-up notification that shows GPS is activated.	None	User will directly active the GPS tracker	Encik Fathi	Pass

### 3.3 User Acceptance Testing

During User Acceptance Testing (UAT), three key functionalities were evaluated. Firstly, users successfully accessed the system by filling in their username and password, meeting the login requirement. Secondly, users obtained longitude and latitude information by clicking the designated "Button Play," fulfilling the system's functionality. Lastly, connecting a USB device enabled the notification pop-up, indicating successful activation of the GPS tracker, meeting the notification requirement. User confirmed the successful completion of all test cases, signifying the system's readiness for deployment

**Table 3.** User Acceptance Testing

<b>USER ACCEPTANCE TESTING (UAT)</b>						
<b>No.</b>	<b>Test Case Name</b>	<b>Acceptance Requirement</b>	<b>Test Result</b>		<b>Tester</b>	<b>Comments</b>
			<b>Pass</b>	<b>Fail</b>		
1.	Login	Users are required to fill the username and password before access the system.	Pass		Encik Fathi	
2.	Button play	User is required to click the button play before getting the information about longitude and latitude.	Pass		Encik Fathi	
3.	Notification	User is required to connect USB first for getting the power to get the notification pop-up that show GPS tracker is successfully activated	Pass		Encik Fathi	

## 4 Conclusion

The significance of this project lies in its numerous benefits, such as enhanced productivity, safer field operations, and effective theft prevention through GPS technology. The system is designed to reduce car theft and is cost-effective, allowing users to easily track their vehicles in case of theft. However, it is important to note that the GPS tracker requires network coverage and light to function effectively, as well as internet access for retrieving vehicle information. The Smart Vehicle Tracking System Using IoT improves productivity and safety measures while providing a cost-effective solution for vehicle

security. It sends GPS coordinates to a mobile phone, displaying the location on Google Maps via an Android app. Despite its advantages, the system has limitations, including the potential failure in areas with no coverage or insufficient light, and the necessity of internet connectivity for accessing vehicle information.

Overall, this system offers a user-friendly interface for simple vehicle tracking, ensuring reliable performance and quicker vehicle retrieval. Economically, the reduction in vehicle theft can lead to lower insurance premiums and decreased financial losses for individuals and businesses, contributing to a more stable economic environment. Socially, the enhanced security fosters a greater sense of safety and trust within communities, as the ability to quickly locate stolen vehicles can deter criminal activities and reduce stress for vehicle owners. We recommend the Smart Vehicle Tracking System for its affordability, efficiency in minimizing search time, and positive impact on both economic stability and social well-being.

## References

1. Bukola, A. Development of an anti-theft vehicle security system using gps and gsm technology with biometric authentication. *International Journal of Innovative Science Research and Technology*, 5(2), 1250-1260. (2020).
2. Adaramola, B. A., Salau, A. O., Adetunji, F. O., Fadodun, O. G., & Ogundipe, A. T. Development and Performance Analysis of a GPS-GSM Guided System for Vehicle Tracking. In *2020 International Conference on Computation, Automation and Knowledge Management (ICCAKM)* (pp. 286-290). IEEE (2020, January).
3. Nagy, A., Abdelftah, M., & Yousef, B. M. (2020). Smart vehicle and Anti-Theft System Using IoT. *International Journal of Engineering Inventions*, 9(4), 1-5
4. Sushmitha, G., Sailaja, B., Ramunaidu, K., Sindhuja, M., & Harika, N. Automatic Vehicle Accident Detection and Rescue System Using GSM & GPS Module. *Journal of Engineering Sciences*, 13(12). (2022).
5. Mounika, J., Charanjit, N., Saitharun, B., & Vashista, B. Accident alert and vehicle tracking system using GPS and GSM. *Asian Journal of Applied Science and Technology (AJAST)* Volume, 5, 81-89. (2021).
6. Crisgar, P. V., Wijaya, P. R., Pakpahan, M. D., Syamsuddin, E. Y., & Hasanuddin, M. O.. GPS-based vehicle tracking and theft detection systems using Google Cloud IoT core & Firebase. In *2021 International Symposium on Electronics and Smart Devices (ISESD)* (pp. 1-6). IEEE (2021, June)

# Gap Analysis to Determine the Scope IT Development in Local Government

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**Abstract.** E-Government is an administration that utilizes information technology (IT) to provide services to the public. In general, e-government also support all changing areas as a fundamental and comprehensive efforts in the development of professionalism in state civil apparatus by utilizing IT to support the good governance. In order to implement the e-government by legal force among the local government organizations in this case in Sambas regency, a master plan of local government IT is needed as a guideline for all local government organizations in building an integrated e-government. The master plan of local government IT is prepared by taking into the direction of policies, strategies and initiatives in the areas of governance, e-government services, IT, and human resources to achieve the strategic goals of e-government and local development plan of Sambas regency. In determining the direction of IT policy in local government, a gap analysis is carried out to find out the programs that need to be implemented so that the current IT conditions in Sambas Regency can be developed into the expected conditions in 2025. Gap analysis be the early phase in transition plan by conclude the result from early assessment in local government organizations and the stakeholders input from Focus Group Discussion (FGD). The gap analysis is based on determining the supporting scheme for implementing e-government which includes information, applications, infrastructure, and human resources adapted to ideal conditions as for stakeholders decision to prepare IT needs in IT implementation strategies and smart e-government.

**Keywords:** gap analysis, IT, e-government, local government

## 1 Introduction

Integration of technology and information in aspects of government is a necessity at this time. One step in implementing IT in government includes various platforms that are present and offer convenience wrapped in one name: *e-government*. *E-government*, also known as an electronic-based government system, is the utilization and use of information and communication technology by the government, which aims to create "good governance" and increase the effectiveness and efficiency of public services. Presidential Instruction No. 3 of 2003 mandates every government, one of which is a regional government, to participate in *e-government development*. In this case, the Regent is given a mandate according to his authority to initiate, formulate, implement, and report on IT development in his area (DISKOMINFOSAMBAS, 2021).

Government with good governance is currently the most important thing in the process of improving the quality of government itself. Moreover, the public is increasingly critical in responding to the various pieces of information they receive and their efforts to obtain transparent information. Therefore, in this situation, it is best for the government to respond by increasing or developing the accessibility of services and information, as well as implementing targeted changes targeted at achieving good governance. Through Law Number 25 of 2009 concerning Public Services, this law can be used as a guide for the government to apply good principles while applying the principle of effectiveness of government functions (Pangestu & Anggraini, 2022).

In 2018, the government issued a regulation through Presidential Regulation Number 95 of 2018 (Presidential Decree, 2018) about electronic-based government system. With the issuance of the e-government Presidential Decree, the Indonesian e-government ranking assessment is no longer carried out. The next national e-government assessment will be through an evaluation process for the implementation of e-government carried out by the Ministry of Administrative and Bureaucratic Reform together with the Ministry of Communication and Information. The Presidential Decree mandates e-government dimensions consisting of 1) governance, 2) management, 3) services, 4) infrastructure, 5) applications, 6) security, and 7) information and communication technology audit.

An Electronic-Based Government System, or e-government, is a government administration that utilizes information and

communication technology to provide services to the public. The aim of e-government is to encourage the realization of government administration in order to increase efficiency, effectiveness, transparency, and accountability in administration, governance, development, and society, and make it easier for the public to obtain public services (Perdani, Widyastuti, & Nupikso, 2021).

Apart from e-government initiation, IT strategic planning in e-government development is used to match the requirements from government organization business strategies and IT strategies so as to gain value added from a government organization. Stages of the requirement identification process information in strategic planning the information system first starts with the organizational environment, which contains the vision, mission, and organizational goals; continues with the identification of the internal and external environments of the organization, as well as internal and external IT organizational environments; then proceeds with analyzing IT software and hardware needs and optimization regarding the appropriate use of computer equipment (hardware and software) to support public services in government offices.

Changes in control and dynamic information flows provide new challenges for governments regarding public services. In the rapid and widespread development of IT, the phenomenon of the digital divide has emerged (Asyikin, Fitri, & Nugroho, 2016). Some of the method that can be the option to get the early information of IT development in e-government implementation are by using the gap analysis technique such as non-probability sampling with derivative in quota sampling (Kurniawan & Setyawan, 2019), another gap analysis in e-government is being researched by (Rachmawati & Fitriyanti, 2021) by conducted the concept of digital divide, workforce, regulation, and infrastructure, and also bridging the gap by using the design-reality gap model in (Puspitasari & Kurniawan, 2023).

In this research, gap analysis be the early phase in transition plan by conclude the result from early assessment in local government organizations and the stakeholders input from Focus Group Discussion (FGD). A gap analysis needs to be carried out before the preparation of the IT masterplan with a focus on e-government development in Sambas regency, in order to become a reference for all Sambas regency government organization in implementing progressive e-government. To anticipate the rapid development of information and communication technology, which will result in changes to the government system, it is a need to analyse the gap between existing condition and ideal implementation to prepare the proper IT development that support e-government in Sambas Regency by using the design-reality gap model that can bridging the transition plan based on gap analysis results.

## **2 Research methods**

In principle, the methodology for preparing the Sambas regency IT master plan document for 2021-2025 includes the following steps:

### **2.1 Analysis of Current Conditions**

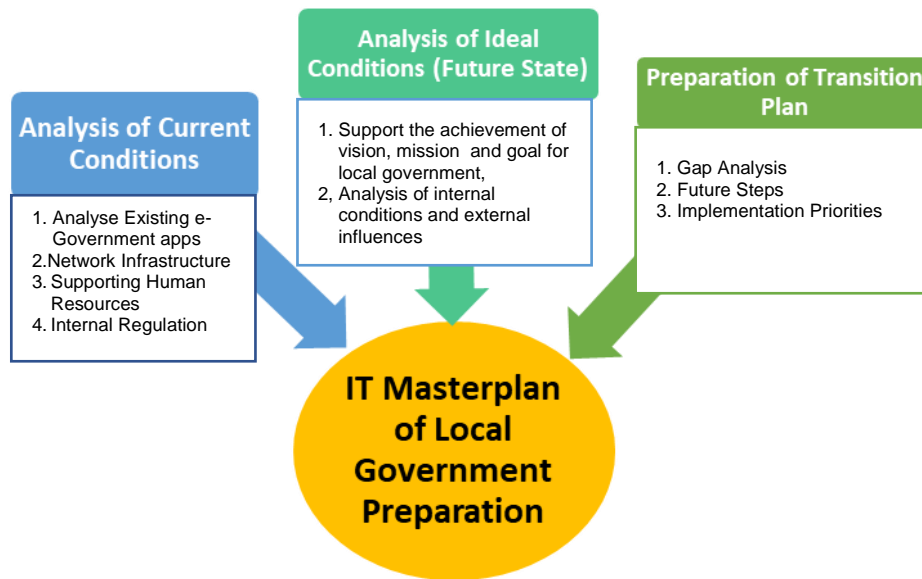
This analysis stage is intended to obtain adequate information regarding the current conditions of e-government implementation within the Sambas regency local government. This includes activities to analyse existing e-government applications, network infrastructure, supporting human resources, and internal regulations related to e-government implementation.

### **2.2 Analysis of Ideal Conditions (Future State)**

This step is intended to develop ideal conditions or concepts for the Sambas regency government to implement e-government to support the main tasks and functions of all its local government organization. This stage focuses on how e-government can support the achievement of the vision and mission of the Sambas regency government. In this case, an analysis of internal conditions is also carried out, namely supporting human resources and internal regulations related e-government, as well as external influences, especially developments in information and communication technology.

### **2.3 Preparation of a Transition Plan**

In this case, an analysis of the existing constraints (gap analysis) is carried out, namely the gap that exists between the ideal conditions to be achieved so that e-government can be used optimally in supporting the vision and mission of the Sambas regency government and the current conditions. From this stage, it can be seen what future steps need to be taken to achieve ideal conditions, along with setting priorities so that the ideal conditions are expected to be achieved within the next five years.



**Fig. 1.** Methodology for Preparing the IT Master Plan in Sambas Regency

### 3 Results and discussions

A gap analysis was carried out to determine the programs that need to be implemented so that the current IT condition of Sambas Regency can develop into the expected condition in 2025.

#### 3.1 Gaps in Fulfilling Information Needs

The fulfillment of information Needs in the Sambas regency government is analyzed regarding three aspects of information, namely availability, integration and accuracy, and information security. In general, the condition of data and information for the Sambas Regency Government is as follows:

**Table 1.** Conditions for Fulfilling Information Needs

Aspect	Indicator	Condition
<b>Availability</b>	Amount of Digital Data/Information	The amount of digital data and information cannot yet be traced and ownership is unclear
	Availability on the Internet	20% of local government organization have provided information via the website
<b>Integration and Accuracy</b>	Structure and Format of Data/Digital Documents	There are no rules and standardization regarding the structure and format of digital data/documents
	Sharing Method	There are several methods of providing data, namely <ul style="list-style-type: none"> <li>a. Manual over physical documents</li> <li>b. Manual via <i>external drives</i></li> <li>c. Via <i>e- mail</i></li> <li>d. Via <i>Chat Application</i></li> <li>e. Via website</li> </ul>
<b>Information Security</b>	There is Data Redundancy	There is still a lot of duplicate data spread across various local government organization
	Distribution of Access Rights	There is no classification of data and information based on potential users
	Logical Data Security	Security is done by installing an antivirus.
	Physical Data Security	There is no local government organization that provides <i>backup</i> and <i>recovery mechanism</i> .

Based on the results of the analysis of the conditions for fulfilling the information needs of Sambas regency, several programs

need to be implemented, namely:

1. Determining a centralized data structure standard design so that data can be easily utilized across local government organization.
2. Determination and standardization of standard formats agreed upon by all local government organizations covering document extension formats, document naming formats, and document filling formats.
3. Providing a centralized data and file storage area that can be accessed according to needs.
4. Classification of information for each element, both society and local government organization and executive government, according to their respective needs updates and logical data security.
5. Design and implement backup and recovery mechanisms to ensure physical data security.

### 3.2 Application Gaps

There is a gap in the penetration level of application use in the local government organization of Sambas regency where there are conditions from the fulfillment level of application requirements in operational activities is still very low. There are a dominant number of local government organization that do not yet have applications to meet functional requirements in carrying out their functions. Existing applications are often not utilized optimally due to various problems experienced.

This very large number makes it less feasible to develop all applications in the 2021–2025 period. Therefore, in this period, application development is prioritized for applications whose functions are the most critical. Based on the results of the condition analysis, several steps are needed to follow up on the application gaps that occur in Sambas district, namely:

1. Provide space for local government organization to innovate and develop applications with funding and policy support.
2. Standardizing application development for each application developed ensures ease of data connection and integration.
3. Carry out application development in a tiered manner to move towards a *scalable application foundation and structure*.
4. Evaluate and update applications that are being used so that they can meet user requirements.

### 3.3 Infrastructure Gaps

The condition of infrastructure within the Sambas Regency government can be seen from the following two aspects:.

1. Management of digital data storage servers

Currently, each local government organization has the responsibility to manage its own data storage. Therefore, there is no standardization in the accountability and supervision of data storage. This causes the goals of data integration and accuracy of information to not be achieved. Therefore, it is necessary to provide data storage services that are integrated with specified standards and procedures.

2. Connection speed

Based on the results of *the Focus Group Discussion (FGD)*, most local government organization stated that the connections used within the government were still slow and that local government organization had installed their own internet, which was separate from the main network. In fact, this could threaten the security of government information. It is necessary to provide a stable and fast network so that local government organization no longer attempts to install a private network without appropriate security.

### 3.4 Gaps in Fulfilling Human Resources Needs

Human resources (HR) needs are divided according to information system human resources *stakeholders* , namely developers, users and maintainers of information systems in the Sambas Regency Government. The results of identification and follow-up to fulfill HR needs are shown in the following table.

**Table 2.** Conditions and Follow-up to Fulfill Human Resources Needs

HR	Condition	Follow-up
Information Systems Developer	System development is given to third parties and advanced development is still with third parties	<ol style="list-style-type: none"> <li>1. Recruit civil servants who are capable of developing information systems.</li> <li>2. Provide assistance to existing civil servants with third parties in stages.</li> </ol>

		3. Improving the quality of competency-based human resources.
Information System Users	Human resources for information system users in the OPD environment are lacking	<ol style="list-style-type: none"> <li>1. Recruit civil servants for IT personnel who specifically handle the use of information systems at the local government organization level.</li> <li>2. Carrying out training (application) to existing civil servants to improve competency.</li> </ol>
IT Facility Maintainer	Human resources maintaining information systems collaborate with third parties	<ol style="list-style-type: none"> <li>1. Recruit civil servants who are capable of carrying out system maintenance.</li> <li>2. Provide assistance to civil servants with third parties in stages.</li> </ol>

## 4 Conclusion

Based on studies related to strategic policies of IT development in Sambas regency and gap analysis, the programs that need to be carried out to achieve the expected targets are defined according to the implementation strategy. Several strategies that can be implemented according to the results of the gap analysis in determining the scope of IT development include carrying out a Deep Assessments through direct inspections regarding IT readiness in each local government organization of Sambas Regency, preparing a technical blueprint or IT development blue print for each local government organization, consistency from the Communication and Information Service as well as other local government organization in implementing the programs stated in the master plan, support from all government parties related to implementation and continued with the development of breakdown components from the local government IT master plan (such as network & communication master plan, application development plan, e-government master plan, IT management, and IT infrastructure blue print).

## References

1. Asyikin, A., Fitri, R., & Nugroho, A. Information and Communication Technology (Ict) Masterplan For Village Government Offices. *Journal of Axis Engineering*, 61-67. (2016).
2. Diskominfosambas. *Sambas Regency Information And Communication Technology Master Plan*. Sambas: Diskominfo Sambas. (2021).
3. Kurniawan, S., & Setyawan, A. Measuring The Digital Gap In Banyumas To Find Out The Community's Readiness In Utilizing The Smart City. *National Seminar on Edusainstek* (pp. 308-314). Semarang: Sebelas Maret University. (2019).
4. Pangestu, D., & Anggraini, W.. Regional Government Strategy In Developing A Smart City Through Smart Government In Serang City. *PRAJA*, 130-141. (2022)
5. Perdani, M., Widyastuti, I., & Nupikso, D. Analysis Of Data Availability Of Smart City Indicators, Tegal District. *Journal of Information Technology and Computer Science*, 1049-1056. (2021).
6. Presidential Decree. *Presidential Decree Number 95 of 2018*. Jakarta: Central Government. (2018).
7. Puspitasari, D. A., & Kurniawan, T.. Accessing the National Complaint Handling System in Indonesia (LAPOR!) Using the Design-Reality Gap Model. *International Journal of Electronic Governance*, (2023)
8. Rachmawati, T., & Fitriyanti, K. D.. Analysis of e-Government Initiative at Local Government Level in Bandung City, Indonesia. *Jurnal Ilmu Sosial dan Politik*, 62-80. (2021)



# Study on Multifunctional Automotive Creeper by Using Remote Controller

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**Abstract.** The multifunctional automotive creeper by using remote controller is designed to be flexible for work that involves confine space especially working under part of the car. The limitation quantity of hydraulic lifter in the automotive workshop makes the creeper useful for working under the car. The floor at the workshop was full of dirty oil and not comfort to lie down directly. Hence this project aims to save time for mechanic job by fabricating a creeper controlled by a remote controller with ergonomic design to a human body. The creeper frame is made from mild steel (2.5x2.5) cm and assembled using bolt and nut. The base is covered by a soft cushion for user comfort. The DC motor with brushless hub is used to move the creeper with remote controller. The overall cost of RM678.00 is more affordable than hydraulic lifter jack that cost around RM25,000. The creeper can be converted to be a stool. It also has a toolbox compartment and LED light for brightness under the car. Based on the study, the usage of this creeper can help reduce working time compared to normal creeper around 5 to 15 minutes according to various tasks.

**Keywords:** Multifunctional, Automotive, Creeper, Remote Controller, Car, DC Motor

## 1 Introduction

Multifunctional automotive creeper with remote controller is designed to improve the original automotive creeper and provide several additional functions. The remote controller can control the movement of the creeper by using a remote function. The automotive creeper is also able to be fold from flat position. Therefore, worker can work while sitting comfortably when working on each side of the vehicle. The purpose of this folding feature is also being to allow the user to save this project in a small space. The Sustainable Development Goals (SDG) is a collection of 17 global designed to be a blueprint to achieve a better and more sustainable in future for human. This product met 2 goals of SDG which are goal 9, Industry, Innovation and Infrastructure and goal 12, Responsible Consumption and Production [1]. This product is an innovative approach by modifying conventional automotive creeper to a multipurpose creeper that can help mechanics to finish their job in a short period of time. The construction of this project also using recycle material which can help to save the environment from pollution. The present creeper includes a retractable extension, which enables the device to be collapsed from its fully extended working configuration to a more compact size for storage within a storage case for carriage within a small storage area in a truck or other motor vehicle [2]. The device also includes removable arm rests with tools pouches for convenience while working, as well as articulated work lights which may be aimed to suit the user and a warning light which may be attached to the device [3].

The cost of creepers is high right now, and the heavy-duty steel frame of the current construction is the source of many issues. In addition, handling the creeper from assembling and disassembling it after use and storing it are challenging tasks. Certain products, particularly those sold in Malaysia, have a wide range of weights, heights, and sizes, and their designs are less ergonomic for Asian mechanics [4].

There are several multipurpose creepers invented in the market. Based on a multipurpose creeper invented by Joseph H. Heckman and patented in 1939, the creeper aimed to provide a durable and versatile solution for mechanics working beneath automobiles. It featured a sturdy construction and the ability to change direction easily. Unlike previous designs with wheels or casters at each corner, which often broke quickly and lacked stability, the creeper had a close-to-the-ground profile and was lightweight for easy transport. Previous designs were prone to breakage, especially under heavy loads or accidental impacts, making them unsuitable for long-term use [5]. In the automotive industry, mechanics use various equipment to repair cars, especially underneath them. One essential tool is a creeper, which is a low platform with wheels or casters. Mechanics use it to slide underneath vehicles for more efficient work. While some creepers have wheels for mobility, others are stationary. Traditional creepers are simple to make and don't require electric components. They typically consist of plywood, wheels, screws, bolts, padding, fabric, and basic tools like a saw, drill, and screwdriver. Over time, advancements in equipment have made mechanics' work safer and more comfortable. In modern versions, creepers may include electric motors controlled by remote controllers for easier movement. These motorized creepers aim to enhance the efficiency and convenience of mechanics' tasks [6].

There are some challenges in the automotive workshop. One big issue is the shortage of hydraulic jacks for lifting cars when mechanics are working on them. With only limited jacks available, it is tough to handle multiple cars at once. Plus, the workshop floor is often oily and uncomfortable for mechanics lying down to work underneath cars. According to [7] there was no attempt in the current market to create a mechanical creeper designed specifically for those with disabilities. Most current automotive creepers have specific restrictions that prevent semi-disabled individuals. To tackle these problems, it is useful to combine a creeper with a remote control. This new setup will make it easier and quicker for mechanics to move under cars without manually pushing the creeper. It will also help them avoid getting dirty from the oily floor and make the work less physically demanding. This solution is not only practical but also saves money compared to buying more hydraulic jacks. Hence, this study aims to save time for mechanic job by fabricating a creeper controlled by a remote controller with ergonomic design to a human body and enhance efficiency compared to traditional models. The scope includes a creeper powered by a DC motor for remote-controlled movement, equipped with a cushion for user comfort and fatigue reduction, featuring a foldable design transforming into a stool with a mini toolbox for convenience, and aimed at saving 10 minutes of working time compared to standard creepers.

## 2 Materials and methods

The first process is the design process using Autodesk Inventor as in Figure 1. This workflow shows the whole planning of the project process including the timeline, idea, workflow, defect detected, improvement and the execution. Additionally, this creeper also stated the cost consist of all measurement and calculation and also include the product design to be able become the picture before the actual project product were built.

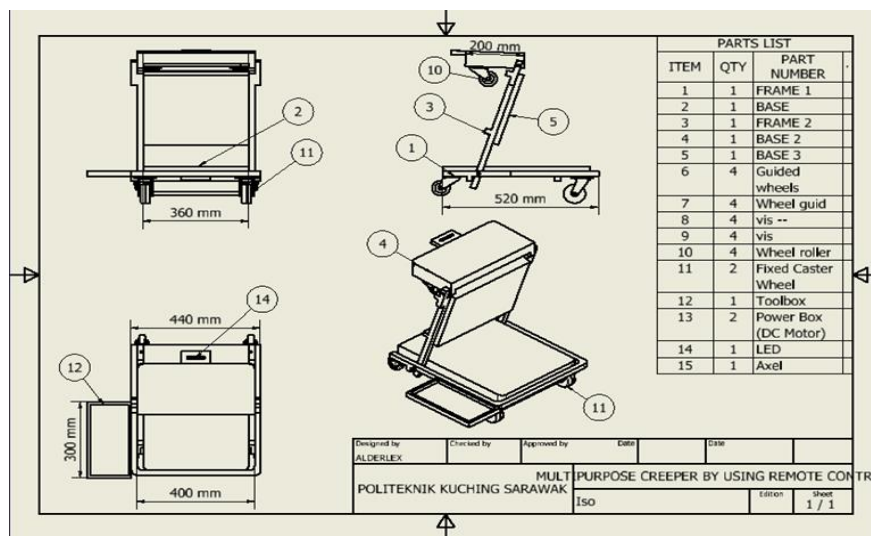


Fig. 1. Design with Autodesk Inventor

The process of making the frame using the ARC and MIG welding in Figure 2. The frame needs to be welded for more durability.



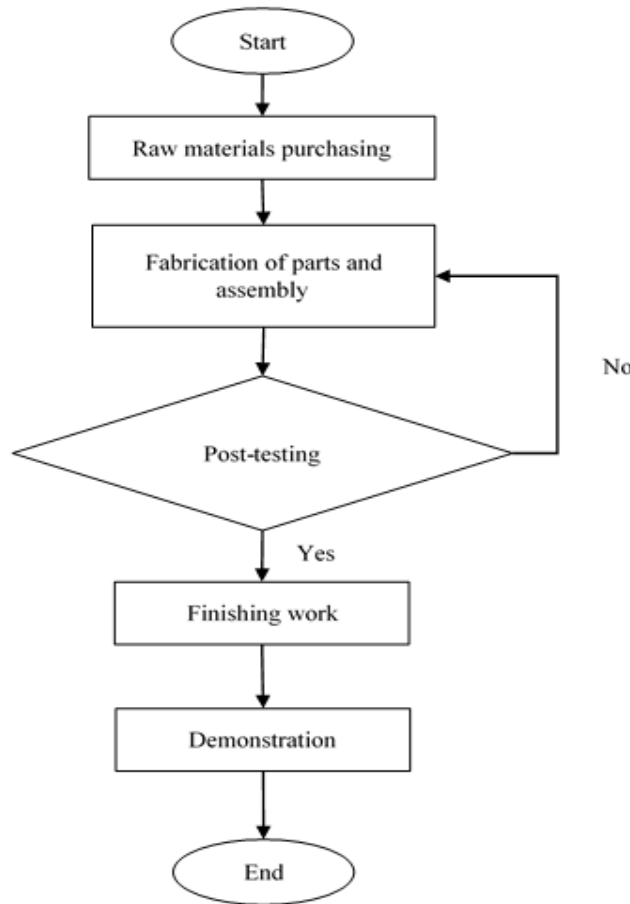
Fig. 2. Welding Frame

Our collaboration with Jin San Engineering Sdn Bhd company has led us to conduct thorough testing. The primary aim of this testing phase is to evaluate both the advantages and disadvantages of this product, thereby determining the optimal

environments for its use. Additionally, any encountered issues can be analyzed and work towards effective solutions. The pre-testing phase involves meticulous steps, initiating with a stopwatch to gauge the time required for a conventional creeper to complete specific tasks, followed by commencing the test of the Multifunctional Automotive Creeper Using Remote Controller and recording the time taken. This setup is meticulously designed to assess the efficiency of the product. Post-testing procedures entail utilizing a stopwatch to calculate the time taken, testing the load limit, and meticulously recording all obtained data to evaluate if our project fulfils its intended objectives in Table 1.

The base of the creeper is thickly padded so the user will not experience much discomfort. It also features a retractable pin which makes it easy for users to adjust their seating position. This creeper features a low profiles design and can be folded into a Z- shape for comfortable sitting

The development of this creeper in based on the flow chart in Figure 3 below:



**Fig. 3.** Flow chart of Multipurpose Creeper by Using Remote Controller

### 3 Result and discussion

The completed product of Multifunctional Creeper by Using Remote Controller and the transformed creeper to a chair are shown in Figure 4 and Figure 5.



**Fig. 4.** Completed product with tool storage attached the creeper



**Fig. 5.** Creeper transformed to a chair



**Fig. 6.** Board DC motor (brushless motor)



**Fig. 7.** The remote controller

The operation of this automotive creeper is easy and simple to use it. This creeper is activated by a switch in Figure 6. When the board is on, the signal will be sent to the receiver to the remote controller in Figure 7. So, the remote controller can move the motor forward and backward.

**Table 1.** Time Comparison for three tasks

Tasks	Multifunctional creeper by using remote controller (minutes)	Traditional creeper box (minutes)	Time difference between both creepers (minutes)
Change oil filter	15	25	10
Change engine oil	20	35	15
Change steering bush	30	40	10

According to Table 1, there are three tasks conducted to compare the time difference between multipurpose creeper and traditional creeper box. The time starts when the mechanic first movement of the creeper to the car from starting point and the time end when the mechanic reach back to the starting point after finishing the task. There are 10 minutes time saving by using this multifunctional automotive creeper for change oil filter, 15 minutes time saving for change engine oil and 10 minutes time saving for change steering bush.

When mechanic can finish their job earlier than usual, more cars can be repair during the working time and customer also do not need to wait longer for their car to be repair or service in a workshop. This translates to increase in productivity in an automotive workshop

**Table 2.** Actual Cost

No	Item	Cost per unit (RM)	Quantity	Total Cost (RM)
1	Mild Steel (2.5x2.5) cm	25	2	50
2	Rotary Caster	26.70	2	53.40
3	Padded Cushion	Recycle		Recycle
4	Plywood	Recycle		Recycle
5	Bolt & Nut	Recycle		Recycle
6	DC Motor (include remote controller, brushless hub)	553.48	1	553.48
7	Spray Paint	5.90	1	5.90
8	Straight Led Light 7w (detachable)	16.70	1	16
Total				678.78

According to Table 2, the total cost of this Multifunctional Creeper by Using Remote Controller is RM678.78. The price for this creeper is very affordable for the mechanic workshop. With the result of time saving, ergonomic benefits and align with the sustainable development goals, this creeper is very significant in an automotive workshop

## 4 Conclusion

In conclusion, the objective of this study is successfully achieved as to save time for mechanic job by fabricating a creeper controlled by a remote controller with ergonomic design to a human body and enhance efficiency compared to traditional model. With the creation of this product, a workshop can obtain more cost benefit when more cars can be service or repair during stipulated working time. This product is also aligned with the sustainable development goal where this is an innovative approach by modifying conventional automotive creeper to a multipurpose creeper that can help mechanics to finish their job in a short period of time. The construction of this project also using recycle material which can reduce the overall cost and help to save the environment from pollution.

## References

1. U.Nations. *Department of Economic and Social Affairs*. Retrieved from <https://sdgs.un.org/>.(2023, 12).
2. Forster, J. Australian Geographer. Multipurpose Trips and Central Place Theory, 16:2, 120-127. (1994).
3. Chen, J. Y. A remote controller system for home appliances using the internet and radio connection. *International Conference on Robotics and Automation*, 249-254. (2004).
4. Siti Rohana Ahmad, S. A.. Analysis of an Adjustable Topside Mechanic's Creeper for Automotive Repair and Maintenance Using Simulation Methods. *Springer*, 65. (2022)
5. J.H.Heckman. Mechanic's Creeper . *United States Patent Office*, 5. (1997).
6. G.Rush.. Mechanic's Creeper. *P & B Manufacturing Co.* (1995)
7. M. Anisha, J. V.. Design of Mechanical Creeper for Disabled Persons. *Proceedings of the Third International Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV 2021)*, 503. (2021)

# The Design and Development of a Web-Based System: E-PolikuExam

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**Abstract.** The ePolikuExam System is a transformative project developed for Unit Peperiksaan Politeknik Kuching Sarawak, designed to streamline graduation matters and the Credit Transfer and Course Exemption (CTCE) processes. This web-based system fills a critical gap by providing an online platform for previously manual and time-consuming procedures. The primary goal of the ePolikuExam System is to enhance the efficiency and effectiveness of managing graduation and CTCE application. Students can easily submit applications through an intuitive interface, upload necessary documents, and monitor submission status in real-time. Furthermore, administrators can review, approve, or reject applications through a secure, streamlined process. Developed using Agile methodology to meet user needs, the system was created in Visual Studio, while web server was chosen for deployment and testing. The implementation of the ePolikuExam System represents a significant shift from traditional, manual procedures to a more efficient, integrated, and user-friendly online experience. Its originality lies in the seamless integration of various functionalities into a single, user-friendly platform. User feedback and usability testing have demonstrated substantial improvements in user satisfaction and operational efficiency. By transforming how graduation and CTCE processes are managed at Politeknik Kuching Sarawak, it offers a modern, reliable, and user-centric solution that benefits all stakeholders involved.

**Keywords:** Web-based System, Examination, Graduation, CTCE, Unit Peperiksaan, Politeknik Kuching

## 1 Introduction

*Unit Peperiksaan* of Politeknik Kuching Sarawak is responsible for managing all examination-related matters and activities, as well as Issuing Certificates/Diplomas/Academic Transcripts to graduates based on the regulations set by the Polytechnic Examination and Certification Board. The responsibilities of *Unit Peperiksaan* include, Credit Transfer and Course Exemption (CTCE), Grade Improvement for Courses, Completion Confirmation Letters and also application for Academic Transcripts for graduates. Currently, there is no official web-based system in *Unit Peperiksaan* Politeknik Kuching Sarawak. The existing non-web systems are limited to information sharing regarding to examination affairs. The *Unit Peperiksaan* is still relies on the traditional methods for examination-related application, such as, academic transcript requests where students must manually fill out and submit forms in person to the administrators of *Unit Peperiksaan* rather than using modern, digital application processes commonly seen in today's education system. This study aims to develop a web-based system that provides an online application platform for graduation matters and Credit Transfer and Course Exemption (CTCE) for *Unit Peperiksaan* in Politeknik Kuching Sarawak. This development is crucial as it addresses several key issues: it modernizes and streamlines the application process, reduces the administrative burden, and enhances the overall efficiency and accuracy of handling student applications. Additionally, it aligns the institution with contemporary digital practices, thereby improving the user experience for students and staff. The implications of implementing the ePolikuExam System are significant. It will lead to increased operational efficiency, reduced processing times, and improved transparency in the handling of student applications. The system's ability to provide real-time status updates and secure document handling will enhance user satisfaction and trust in the administrative processes. Ultimately, the ePolikuExam System will not only benefit the current stakeholders but also future-proof the institution's examination management practices, ensuring they remain relevant and efficient in an increasingly digital world.

## 2 Literature review

To guide the design and development of ePolikuExam System, it is essential to review existing research and developments in web-based systems for examination administration, online application platforms, and related topics. The literature review



will explore key concepts, theories, and best practices in web-based system design, user interface development, system architecture, security considerations, and usability testing. By synthesizing the findings from relevant literature, this study aims to identify insights, trends, and recommendations that can guide the design and development process of ePolikuExam System. There are three existing web-based systems related to the study.

## 2.1 Sistem Pengurusan Unit Peperiksaan Politeknik Mukah

The Sistem Pengurusan Unit Peperiksaan Politeknik Mukah allows students or graduation of Politeknik Mukah to make applications for Sijil/Diploma Awards, *Surat Pengesahan Tamat Pengajian*, Academic Transcripts and Certificate Diploma online. In addition, students or graduates can check the status of their application through this system after the application is made.



Fig. 1. Interface of Sistem Pengurusan Unit Peperiksaan Politeknik Mukah

## 2.2 Official Website of University Nottingham Malaysia

The University of Nottingham Malaysia is a private university branch campus of the University of Nottingham. The university is situated in Semenyih, Selangor, Malaysia. The campus has an Examinations Office that is responsible for organizing and administering all written exams for the courses offered by the University.

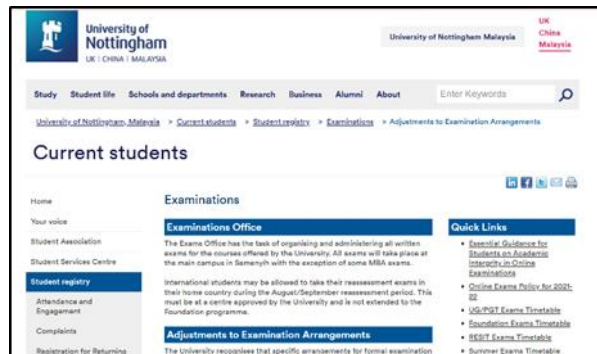


Fig. 2. Interface of Official Website University of Nottingham

## 2.3 Universiti Malaya Academic Administration & Services Department (AASD) Website

The Universiti Malaya Academic Administration & Services Department (AASD) Website is set up with the objective of centralizing all academic services for local and international students for both undergraduate & postgraduate levels, serving as the central platform and one stop centre for this very purpose.

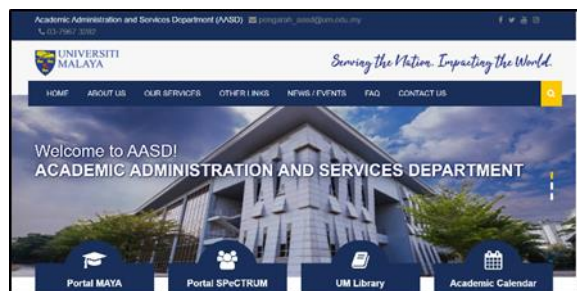


Fig. 3. Interface of the Universiti Malaya Academic Administration & Services Department (AASD) Website



## 2.4 Comparison Table

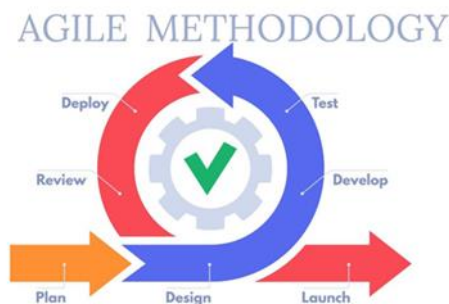
The table below shows a comparison of the features of the systems. By leveraging insights from existing systems and adhering to these key takeaways, the ePolikuExam System can be designed to provide a modern, efficient, and user-centric platform for managing graduation and CTCE processes at Politeknik Kuching Sarawak.

**Table 1.** Comparison table

Features	Sistem Pengurusan Unit Peperiksaan PMU	University Nottingham Malaysia	Academic Administration & Services Department (AASD)	ePolikuExam
Form of application (if any)	Online form	Hardcopy form	Hardcopy form	Online form
(For graduates absent of graduation ceremony)	✓	✗	✓	✓
Application for Sijil/Diploma				
Application for Credit Transfer (CTCE)	✗	✗	✓	✓
Checking Application results	✓	✗	✗	✓
Real-time tracking (Being process/ Being delivery)	✗	✗	✗	✓
User authentication	✓	✓	✓	✓
Email Notification	✓	✗	✗	✓
Interface that is easy to use	✓	✓	✓	✓
Well organized design	✓	✓	✓	✓
FAQs	✗	✓	✓	✓
User Manual	✓	✓	✓	✓

## 3 Methodology

A methodology is a systematic and structured approach used to conduct research or complete a project. It encompasses the methods, techniques, and procedures used to collect and analyse data. A well-defined methodology ensures that the research or project is carried out consistently, objectively, and efficiently. For this study, Agile methodology is the chosen systematic and structured approach to developing a web-based system for *Unit Peperiksaan* in Politeknik Kuching Sarawak. Agile methodology is well-suited for this project due to its iterative and collaborative nature, which allows for flexibility, adaptability, and continuous improvement throughout the development process. The rationale for choosing Agile over other methodologies includes its flexibility and adaptability, allowing for changes in requirements and priorities, which is crucial for a project with evolving stakeholder needs. Agile promotes a collaborative approach among team members and stakeholders, ensuring that the system meets user expectations. Its iterative nature supports continuous feedback and improvement, resulting in a more refined and user-centric system. Additionally, Agile's incremental approach helps identify and mitigate risks early in the development process, reducing the likelihood of project failure. Agile's focus on delivering functional increments of the system ensures that valuable features are developed and deployed quickly, providing immediate benefits to users. There are 6 phases in the agile model used for this study, planning, analysis, design, development, testing and review.



**Fig. 4.** Agile Software Development Life Cycle

### 3.1 Planning

In this phase, the project scope, objectives, and requirements are defined. The product backlog is created, listing all desired features and functionalities of the web-based system. This phase involves engaging key stakeholders, including administrators, department heads, IT staff, and students, to gather requirements and define project goals. Additionally, it

includes identifying potential risks, such as technical challenges and resource constraints, and developing mitigation plans to address them

### 3.2 Analysis

During the analysis phase, the detailed analysis of user needs, expectations, and workflows are conducted. User stories are developed to capture specific user requirements and scenarios. Data collections and suggestions are gathered through discussion with the officers of *Unit Peperiksaan* Politeknik Kuching to develop the system that aligns with the requirements. Flow chart is also created to outline the system's functional parts. Additionally, in this phase, data handling practices involve collecting and analyzing data from existing manual processes to pinpoint pain points and areas for improvement, all while prioritizing data security and privacy. Additionally, defining evaluation criteria for system performance, usability, and user satisfaction based on stakeholder feedback and industry standards ensures a comprehensive approach to assessing the effectiveness and usability of the system being developed.

### 3.3 Design

In the design phase, detailed plans for the system are created. This includes defining the system's structure, user interface, and data models. Storyboards are used to visualize the user's journey and interactions, helping to improve the design. Diagrams such as flowcharts, use case diagrams, and sequence diagrams are created to map out the system's processes and user interactions. Additionally, focus is given to database design and maintaining a data dictionary. Ensuring a user-friendly interface is key. This thorough planning lays a strong foundation for development, ensuring all parts of the ePolikuExam System work well together and are easy to use

### 3.4 Development

Once the requirements are defined based on feedback from the *Unit Peperiksaan* officer, the development phase begins. In this phase, tasks are broken into smaller iterations and delivered continuously, building the system incrementally until the final version of the unit exam system is produced. For each iteration, code is written for the selected task, developing both the front-end and back-end of the ePolikuExam system based on the design. Tasks may include creating webpages and implementing features like online application forms and notifications. At the end of each iteration, a working component is delivered. Development tools include hosting server for the development environment, with MySQL for database management. Code is written using programming languages such as HTML, CSS, Java, and PHP. During the implementation stage, tasks like system changeover (transitioning from the old system to the new one) and data conversion (adapting existing data to fit the new system) may be necessary.

### 3.5 Testing

In the testing phase, both automated and manual testing are conducted to ensure the system functions correctly and meets quality standards. Testing is done continuously throughout development to catch and fix any issues. After coding, each program is tested for proper operation, with testing preferred after each iteration in the Agile lifecycle. There are two types of system testing:

- i. Unit Testing: Tests individual programs, like the login function.
- ii. Integration Testing: Tests combined modules that depend on each other, like menu navigation.

Any bugs found during testing are prioritized and fixed promptly. Comprehensive testing is completed, results are recorded, and the system is released into production. Feedback from stakeholders is then gathered and used for improvements in the next sprint

### 3.6 Review

In the review phase, completed increments of the system are evaluated against project objectives and requirements. Feedback is gathered from stakeholders, including *Unit Peperiksaan* administrators and end-users (students), to inform further refinements. This evaluation checks if the ePolikuExam functions as intended and meets user requirements and objectives. It helps determine whether the system advances to the next iteration or needs incremental improvements.

## 4 Technology used / Software package for development

The ePolikuExam System was developed using a combination of modern technologies and software packages.

### A Hypertext Preprocessor

PHP (Hypertext Preprocessor) is a widely-used open-source scripting language especially suited for web development. It is used to create dynamic content that interacts with databases, hence it is highly suitable and ideal choice for developing the ePolikuExam system. ePolikuExam system is written in PHP scripting language, and since PHP runs seamlessly on various operating systems, it is easy to deploy and maintain on the internet.

### B Web Server

A web server is a computer system or software that serves web pages to users over the internet. It is a platform that hosts websites and provides services to clients upon request. When a user requests a web page by entering a URL in their browser, the web server processes this request and delivers the corresponding content to the user's browser. In this study, the 000webhost server is selected to deploy the web application. It is a web hosting service that offers free and premium hosting solutions for websites, allowing users to host their sites and access various web services.

### C Bootstrap

Bootstrap is a free, open-source front-end development framework used for creating websites and web applications. It is designed to facilitate the responsive development of mobile-first websites by offering a set of syntax for template designs. In this research, the interface layout of the ePolikuExam system is constructed using Bootstrap. It is crafted utilizing Hypertext Markup Language (HTML), Cascading Style Sheets (CSS), and JavaScript to produce web pages that are responsive, interactive, and dynamically adaptable.

## 4.1 Logical Design

The logical design of the ePolikuExam System can be represented in user system flowcharts. In this system, there are three actors involved which are student, administration, and head of departments (KJ) / head of program (KP). Students can use the system to apply online for graduation matters, and for Credit Transfer and Course Exemption (CTCE). Students have access to view the status of their applications through the system. Meanwhile, the administration has authority to enhance the system by implementing modifications, updates, and adding functionalities as required. Administrators can review and manage student applications to approve or reject applications based on the completeness of information. The Head of Departments and Head of Programs on the other hand are able to manage the CTCE approval. The figure below shows the flowcharts for each actor involved in the ePolikuExam system.

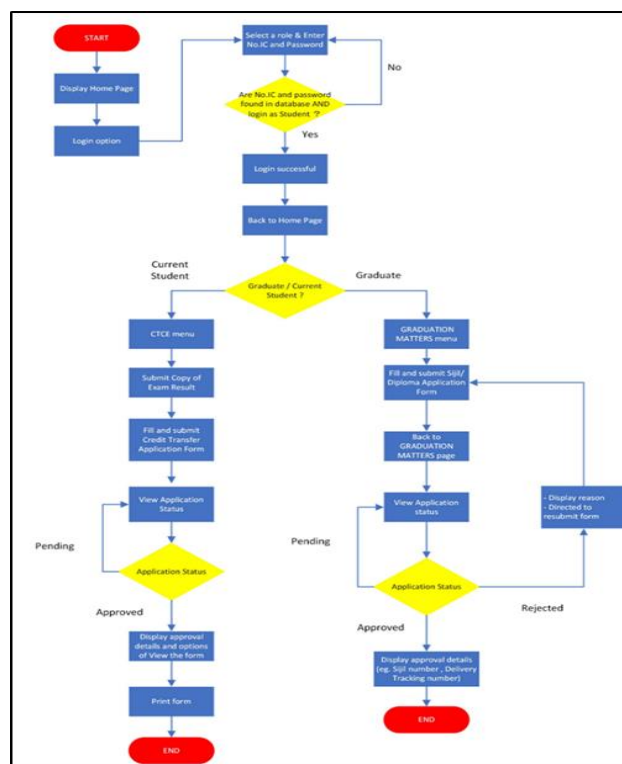


Fig. 5. User flowchart for student

```

graph TD
    Start([START]) --> Input[From No. 8 and password]
    Input --> Decision1{New No. 8 and password is valid according to the rules in 8.10.1?}
    Decision1 -- No --> Input
    Decision1 -- Yes --> Login[Login successful]
    Login --> DisplayLMS[Display LMS Management page]
    DisplayLMS --> ViewCDEForm[View CDE form]
    ViewCDEForm --> End1([End])
    DisplayLMS --> ViewCDEAppForm[View CDE Application form]
    ViewCDEAppForm --> SpecifyReply[Specify solution & reply]
    SpecifyReply --> Action{Action}
    Action -- Approve --> SelectMonitoring[Select Monitoring of Tables displaying for each business]
    SelectMonitoring --> Submit[Submit]
    Submit --> End2([End])
    Action -- View --> DisplayAppForm[Display the Application form]
    DisplayAppForm --> End3([End])
  
```

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**Fig. 9.** Graduate interface

**Fig. 10.** Application form interface

Approved Details	
Date of latest application	2023-10-18 14:28
Date of complete process	2023-10-18 14:28
No. Tuntutan	1000000
No. Tuntutan	1000000

**Fig. 11.** Application status interface

*B Admin interface*

**Fig. 12.** Dashboard interface

**Fig. 13.** Manage form interface

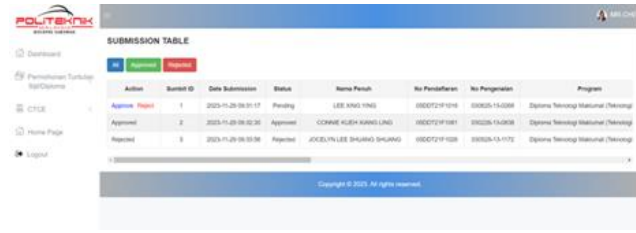


Fig.14. View Application submission interface

*C Head of Department/Head of Programme interface*



Fig. 15. View submission interface

## 5 Result and discussion

### 5.1 Result

System testing presents a structured presentation of the results, incorporating performance evaluation and user feedback to provide a comprehensive assessment of the ePolikuExam System. There are two types of system testing:

- Unit Testing: testing individual units or components of a software application in isolation from the rest of the system. It is a fundamental part of software development where each unit (such as functions, methods, or classes) is tested to ensure that it performs as expected.
- Integration Testing: individual units or components are combined and tested as a group.

#### *A Unit Testing*

Table below shows the unit testing for login.

Table 2: Unit Testing

Test No.	Test Case Name	Test Procedure	Pre-condition	Expected Result	Tester	Result (Pass/Failure)
UT001	Login as Admin	Admin select admin/KJKP option, fill the IC number and password field	None	- Display dialog successful login - Go to admin interface.	Neelam	Pass
UT002	Login as Head of Department/Head of Programme	Admin select admin/KJKP option, fill the IC number and password field	None	- Display dialog successful login - Go to KJKP interface.	Neelam	Pass
UT003	Login as graduate	Students select graduate option, fill the IC number and password and click login button.	None	- Display dialog successful login - Go to homepage ePolikuExam. - Graduation option is available on menu bar	Neelam	Pass
UT004	Login as current student	Students select current student option, fill the IC number and password and click login button.	None	- Display dialog successful login - Go to homepage ePolikuExam. - CTCE option is available on menu bar.	Neelam	Pass
UT005	Logout	User click on logout button	Login account	User logged out and directed to homepage	Neelam	Pass
UT006	Login with invalid data	User login using invalid IC number or password then login	None	Prompt message error	Neelam	Pass
UT007	Login with missing input	User leave one or more required fields blank then login.	None	Display alert at missing fields	Neelam	Pass
UT008	Login with incorrect role selected	User select incorrect role then login	None	Prompt message error	Neelam	Pass

## B Integration Testing

Tables below shows the integration testing for each combined module.

**Table 3.** Integration testing

No.	Test Case Name	Test Procedure	Pre-condition	Expected Result	Tester	Result (Pass/Failure)
IT001	Login	User click on "Login" button on the header	None	Directly go to Homepage after login	Neelam	Pass
IT002	Homepage	User clicks on "Home" options on the navigation bar	None	Go to the homepage	Neelam	Pass
IT003	Graduation Page	User clicks on "Graduation" options on the navigation bar	Logged In	Go to the Graduation Page	Neelam	Pass
IT004	CTCE Page	User clicks on "CTCE" options on the navigation bar	Logged In	Go to the CTCE Page	Neelam	Pass
IT005	Contact	User click on the contact links at the footer	None	Navigate to contact	Neelam	Pass
IT006	Quick Links	User click on the Quick links at the footer	None	Navigate to the corresponding website	Neelam	Pass
IT007	Social media navigation	User click on the social media icon at the footer	None	Navigate to the social website	Neelam	Pass
IT008	Submit <del>sijil</del> application form	After entering the required data then click on submit button	Logged in	Submit successfully and available to view status	<del>Safinah</del>	Pass
IT009	View status <del>sijil</del> application	User click on the view status on the graduation page	User had submitted <del>sijil</del> diploma application form	Get directed to 'Status Application Page'	<del>Safinah</del>	Pass
IT010	Submit CTCE application form	After entering the required data then click on submit button	Logged in	Submit successfully and available to view status	<del>Safinah</del>	Pass
IT011	View status CTCE application	User click on the view status on the CTCE page	User had submitted a CTCE application form	Get directed to 'Status Application Page'	<del>Safinah</del>	Pass
IT012	View and Print form	Users click on 'View and Print form' options	The application has been approved	Display the completed form, the details of approval, and the options available to print form.	<del>Safinah</del>	Pass
IT013	View submission of application form	After submitted, admin can view the submission of application form	None	The page displays the status of application (Pending/Approve/Reject)	<del>Safinah</del>	Pass
IT014	View submission of CTCE form	After submitted, KPKJ can view the submission of CTCE form	None	The page displays the status of application (Pending/Approve)	<del>Safinah</del>	Pass

## 5.2 Discussion

The results of the system testing demonstrate that the ePolikuExam System effectively meets its primary goal of enhancing the efficiency and effectiveness of managing applications related to graduation and CTCE. Overall, the implementation of the ePolikuExam System represents a significant advancement in streamlining graduation matters and CTCE processes at *Unit Peperiksaan Politeknik Kuching Sarawak*. By providing a modern, reliable, and user-friendly online platform, it offers tangible benefits to students, administrators, and department heads, ultimately improving the overall experience for all stakeholders involved.

### 5.2.1 Potential Limitation

Despite its strengths, the ePolikuExam System may encounter several potential limitations. The ePolikuExam System introduces a dependency on internet access, requiring users to connect via wireless internet or mobile data to access and



utilize its web-based functionalities. This dependency ensures that all interactions with the system, including application submissions and status monitoring, are contingent upon internet availability. Additionally, while the system provides administrators the capability to reject incomplete applications, there exists a risk that it may not always effectively identify all missing information, potentially resulting in applications being rejected due to minor oversights or misunderstandings that could be clarified through improved validation mechanisms or clearer user guidance.

### 5.2.2 Suggestions for Future Research or Development

To enhance the ePolikuExam System, several improvements can be considered. Firstly, implementing a mobile application would significantly enhance the user experience for students by allowing them to conveniently access graduation matters and CTCE features directly from their smartphones, catering to the growing trend of mobile device usage. Secondly, expanding security measures with biometric authentication for student access to sensitive information would add an additional layer of security, ensuring only authorized users can access and modify critical data, thereby safeguarding sensitive information within the system.

## 6 Conclusion

The development and implementation of the ePolikuExam System represents a transformative advancement in the management of graduation matters and CTCE processes at *Unit Peperiksaan Politeknik Kuching Sarawak*. The online application process has been significantly simplified, offering efficient solution that benefits students, administrators, and department heads alike, thereby eliminating the constraints of physical submissions. Real-time tracking and automated notifications further contribute to a seamless experience, empowering students and ensuring prompt reviews by administrators. In conclusion, the ePolikuExam System not only makes tasks easier and faster but also sets a new standard for modernizing educational administrative practices, demonstrating its significant impact on operational efficiency and user satisfaction within the institution.

## References

1. Christian Paul W. Apiag, E. B.. *A Review on PHP Programming Language*. (2023)
2. Dr. Alexander Pons.. *Evaluation of Server-Side Technology For Web Deployment* . (2023)
3. Dzulkipli Marasan, N. Z.. Development of Web Based Examination Question Bank Record Keeping System. *International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)* , 11. (2022)
4. Dzulkipli Marasan, N. Z.. The development of e-Equation System (3E System). *International Seminar of Science and Applied Technology: Natural Resources Management for Environmental Sustainability (ISSAT 2023)*, 1-12. (2023)
5. Mrunmayee Gondhalekar, Y. P.. Agile Methodologies . *International Journal of Trend in Scientific Research and Development (IJTSRD)*. (2021)
6. Panthangi Venkateswara Rao, V. P.. Applying Agile Software Methodology for the . *Journal for Research / Volume 04 / Issue 02 / April 2018*, 90. (2018)
7. Samar Alsaqqa, S. S.-N.. *Agile Software Development: Methodologies and Trends*. *International Journal of Interactive Mobile Technologies (ijim)*. (2020)



# Healthcare Services Chatbot – The Evolution of Healthcare Assistance in Digital Era

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**Abstract.** In recent years, chatbots have been rapidly developing and advancing in various fields. In the healthcare sector, they can solve several challenges like patient engagement, appointment scheduling, or help to find whether they have the flu or fever. This paper offers an in-depth overview of prior research on the usage of chatbots in healthcare. It assesses creation, application, and findings from applications of chatbots in several healthcare sectors. Besides, the review provides an assessment of the supporting technology that underpins healthcare applications, such as machine learning algorithms or NLP. It also evaluates capabilities of chatbots to assist healthcare managers in various jobs or maximise patient interaction, deliver customised health information, or make remote consultations. We also go over the opportunities and problems that come with integrating chatbots into healthcare systems, including concerns about security, privacy, and ethics. We hope that this assessment will clarify the ways in which chatbots could transform the way healthcare is delivered and point up directions for further study and advancement in this quickly developing area.

**Keywords:** Chatbot, NLP, OpenAI, Flask, Python, Healthcare Assistance

## 1 Introduction and literature review

### 1.1 Overview of chatbot in healthcare sector

#### 1.1.1 What are chatbot?

A chatbot is a piece of software that facilitates text-based online chat conversations by putting users in direct communication with real human agents. Chatbots are computer programs created to mimic human-user communication, usually via text-based user interfaces like messaging applications or webpages. They are driven by artificial intelligence algorithms, which allow them to comprehend human input in plain language and produce relevant responses. Chatbots are useful for many things, such as entertainment, information retrieval, and customer support. They range from basic rule-based systems to highly advanced machine learning models that can understand context and give answers that are practically indistinguishable from humans. In the project, we have the rule-based system, and finally, we will use methodologies like the flask and OpenAI API whereby given the input by the user, we shall be able to get a response that looks like a human.

#### 1.1.2 Chatbot's in healthcare sector

Healthcare services chatbots are specifically designed to address the following:

1. *Symptom Evaluation:* This kind of technology could ask a patient to talk about their symptoms and then use that information to make an initial diagnosis or suggest what they should do next.
2. *Booking Appointments:* People can book, reschedule or cancel appointments with doctors through chatbots. The chatbot may also check when there is space free and give confirmation details.
3. *Educating Patients:* Chatbots can offer patients knowledge on a variety of medical conditions, treatment options, preventive care measures as well as healthy living tips so that they can be able to make informed decisions about their well-being.
4. *Medication Reminders:* Chatbots can give dosing instructions, notify patients of possible side effects or drug interactions, and remind patients to take their meds on time.
5. *Telemedicine Facilitation:* Chatbots can assist patients with scheduling appointments, finishing pre-appointment questionnaires, and gaining access to virtual appointment links in order to start telemedicine consultations.
6. *Health Surveillance* Chatbots can gather and analyze patient data, such as vital signs, exercise circumstances, and sleep patterns, to provide personalized health insights and suggestions for treating chronic illnesses.

7. *Help in an Emergency:* Chatbots can give users fast advice on calling emergency services and getting the right medical assistance in an emergency.
8. *Language Translation:* Chatbots that possess language translation skills can converse with patients in the language of their choice, enhancing accessibility for a variety of patient demographics

## 1.2 Importance of chatbot in healthcare sector

Here are some factors that states the importance of chatbots in healthcare services:

1. *24/7 Availability:* Even beyond regular business hours, patients can receive round-the-clock support via chatbots, which can provide prompt answers to their questions and concerns. This minimizes waiting times for care or information by guaranteeing that patients have access to assistance anytime they need it.
2. *Efficient Triage and Appointment Booking:* By evaluating a patient's symptoms and guiding them to the right treatment levels, chatbots can assist patients in the triage process. Chatbots can increase scheduling efficiency and lessen administrative constraints on healthcare workers by automating the appointment booking procedure.
3. *Improved Patient Engagement:* Chatbots converse with patients in an interactive manner while offering individualized health information, guidance, and assistance. Patients are encouraged to take charge of their health, which promotes improved adherence to treatment programs and healthier lifestyle selections.
4. *Scalability and Cost-Effectiveness:* Because chatbots can manage several conversations at once, they are scalable technologies that help healthcare businesses handle high patient inquiry and interaction volumes. Patient wait times can be shortened and resource usage can be maximized with this scalability.
5. *Remote Monitoring and Chronic Disease Management:* Chatbots with remote monitoring features can gather and examine patient information, including medication adherence and vital signs, to monitor the course of a condition and deliver prompt interventions. This lessens the need for frequent in-person consultations and enables proactive management of chronic illnesses.
6. *Better Access to Healthcare Services:* Chatbots that provide virtual consultations might help close gaps in healthcare access, particularly in underserved or remote areas where access to medical facilities may be restricted. This lessens healthcare delivery inequities and improves accessibility to healthcare.
7. *Providing Information to Patients:* Chatbots provide patients with pertinent health information and resources, enabling them to decide on their course of treatment and general well-being. Patient satisfaction with their care experiences and health literacy may both increase as a result of this.
8. *Data-Driven Insights and Decision Support:* Chatbots gather useful information from patient interactions, which can be examined to spot patterns, areas where care is lacking, and ways to enhance the way healthcare is provided. Healthcare businesses are able to optimize treatment procedures and make well-informed decisions thanks to this data-driven strategy

## 1.3 Natural Language Processing (NLP)

A branch of artificial intelligence called "natural language processing" looks at how computers and human language interact. It makes it possible for computers to meaningfully and practically perceive, understand, and produce human language. NLP analyzes and interprets textual data using a range of techniques. This includes tokenization jobs. It covers a variety of topics, such as deep learning, machine learning, language production, and comprehension

## 1.4 Traditional Approach vs Modern Approach

### 1.4.1 Traditional Approach

1. *Rule-based systems:* In the traditional approach, healthcare chatbots are often built using rule-based systems. These systems follow predefined rules and responses based on keywords or patterns detected in user inputs.
2. *Limited functionality:* Traditional chatbots may have limited functionality and may struggle to handle complex queries or understand natural language inputs accurately.
3. *Static responses:* Responses provided by traditional chatbots are usually static and may not adapt well to the specific needs or context of the user.
4. *Minimal personalization:* Traditional chatbots may lack personalization, providing generic responses that do not take into account the individual's medical history, preferences, or specific needs.
5. *High maintenance:* Rule-based systems require frequent updates and maintenance to keep up with changes in medical knowledge, terminology, and user needs.

### 1.4.2 Modern Approach

1. *AI and machine learning:* Modern healthcare chatbots leverage artificial intelligence (AI) and machine learning algorithms to understand and respond to user queries more accurately.

2. *Natural language processing (NLP)*: NLP techniques enable modern chatbots to understand and generate human-like responses, allowing for more natural and effective interactions with users.
3. *Personalization*: Modern chatbots can provide personalized responses and recommendations based on the user's medical history, preferences, and real-time data, leading to a more tailored and engaging user experience.
4. *Integration with data sources*: Modern chatbots can integrate with electronic health records (EHRs), medical databases, and other data sources to provide comprehensive and up-to-date information to users.
5. *Continuous learning*: AI-powered chatbots can learn from user interactions and feedback, continuously improving their performance and adapting to changing user needs and preferences.
6. *Multi-channel support*: Modern chatbots can be deployed across various channels such as websites, mobile apps, messaging platforms, and voice assistants, providing seamless access to healthcare information and services.
7. *Scalability*: AI-powered chatbots are highly scalable and can handle a large volume of user queries simultaneously, making them suitable for healthcare organizations of all sizes.

## 1.5 Objectives of the paper

The goal of this research paper is to thoroughly examine the creation, application, and effects of chatbot technology within healthcare services, given the quickly changing field of healthcare technology and the growing need for easily accessible, effective, and customized healthcare services. The specific objectives of this research are as follows:

1. Assess the capabilities and limitations of the most recent state-of-the-art chatbot technologies in the healthcare industry, including natural language processing (NLP), machine learning techniques, various frameworks like flask, and conversational design.
2. Examine the various uses of chatbots in the healthcare industry, including post-discharge follow-ups, appointment scheduling, medication reminders, and patient triage. Pay particular attention to how these applications could improve patient satisfaction, engagement, and health outcomes.
3. Evaluate the usability and user experience (UX) of chatbots for healthcare across a range of demographics, such as patients, carers, and medical professionals, in order to pinpoint design elements that support efficient communication and uptake.
4. Examine the ethical and privacy considerations associated with deploying chatbots in healthcare settings, including data security, confidentiality, informed consent, and algorithmic bias, to ensure compliance with regulatory standards and safeguard patient rights.
5. Examine the resource and cost-effectiveness of incorporating chatbots into healthcare processes, taking into account possible savings on administrative tasks, provider workloads, and medical expenses, all while preserving or raising the standard of care.
6. Examine the obstacles and hindrances to the extensive integration of chatbots for healthcare, including technological impediments, societal acceptability, opposition from healthcare stakeholders, and legal ramifications. Subsequently, suggest approaches for a smooth and expandable rollout.
7. Examine the most recent advancements in AI-driven customized medicine, as well as how chatbots are incorporated into electronic health records (EHRs), compatible with various healthcare systems, and used in telemedicine and remote patient monitoring.

By addressing these goals, the research paper hopes to offer insightful information about the possible advantages, difficulties, and factors to take into account when incorporating chatbot technology into healthcare services, ultimately advancing patient-centered, easily accessible, and effective healthcare delivery."

## 2 Proposed methodology

- a. **Data Collection**: Identify the sources of information about healthcare, including patient FAQs, medical records, and databases. - Compile and preprocess data to provide a suitable corpus for the chatbot's training.
- b. **Choosing the Right NLP Models and Techniques**: Choose the appropriate NLP models and techniques for the chatbot, considering factors like entity extraction, intent identification, and answer generation; - Try out various pre-trained models or train your own models using the given dataset.
- c. **Integration with OpenAI**: Examine how OpenAI's technology can be used to enhance the chatbot's functionality. - Integrate OpenAI's language models using our own OpenAI API key to produce responses that are more logical and appropriate for the given context.
- d. **Chatbot Development**: Use the Python programming language and the Flask framework to create the chatbot application. Use OpenAI's API and NLP approaches to implement user interaction, input processing, and response generation functionalities.
- e. **Assessment**: Establish assessment criteria, such as accuracy, response time, user happiness, and job completion rate, to gauge the chatbot's effectiveness. - Test the chatbot's usability and get input from prospective users to determine its advantages and disadvantages.

### 3 Challenges of chatbots in healthcare services:

1. **Security and privacy:** It's critical to make sure that the sensitive patient data that chatbots gather is both private and safe. Regulations like HIPAA pertaining to data protection must be followed by healthcare providers.
2. **Accuracy:** When offering medical recommendations and guidance, chatbots need to be precise. If the chatbot gives false information, there could be dire repercussions
3. **Integration with current systems:** To offer a smooth patient experience, chatbots must be connected with current healthcare systems. The intricacy of healthcare IT systems makes this difficult at times

### 4 Design and implementation

HTML, CSS, and JavaScript will be used to design the chatbot's user interface, which will include text areas for users to enter their questions and other ways for users to communicate with the chatbot via text. The backend server will be Flask, with routes configured to accept and handle incoming requests from the user interface. Various methods in Python will be developed to interface with both the OpenAI API and the NLP model. NLTK and other NLP packages will be used to preprocess user queries in order to remove noise, tokenize text, and extract pertinent data. After gaining access to the knowledge base containing information about the user's inquiry, the chatbot will produce a pertinent response depending on the question, entities, and intent.

Let's break this down with an example. For simple questions entered by the user, the chatbot may respond with pre-programmed answers from its knowledge base; however, for more intricate and customized inquiries, the chatbot may employ AI and natural learning techniques to generate responses on the fly.

### 5 Conclusion

The creation of a healthcare services chatbot for sanatorium administration is a crucial step to improved patient care, streamlining executive operations, and adding overall effectiveness in healthcare institutions. Our exploration, which uses Python, NLP styles, OpenAI, and Flask, has shown that chatbots have the eventuality to alter the way hospitals engage with cases and manage operations.

In conclusion, our study achieved the following key outcomes:

1. **Enhanced Accessibility:** Patients may easily seek medical help, make appointments, obtain healthcare information, and get fast answers to their questions on the healthcare chatbot.
2. **Efficient Resource Utilization:** The chatbot frees hospital staff to concentrate on more intricate and crucial aspects of patient care by automating repetitive tasks like appointment scheduling, billing inquiries, and medication reminders. This reduces administrative burden and optimizes resource utilization.
3. **Improved Patient Experience:** The chatbot's capacity to comprehend natural language inquiries, deliver precise information, and make tailored recommendations improves the patient experience in general, which raises satisfaction and increases patient involvement.
4. **Cost-Effectiveness:** By lowering the need for manual interventions, implementing a chatbot for hospital management can save a lot of money.
5. **Scalability and Adaptability:** The chatbot's modular architecture, which was developed with Flask, makes it simple to scale and adapt to changing healthcare requirements and technology developments. Furthermore, by integrating with OpenAI's technology, the chatbot's capabilities are improved and its relevance in the quickly evolving healthcare industry is ensured.

In the future, research and development efforts can concentrate on enhancing the chatbot's functionalities, broadening its scope to encompass new healthcare services, facilitating seamless data exchange with electronic health record systems through integration, resolving any security and sequestration issues related to patient data, and delivering a better case outcome.

The study's healthcare services chatbot, which offers several advantages in terms of accessibility, efficacy, patient experience, and cost-efficiency, is a promising result for sanatorium operations. We can continue to expand the capabilities of healthcare chatbots and bring about positive change in the healthcare sector by utilizing innovation and technology.

## References

1. Esteban Vazquez Becerra, G., Bennett, R. A., Chávez, M. C., Trejo Soto, M. E., & Zhou, L., Blackley, S. V., Kowalski, L., & Doan, R. (2017). Chatbots in health care: A promising tool for ethical practices and regulatory compliance. In *IEEE International Conference on Healthcare Informatics (ICHI)* (pp. 523-527). IEEE.
2. Abd-Alrazaq, A., Alajlani, M., Alalwan, A. A., Bewick, B. M., & Gardner, P. (2019). A scoping review of health chatbots: Examining the range of topics, user types, and purposes. *Journal of Medical Internet Research*, 21(4), e13804.
3. Rajkomar, A., Dean, J., & Kohane, I. (2019). Machine learning in medicine. *New England Journal of Medicine*, 380(14), 1347-1358.
4. Nguyen, A. T., Doan, N. T., & Phan, D. T. (2018). Applying recurrent neural network for drug–drug interaction extraction from biomedical text: An evaluation study. *Computer Methods and Programs in Biomedicine*, 153, 137-145.
5. Vaidyam, A. N., Wisniewski, H., Halamka, J. D., Kashavan, M. S., & Torous, J. B. (2019). Chatbots and conversational agents in mental health: A review of the psychiatric landscape. *Canadian Journal of Psychiatry*, 64(7), 456-464.
6. Li, H., Wu, X., Luo, J., & Xiao, J. (2020). Towards ethical guidelines for designing conversational agents: The effects of designer, user, and AI agent attributes. *Journal of the Association for Information Science and Technology*, 71(1), 65-79.
7. Alanazi, H. O., Abdullah, A. H., & Qureshi, K. N. (2018). Mining Twitter data using distributed clustering for healthcare recommendations. *IEEE Access*, 6, 37272-37281.
8. Shortliffe, E. H., & Sepúlveda, M. J. (2018). Clinical decision support in the era of artificial intelligence. *JAMA*, 320(21), 2199-2200.
9. Bozkurt, S., & Bogaard, T. (2018). Evaluating the performance of machine learning algorithms for the detection of patients with severe sepsis. *Journal of Medical Systems*, 42(7), 128.
10. Manish Bali, Samahit Mohanty, Subarna Chatterjee, Manash Sarma, Rajesh Puravankara, “Diabot: A Predictive Medical Chatbot using Ensemble Learning”, *International Journal of Recent Technology and Engineering (IJRTE)* ISSN: 2277-3878, Volume-8 Issue-2, July 2019
11. Adamopoulou E, Moussiades L. An overview of chatbot technology. *IFIP Advances in Information and Communication Technology*, vol 584; AIAI 2020: Artificial Intelligence Applications and Innovations; June 5-7, 2020; Neos Marmaras, Greece. 2020. May 29, pp. 373–383

# Development of Smart Walking Cane Using Pico Raspberry Pi, IOT and Mobile Apps

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**Abstract.** In Malaysia, individuals with visual impairments encounter considerable difficulties in navigation and independent mobility. This paper details the design and implementation of a smart walking cane, specifically developed to improve accessibility and user experience for blind individuals. The smart walking cane integrates various advanced technologies, such as a Global Positioning System (GPS) module for real-time communication, ultrasonic sensors, infrared sensors, proximity sensors, and a vibration motor. A Raspberry Pi microprocessor serves as the core processing unit, supplemented by sound output for auditory feedback. The GPS module enables precise location tracking, allowing family members to locate the smart walking cane in emergencies. Ultrasonic, infrared, and proximity sensors provide extensive environmental awareness by detecting obstacles and terrain changes. The vibration motor delivers haptic feedback, warning users of potential hazards in their vicinity. Moreover, the smart walking cane connects seamlessly with mobile applications, offering an intuitive interface for users to customize settings and receive real-time updates. This integration provides a comprehensive solution that enhances the mobility, safety, and independence of visually impaired individuals. The proposed solution addresses the immediate needs of blind individuals in Malaysia and sets a precedent for future innovations in assistive technology. The final development phase will conduct field tests and user feedback to assess the effectiveness of the smart walking cane. These evaluations will involve users from the Society of Blind Malaysia, Sarawak branch, located in Kuching.

**Keywords:** GPS, Ultrasonic Sensors, Infrared Sensors, Proximity Sensors, Vibration

## 1 Introduction

In recent years, the integration of technology into assistive devices has significantly enhanced the quality of life for individuals with disabilities (Abner & Lahm, 2002; Bouck, 2016). Among these advancements, the development of smart canes stands out as a transformative innovation for the visually impaired (Jain & Singh, 2019). This paper focuses on the development of a Smart Walking Cane utilizing Pico Raspberry Pi, Internet of Things (IoT) technology, and mobile applications, specifically tailored for the blind community in Malaysia.

Malaysia, with its diverse and rapidly growing urban landscapes, presents unique challenges for visually impaired individuals (Lim, 2018). Navigating busy streets, crowded public transport, and complex urban environments requires tools that can provide real-time guidance and safety. Traditional canes, while useful, offer limited assistance in detecting obstacles beyond physical reach or providing navigational directions (Yusof & Abdullah, 2017).

The Smart Walking Cane aims to bridge this gap by integrating modern technology to enhance mobility and independence for the blind. The Pico Raspberry Pi, a versatile and compact microcontroller, enables the integration of various sensors and connectivity options into the cane (Raspberry Pi Foundation, n.d.). IoT technology further enhances the device's capabilities, allowing it to communicate with mobile applications and other smart devices. This connectivity provides users with real-time updates and feedback, ensuring safer and more efficient navigation (IoT for All, 2020).

Mobile applications developed alongside the Smart Walking Cane serve as an interface for users to customize their cane's settings, receive notifications, and access additional features such as location tracking and emergency alerts. Individuals with visual impairments can easily access and use these applications due to their user-friendly interface design (Proulx et al., 2016).

In this development project, the emphasis on Malaysia acknowledges the specific needs and challenges faced by the country's blind community. By focusing on local requirements, such as language preferences, common urban navigation obstacles, and cultural considerations, the Smart Walking Cane aims to offer a highly relevant and effective solution (Malaysian Association for the Blind, n.d.).

This paper will delve into the technical aspects of the Smart Walking Cane, including the hardware and software components, the design and development process, and the implementation of IoT and mobile app integration. Furthermore, it will discuss the potential impact of this technology on the lives of blind individuals in Malaysia, highlighting user feedback and future improvements. By leveraging cutting-edge technology, the Smart Walking Cane represents a significant step

forward in assistive devices, offering new levels of independence and confidence to visually impaired individuals in Malaysia and beyond.

## 2 Literature review

Phan (2021) meticulously examined the development of an innovative smart walking stick designed to assist visually impaired individuals. This device integrates ultrasonic and infrared sensors, a vibration motor, a buzzer, and a GPS module to enhance obstacle detection and provide real-time location tracking via a smartphone app. The study highlights the limitations of traditional white canes and underscores the necessity of comprehensive real-world testing to validate the device's efficacy and dependability. Akhil et al. (2022) described the creation of a smart walking stick intended to improve the safety of visually impaired individuals as they navigate their environment. This stick features infrared sensors for detecting staircases, ultrasonic sensors for identifying obstacles within a four-meter range, and a water sensor. The system uses an Arduino UNO R3 microcontroller to provide real-time feedback through a buzzer. The study emphasizes the practicality, affordability, and effectiveness of this device in obstacle detection. Additionally, future enhancements such as GPS integration for location tracking and Global System for Mobile communication (GSM) modules for emergency communication are discussed as potential improvements.

Vanitha et al. (2018) proposed an advanced smart walking stick that utilizes a Raspberry Pi microprocessor to integrate various sensors and a camera. The device is equipped with four ultrasonic sensors for obstacle and pothole detection, as well as a camera for object and text recognition. Audio feedback is provided through earphones, enabling the stick to function as a virtual eye for users. The paper emphasizes the device's ability to deliver real-time environmental information and its superiority over current technologies, attributed to the incorporation of digital image processing and computer vision techniques. Setiadi (2023) introduced an adaptive stick that assists visually impaired individuals with sound and vibration alerts for obstacles detected within a range of 1 to 15 feet. The stick is compact (13.4 cm) and lightweight (128 grams), making it simple to handle without interfering with other senses. It includes an on/off switch, a mode selection button, and a Universal Serial Bus (USB) charging port, with a battery life of up to two days and plug-and-play functionality.

Ganesan et al. (2020) developed a smart stick using a Raspberry Pi with ultrasonic sensors and a camera for real-time object recognition. Images are sent to the cloud for analysis, and voice commands are issued to the user. The stick also includes GPS navigation and a radio frequency (RF) system for locating the stick, enhancing safe and independent navigation. Odong et al. (2018) designed a smart stick incorporating ultrasonic and water sensors for detecting obstacles and water. It also features an RF system for locating the stick, is lightweight, energy-efficient, and provides auditory and vibratory alerts. Sakib et al. (2018) developed a smart stick with ultrasonic and proximity sensors for detecting obstacles, water, and moving objects. The system includes GPS for emergency location sharing, thereby improving mobility and safety through real-time auditory and vibratory feedback.

Another design by Odong et al. (2018) included ultrasonic sensors for obstacle detection and water alerts, along with an RF system for locating the stick. This lightweight and energy-efficient stick provides reliable auditory and vibratory feedback, enhancing the mobility and independence of visually impaired individuals.

Table 1 below summaries the findings from previous works on the development of assistive technology for blind people.

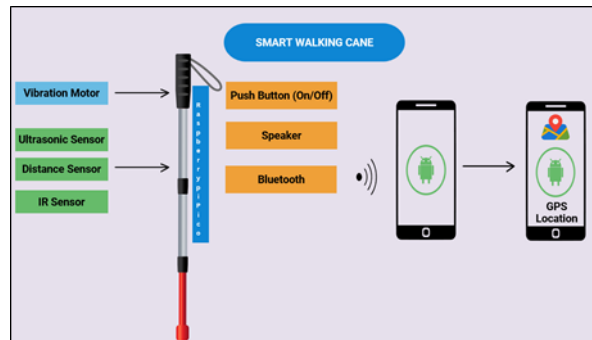
**Table 1.** Summary of Previous Works

Study	Advantages	Disadvantages
Phan (2021)	<ul style="list-style-type: none"> <li>Overcomes limitations of traditional white canes</li> <li>Detects obstacles above knee level</li> <li>Provides emergency location tracking through GPS</li> </ul>	<ul style="list-style-type: none"> <li>Requires comprehensive real-world testing to verify effectiveness</li> <li>Potential challenges with GPS accuracy in certain areas</li> </ul>
Vanitha et al. (2018)	<ul style="list-style-type: none"> <li>Uses Raspberry Pi for enhanced processing capabilities</li> <li>Real-time object and text recognition</li> <li>Lightweight and easy to carry</li> </ul>	<ul style="list-style-type: none"> <li>Complexity in managing multiple sensors</li> <li>Higher power consumption due to Raspberry Pi</li> </ul>
Akhil et al. (2022)	<ul style="list-style-type: none"> <li>Affordable and practical</li> <li>Effective obstacle detection up to four meters</li> <li>Includes water detection</li> </ul>	<ul style="list-style-type: none"> <li>Limited to detecting obstacles and moisture only</li> <li>Does not detect holes or other types of obstacles</li> </ul>
Adaptive Stick with Sound and Vibration (Setiadi, 2023)	<ul style="list-style-type: none"> <li>Compact and lightweight (13.4cm, 128 grams)</li> <li>Plug-and-play functionality non-interfering with other senses</li> <li>Object detection up to 15 feet battery life of up to 2 days</li> </ul>	<ul style="list-style-type: none"> <li>Limited detection range battery reliance may be inconvenient for continuous use</li> </ul>

Raspberry Pi-Based Smart Walking Stick (Ganesan et al., 2020)	<ul style="list-style-type: none"> <li>• Real-time object recognition</li> <li>• Voice guidance and GPS navigation</li> <li>• RF transmitter and receiver for locating the stick</li> </ul>	<ul style="list-style-type: none"> <li>• Complex setup and maintenance</li> <li>• Requires constant internet connectivity</li> <li>• Higher power consumption</li> </ul>
Arduino-Based Smart Stick (Odong et al., 2018)	<ul style="list-style-type: none"> <li>• Accurate obstacle and water detection</li> <li>• Lightweight and energy-efficient</li> <li>• Easy to locate using RF transmitter and receiver</li> </ul>	<ul style="list-style-type: none"> <li>• Limited detection range of sensors</li> <li>• Integration and calibration of multiple sensors can be difficult</li> <li>• Dependence on RF signal with limited range</li> </ul>
Integrated Ultrasonic and Proximity Sensors Stick (Sakib et al., 2018)	<ul style="list-style-type: none"> <li>• Detection of water, obstacles, and moving objects</li> <li>• GPS functionality for emergency location sharing</li> </ul>	<ul style="list-style-type: none"> <li>• Shape-sensitive sensors</li> <li>• GPS and NodeMCU performance affected by weak network signals</li> <li>• Requires precise positioning for optimal performance</li> </ul>

### 3 Methodology

The development of smart walking cane involves integrating advanced sensor technology and robust communication features to enhance user safety and mobility, as shown in Figure 1.



**Fig. 1.** Proposed Smart Walking Cane

#### 3.1 Design process

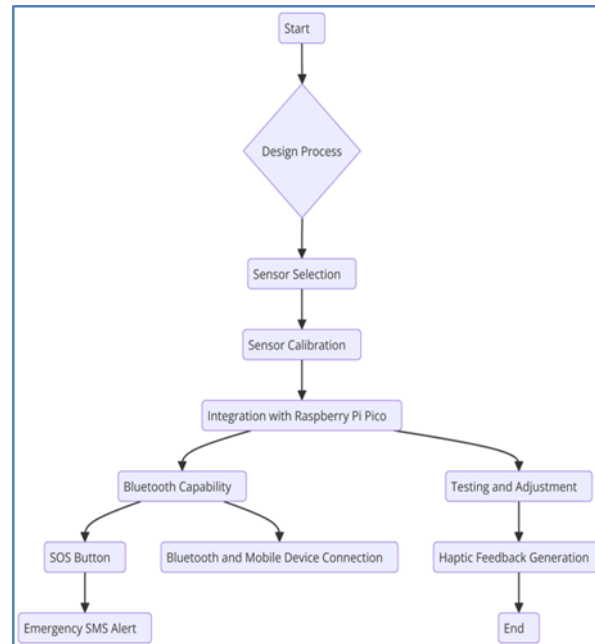
The process of designing a sensor system for visually impaired individuals involves a meticulous and structured approach, with the goal of creating a reliable and effective navigational aid. This process begins with a thorough understanding of the challenges faced by visually impaired users, particularly the need to detect common obstacles in their environment accurately.

The system leverages ultrasonic, distance, and infrared (IR) sensors, known for their high precision in measuring distances, to provide real-time feedback, thereby enhancing the user's spatial awareness and safety. The ultimate objective is to transform sensor data into haptic feedback, providing a tactile mode of communication that the user can easily comprehend.

The system incorporates Bluetooth connectivity and mobile device connection to facilitate seamless integration with smartphones, enabling users to customize settings and receive notifications. Additionally, the system includes an emergency SMS alert feature, which sends immediate notifications to designated contacts in case of emergencies, further enhancing user safety.

The Figure 2 outlines each critical phase of the design process, from the initial sensor selection and calibration to the integration with a Raspberry Pi Pico microcontroller and the generation of haptic feedback. Each step is carefully planned and executed to ensure the system's performance meets the necessary standards for accuracy, reliability, and user-friendliness. The culmination of these efforts is a robust solution that significantly improves the mobility and independence of visually impaired individuals.





**Fig. 2.** Design process

### 3.2 Components and features

In the following paragraphs, we will provide a detailed description of its components, capabilities, and supplementary emergency alarm system.

#### *A Ultrasonic Sensor*

The ultrasonic sensor is an essential component for the identification of obstacles. In order to function, it sends out ultrasonic waves, which are then collected by the sensor after being reflected off of things. The distance to the item is determined by calculating the amount of time it takes for the waves to revert to what they were before. This real-time distance measurement serves to inform the user of surrounding obstructions, which ultimately improves the user's safety and navigational capabilities.

- The design process involves selecting suitable ultrasonic sensors that have optimum range and sensitivity for the purpose of identifying some of the most typical obstacles that visually impaired people encounter.
- Calibration of the Sensor: Calibration is the process of modifying the sensitivity and range settings of the sensor in order to calibrate it so that it can reliably measure distances. This is accomplished by putting the sensor in a variety of controlled conditions.
- During the integration phase, the sensor is linked to the Raspberry Pi Pico, which is then responsible for processing the information and converting them into haptic feedback signals.

#### *B Distance Sensor*

The distance sensor uses both infrared (IR) and laser technologies to deliver accurate readings of the world ahead. Identifying things at varied distances and noticing changes in the landscape are both very important tasks that require it. This improves the user's spatial awareness and increases safety during navigation.

- The design process entails determining the most suitable type of distance sensor, taking into account the required detection range as well as the characteristics of the surrounding environment.
- Sensor Calibration: This process entails tweaking the sensor's range parameters and making certain that it correctly counts distances in a variety of lighting situations.
- Integration: We interface the Raspberry Pi Pico with the distance sensor to provide constant data on topography changes, which aids in real-time navigation.

#### *C Infrared (IR) Sensor*

The IR sensor detects infrared radiation emitted by objects. It is particularly useful in low-light conditions, ensuring effective obstacle detection even when visibility is poor. The IR sensor works by emitting an IR beam and measuring its reflection to determine the presence and distance of obstacles.

- Design Process: Choosing IR sensors with adequate range and sensitivity for low-light environments.

- **Sensor Calibration:** Adjusting the sensor to detect objects accurately in various lighting conditions by testing and fine-tuning its response to IR reflections.
- **Integration:** Integrating the IR sensor with the Raspberry Pi Pico to enhance the cane's ability to detect obstacles in low-light scenarios.

#### *D Main Controller: Raspberry Pi Pico*

- The Raspberry Pi Pico serves as the smart walking cane's main controller. The Raspberry Pi Pico is a cost-effective yet powerful microcontroller. It supports a variety of digital interfaces, making it simple to integrate multiple sensors and components. The RP2040 microcontroller chip, with its dual-core ARM Cortex-M0+ processor, serves as the foundation for its robust data processing and real-time sensor management.
- **Design Process:** Selecting the Raspberry Pi Pico for its processing power and cost-effectiveness.
- **Software Development:** Developing firmware to manage sensor data processing, Bluetooth communication, and emergency alerts. This involves programming in Python.
- **Integration:** The Raspberry Pi Pico acts as the central hub, coordinating inputs from all sensors and managing output signals to provide feedback to the user.

#### *E Bluetooth Connectivity*

The Raspberry Pi Pico's Bluetooth capability enables wireless communication with the user's mobile device. This connectivity is crucial for additional functionalities such as emergency alerts.

##### *i. SOS Button*

The smart walking cane is equipped with an SOS button for emergencies. When the user presses this button, it triggers an emergency alert system. (SOS: Morse Code distress signal)

- **Design Process:** Incorporating a reliable and easily accessible SOS button.
- **Integration:** The SOS button is wired to the Raspberry Pi Pico, programmed to send an alert when pressed.

##### *ii. Bluetooth and Mobile Device Connection*

The Bluetooth module on the Raspberry Pi Pico connects the smart cane to the user's mobile device. This connection allows the cane to send real-time data and alerts.

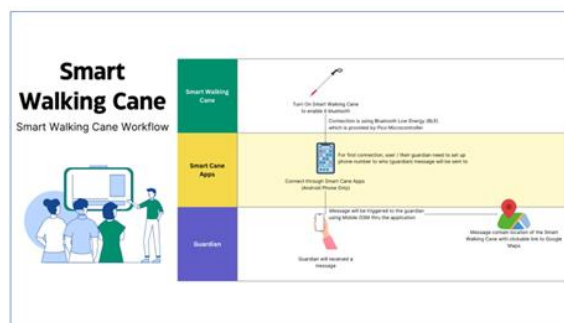
- **Software Development:** Creating a mobile application to interface with the cane, allowing users to receive alerts and customize settings.
- **Integration:** Ensuring seamless Bluetooth pairing between the cane and mobile devices for real-time data transmission.

##### *iii. Emergency SMS Alert*

Upon pressing the SOS button, a Short Message Service (SMS) message is automatically sent to a pre-designated contact's mobile phone. This message includes the user's current location, allowing for immediate assistance and ensuring the user's safety in emergency situations as shown in Figure 3.

**Design Process:** Implementing an SMS alert system using available Bluetooth or GSM modules.

- **Software Development:** Programming the Raspberry Pi Pico to send location data via SMS upon activation of the SOS button.
- **Integration:** Ensuring the emergency alert system is reliable and triggers correctly during emergencies.



**Fig. 3.** Bluetooth Connection with User Mobile Apps

## **4 Finding and analysis**

The Raspberry Pi Pico is responsible for gathering information from the infrared, ultrasonic, and distance sensors. The Raspberry Pi Pico processes this data to detect barriers and estimate distances, and uses this information to provide real-time feedback to the user. The cane alerts the user to surrounding impediments and changes in the walking route, emitting

vibrations or audio cues based on the data collected by the sensor. In the event of an emergency, the user can press the SOS button. The Raspberry Pi Pico can send an SMS alert with the user's position to a pre-designated contact via Bluetooth. In partnership with the Sarawak chapter of the Society of Blind Malaysia, we will conduct rigorous user and acceptance testing to ensure that our artificially intelligent walking cane can meet the needs of visually impaired individuals. This procedure will play a crucial role in gauging the gadget's success and user acceptance, while also offering crucial feedback for its improvement.

## 5 Conclusion

The development of the smart walking cane using the Raspberry Pi Pico represents a significant advancement in assistive technology for visually impaired individuals in Malaysia. By integrating GPS modules, ultrasonic sensors, infrared sensors, proximity sensors, and a vibration motor, the cane provides comprehensive environmental awareness and real-time feedback, enhancing safety and mobility. The inclusion of Bluetooth connectivity and an SOS emergency alert system ensures that users can receive timely assistance when needed, further improving their independence and confidence. User testing with the Society of Blind Malaysia, Sarawak branch, will be instrumental in refining the cane's design and functionality, ensuring it meets the specific needs of its users. This innovative solution not only addresses the immediate challenges faced by visually impaired individuals but also sets a precedent for future developments in the field of assistive technology.

## Acknowledgment

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## References

1. Abner, G. H., & Lahm, E. A. (2002). Assistive technology for students with disabilities. *Journal of Special Education Technology*, 17(2), 15-26.
2. Akhil, P., Akshara, R., Athira, R., Kumar, S. P. K., Thamotharan, M., & Christila, S. S. (2022). Smart blind walking stick with integrated sensor. *Materials Proceedings*, 10, 12. <https://doi.org/10.3390/materials2022010012>
3. Bouck, E. C. (2016). A national snapshot of assistive technology for students with disabilities. *Journal of Special Education Technology*, 31(1), 4-13.
4. Ganesan, M., Hemanth, R., Gunalan, S., & Hemprasad, J. (2020). Raspberry Pi based smart walking stick. *IOP Conference Series: Materials Science and Engineering*, 981, 042090. <https://doi.org/10.1088/1757-899X/981/4/042090>
5. IoT For All. (2020). An Introduction to IoT: Key Concepts and Applications. Retrieved from <https://www.iotforall.com/what-is-iot-simple-explanation>
6. Jain, V., & Singh, M. (2019). Smart Assistive Devices for the Visually Impaired: A Review. *Journal of Rehabilitation Research and Development*, 56(1), 69-80. doi:10.1682/JRRD.2018.01.0003
7. Lim, K. S. (2018). Assistive Technology for the Blind in Malaysia: Challenges and Prospects. *Malaysian Journal of Medical Sciences*, 25(4), 1-10. doi:10.21315/mjms2018.25.4.1
8. Malaysian Association for the Blind (MAB). (n.d.). Services and Resources for the Visually Impaired. Retrieved from <https://www.mab.org.my/>
9. Odong, S., Niwareeba, R., Tumwijekye, M., Ijotre, N., & Maraka, M. (2018). Design and construction of a smart walking stick for visually impaired individuals. 6th East African Healthcare Engineering Regional Conference and Exhibition (EARC). Kampala, Uganda.
10. Phan, G. H. (2021). Smart walking stick for visually impaired people. *Turkish Journal of Computer and Mathematics Education*, 12(13), 1558-1564.
11. Proulx, M. J., et al. (2016). Technology for the Visually Impaired: The Role of Artificial Vision. *Optometry and Vision Science*, 93(2), 146-152. doi:10.1097/OPX.0000000000000801
12. Raspberry Pi Foundation. (n.d.). Raspberry Pi Pico. Retrieved from <https://www.raspberrypi.org/products/raspberry-pi-pico/>
13. Sakib, S. S., Uddin, G. B., & Ahmed, S. (2018). Smart Blind Stick. *Project Planning of Smart Blind Stick*.
14. Setiadi, B. (2023). Adaptive Stick. *International Community Service*, December 13-16, 2023.
15. Vanitha, M., Rajiv, A., Elangovan, K., & Vinoth Kumar, S. (2018). A smart walking stick for visually impaired using Raspberry Pi. *International Journal of Pure and Applied Mathematics*, 119(16), 3485-3489.
16. Yusof, S. M., & Abdullah, A. H. (2017). Smart Walking Stick for the Visually Impaired: Design and Development Approach. *Procedia Computer Science*, 105, 122-128. doi:10.1016/j.procs.2017.01.204.

# Prototype of Short EDM Baseline Test Site for Survey Grade Receiver

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**Abstract.** Study aims at developing a Prototype of short Electronic Distance Measurement (EDM) Baseline Test Site for survey Grade Receiver based in Politeknik Kuching Sarawak (PKS). This Short EDM Baseline test site consists a six pillars with total distance of 214.616m. Although it is a prototype of Short EDM Baseline Test Site, the students can feel the experience of doing Global Navigation Satellite System (GNSS) instrument calibration work in a real situation. This will indirectly improve their psychomotor skills, which is crucial for Technical and Vocational Education and Training (TVET) institution likewise in PKS. Students able to train themselves individually and their safety is guaranteed as the training is carried out in campus. In addition, it is time and energy effective because students do not have to wait for their turn to measure at the actual site located far from the campus. The methodology used is following the standard procedure for EDM equipment which is by using GNSS-Rapid Static technique and Real Time Kinematic (GNSS-RTK) technique. This is through considering the distance component by comparing the distances observed using GNSS-Rapid Static technique and GNSS-RTK technique with the corresponding established values measured by the EDM. Result showed that the difference is below 10 mm which signifies reliability of the compared data.

**Keywords:** EDM Baseline Test; Calibration; GNSS Receiver

## 1 Introduction

The GNSS calibration tests that are conducted for the GNSS survey have been provided in the KPUP circular No. 6 1999 and KPUP circular No 1 2008. To ensure that the GNSS survey equipment used to observe distances and obtain relative coordinates on the surface of the earth is in good condition, the equipment must be calibrated at least once a year for GNSS instruments. Precise and accurate measurements are needed for purposes. Investigation of the calibration status of the instruments becomes therefore a crucial step. (S.Saadati, M. Abbasy, 2019) Calibration is essential to minimize uncertainty and enhance the quality of GNSS measurements. The calibration of geodetic instruments such as geodetic-grade GPS receivers and EDM is of importance for applications requiring the highest precision. (Esteban Vazquez Becerra et al., 2015). It is generally advised to calibrate GNSS survey equipment at least annually, or more frequently if it is exposed to harsh weather, vibration, shock, or frequent handling. An EDM baseline test should be conducted annually or before any major survey campaign to verify the proper functioning of the receiver and data processing software. Surveyors have the task and duty to report reliable measurement results and reasonable accuracy data. GNSS receivers are essential sensors for modern global positioning, navigation, and timing applications (Tupek & Zrinjski, 2024). For high-precision GNSS positioning based on carrier-phase measurements, knowledge of the GNSS receiver antenna electrical signal reception characteristics, i.e., phase center, is crucial (Tupek et al., 2023). The GNSS antenna phase centre is a function of the direction of the incoming signal, and it is different for each antenna (Kallio et al., 2019).

Efforts to improve the level of knowledge and skills of Geomatics Diploma graduates, PKS from time to time therefore our view is that it is very necessary for students to be directly exposed to the ways of performing calibration according to actual surveying practice. In the current situation, students of the Geomatics program are facing problems to implement one of the practical's found in the DCG50173 Geodesy 2 course. The instrument calibration site or EDM Test Base Kuching established by the Land and Survey Department, Sarawak is the closest to PKS is at which is approximately 10 KM with a travel time of approximately 12 minutes from PKS. The bus travel time to reach this far distance will have an impact on the cost of transportation, movement time and student safety while outside the PKS area. This causes Geomatics students at PKS do not have the opportunity to carry out GNSS survey equipment calibration practice.

In addition to the location of the calibration site being far from PKS, another problem that arises every time they want to do calibration work is that students have to wait for their turn with Licensed Land Surveyor survey party who also does calibration work on the same site. Based on this consideration, it is necessary for PKS to create a prototype of short EDM

Baseline test for survey grade receiver that can be used for student teaching and learning so that the graduates produced will be more competent and competitive in the current market. Considering the negative impact on transportation costs, practical time, student safety and the safety of government assets while outside the PKS area, this innovation was developed.

## 2 Materials and Methods

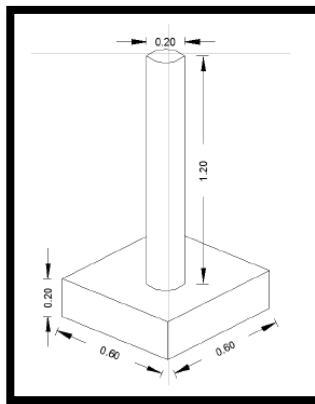
### 2.1 Study area

The EDM baseline test work was conducted at PKS campus (Figure 1), where the surrounding environment represents rather optimal observability conditions with open sky and no obstructions.

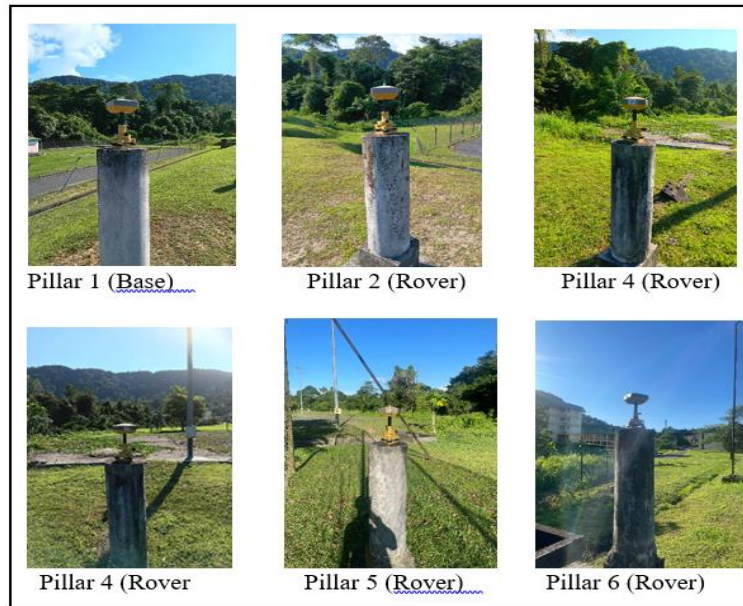


**Fig. 1.** Location of short EDM Baseline Test at PKS

The pillar monumentation for the short EDM baseline test experiment, located at PKS Campus. The pillars are placed in a straight layout and consists of six concrete structural columns (figure 2) denoted as Pillar 1, Pillar 2, Pillar 3, Pillar 4, Pillar 5 and Pillar 6 (Figures 3). The GNSS receiver are placed at the same concrete positions as the total station. Thus baselines, which will be measured by the GNSS receiver can be compared directly to the established distances between the pillars.



**Fig. 2.** Illustration of short EDM Baseline Test Pillar at PKS

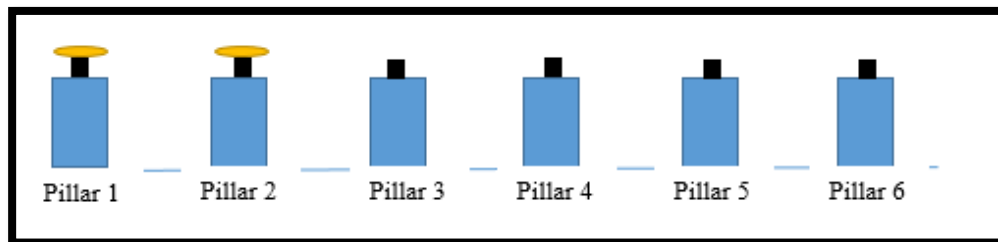


**Fig. 3.** GNSS Receiver is mounted on the pillar short EDM Baseline Test

## 2.2 EDM baseline test

An EDM baseline test is conducted to verify the proper functioning of a pair of GNSS receivers intended for baseline measurements and to make sure GNSS survey equipment is in good condition and under acceptance tolerance. This assessment occurs at a designated EDM baseline test site, where pillars with a minimum of 90% sky visibility are occupied. A series of EDM baseline tests have been conducted at the prototype of Short EDM Baseline Test site in PKS.

The EDM test site consists of six pillars spaced at specified intervals, with the longest baseline is 214,616 meter. The layout is shown in Figure 4. The coordinate for each pillar is shown in table 1 and Prototype of Short EDM baseline test site distance established value shown in table 2.



**Fig. 4.** Prototype Short EDM Baseline Test Site

**Table 1.** Local Grid Coordinate System for Each Pillar Using Borneo Triangulation Datum 1968.

Points	Established Value	
	Northing (m)	Easting (m)
Pillar 1	5180197.197	2056072.628
Pillar 2	5180197.627	2056067.058
Pillar 3	5180199.797	2056038.123
Pillar 4	5180202.049	2056008.227
Pillar 5	5180206.540	2055948.351
Pillar 6	5180213.295	2055858.608

**Table 2.** Prototype of Short EDM Baseline Test Site Distance Established Value

From	To	Distance Established Value (m)
1	2	5.586
1	3	34.602
1	4	64.583
1	5	124.627
1	6	214.624

### 2.3 GNSS Survey Equipment Calibration procedures using GNSS-Rapid Static technique

The test was conducted using the GNSS rapid static technique. One receiver (R1) remained at Pillar 1 as a base for the entire duration of the observations, while the other receiver (R2) were roving. Two Topcon Hyper VR dual-frequency GNSS receivers were used in the test. The following criteria were adhered to during the field measurements: the observation length was 15 minutes, with a recording interval of 1 seconds. The number of satellites was more than 5, and the GDOP was less than 6. Additionally, the sky clearance was more than 90%, and the cut-off angle was 15 degrees. Once the field data files such as raw satellite data includes positions, satellite signals, and timestamps are downloaded from the receivers, they can be processed using standard baseline processing procedures using magnet tools processing software. This software applies mathematical models and algorithms to correct errors caused by various factors such as satellite clock errors, atmospheric conditions, and signal multipath (reflections).

### 2.4 GNSS Survey Equipment Calibration procedures using GNSS-RTK GPS technique

The experimental setup is involving the use of two GNSS receivers, a base station at a known location at pillar 1 and a rover at pillar 2 until pillar 6. The base station transmits correction data to the rover in real-time. Requires a communication radio link between the base and rover to provide real-time corrections.

## 3 Result and discussion

The test is conducted following the standard procedure for EDM equipment. This experiment EDM baseline testing only considers the distance component. This comparing the distance between short EDM baseline pillars at PKS obtained from Rapid Static and RTK observation techniques.

**Table 3.** Distances differences between GNSS-Rapid Static observation techniques and EDM values for R1/R2 receiver pair in the morning.

Baselines (pillars)	Distances		
	R1 – R2 (m)	EDM (m)	Differences (mm)
1-2	5.581	5.586	-5
1-3	34.600	34.602	-2
1-4	64.587	64.583	4
1-5	124.629	124.627	2
1-6	214.621	214.624	-3

Table 3 shows the result of distance differences between GNSS-Rapid Static observation techniques and EDM values for R1/R2 receiver pair in the morning. The result indicates that both pairs of receivers recorded differences of less than 10 mm. This demonstrates that the GNSS survey equipment set is in good condition.

**Table 4.** Distances Differences Between GNSS-Rapid Static Observation Techniques and EDM Values for R1/R2 Receiver Pair in The Afternoon

Baselines (pillars)	Distances		
	R1 – R2 (m)	EDM (m)	Differences (mm)
1-2	5.592	5.586	6
1-3	34.605	34.602	3
1-4	64.579	64.583	-4

1-5	124.624	124.627	-3
1-6	214.631	214.624	7

Table 4 shows the result of distance differences between GNSS-Rapid Static observation techniques and EDM values for R1/R2 receiver pair in the afternoon. The result indicates that, for both pairs of receivers, the differences are less than 10mm. This demonstrates that the GNSS survey equipment being used is in good condition.

**Table 5.** Distances differences between GNSS- Rapid Static observation techniques and EDM values for R1/R2 receiver pair in the evening.

Baselines (pillars)	Distances		
	R1 – R2 (m)	EDM (m)	Differences (mm)
1-2	5.593	5.586	7
1-3	34.605	34.602	3
1-4	64.587	64.583	4
1-5	124.622	124.627	-5
1-6	214.617	214.624	-7

Table 5 shows the result of distances differences between GNSS- Rapid Static observation techniques and EDM values for R1/R2 receiver pair in the evening. The result shows that the differences for both pairs of receivers are less than 10mm indicating that the GNSS survey equipment is in good condition.

**Table 6.** Distances differences between GNSS-RTK Observation Technique and EDM Values for R1/R2 Receiver Pair in The Morning.

Baselines (pillars)	Distances		
	R1 – R2 (m)	EDM (m)	Differences (mm)
1-2	5.580	5.586	-6
1-3	34.596	34.602	-6
1-4	64.586	64.583	3
1-5	124.623	124.627	-4
1-6	214.631	214.624	7

Table 6 shows the distances differences between GNSS-RTK observation technique and EDM values for R1/R2 receiver pair in the morning. The result reveal that the differences between both pairs of receivers are under 10mm, confirming that the GNSS survey equipment is in good condition.

**Table 7.** Distances Differences Between GNSS-RTK Observation Technique and EDM Values for R1/R2 Receiver Pair in The Afternoon.

Baselines (pillars)	Distances		
	R1 – R2 (m)	EDM (m)	Differences (mm)
1-2	5.591	5.586	5
1-3	34.607	34.602	5
1-4	64.580	64.583	-3
1-5	124.621	124.627	-6
1-6	214.632	214.624	8

Table 7 shows the distances differences between GNSS-RTK observation technique and EDM values for R1/R2 receiver pair in the afternoon. The result indicate that both pairs of receivers recorded differences of less than 10 mm. This demonstrates that the results which GNSS survey equipment set is in good condition.



**Table 8:** Distances Differences Between GNSS-RTK Observation Technique and EDM Values for R1/R2 Receiver Pair in The Evening.

Baselines (pillars)	Distances		
	R1 – R2 (m)	EDM (m)	Differences (mm)
1-2	5.593	5.586	7
1-3	34.597	34.602	-5
1-4	64.586	64.583	3
1-5	124.633	124.627	6
1-6	214.632	214.624	8

Table 8 shows the distances differences between GNSS-RTK observation technique and EDM values for R1/R2 receiver pair in the evening. The tables 8 indicate that the differences between both pairs of receivers are below 10mm, confirming that the GNSS survey equipment is in good condition. The tables 8 indicate that the differences between both pairs of receivers are below 10mm, confirming that the GNSS survey equipment is in good condition.

The resulting difference in distance must be within ten (10) mm. If this tolerance is not achieved, the test should be repeated, or the GNSS survey equipment should be sent to the manufacturer for further inspection and testing.

## 4 Conclusion

Recap on the problems faced by Geodesy 2 students on implementing instrument calibration site far from PKS and at the same time exercise actual surveying practice, study has come out with the invention of Short EDM Baseline Test Site for Survey Grade Receiver prototype.

Series of observations using GNSS technique that have taken place successfully shown that using this developed prototype is reliable. The observation period which took place for two (2) days in three (3) different sessions had indicated that the result differences obtained were less than 10mm. Obviously, it signifies reliability and consistency of the collected data. Besides, through the observation processes with 50 respondents of students taking subject Geodesy 2, it was recorded that time, cost and energy were less consumed whilst producing accurate and reliable calibration results besides indirectly improve students' psychomotor skills.

Overall, it was found that the provision of this short EDM baseline test greatly benefits students. Students do not need to waste a long time and spend certain cost for the calibration work. Adding more, students can instil and absorb positive work ethics and can have practical work satisfaction. In terms of organization, this study can also be used as a collaboration prototype with external parties in terms of expert services and negotiation advice. This wraps that Short EDM Baseline Test Site for Survey Grade Receiver prototype has successfully benefits both the students and lecturers in their calibration test practical work. For future recommendations based upon this study is to conduct GNSS observation at this short EDM baseline test using CORS system developed by the Land and Survey Department, Sarawak to compare the accuracy.

## References

1. Esteban Vazquez Becerra, G., Bennett, R. A., Chávez, M. C., Trejo Soto, M. E., & Gaxiola-Camacho, J. R. (2015). Short baseline calibration using GPS and EDM observations. *Geofisica Internacional*, 54(3), 255–266. <https://doi.org/10.1016/j.gi.2015.04.017>
2. Kallio, U., Koivula, H., Lahtinen, S., Nikkonen, V., & Poutanen, M. (2019). Validating and comparing GNSS antenna calibrations. *Journal of Geodesy*, 93(1), 1–18. <https://doi.org/10.1007/s00190-018-1134-2>
3. Pekeliling Ketua Pengarah Ukur dan Pemetaan Malaysia Bil. 1, Tahun 2008 (KPUP 2008)
4. Pekeliling Ketua Pengarah Ukur dan Pemetaan Malaysia Bil. 6, Tahun 1999 (KPUP 1999)
5. S.Saadati, M. Abbasy, A. A.-S. (2019). Geodetic calibration network for total stations and GNSS receivers in sub-kilometer distances with sub-millimeter precision. *Measurement*, 141, 258–266. <https://doi.org/https://doi.org/10.1016/j.measurement.2019.04.044>
6. Tupek, A., & Zrinjski, M. (2024). ABSOLUTE GNSS RECEIVER ANTENNA CALIBRATION AT THE FACULTY OF GEODESY – UNIVERSITY OF ZAGREB. *9th International Conference Contemporary Achievements in Civil Engineering, Subotica, SERBIA, May*. <https://doi.org/10.14415/CACE2024.52>

# Study on Development of Green Pavement for Motorcyclist Shelter (GPMS)

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**Abstract.** Motorcycles have become a very popular mode of transportation among highway users. However, motorcyclists often face challenges during rain, seeking temporary shelter in Rest and Relax (R&R) areas, designated open shelters, or under flyovers. Unfortunately, the number and size of motorcycle shelters on highways are quite limited. This study focuses on the alternative stop areas under flyovers, which are frequently used by motorcyclists despite being unauthorized. Therefore, these areas can be improved as options for motorcyclist shelters. The issues highlighted include uneven terrain, an ineffective drainage system causing water to stagnate, and insufficient space to accommodate the large number of riders, leading to inadequate parking areas. To address these problems, we have developed an easy-to-install, low-cost paved flooring solution called Green Pavement for Motorcyclist Shelter (GPMS). The dimensions of the pavement are 2'x2', and it is made from a mixture of recycled waste materials such as plasticware and glass bottles. These materials were added to the aggregates, and three samples were produced. The samples contained 10%, 15%, and 30% of the plastic and glass mixture in the aggregates. The samples were then tested with a Compression Test on day 7th, 14th, and day 28th with results showing that GPMS with a 30% mixture recorded compressive strengths of 12 MPa, 15MPa and 35 MPa, respectively, demonstrating very good performance.

**Keywords:** motorcycle shelter, green pavement, compressive strength, GPMS

## 1 Introduction

Riding a motorcycle carries a significant risk of accidents on the road. Especially during rain, motorcyclists need to stop and seek shelter to reduce the risk of accidents. There are approximately 353 existing motorcycle stops on the highway, with 119 new stops planned from 2023 to 2024 (The Star, 2023). These are comprised of standalone shelters and under bridges shelters excluded the R&R areas or petrol stations. As the use of motorcycles as a preferred mode of transportation has drastically increased, the shelter facilities need to be improved to accommodate the high rainfall intensity in our country Malaysia.

This paper focuses on the site ground floor of motorcycle shelters under bridge highway. Observations show that these areas are preferred by motorcyclists due to the larger coverage area compared to the standalone shelters which are too small. Some shelters under the flyover are not designated as protection areas due to high risks, yet they are still used by motorcyclists. Thus, it is not surprising that the shelter floors are often just bare ground. Some other shelters are paved with concrete, but the coverage is not extensive, and some have deteriorated with poor drainage systems, leading to water stagnation during rain.

The shelter space is also very limited and narrow, with uneven floors causing instability when parking motorcycles. Motorcycles can get damaged when they fall, increasing maintenance costs for riders. Following frequent incidents, the idea emerged to study and develop environmentally friendly concrete pavement shelter floors to address these issues.

The field of concrete pavement engineering has seen significant advancements today. Researchers are driven to innovate through continuous efforts, seeking longer-lasting, sustainable, and cost-effective infrastructure solutions. Concrete pavement made from recycled materials is a research branch aimed at producing alternative materials in construction engineering. These alternative pavements are suitable as static load-bearing floor sites, cost-effective, and functional, providing convenience to road traffic users. This study aims to participate in designing and producing Green Pavement for Motorcyclist Shelter (GPMS). To validate the production, the product will be tested on strength and durability: It specifically

use for ground floor under bridge sites, easy to install and transport, and using recycled materials from local sources. It's hoped this project to be benefit to the riders to have more facilities.

## 2 Literature review

Reviewing previous studies reveals the dynamic landscape of innovation in pavement engineering, from sustainable materials and smart technology to new design approaches. These advancements address current challenges in infrastructure development while paving the way for more resilient, environmentally friendly, and economically viable pavement solutions.

### 2.1 Sustainable pavement materials using recycled waste

Reclaimed Asphalt Pavement (RAP) is mixed with aggregate and asphalt binder to yield a recycled mix and there are different ways to complete the process and it is governed by the configuration of the hot mix plant. RAP is added directly to the mixer in a drum mix plant. The most RAP is used in hot asphalt mix. It involves mixing RAP with new or virgin aggregates, asphalt binder, and/or recycling agents in a central hot mix plant to produce a recycled mix. Research by Li et al. (2022a) emphasizes the incorporation of recycled materials, such as RAP and recycled concrete aggregates in asphalt mixtures. These materials not only reduce environmental impact but also enhance pavement performance. The study on binder regeneration by Zhang & Kevern (2021) investigates the rejuvenation of aged asphalt binders through the incorporation of RAP in asphalt mixtures. The study highlights the potential of RAP to improve binder properties and reduce the need for virgin materials in pavement construction. Exploration of bio-based binders, as discussed by Jamshidi & White (2020), offers a sustainable alternative to traditional petroleum-based binders. These binders, derived from renewable sources, contribute to reduced carbon emissions and improved long-term performance. Studies by Wang et al. (2020) and Anderson et al. (2019) explore the engineering properties of asphalt mixtures containing various percentages of RAP. These investigations assess impacts on rutting resistance, fatigue life, and overall performance.

The shift towards mechanistic-empirical design, discussed by White et al. (2019), evaluates pavement structural response and environmental conditions. This approach allows for more accurate performance predictions under varying loads and weather conditions. The use of permeable pavements, examined by Zhang & Kevern (2021), addresses stormwater management challenges. These pavements allow water infiltration, reducing runoff and minimizing environmental impact. The application of 3D printing technology in pavement construction, explored by Li et al. (2022b), offers new insights into the fabrication of adaptive pavement structures on-site. This technology has the potential to enhance construction efficiency and reduce material waste.

Silva et al. (2019) in their research evaluates the mechanical properties of concrete mixtures incorporating recycled materials. This study examines aspects such as compressive strength, flexural strength, and durability, providing insights into the feasibility of recycled materials in concrete pavement applications. The environmental impact of using recycled materials in concrete pavements is discussed by Tam et al. (2018). Life cycle assessments are used to evaluate sustainability aspects, including carbon footprint reduction and energy use. Studies by Kazemian et al. (2019) investigate the incorporation of waste plastics, such as recycled polyethylene, into bitumen mixtures. Research explores effects on rheological properties, fatigue resistance, and potential for reducing plastic waste in pavement construction. Research on rubber-modified asphalt by Al Fayez et al. (2020) and Mohammad Hosseini et al. (2018) uses recycled tire rubber, carpet waste, and coconut shell ash in asphalt pavements. These studies examine impacts on pavement durability, skid resistance, and environmental benefits, including waste disposal reduction.

Challenges related to the durability of pavements incorporating recycled waste materials are discussed by Huang et al. (2019). Criteria for potential solutions are examined to optimize material design and foster sustainable practices in pavement engineering. Economic evaluations by Wu & Montalvo (2021) provide insights into the cost-effectiveness of using recycled waste materials in pavement construction.

Several guidelines highlight the potential and challenges of integrating recycled waste materials in pavement construction. While construction performance shows promising aspects, there are areas for improvement in understanding the engineering properties and environmental benefits. Continuous research is crucial to addressing concerns about the strength and durability of material mixtures, optimizing mix design, and promoting sustainable practices in pavement engineering. Integrating recycled waste materials in pavements not only conserves resources but also aligns with broader goals for sustainable infrastructure development.

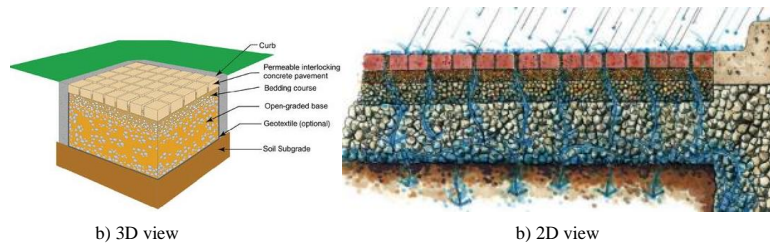
### 2.2 Types of pavements

Common conventional floor types for motorcycle shelters during rainy days include soil, reinforced grass, gravel, or concrete. Many floor types can be used and are commonly seen in other parts of the road, including gravel floor, reinforced grass, porous concrete, paved concrete, or interlocking concrete.

Gravel floor used for pedestrian and low-traffic pavements in urban areas, neighbourhoods, and historic town centers with architectural and environmental value. Reinforced grass allows grass to be integrated into plastic grid pavers to provide a permeable surface. This system is thin and flexible, limited to low-load transportation. Permeability depends on geometry, pattern elements, and infill materials like natural soil or gravel.

The floor from porous concrete consists of a permeable concrete surface with 15%-25% void content placed over a granular base. Pavement structure consists of an 8-10 cm thick surface layer. It can be used if the sub-surface is not water-sensitive, as shown in Figure 1. The parallel grid concrete pavers: have voids at the joints to allow water to pass through.

Typically, porous or pervious concrete has sufficient base thickness to handle stormwater and allow uniform infiltration into the open-grid reservoir design. These are categorized as modular cell pavements filled with soil and grass, achieving up to 40% permeability. Another porous concrete for sidewalks has been studied by Moretti et al. (2019) measured the structural performance, functionality, and environmental aspects of porous concrete pavements for sidewalks. The study used green, orange, and red emoji symbols representing good, fair, and poor performance, respectively. Results showed porous concrete was well received, followed by asphalt, while gravel was rated poorly due to aspects such as regularity, durability, weather resistance, dust-free, and low maintenance.



**Fig. 1.** Permeability of pavement from porous concrete

## 2.2 Innovation of Concrete

The material of graphene is innovation material used as concrete reinforced. Graphene is a single layer of carbon atoms tightly bound in a hexagonal honeycomb lattice. Stacked layers of graphene form graphite, a crystalline form of carbon most used in pencils and lubricants. The individual layers of graphene in graphite can be separated into sheets only one atom thick. Graphene is the thinnest, lightest, and strongest compound, being more than 100 times stronger than steel. Graphene concrete is made by dispersing graphene sheets in water, then mixing that water with traditional concrete materials such as cement and aggregate.

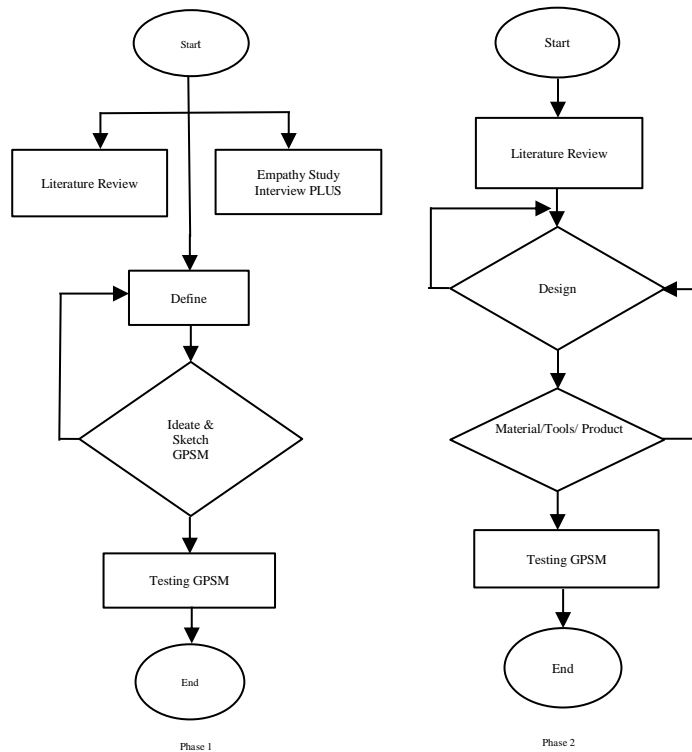
The plastic aggregate has been used as an innovation where plastic waste is sourced from various origins. Generally, plastic bottles are shredded in the laboratory using a grinding machine and then sieved to obtain the appropriate size fractions (Saikia & Brito, 2012). Various types of crushers are used, such as fan crushers or industrial blades, to grind plastic waste. However, in some studies, plastic waste is collected in suitable sizes directly from plastic waste treatment plants. Studies on rubber tire aggregate have been conducted by Kotresh & Belachew (2014), using rubber tires in four types of mixtures to replace aggregate. The concrete mix design ratios use cement, water, sand, and aggregate with 10%, 20%, and 30% of coarse aggregate replaced by waste rubber tires. The workability of the concrete is measured using the Slump Test. The results are shown in Table 1. Each sample demonstrates its workability performance, surpassing ordinary concrete by 85 mm. The higher the percentage of rubber aggregate, the higher the workability, with a reading of 150 mm for 30% tire waste.

**Table 1:** Slump Test Workability. Reproduced with permission : Kotresh & Belachew, 2014

SI No	Test Series	Workability (Slump)
1	Concrete	85mm
2	Concrete with rubber (10%)	100mm
3	Concrete with rubber (20%)	125mm
4	Concrete with rubber (30%)	150mm

## 3 Methodology

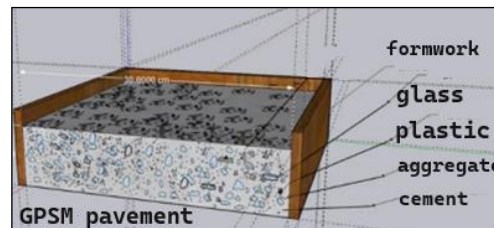
The study is divided into two phases using the design thinking method. Phase 1 involves empathy study to define problem statement, objectives, and sketch solution ideas and testing. This phase considering respondent needs with simple framework POEMS stand for People, Objects, Environments, Messages, and Services. This exercise provides for quick and surprisingly deep observation. Another framework is SMART (Specific, measurable: assignable, realistic and time-related) used to write project's goals and objectives, emphasizing the importance of clear goals. In phase 2 the activities include the detail of prototyping to develop actual project and verification testing. Figure 2 shows the workflow for both phases. The following explanation covers phase 2, including design, material calculations, sample preparation, and testing.



**Fig. 2.** Flow chart of development GPMS

### 3.1 GPMS Design

The GPMS is designed with dimensions of 2' x 2' x 2". It is designed to be easily portable and installable. The content of GPMS is based on recycled materials, utilizing waste materials from glass bottles and plastic. Green Pavement Motorcycle Shelter (GPMS) samples, the process of calculating the material mix was generated and shown in Table 2, involving percentages of recycled materials, namely a mixture of plastic and glass at 10%, 15%, and 30%. The overall concrete mix ratio uses a ratio of 1:3:6. The design of the cement and mix remains constant. The flexural modifier is the aggregate with added plastic and glass materials.



**Fig. 3.** GPMS Design



**Fig. 4.** Preparation of materials and tools

### 3.4 GPMS Testing

Testing of the GPMS concrete was conducted using a Compression Test to determine its strength according to Standard Test

Method for Compressive Strength of Concrete Specimens (ASTM C39/C39M). Compressive Strength Test of concrete requires at least six sample cubes to be tested. The tests are conducted on the seventh day and again on the 28th day using three cubes each. The test results will indicate whether the mixed design and the concrete strength are accurate. Equipment Used: Steel cube molds measuring 150mm x 150mm x 150mm, tamping rod measuring 380mm in length, padding equipment, mold oil, steel trowel, small shovel & wet sackcloth. Making Sample Cubes: a) Apply oil to the inner surfaces of the steel molds, b) Place the steel molds on a flat surface, c) Pour concrete into the molds in three approximately equal layers. Each layer should be compacted at least 35 times with the tamping rod until the concrete appears dense and well-formed, c) Level the surface of the concrete in the mold. Clean any excess concrete around the mold. Clearly mark each cube with the casting date and serial number using non-fading paint or nails, d) Maintain a record to identify the date and serial number of each cube corresponding to the section of work from which the cube was taken. Curing Process for Sample Cubes: Cubes are kept in mold for 24 hours. The curing process begins by placing a wet sackcloth over the cubes. After 24 hours, the cubes are removed from the molds and immediately placed in water, where they are stored until the testing date. Figure 5 shows that after the curing process was carried out until day 7 and day 28, a total of 9 samples were tested, and the results were recorded in the sample table.



**Fig. 5:** Sample of GPMS dan Compression Test

#### 4 Results and Analysis

The results from GPMS testing were obtained and shown in Figure 6. The Compression Test results for maximum concrete strength were found for sample 3 with a 30% plastic and glass mix, with readings of 12.4 MPa on day 7 and increasing to 15.6 MPa on day 15 and maximum strength reach to 35.9 MPa on day 28th. Sample 2 with a 15% plastic and glass mix recorded a minimum reading of 1.7 MPa on day 7 and an increase to 3.2 MPa on day 15 and reached 28.4MPa on day 28th. The samples 1 with mix 10% of plastic and glass also represent on day 7<sup>th</sup>, 15<sup>th</sup> and 28<sup>th</sup> respectively 5.9, 7.5 and 27.3 MPa.

The power trendline shows regression analysis found an R square reading each sample 1, 2, 3 with 0.838, 0.9229 and 0.8389, indicating that the results of the percentage mix of materials were acceptable and satisfactory. The equation (1), (2) & (3) is shown below with y is compression strength (MPa) and x is the day.

$$y_1 = 4.9539x^{1.2815} \quad (1)$$

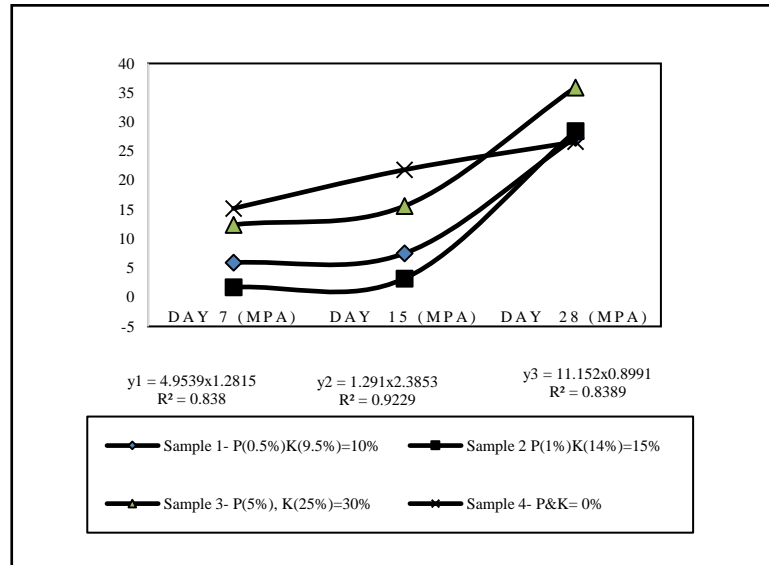
$$R^2 = 0.838$$

$$y_2 = 1.291x^{2.3853} \quad (2)$$

$$R^2 = 0.9229$$

$$y_3 = 11.152x^{0.8991} \quad (3)$$

$$R^2 = 0.8389$$



**Fig 6:** Compression Result of GPMS

The result of strength also shows on day 7<sup>th</sup> and 15<sup>th</sup> of sample 2, with a 15% plastic mixture, increased dramatically by 47%. For the first and third samples, the strength difference each showed an increase of 20-21%. This may be due to the 15% plastic and glass mixture optimally achieving higher strength compared to the minimum and maximum mixtures. According to British Standards (BS 8110), the typical compressive strength for ordinary concrete used in flooring should be around 25 to 30 MPa after 28 days of curing. The results indicate that the Compression Test for GPSM each sample showed an increase and was more effective than controlling concrete strength. This result is also supported by Ahmad et al. (2022) which with their study using response surface methodology to predict various mechanical properties and optimized proportions of waste glass with recycled concrete aggregate. The optimal amounts of 20% and 30% were identified through this analysis, demonstrating compressive strength nearly equivalent to that of the reference concrete 21.6 MPa.

## 5 Conclusion

The results indicate that the GPMS development study has been successfully completed and achieved its objectives, with the compression strength verification for the 30% plastic and glass mixture reaching 35.9 MPa. Therefore, concrete pavement using recycled materials can be considered as an alternative to aggregate. Several limitations were encountered during the study, including time management, human resource shortages, and financial constraints. However, all constraints were overcome through discussion and cooperation.

Based on the literature review, calculations, and testing conducted, this project has been successfully executed. The tests conducted have proven that the project has achieved its goals and objectives. There is also room for improvement in the future by increasing the number of samples, refining the percentage of material mixtures, conducting compression strength tests up to day 28, and adding other recycled materials. Hopefully, this project study can benefit readers and serve as a source of literature in the study of innovative uses of recycled materials in concrete.

## Acknowledgments

We express our gratitude to the late member of the group, Abdullah Abas Abdul Rani, for the initial idea of the project. May the publication of this article convey continuous knowledge rewards to him. Al-Fatihah.

## References

1. Ahmad, J.; Martínez-García R.; de-Prado-Gil, J.; Irshad, K.; El-Shorbagy, M.A.; Fediuk R. Vatin, N.I. (2022). Concrete with partial substitution of waste glass and recycled concrete aggregate. *Materials*. 15, 430.
2. Al Fayez, S. A., Suleiman, A. R., & Nehdi, M. L. (2020). Recycling tire rubber in asphalt pavements: State of the art. *Sustainability*. 12(21), 9076.
3. Anderson, J. (2019). Polycyclic Aromatic Hydrocarbon Release from Pavement Rejuvenators Due to Rolling Wheel Contact: An Investigation Using a Model Mobile Load Simulator. *Civil Engineering*.

4. Dong Wang, Bingyu Ren, Bo Cui, Jiajun Wang, Xiaoling Wang, Tao Guan. (2021). Real-time monitoring for vibration quality of fresh concrete using convolutional neural networks and IoT technology. *Automation in Construction*. 123, 103510.
5. Huang, H., Luo, J., Moaveni, M., Qamhia, I. I., Tutumluer, E., & Tingle, J. S. (2019, July). Advanced analytical tool for flexible pavement design and evaluation. In *International Airfield and Highway Pavements Conference*. Reston, VA: American Society of Civil Engineers. (61-71).
6. Jamshidi, Ali, and Greg White. (2020). Evaluation of Performance and Challenges of Use of Waste Materials in Pavement Construction: A Critical Review. *Applied Sciences*. 10(1): 226.
7. Kazemian, F., Rooholamini, H., & Hassani, A. (2019). Mechanical and fracture properties of concrete containing treated and untreated recycled concrete aggregates. *Construction and Building Materials*, 209, 690-700.
8. Kotresh K.M & Belachew, Mesfin Getahun. (2014). Study On Waste Tire Rubber as Concrete Aggregates. *International Journal of Scientific Engineering and Technology*. 3(4), 433-436.
9. Li, D., Leng, Z., Zhang, S., Jiang, J., Yu, H., Wellner, F., & Leischner, S. (2022a). Blending efficiency of reclaimed asphalt rubber pavement mixture and its correlation with cracking resistance. *Resources, Conservation and Recycling*, 185, 106506.
10. Li, W., Wang, D., Chen, B., Hua, K., Huang, Z., Xiong, C., & Yu, H. (2022b). Preparation of artificial pavement coarse aggregate using 3D printing technology. *Materials*. 15(4), 1575.
11. Mohammad Hosseini, H., Tahir, M. M., & Sayyed, M. I. (2018). Strength and transport properties of concrete composites incorporating waste carpet fibers and palm oil fuel ash. *Journal of Building Engineering*. 20, 156-165.
12. Moretti, Laura, Paola Di Mascio, and Ciro Fusco. (2019). Porous Concrete for Pedestrian Pavements. *Water*. 11(10): 2105.
13. Saikia, Nabajyoti, Brito, Jorge de. (2012). Use of plastic waste as aggregate in cement mortar and concrete preparation: A review. *Construction and Building Materials*. 34, 385-401.
14. Silva, M. V., de Rezende, L. R., dos Anjos Mascarenha, M. M., & de Oliveira, R. B. (2019). Phosphogypsum, tropical soil, and cement mixtures for asphalt pavements under wet and dry environmental conditions. *Resources, Conservation and Recycling*. 144, 123-136.
15. Tam, V. W., Soomro, M., & Evangelista, A. C. J. (2018). A review of recycled aggregate in concrete applications (2000–2017). *Construction and Building Materials*. (172), 272-292.
16. The Star, Malaysia. (Wednesday, 29 Nov 2023). 119 motorcycle shelters to be built nationwide, says Deputy Minister. <https://www.thestar.com.my/news/nation/2023/11/29/119-motorcycle-shelters-to-be-built-nationwide-says-deputy-minister>
17. Wang, H., Liu, X., Apostolidis, P., van de Ven, M., Erkens, S., & Skarpas, A. (2020). Effect of laboratory aging on chemistry and rheology of crumb rubber modified bitumen. *Materials and Structures*. 53, 1-15.
18. White, D. J., Vennapusa, P., Roesler, J. R., & Vavrik, W. (2019, March). Plate load testing on layered pavement foundation system to characterize mechanistic parameters. In *Eighth International Conference on Case Histories in Geotechnical Engineering*. Reston, VA: American Society of Civil Engineers. 214-226.
19. Wu, S., & Montalvo, L. (2021). Repurposing waste plastics into cleaner asphalt pavement materials: A critical literature review. *Journal of Cleaner Production*. 280, 124355.
20. Zhang, K., & Kevern, J. (2021). Review of porous asphalt pavements in cold regions: the state of practice and case study repository in design, construction, and maintenance. *Journal of Infrastructure Preservation and Resilience*. 2, 1-17.



# An Evaluation of Structural Design Analysis of Slab Capacity for Sustainable Modular Skid in Process Plant

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**ABSTRACT.** Safety related issue on skid plant buildings is commonly evaluated in structural analysis to determine the sustainability of the existing slab having satisfactory strength without jeopardizing the operation and any defect issue. It is implicitly assumed that cracks in floor slabs can be caused by vibration of skid plant during operation. This paper critically evaluates the slab capacity in typical modular skid plant buildings using structural analysis and presents a practical approach to overcome the issue. Non-generated weights of equipment are calculated in accordance with the design and included in the model as point or distributed load. A satisfactory analysis procedure would consist of structural analysis to obtain overall boundary condition, design load, reaction, deflection and buckling using suitable method to validate the existing slab capacity. The unity design check was found to be less than 1.0, which is satisfactory.

**Keywords:** slab capacity, structural analysis, modular skid, in place analysis

## 1 Introduction

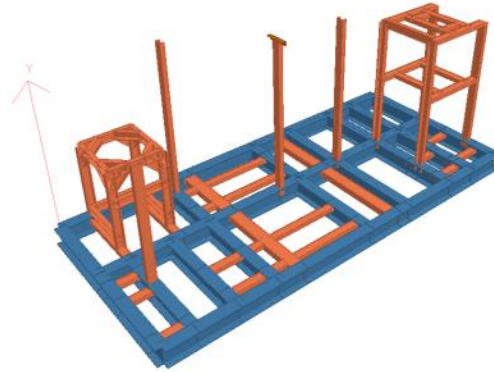
Structural concepts with their appropriate analysis techniques are the foundation for the design process. Design is the process through which we give life to our established concepts. A multi-story frame system can be designed with other systems, for instance shear walls or braced frames. However, at the time of the design, the slab is always considered to take the positive and negative moments produced by the lateral forces. The connections between the slabs and the beams should be able to transfer the positive moments, and the beams should transfer these positive moments to the columns. Once the beams and the slabs are designed to take the moments, they must be part of the lateral resistance system at their respective columns. It is vital that the slabs on the right account for any lateral forces, distributed sometimes only with their own resistance and sometimes in conjunction with the strength of the beams.

The structural development during 19th and early 20th centuries has created method of diagrid system with thin shell and tensile structures with various types of elements, such as the metal, concrete, or wooden beams in the construction of buildings [1]. The experts' studies tried to find formulas for their collapse loads which based simple rectangular uniform diagonal grids on the elastic and plastic behaviour [2,3]. The last few decades have required architectures that can overcome issues in vertical growth due to the rapidly growing population in the urban land. Structural safety has always been a key preoccupation and responsibility in the design of civil engineering projects [4]. Framing systems can be found in load-bearing walls, beams, girders and other elements of the structure. Steel moment, braced, and diagrid frames offer the strength that aids in lateral load resistance. Furthermore, these structures are known for their strength, durability, and cost-effectiveness. These structures are typically constructed with steel frames and modular components, such as walls, floors, and roofs, which are designed to fit together like a giant puzzle [5].

The experimental slab testing program was conducted at the University of South Alabama in 1988 and only partially documented in the PCA-CES publication but today, STAAD Pro is one of the popular and widely used software for structural analysis and design across the globe by Civil engineers. It is interoperable with applications such as RAM Connection, AutoPIPE, SACS and many more engineering design and analysis applications to further improve collaboration between the different disciplines involved in a project. STAAD.Pro can be used for analysis and design of all types of structural projects from plants, buildings, and bridges to towers, tunnels, metro stations, water/wastewater treatment plants for all types of structures starting from concrete, steel to aluminium, timber and even piping design for both static and dynamic analysis can be performed here for advanced analysis [6]. In recent studies, this software is used to analyse a comparative behaviour of conventional and pre-engineered industrial structures [7] and seismic and analysis design for multistorey and duplex building [8-10].

## 2 In place - Operation analysis

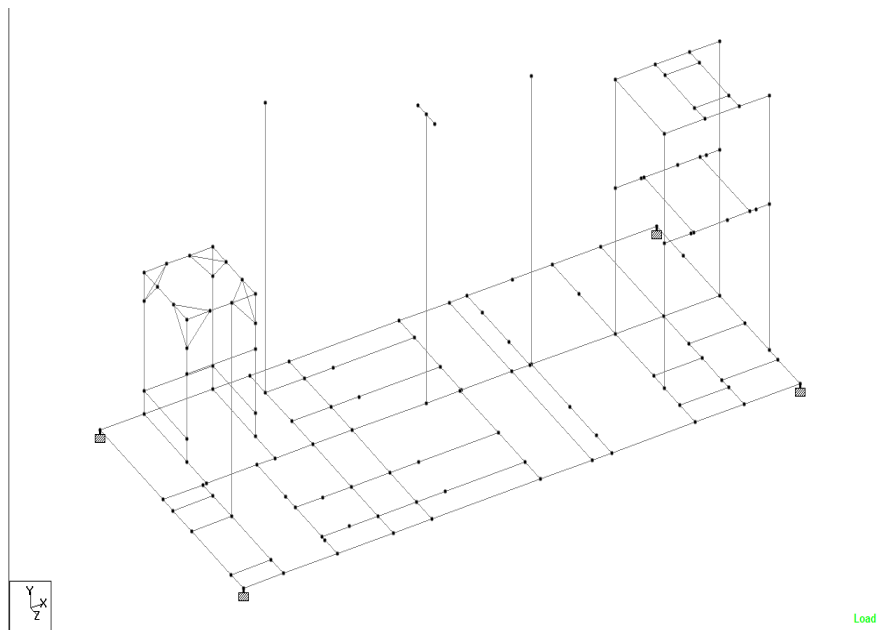
The In place analyses in STAAD.Pro are intended to assess the adequacy of units for all anticipated loading conditions once the unit is in place for its expected functions and operations. The skid is installed on the module deck and shimmed to match the surveyed as built shape of the module at the underside of the skid base and the structure is simulated using beam elements along the member centrelines and the model comprises of various sections. The design in Fig.1 below shows the typical modular skid designed in STAAD.Pro for this analysis.



**Fig. 1** Operation structure model for Modular Skid

### 2.1. Boundary condition

The consideration load for in place, under test have been simulated for the most stringent cases according to the Table 2.1 above. The skid is installed on the module deck and shimmed to match the surveyed as-built shape of the module at the underside of the skid base. To simulate this using STAAD.Pro the skid base is defined as fixed support at the members as shown in Fig.2 below



**Fig.2** Skid base using boundary condition

### 2.2. Design load

The Total Test Weight of the skid including frame and equipment is 5851 kg as shown in Table 2.2 and load summary for In Place Analysis displayed in Table 1.

**Table 1.** Load summary with In Place Analysis

Load Cases	Name	Load(kg)
1	Skid (Self-weight)	1550
2	Equipment (Y+ Heave)	4619
3	Z+ Roll	105
4	X+ Pitch	105
5	Live Load	-5 kN/m <sup>2</sup>
6	Wind Load X	33.5 m/s
7	Wind Load Z	33.5 m/s
8	ULS Operating Load	Live
9	Combination Load Case 9	Combined
10	Combination Load Case 10	Combined
11	Combination Load Case 11	Combined
12	Combination Load Case 12	Combined
13	Combination Load Case 13	Combined
14	SLS Operating Load	Live
15	Combination Load Case 15	Combined
16	Combination Load Case 16	Combined
17	Combination Load Case 17	Combined
18	Combination Load Case 18	Combined
19	Combination Load Case 19	Combined

The live load imposed is -5 kN/m<sup>2</sup> which is minimum uniformly distributed load for floors, platforms, walkways and staircases operational/maintenance. The wind load data is 33.5 m/s as per MS1553:2002 in Code of Practice on Wind Loading for Building Structure. The seismic load is 0.6 m/s<sup>2</sup> as per MS EN 1998-1 which not applicable due to very low seismicity geographical location.

Structures shall be designed to sustain the following Strength Stability & Ultimate Limit State Load

Combinations:

- a) 1.4Gk+1.6Qk
- b) 1.2Gk+1.2Qk+1.2WL-x
- c) 1.2Gk+1.2Qk+1.2WL-z
- d) 1.4Gk+1.4 WL-x
- e) 1.4Gk+1.4 WL-z
- f) 1.4Gk

where,

G = Dead Load

Q = Imposed Live Load

WL = Lateral Wind Load

### 3 Results and discussion

The skid is installed on the module deck and shimmed to match the surveyed as built shape of the module at the underside of the skid base. To simulate this using STAAD.Pro, the skid base is defined as fixed support at the members. The consideration load for in place analysis, under boundary condition test have been simulate for the most stringent cases which is gravity loads (structure) and operating loads (full weight of equipment and support beam) is applicable. The reaction, deflection and buckling summary were also discussed and result summary were summarized in this section.

#### 3.1 Reaction summary

Maximum Reaction for Each Support Location based on Load Case using In Place Analysis and the reaction envelope is tabulated in Table 2 below.

**Table 2.** Reaction envelope

Node			Max +ve	L/C	Max -ve	L/C
1	Horizontal	FX (kN)	0.00		-2.02	9
	Vertical	FY (kN)	33.62	8	-0.42	3
	Horizontal	FZ (kN)	0.00		-1.56	12
	Moment	MX (kN-m)	0.00		-4.15	8
		MY (kN-m)	0.19	12	0.00	6
		MZ (kN-m)	24.73	8	-0.30	3
11	Horizontal	FX (kN)	0.45	10	-0.18	11
	Vertical	FY (kN)	36.74	8	-0.30	7
	Horizontal	FZ (kN)	0.04	11	-0.99	12
	Moment	MX (kN-m)	0.04	7	-1.14	8
		MY (kN-m)	0.01	4	-0.07	12
		MZ (kN-m)	0.10	7	-26.08	8
30	Horizontal	FX (kN)	0.40	12	-0.13	6
	Vertical	FY (kN)	35.37	8	-0.04	6
	Horizontal	FZ (kN)	0.05	4	-1.16	12
	Moment	MX (kN-m)	3.40	8	0.00	
		MY (kN-m)	0.16	12	-0.02	4
		MZ (kN-m)	25.04	8	-0.06	6
65	Horizontal	FX (kN)	0.07	4	-0.43	11
	Vertical	FY (kN)	38.07	8	0.00	
	Horizontal	FZ (kN)	0.04	4	-0.84	12
	Moment	MX (kN-m)	1.50	8	-0.03	7
		MY (kN-m)	0.02	11	-0.09	12
		MZ (kN-m)	0.15	6	-26.88	8

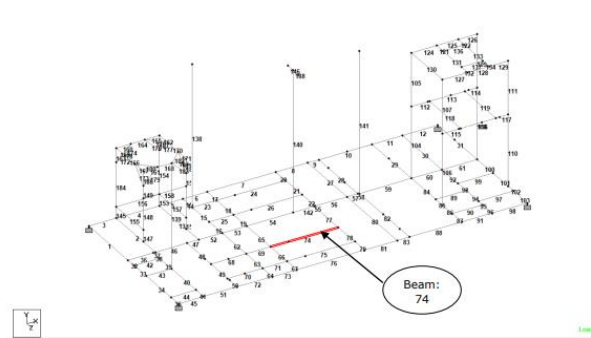
### 3.2 Deflection summary

At the end of this in place analysis, it can be concluded that increase in modulus of elasticity and moment of inertia decreases the deflection where increase in number of loads, magnitude of load and distance of load from ends increase the deflection of beam. The allowable deflection is  $L/500$  for supporting beams with equipment. The maximum deflection is 3.732mm which is allowable deflection is 10mm. Table 3 below shows the deflection summary for the place analysis.

**Table 3.** Deflection summary

Code Check	Span of the Member, L (mm)	Beam	Maximum Deflection (mm)	Allowable Deflection (mm)
BS5950-1: 2000	5000	74	3.732	10

The deformation or bending of a slab under the influence of applied loads, which can impact the structural integrity, serviceability, and safety of a building. Buckling refers to the loss of stability of a component and is usually independent of material strength. This loss of stability usually occurs within the elastic range of the material. The in place analysis shows in Fig. 3 below is presented as deflection summary for member beam.



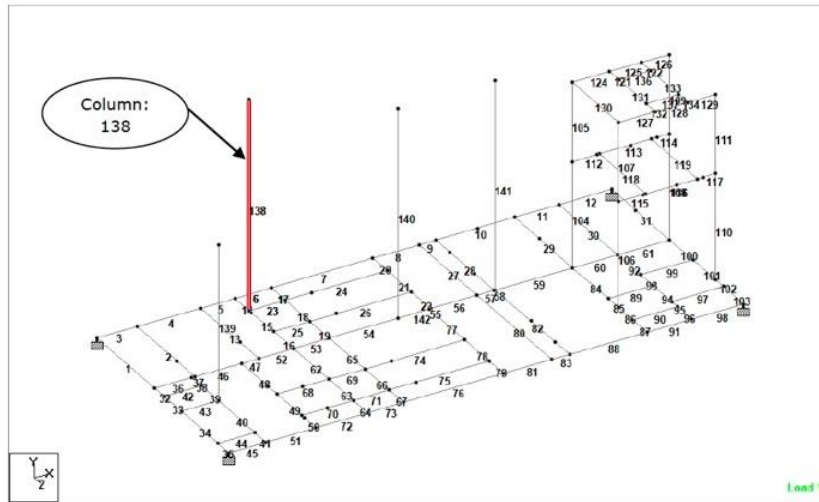
**Fig. 3** Member Beam – In Place Analysis for Deflection

### 3.3 Buckling Summary

Buckling tests simulating the load imposed on the support post have been conducted to obtain the empirical data for assessing the buckling limit of the support post, because the buckling behaviour of the support post is generally difficult to predict only analytical approach. The allowable buckling is  $H/150$  for portal frame which maximum buckling of the column is found as 4.822mm within allowable buckling 13.29mm. The maximum buckling of the column is found as shown in Table 4 and Fig.4 below.

**Table 4.** Buckling summary

Code Check	Height of Structure, H (mm)	Column	Maximum Buckling (mm)	Allowable Buckling (mm)
BS5950-1: 2000	1993	138	4.822	13.29



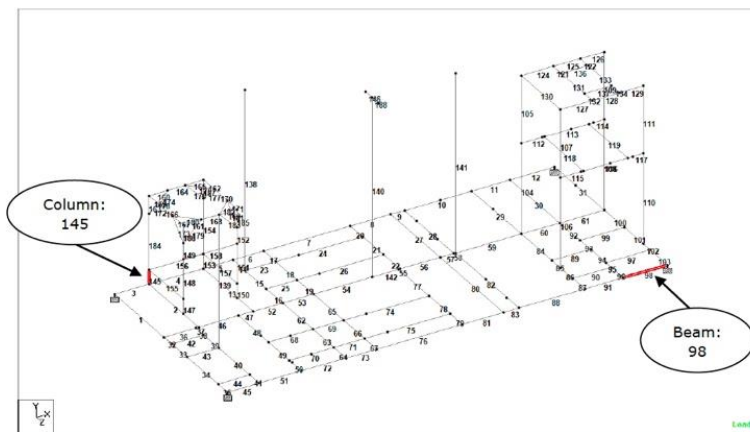
**Fig. 4.** Member column – in place analysis for buckling

### 3.4 Result Summary

The design check of the Steel members was carried out and shows in Table 5 and Fig.5 below. It shows that the unity design check was found to be less than 1.0, which is satisfactory.

**Table 5.** Design summary

Code Check	Member	Maximum Utilization	Max. Allowable Utilization
BS5950-1: 2000	98 (W8x21)	0.292	1.0
BS5950-1: 2000	145 (CH100x50)	0.597	1.0



**Fig. 5.** Member column and beam – In Place Analysis for design summary

### 3.5 Result Validation

To validate the existing slab capacity, the weight of the salt water tank is used as a benchmark. This helps to determine the condition of the existing slab that can sustain the load without any damage. According to the salt water drawing, the concrete of the tank used is Grade 40, Which  $40\text{N/mm}^2$  represent the minimum characteristic strength of concrete based on cube test

at 28 days as per BS EN 1992-3. The density of the reinforced concrete according to EN 1992-1-1 is 2500kg/m<sup>3</sup>.

#### Concrete Slab

Volume = 4m (L) x 2m (W) x 0.15m (thk) = 1.2 m<sup>3</sup>

Density of concrete = 2500 kg/m<sup>3</sup>

Weight of the concrete slab = 2500 kg/m<sup>3</sup> x 1.2 m<sup>3</sup> = 3000 kg

#### Concrete Wall A (Qty – 2)

Volume = 2 x [4m (L) x 1.40m (H) x 0.15m (thk)] = 1.68 m<sup>3</sup>

Density of concrete = 2500 kg/m<sup>3</sup>

Weight of the concrete slab = 2500 kg/m<sup>3</sup> x 1.68 m<sup>3</sup> = 4200 kg

#### Concrete Wall B (Qty – 2)

Volume = 2 x [2m (L) x 1.40m (H) x 0.23m (thk)] = 1.29 m<sup>3</sup>

Density of concrete = 2500 kg/m<sup>3</sup>

Weight of the concrete slab = 2500 kg/m<sup>3</sup> x 1.29 m<sup>3</sup> = 3220 kg

Total weight of the saltwater tank = 10420 kg

Based on the detailed investigation, the key findings are summarized as follows:

- a) The unity design check was found to be less than 1.0 which is satisfactory. All stress ratios for various kind of load are within allowable stress limit.
- b) The deflection and buckling summary were found within allowable deflection which is satisfactory.

## 4 Conclusion

The paper aims to evaluate sustainability of the existing slab and the research focused on the deflection summary, buckling summary, and load summary in place analysis. This typical modular skid in process plant comprises all calculation required for evaluation of structural design analysis. It covers calculation for in place condition. This proves that the existing slab has sufficient strength and can cope with such load without any risk to operation or defects.

## References

1. Boake, T.M. Diagrid Structures: Systems, Connections, Details; Birkhauser Verlag: Basel, Switzerland, (2014)
2. Elsanadedy, H.; Khawaji, M.; Abbas, H.; Almusallam, T.; Al-Salloum, Y. Numerical modeling for assessing progressive collapse risk of RC buildings exposed to blast loads. *Structures* 2023, 48, 1190–1208. (2023)
3. Kato, T.; Sakino, Y.; Sano, Y. Effect of Laser Peening with a Microchip Laser on Fatigue Life in Butt-Welded High-Strength Steel. *Appl. Mech.* 2, 878–890. (2021)
4. Tavakoli, H.R.; Alashti, A.R. Evaluation Of Progressive Collapse Potential Of Multi-Story Moment Resisting Steel Frame Buildings Under Lateral Loading. *Sci. Iran.* 20, 77–86. (2013)
5. Shan, S.; Pan, W. Progressive Collapse Mechanisms Of Multi-Story Steel-Framed Modular Structures Under Module Removal Scenarios. *Structures*, 46, 1119–1133. (2022)
6. Ghosal, Mainak. (2016). Advanced Analysis of a Structure using Staad Pro. 2395-1001.
7. Jangam, Tanmay & Kumbhar, Popat. (2024). Comparative behaviour of ‘conventional’ and ‘pre-engineered’ industrial structures with diagonal bracings considering smaller and larger openings. *Asian Journal of Civil Engineering*. 1-12. 10.1007/s42107-024-01089-7.
8. Goud, Guruswamy & Priyanka, S & Prabhakar, K. (2024). Design of G+1 Duplex Building Using Limit State Method and Staad-Pro. 9. 1-40.
9. Minachi, C.. (2024). Planning ,Design and Analysis of Institutional Building as per AICTE norms.
10. Verma, Monika & Bisen, Gagan & Naveen, Sura & Singh, Abhinandan. (2024). Research on Design and Analysis of Multi-Story Building by using AutoCAD and STAAD-Pro. *IOP Conference Series Earth and Environmental Science*. 1327. 1-16. 10.1088/1755-1315/1327/1/012023.
11. Jones, J.; Telionis, D. *Aeroform: Designing for Wind and Air Movement*; Taylor & Francis: Abingdon, UK (2022)
12. Al-Kodmany, K. *Understanding Tall Buildings: A Theory of Placemaking*; Routledge: New York, NY, USA, (2017)
13. Al-Kodmany, K. *Eco-Towers: Sustainable Cities in the Sky*; WIT Press: Southampton, UK, (2015)
14. Viswanath K.G, Prakash K.B., A. Desai, Seismic Analysis of Steel Braced Reinforced Concrete Frames. *International Journal of Civil and Structural Engineering* Vol. 1, (2010)
15. V Suwalka, N Laata, B Nagar, Comparative Study and Modelling of Framed Structure with Shear Wall & Without Shear Wall by Using ETABS, *International research journal of engineering and technology (IRJET)*, Vol.5, Jagannath Gupta Institute of Engineering and Technology, India (2018).

# A Study on Composite Adsorbent for Textile Wastewater Treatment

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**Abstract.** Textile production has been known as a water-intensive industry with highly fragmented operations. Consequently, the wastewater generated normally contains a wide variation of organic and inorganic pollutants that carry a significant number of hazardous parameters that often exceed the standard Department of Environment permissible discharge limit. Untreated textile wastewater may cause severe pollution to receiving water bodies and damage the ecosystem. Hence, many scientists are working seriously and battling against time to find appropriate and efficient treatment technologies for textile wastewater. Nevertheless, the literature review claimed that the application of waste materials as adsorbents for raw textile wastewater treatment has been established years ago. However, there is limited data on the production of composite adsorbent derived from rubber seed-coated activated carbon (RSCAC) and limestone powder (LP) as the core materials. The utilization of sea-weed alginate binder has never been reported specifically for the composite adsorbent preparation. The composite adsorbent's selected weight comprised 40% RSCAC, 40% LP, and 20% alginate. In the present study, the application of composite adsorbent for the treatment of textile wastewater was established. The best results were obtained using 15 g of composite adsorbent in a 1000 ml wastewater sample. At this dosage, there are about 71, 62, and 49% of COD, color, and Cu, were removed, respectively. Steady parameter removal was observed when contact time was increased from 20 to 120 minutes. Meanwhile, the parameters removal was found to increase beyond 150 rpm and the best pH condition was at pH 8.

**Keywords:** Adsorbent, Composite adsorbent, Textile, Textile Wastewater, activated carbon

## 1 Introduction

Most of the procedures used in the textile industry typically result in emissions, which might include solid waste, water, and air pollutants. Textile industries are known as water-intensive users whereby a substantial amount of water is consumed at every stage of processing operations including bleaching, dyeing, printing, and finishing. Water usage in mechanical processes, such as spinning and weaving, is comparatively lower than in wet textile processes.

However, in wet processing, where washing demands water for the rinsing medium, water is primarily used as a solvent in chemical processing. It is estimated that 36000 liters of water are needed, depending on the size of the textile production factory, to manufacture just 20,000 pounds of fabrics every day.

In addition, increasing demand for textile products in the domestic and export markets has been the reason for the wastewater increased proportionally, making it one of the main sources of severe pollution problems worldwide (Ahmad et al., 2010).

The creation of fibers, manufacturing processes, and final commodities all influence the environment. The most important pollution found in the textile production process is related to water quality. On the other hand, gaseous or atmospheric emissions rank as this industry's second-biggest pollution issue. Low process efficiency can lead to significant waste production and waste resource accumulation. The textile industry uses a wide variety of chemicals in its manufacturing processes, which leads to extended chains of wastewater generation in terms of quantity and quality. The wastewater generated during the textile production process, which comes from multiple sources, is a specific source of concern. Textile wastewater created from these operations typically contains a wide range of dyes and chemical additives; therefore, operators must manage the wastewater to comply with government regulations and environmental protection laws. Furthermore, there are notable variations in waste streams and loads because of wide variations in the demand for different types, patterns, color schemes, and fabric combinations (Ahmad et al., 2011).

## 1.1 Problem statement

During wet processing, the textile industries use a lot of water, chemicals, and additives. Furthermore, a wide range of substances with different compositions can be used, including polymers and organic products as well as organic and inorganic

compounds. Chemicals and additives are used in a variety of textile manufacturing processes from the very beginning of production till the finished product. These compounds are mostly used to improve the look of textiles, speed up the response time between dyes and textiles, and increase fabric durability (Alrozi, 2010).

Effluent from textiles frequently includes a mixture of additives, solvents, and chemicals. They do call for a variety of affordable, effective, and efficient physical and chemical approaches that also benefit society, the environment, and the operators themselves. Numerous researchers have employed a wide range of physical and chemical procedures up to this point, such as adsorption, coagulation, chemical oxidation, ozonation, flotation, membrane separation, and extraction. Though these procedures are practical, it is important to note that they have certain limitations, especially when solute concentrations are relatively high. Furthermore, aerobics and high operational costs are associated with these processes. For instance, coagulation generates a lot of sludge, which raises the expense of disposal. In a different scenario, the ion exchange mechanism regenerates without losing adsorbent; nevertheless, it is not economical and has trouble handling a large variety of colors. Although membrane separation is a well-known and effective method of removing dyes from textile effluent, its use is restricted due to high investment costs and membrane fouling (Rafatullah et al., 2010).

One of the earliest techniques for treating wastewater is adsorption. It has been extensively utilized in wastewater treatment facilities associated with industry all over the world, as well as municipal and sewage treatment facilities and landfill leachate treatment facilities. Because of its simplicity in design, ease of operation, and convenience, the adsorption method is thought to be a better choice. Furthermore, adsorption has a wide range of applications in water treatment systems since it may reduce a variety of pollutants. Studies on adsorption have been carried out to eliminate organic materials and heavy metals from synthetic and actual textile effluents. It's interesting to note that a lot of adsorbents have been produced that can withstand broad fluctuations in the components of wastewater due to the various roles of adsorption in wastewater treatments. A portion of these adsorbents come from three primary sources: mineral deposits, industrial wastes, and agricultural wastes (Ahmad et al., 2010).

Traditionally, one of the most extensively used and oldest known adsorbents is activated carbon, which is created by carbonizing and dehydrating the material before activating it. Activated carbon typically possesses a huge surface area, ranging from 600 to 2000 m<sup>2</sup>/g, and an extremely porous structure. Moreover, activated carbon is a superior adsorbent presently when compared to some other adsorbents due to its high adsorption capacity, high degree of surface reactivity, and chemical and mechanical stability. The benefits of activated carbon in treating textile wastewater have been extensively documented. It can eliminate a wide variety of contaminants, such as metal ions, dyes, phenols, detergents, and many more. Notwithstanding these benefits, the manufacture of activated carbon is expensive due to high energy needs during activation and limitations on regeneration (Alrozi, 2010).

Several studies published recently have demonstrated the potential for using different mineral and carbon compounds to create hybrid materials. Usually, they are made by mechanically combining carbon compounds with minerals or by carbon deposition. These materials are most frequently chosen from highly developed surface areas, such as alumina and silica. In addition, known-composition organic molecules like formaldehyde, alcohols, naphthene, and mixtures of organic chemicals have also been employed as precursors in the synthesis of composite adsorbents. Most carbon-mineral adsorbents share a few unique characteristics, such as a mosaic surface that allows for the simultaneous adsorption of both organic and inorganic materials. Furthermore, the polar interaction functionality of the chemical functional groups on the adsorbent surface was crucial to the adsorption process (Alrozi, 2010).

The treatment of actual textile wastewater from a Penang-based cotton textile mill is the main subject of this study. Because of the high-quality fabrics it produces, the mill is one of the leading companies in Malaysia's textile industry, specializing in textiles and garments for the export market. The mill currently produces 250 m<sup>3</sup>/day of mixed effluent through a variety of internal operations. The mill operator used physicochemical and biological treatment in combination due to the volume of wastewater generated. However, a strict permitted discharge limit has been enforced, according to the new Department of Environment Legislation from 2013, making it difficult for the operator to comply, especially with typical effluent criteria like COD, color, and heavy metals (Alrozi, 2010).

In the present study, the treatability of textile wastewater via composite adsorbent was investigated.

## 1.2 Objective of research

The main objective of the present study included the following: -

To compare the performance of rubber seed-coated activated carbon (RSCAC) and limestone in composite by investigating the effect of dosage, shaking speed, shaking time, and initial pH.

## 2 Literature review

The textile industry is a highly fragmented sector that is defined by the coexistence of numerous factories operating across the country alongside small and medium-sized businesses. The primary impediments to the textile industries' progress toward



an open global market are mostly related to the environmental effects of air, water, and solid waste generation. Depending on the methods of production, the textile manufacturing sectors generally emit wastewater in different volumes and quality. A mill that produces 60,000 meters of fabric a day on average is probably going to release 1.5 million liters of effluent every day. Approximately 100,000 commercially accessible dyes are thought to exist in the market, accounting for most of the world's dye manufacturing.

Several organic-based substances, chemicals, and dyes used in both dry and wet processing stages can be found in the wastewater from the textile industry's manufacturing processes. Parameters include pH, color, salinity, biological oxygen demand (BOD), and chemical oxygen demand (COD) fluctuate greatly. The dyeing and finishing processes, which entail dyeing materials of the desired color and processing those fibers into finished goods, are typically the primary sources of contaminants in textile effluent. Additionally, after fabric production, sizing and resizing wastewater contain about 50% of the organic load in the wastewater (Arami-Niya et al., 2012).

Scouring and desizing wastewater is recognized as the primary source of the organic load, including COD, from the beginning of textile manufacturing. Under both aerobic and anaerobic circumstances, conventional starches might biodegrade; however, bulking of activated sludge frequently happens when a sizable amount of the wastewater is made up of desizing wastewater. A significant number of inorganic compounds that are extremely toxic to marine life during scouring include hydrochloric acid, sodium hypochlorite, sodium hydroxide, and sodium sulfide. Due to the variety of starches used in the designing process, high BOD and total solids are also a result. According to Auta et al. (2011), wastewater de-sizing accounts for as much as 50% of the total BOD in woven fabric processing.

In the dyeing process, dyes are employed to give the fabric color. In the past, dyes were created to withstand adverse conditions for the duration that the colored material was in use. Furthermore, dyes used in dyeing can range from 0.01 g/L to 0.25 g/L, depending on the type and method that is preferred. The release of textile wastewater is usually accompanied by a significant issue: dyes that produce high visibility and recalcitrance in natural systems are present in the water streams. Furthermore, the discharge of wastewater containing colorants into the ecosystem modifies eutrophication, aesthetic pollution, and disturbances in aquatic organisms. Reactive blue 21 and direct blue 80 were among the low biodegradability of the leftover colored wastewater which contributed to COD/BOD ratios of 17.7, and 10.8, respectively. In addition, the dye wastewater may contain diluents, organic acid, fixing agents, defoamers, oxidizing agents, and oxidizing agents, with the wastewater containing around 75% of the salts. Regarding heavy metals, these substances are typically found in bleaching chemicals, complicated dyes, wool dyeing, and bath additives. According to Bello et al. (2011), copper, chromium, cadmium, zinc, and other metal atoms are a few of the discovered heavy metals.

The textile industry has an environmental concern due to the substantial levels of contaminants found in textile wastewater, which are mostly sourced from dyes, chemicals, and additives. This is because textile wastewater was challenging to handle due to wide variations in chemical composition and a wide variety of dyes used. Additionally, the organic and poisonous chemicals found in textile wastewater pose a risk to fish and other aquatic life. Therefore, a variety of methods that can withstand a wide range of contaminants from the wastewater must be included in textile wastewater treatment strategies (Bhandare et al., 2015).

Before being safely released into the environment, effluent from the textile industry may need to go through several biological, physicochemical, and appropriate combinations of these treatments. The concentration of organic compounds found in textile wastewater during the first stage of treatment can be reduced via biological treatment. Additionally, it has been believed that the most viable possibilities for the treatment approach are the low-cost implications and environmentally safe techniques. Membrane filtration, coagulation, flocculation, precipitation, ion exchange, ultrasonic mineralization, electrolysis, advanced oxidation, and chemical reduction are examples of physicochemical techniques. These techniques are typically used in the latter stages of the treatment process to successfully lower challenging parameters, such as inorganic compounds and heavy metals. In contrast, it has been reported that physicochemical treatment processes alone are not preferred, despite their effectiveness, due to the high costs involved (Chakravarty et al., 2010).

Regarding the edge of their treatment procedures, a variety of physical chemicals and biological techniques covered in earlier sections provide a broad range of pollution removal options. Additionally, a variety of methods have been developed recently for treating wastewater that contains heavy metals and organic pollutants. These methods seek to both improve the quality of treated effluent and lower excessive concentrations of the various contaminants, as evidenced by numerous literatures. Furthermore, the therapeutic options that have been presented possess intrinsic benefits and limitations in their respective applications. The most widely used physicochemical techniques for treating textile wastewater include chemical precipitation, ion exchange, membrane filtration, adsorption, and advanced oxidation processes (AOPs) (Rafatullah et al., 2010).

Usually, chemical oxidation is used to break down refractory materials in wastewater from textiles. High degrading efficiency direct oxidation techniques are conceivable; however, the selection of an acceptable direct oxidation process is mostly determined by operating conditions, pollutant load, and process restrictions. To change the chemical composition of group compounds, including dyes, in wastewater, common oxidation processes like wet air oxidation and catalytic wet air oxidation primarily employ oxidizing agents like ozone (O<sub>3</sub>), hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), UV light, and permanganate (MnO<sub>4</sub>). Due to its excellent dye reactivity, ozone is the most used. Furthermore, it can oxidize aromatic hydrocarbons, phenols, and chlorinated hydrocarbons (Bello et al., 2011).

Fenton's reagent may effectively remove color and COD; however, the main disadvantages of this technique include managing iron-contaminated sludge and extended treatment times. Additionally, due to their slower and longer reaction durations, some commercial dyes, such as dispersion and vat dyes, are not appropriate for ozonation. Furthermore, some AOPs have limitations, such as O<sub>3</sub>/UV, and the ozonation procedure did not significantly alter color removal since the dyes absorbed most of the UV light, which could result in a tiny quantity of hydroxyl free radicals being created (Alrozi, 2012)

Mahmoodi et al. (2011) state that practically all AOPs require high temperatures and pressures, as well as expensive installation and operating expenses. Dye-containing waste coagulating and flocculating. Water treatment is considered the oldest wastewater treatment process and has been utilized for several decades. In the presence of a coagulant, this process destabilizes colloidal particles, which are then flocculated to increase their particle size into large flocs. Among many coagulants, pre-hydrolyzed metallic salts such as Polyaluminium Chloride (PACl), Polyferric Chloride (PFCI), Polyferrous Sulfate (PFS), and Polyaluminium Ferric Chloride (PAFCI) are found to be more effective than hydrolyzing metallic salts such as aluminum sulfate (alum), ferric sulfate (FeSO<sub>4</sub>), Ferric Chloride (FeCl<sub>3</sub>) and Magnesium Chloride (MgCl<sub>2</sub>) because they are readily soluble in water.

However, when this procedure is used, sludge generation always happens; therefore, the right parameters, such as a good choice of flocculant and coagulant, should be selected. In addition, the sludge produced could contain hazardous substances from the treatment, necessitating additional sludge treatment to stop heavy metals from leaking into the environment (Pang et al., 2013).

### 3 Methodology

In this study, two types of untreated adsorbents were used for the preparation of composite adsorbent namely rubber seed-coated activated carbon (RSCAC) and limestone powder (LP). The RSCAC was obtained from a local supplier (Tangkas Laksana Sdn Bhd, Penang). Next, the limestone chip was obtained from a limestone quarry located in Batu Gajah, Perak. Both raw materials were collected without any pre-modification to maintain their natural conditions. Plate 3.1 (a) and (b) show the RSCAC and LP obtained from suppliers.

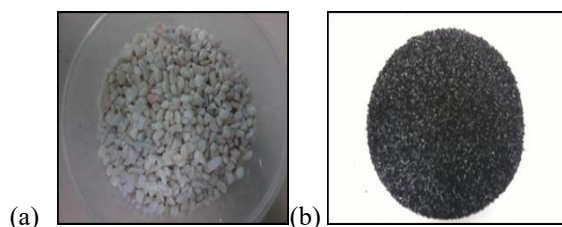
All the chemicals and reagents used in the present study are listed in Table 3.1. The chemicals were used as received without further purification. Before conducting the experimental works, the material safety data sheet (MSDS) of all the chemicals was read and used based on supplier guidelines.

#### a) Sampling Procedure

Wastewater samples were manually collected from the outlet of the buffer pit of a cotton textile mill plant in Penang state, Malaysia. The samples were collected in a Teflon container (20 L per sample). By the Standard Method of Water and Wastewater Examination, the samples were immediately transported to the USM Environmental Engineering Laboratory and stored at 4 °C to avoid any changes in their physicochemical characteristics before use. The samples were analyzed for COD, color, heavy metals, pH, and conductivity according to the Standard Methods for the Examination of Water and Wastewater (APHA, 2005).

#### b) Site Location and Wastewater Characteristics

The investigation was carried out at a wastewater treatment facility for cotton textile mills. Located in Penang state's Perai Free Zone, the mill is situated at 5°21'37"N 100°23'29" E. The cotton mill's primary output is 100% cotton and blended polyester/cotton woven cloth that has been colored, printed and left white. It is projected that the mill produces 10 million yards each month. About 250 m<sup>3</sup>/hour of wastewater is currently being treated at the wastewater treatment facility; Table 3.2 lists the primary properties of the effluent. The three components of the treatment plan are the oxidation pond, activated sludge, and neutralization.



**Plate 3.1:** (a) Limestone chip and (b) Rubber seed-coated activated carbon

Table 3.2: Characteristics of textile wastewater

Parameters	Raw Wastewater	Treated effluent	Effluent Standard B*
Flow rate (m <sup>3</sup> /hr)	250-300	250-300	
pH	11.10-11.8	7.2-7.8	5.5-9.0
BOD	700-900	10-30	40
COD	1,600-2,000	180-260	250
Color (Pt-Co)	2,000-4,000	500-700	200
Suspended solids (mg/L)	15-30	20-40	100
Oil and Grease (mg/L)		2-8	10

\*Extracted from Environmental Quality (Industrial Effluent) Regulations 2013, Fifth schedule, Acceptable conditions for discharge of Industrial effluent for mixed effluent Standards A and B. Standard B refers to discharges outside the catchment area.

### c) Analytical Methods

The Standard Procedures for the Examination of Water and Wastewater were used for all tests (Alrozi, 2010). The DR 6000 (Hach, USA) spectrophotometer was used to assess color concentration as apparent color, and Method No. 8025 was used to fix the wavelength at 455 nm (Program number 120). The manufacturer's guideline, 2495402, which states that the fill line should face the right of the cell orientation, was closely adhered to by the sample cells used. The COD test was conducted at high-range concentrations (20–1500 mg/L) by Method 8000 (Program number 435). We acquired the COD reagent from Hach. Before measurement, a 2.5 mL sample was added to the COD vial and heated for two hours at 150 °C in the reactor. At 620 nm, the wavelength was chosen.

Ion Conductive Plasma was used to measure the number of heavy metals (ICP-OES, Varian, Australia). The stock solution, which contained 100 mg/L, was used to prepare the standard solutions. The manual was followed to prepare the individual concentrations of 1 mg/L, 2 mg/L, 4 mg/L, and 8 mg/L. Throughout the standard preparation, 50 mL volumetric flasks were employed, and a micropipette was used to separate a small volume of the standard solution. To guarantee a pure and uniform solution, 1% nitric acid (65% purity, Merck, Germany) was utilized in the stock solution's formulation. The desktop pH meter PC 2700 (Thermo Scientific, USA) was used to measure the pH of the wastewater from textile dyes.

All in situ measurements for the site sampling were completed with a YSI Pro Plus Multimeter (Professional Plus, USA). Conductivity, pH, dissolved oxygen (DO), total dissolved solids (TDS), salinity, and resistivity are among the parameters that are measured. To acquire consistent results, all tests were run in triplicate and all equipment was calibrated to ensure appropriate readings throughout the study. The percentage removal of the studied parameters was obtained using ion:

$$Removal (\%) = \frac{C_i - C_f}{C_i} \times 100 \quad (3.1)$$

Where  $C_i$  and  $C_f$  are the initial and final concentrations of parameters (mg/L), respectively.

### d) Composite Adsorbent Preparation

The main materials used in this study were RSCAC and LP. The selection of these materials was done based on their availability and effectiveness for the removal of organic and heavy metals from textile wastewater. In addition, extensive reports about these materials have been reported elsewhere.

### e) Preparation of CSAC and LP.

The AC preparation rig consists of a stainless steel (SS) vertical tubular reactor equipped with a programmable temperature controller. The gas flow meter was used to control the flow rates of N<sub>2</sub> and CO<sub>2</sub> supplied to the reactor. The piping system was mainly made of Teflon and SS fittings and pipes. The vertical stainless-steel reactor with dimensions of 150 mm long

and 25 mm inner diameter was used to carry out carbonization and activation processes. An SS wire mesh was positioned at the bottom part of the tubular reactor to hold the sample intact. The reactor was stood and placed inside a vertical tubular furnace with a programmable controller (Model Carbolite, USA). The dimensions of the furnace were 500 mm in length and 82 mm inner diameter. A K-type thermocouple was used to measure the temperature of the sample inside the reactor. The maximum tolerance of the thermocouple is 1000 °C. The excess flue gas was released into a condenser.

The RSCAC (2- 5 mm particle size) was first washed with tap water several times to remove impurities and dried in an oven (Model 600, Memmert, Germany) for 24 hours at 105 °C. Then, the dried RSCAC was crushed by a heavy-duty ball mill with ceramic-type balls. The grinding process was fixed for 12 hours until the size of the RSCAC was reduce to less than 1 mm. Next, the grind products were sieved with a sieve passing 150 µm and retained at 75 µm. The LP was obtained in fine granules (1 mm particle size). To LP was sieved with a sieve aperture of 150 µm and retained at 75 µm. The resulting materials were stored in an airtight container before use.

#### f) Preparation of composite adsorbent

The composite adsorbent preparation involved several physical and mechanical procedures. First, a known amount of RSCAC and LP was introduced into a 500 mL beaker. Distilled water was then added and stirred with a mechanical stirrer (Ika, Germany) for 15 minutes at 50 rpm speed. Next, the beaker was heated to 80 °C on a hot plate and alginate solution was slowly added into the beaker. This process was maintained for 15 minutes until homogeneous conditions between RSCAC, LP, and alginate were reached. The selected weight of the composite adsorbent was 40% for RSCAC, 40% for LP, and 20% for alginate.

### 4 Finding and analysis

#### a) Effect of Dosage

The effect of adsorbent dosage is relatively the most crucial parameter to be considered in the adsorption process because it determines the extent of the adsorption ability of the adsorbent to remove parameters being studied. The results for the removal of COD, color, and Cu by using composite adsorbent are demonstrated in Figure 4.1. The shaking speed and the contact time were fixed at 200 rpm and 15 min, respectively. The dosage of composite adsorbent was varied from 0.2 g to 20 g. The best outcomes, as seen in Figure 4.1, came from utilizing 15 g of composite adsorbent. Approximately 71, 62, and 49% of COD, color, and Cu were eliminated at this dosage, respectively. After this dosage, only a minor removal was seen, especially at 17 g, when the percent removal for color and Cu decreased from 72% to 70% and 64% to 62%, respectively.

In general, it was discovered that when the adsorbent dosage increased, so did the removal trend for composite adsorbent. The quantity of sorption sites that are available is related to this phenomenon. It was discovered that increasing the adsorbent dosage improved the adsorption process inside the adsorbate and adsorbent system by increasing the number of sorption sites at the adsorbent's surface. The concentration gradient's driving force increased with the concentration of wastewater. The diffusion of COD, color, and Cu from the solution into the adsorbent was sped up by this driving force. The reason for this was that during the adsorption process, the composite adsorbent sites reached saturation. The pore that formed inside the layers of calcium carbonate and the composite adsorbent provided the active sites that increased adsorption capacity.

Expanding the grafting chains allowed more functional groups, including OH and hydrogen bonds, to be linked with water molecules and metal ions. This was the function of the AG incorporated in the composite adsorbent. Consequently, the effective uptake of metal ions was enhanced by AG's ionic binding. Conversely, because of the saturation adsorption sites throughout the adsorption process, increasing the dose of composite adsorbent further caused a steady decline in the percent removal. The characteristics of the adsorption capacity were also connected to this event. Similarly, the overlapping or aggregation of adsorption sites led to a decrease in adsorption capacity when the dosage of adsorbent was increased proportionately. This further led to the depression of total adsorbent surface area and elevation in diffusion path length (Rafatullah et al., 2010).

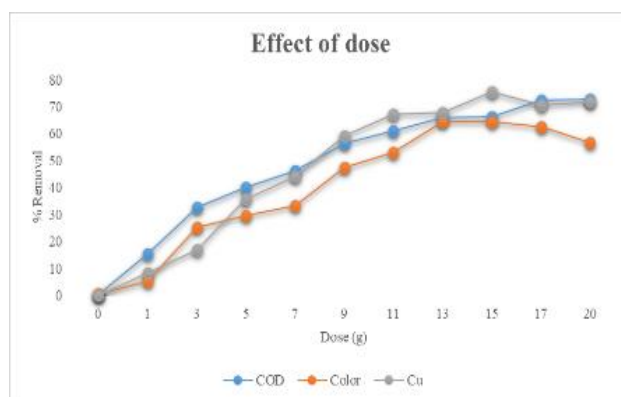


Fig 4.1: Effect of composite adsorbent dosage

## b) Effect of Contact Time

The contact time between the adsorbate and the adsorbent is one of the important parameters for the assessment of the adsorption process applicability. The effect of contact time on studied parameters towards composite adsorbent is shown in Figure 4.2. The composite adsorbent dosage was fixed at 15 g and the shaking speed was fixed at 200 rpm. In general, adsorption capacity and parameters removal efficiency proportionally increase by prolonging contact time. However, it can be observed that low removal of parameters was recorded during at first 15 minutes of contact time for COD, color, and Cu, respectively. This behavior was due to the dissociation of water molecules that bear different types of pollutants and require a certain time for a reaction to occur effectively.

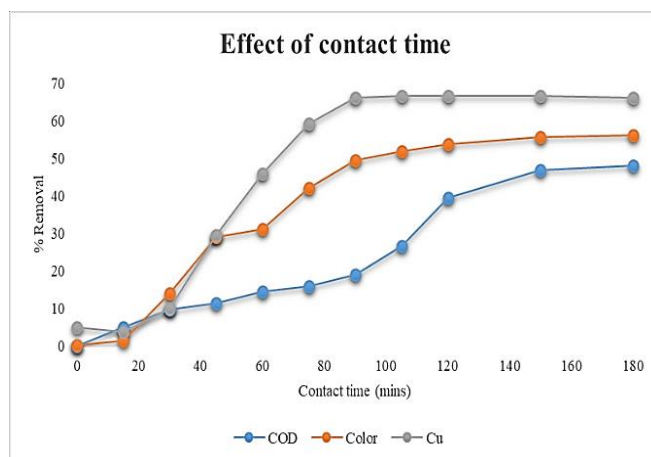
During the adsorption course, mass transport involving adsorbent and adsorbate can be explained as follows. Before the solute moves from the particle surface into the interior site by pore diffusion, the water molecules must first overcome the boundary layer effect and travel through the solution (film diffusion). As a result, the adsorbate was adsorbed into the composite adsorbent's internal porous structure (Arami-Niya et al., 2012).

The elimination patterns for every parameter increased dramatically after the 15-minute interval. Water molecules' appropriateness for diffusing within the composite adsorbent matrix was explained by this phenomenon, which allowed for a seamless transition from the liquid to the solid phase (adsorbate to adsorbent), resulting in a faster rate of adsorption. After that, when the duration of interaction was extended from 20 to 120 minutes, a consistent parameter elimination was noted. By this time, 66% of Cu, 40% of color, and over 30% of COD had been eliminated. After an additional 140 minutes of contact, the percentage elimination of COD, color, and Cu started to stabilize.

It suggests that the quantity of water molecules adsorbed onto the composite adsorbent and the amount of water molecules desorbing from the adsorbent are in a state of dynamic equilibrium. As a result, equilibrium time is the amount of time needed to reach the condition of equilibrium. Significantly, after 120 minutes, the removal trends for COD, color, and Cu began to decline, suggesting a decrease in the number of active adsorption sites on the composite adsorbent that were available. The reason for this was that the adsorbate molecules' limited mass transfer from the bulk liquid to the exterior surface of the composite adsorbent was caused by time (Pang et al., 2013).

The removal efficiencies for color, Cu, and COD showed that the composite adsorbent successfully interacted with it through both internal and external surfaces during the designated contact time. There were probably two major stages at which the removal patterns for all the parameters happened. a faster phase between 90 and 180 minutes, followed by a slower phase during the first 80 minutes of adsorption. Surface adsorption mostly took place around the composite adsorbent surface at this early phase. Thus, the adsorption happened because of a shorter reaction time with the water sample. sticky substance (Pang et al., 2013).

However, in the subsequent phase, surface-adsorbed water was mostly transported to the interior adsorption site by adsorption (Shaarani et al., 2010). To make room for the subsequent adsorption, a portion of the external sites were released and cycled in the interim.



**Fig 4.2:** Effect of Contact Time

## c) Effect of Shaking Speed

To regulate the adsorption rate in the early stages, external mass transfer is comparatively significant. The water sample's ion mobility was affected by the application of the proper agitation or shaking speed, which decreased the mass transfer resistance. The impact of shaking speed on parameter removal is depicted in Figure 4.3. Significant COD removal was noted during the first part of the shaking time, and this was followed by color and Cu, in that order. As a result, the COD plateau was detected after the shaking speed of 150 rpm was exceeded. At this point, more than 51% of COD was eliminated. Meanwhile, color and Cu removal were found to increase beyond 150 rpm and became consistent at 250 rpm. The maximum removal for color and Cu were 49 and 47%, respectively.

At a high rate of agitation, the resistance of the boundary layer encircling the adsorbate breaks down. Consequently, a further increase in shaking speed from 250 rpm to 350 rpm resulted in almost negligible removal for each of the parameters.

Considering that the removal parameters had reached equilibrium and no further rise in adsorption had occurred, the optimal shaking speed was 200 rpm. This result can be explained by the fact that, at first, the kinetic energy of the adsorbent particles as well as the water sample molecule rose as the shaking speed increased. When the ideal shaking speed is attained, the kinetic energy of the adsorbent and adsorbate particles rises to the point where collisions occur, which causes weakly confined molecules (Arami-Niya et al., 2012).

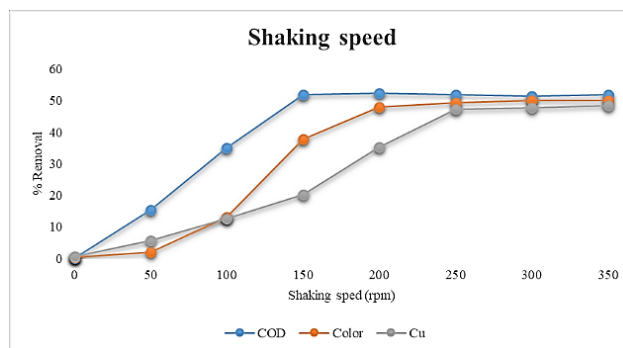


Fig 4.3. Effect of shaking speed

#### f) Effect of Initial pH

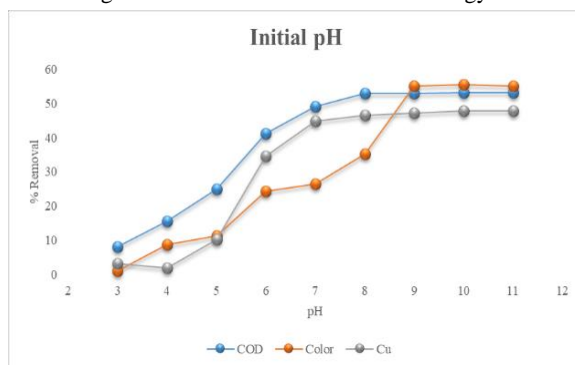
One of the most significant variables influencing an adsorbent's ability to treat wastewater is its initial pH. Additionally, changes in pH cause changes in the adsorptive molecule's degree of ionization as well as its surface characteristics. The primary factors influencing the degree of ionization have also been the metal chemistry and the surface characteristics of the adsorbent (Alrozi, 2010). The effects of different water pH levels on COD, color, and Cu removal are shown in Figure 4.4. In summary, removal patterns for every parameter increased in tandem with the water sample's rising pH. For COD, color, and Cu, pH 8 produced the greatest results (48, 35, and 52%). However, further increased pH to 9 resulting in higher removal of color to 55%. The lowest parameter removal was observed when the pH of the water sample was fixed at 3. At this pH, the removal of COD, color, and Cu were 7.9, 0.8, and 3.1%, respectively.

After pH 3, it was found that the removal patterns rose proportionately as pH rose. Thus, it may be concluded that at pH values below 5, the composite adsorbent was not beneficial. This is because the existence of electrostatic repulsion prevented positively charged cations from being adsorbed at lower pH values since there were more positively charged surface sites and fewer negatively charged active sites. When the pH was less than 4 (1.9% in this instance), the Cu ion showed minimal elimination. Furthermore, it was discovered that the adsorption process was rendered ineffective by the abundant  $H^+$  ions that competed with dye cations for the adsorption sites of the composite adsorbent. Generally, a change in pH influences the adsorption mechanism through the dissociation of functional groups of the active sites on the surface of the adsorbent. In this work, the adsorption might be due to the interaction of sulfonic ( $-SO_3^-$ ) groups of reactive dyes from wastewater samples with  $-OH$  groups that are present on the surface of composite adsorbent prepared whereby the  $-OH$  groups in the structure of the adsorbent and the  $S=O$  stretching and  $-N=N-$  stretching in the structure of the reactive dyes were diminished after the adsorption process (Arami-Niya et al., 2012).

Due to the negligible shift in polarity, the elimination of COD, color, and Cu rose gradually after pH 5 and reached a peak at pH 8 (48 and 52%) for both COD and Cu. At pH 9, color removal achieved an optimal elimination of 55%. The color removal trend suggested that color loss rises in a pH-dependent manner. According to theory, in extremely acidic environments, several functional groups become protonated and change into species that are positively charged, which lessens the attraction between the metals and the minerals (Alrozi, 2010). This phenomenon demonstrated the crucial property of the low pH-protonated carboxylate group. Elevating pH leads to the deprotonation of functional groups, which then operate as negatively charged entities that draw heavy metals. efficiently.

As a result, the metal ion conformed to the surface chemistry analysis of the composite adsorbent and was drawn to the functional groups' negative charge. However, in more alkaline environments, metals become less soluble, which permits precipitation and could make the sorption process more difficult. As such, precipitation that took place in an alkaline environment made the metal sorption efficiency of the composite adsorbent apparent (Pang et al., 2013).





## 5 Conclusion

In conclusion, the best results were obtained by using 15 g of composite adsorbent in a 1000ml sample of wastewater. At this dosage about 71, 62, and 49% of COD, color, and Cu, were removed, respectively. Steady parameter removal was observed when contact time was increased from 20 to 120 minutes. At this point, over 30% of COD, 40% of color, and 66% of Cu were removed. The parameters removal was found to increase beyond 150 rpm and became consistent at 250 rpm and finally, the best results obtained for COD, color, and Cu were at pH 8, respectively 48, 35, and 52%.

## References

1. Ahmad., M.A. and Alrozi., R. (2010). Optimization of preparation conditions for mangosteen peel-based activated carbons for the removal of Remazol Brilliant Blue R using response surface methodology. *Chemical Engineering Journal*, 165, 883–890.
2. Ahmad, M.A. and R. Alrozi (2011). Removal of malachite green dye from aqueous solution using rambutan peel-based activated carbon: Equilibrium, kinetic and thermodynamic studies. *Chemical Engineering Journal*, 171, 510-516.
3. Alrozi, R. 2010. Preparation of Activated Carbon From Tropical Fruit Wastes For The Removal of Basic And Reactive Dyes. MSc Thesis, Universiti Sains Malaysia.
4. Arami-Niya, A., Wan Daud, W.M.A., Mjalli, F.S., Abnisa, F. and Shafeeyan, M.S. (2012). Production of microporous palm shell based activated carbon for methane adsorption: Modeling and optimization using response surface methodology, *Chemical engineering research, and design*, 90, 776-784.
5. Auta, M. and Hameed, B.H. (2011). Preparation of waste tea activated carbon using potassium acetate as an activating agent for adsorption of acid blue 25 dyes, *Chemical Engineering Journal*, 171, 502-509.
6. Bello, O. S., Ahmad, M.A., Ahmad, N. (2011). Adsorptive features of banana (*Musa paradisiaca*) stalk-based activated carbon for malachite green dye removal, *Chemistry, and Ecology*, 28, 153-167.
7. Bhandare, A. M., Vyawahare, N. S. and Kshirsagar, A. D. (2015). Anti-migraine effect of Areca Catechu L. nut extract in bradykinin-induced plasma protein extravasation and vocalization in rats. *Journal of Ethnopharmacology*, 171, 121-124.
8. Chakravarty, P., Sarma, N. S. and Sarma, H. (2010). Biosorption of cadmium (II) from aqueous solution using heartwood powder of Areca catechu. *Chemical Engineering Journal*, 162, 949-955.
9. Hassan, M. M., Wagner, M. H., Zaman, H. and Khan, M. A. (2010). Physico-mechanical performance of hybrid betel nut (*Areca catechu*) short fiber/seaweed polypropylene composite. *Journal of Natural Fibers*, 7, 165-177
10. Mahmoodi, N.M, Hayati, B., Arami, M., Lan, C. (2011). Adsorption of textile dyes on pine cone from colored wastewater: Kinetic, equilibrium and thermodynamic studies. *Desalination*, 268, 117–125.
11. Pang, Y. L. and Abdullah, A. Z. (2013). Current status of textile industry wastewater management and research progress in Malaysia: A review. *Clean – Soil, Air, Water*, N/A-N/A.
12. Rafatullah, M., Sulaiman, O., Hashim, R. and Ahmad, A. (2010). Adsorption of methylene blue on low-cost adsorbents: A review, *Journal of Hazardous Material*, 177, 70–80.
13. Shaarani, F.W. and Hameed B.H. (2010). Batch adsorption of 2,4-dichlorophenol onto activated carbon derived from agricultural waste, *Desalination*, 255, 159–164.

# Biomass-Based Activated Carbon from the Seeds of *Canarium Odontophyllum* for Dye Wastewater Treatment

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**Abstract.** The synthesis of activated carbon from the seed of *Canarium Odontophyllum* (COAC) through physicochemical activation has been successfully investigated. The physicochemical activation was carried out by using potassium hydroxide (KOH) impregnation and carbon dioxide (CO<sub>2</sub>) gasification. The adsorption performance of COAC was evaluated through the removal of methylene blue (MB) dye from synthetic wastewater. By using an experimental design, the results revealed that the activation temperature, activation time, and KOH impregnation ratio (IR) were significant factors influencing the adsorption performance for all pollutants. The optimum preparation conditions for COAC were an activation temperature of 757 °C with an activation time of 1.43 h and an impregnation ratio of 1.83, respectively. The effects of adsorbate initial concentration (50-500 mg/L) and contact time (0-24 h) were evaluated through batch adsorption test. Optimized COAC gave removal of MB, 95.57 % while the adsorption uptakes of the COAC increased with an increase in adsorbates' initial concentration and contact time.

**Keywords:** Activated carbon, *Canarium Odontophyllum*, physicochemical activation

## 1 Introduction

Textile wastewater presents major challenges due to color contamination, which represents a threat to human health and the environment. The fact that dye-containing wastewater is classified as scheduled waste in Malaysia underscores the gravity of the issue and the pressing need for appropriate treatment. In the textile industry, a variety of dyes are used, including basic, reactive, and acid dyes. The persistence and potential toxicity of these colors pose challenges for wastewater treatment. A common basic dye used to color cotton and silk, methylene blue (MB), is a prime illustration of these challenges due to its resilience to degradation and negative impacts on human health and the environment (Ahmad et al. 2011).

Inadequate handling of wasted dyes can have detrimental effects on aquatic environments, interfering with natural processes like photosynthesis and making water supplies unsafe to drink. The effect on public health emphasizes how urgent it is to address this issue, especially in poorer nations where water contamination is a leading cause of illness. Activated carbons made from agricultural waste offer a promising way to remove the dye. Considering the quantity of agricultural waste materials, this approach is reasonably accessible and efficient in adsorbing dyes from wastewater. To reduce the harmful impacts of textile wastewater discharge on the environment and public health, it is imperative to implement such sustainable and efficient treatment procedures (Ahmad et al., 2010).

### 1.1 Research Objective

- To optimize preparation conditions by using response surface methodology (RSM) for the development of COAC.
- To evaluate the effects of adsorbate initial concentration and contact time through batch adsorption test for MB onto optimized COAC

## 2 Literature review

The comprehensive overview of textile manufacturing processes and the subsequent wastewater generation highlights the complexity and environmental impact of the industry. From fiber processing to finishing, each stage involves various chemical treatments and water-intensive processes, leading to significant wastewater production (Alrozi, 2010).

Effluent from the textile sector may require many biological, physicochemical, and suitable combinations of these treatments before it may be properly released into the environment. Biological treatment can lower the concentration of



organic chemicals detected in textile effluent during the initial stage of treatment. Furthermore, it has been thought that environmentally safe procedures and low-cost implications offer the best chances for the treatment strategy. Techniques in physicochemical include membrane filtration, advanced oxidation, flocculation, coagulation, precipitation, ion exchange, and ultrasonic mineralization (Arami-Niya et al., 2012).

These methods are usually applied in the later phases of the treatment regimen to effectively reduce difficult parameters, like heavy metals and inorganic compounds. On the other hand, because of their high cost, physicochemical treatment methods by themselves are not recommended, even though they are effective (Chakravarty et al., 2010). Physicochemical procedures include chemical reduction and advanced oxidation.

A wide range of physical chemicals and biological techniques discussed in previous sections offer a broad range of alternatives for removing pollutants from the periphery of their treatment procedures. Furthermore, numerous techniques for handling wastewater containing organic contaminants and heavy metals have been developed recently. As multiple studies have shown, these techniques aim to reduce excessive amounts of different pollutants while also enhancing the quality of treated effluent. Moreover, the treatment alternatives that have been put out have inherent advantages and restrictions in the context of their particular uses. Advanced oxidation processes (AOPs), membrane filtration, adsorption, chemical precipitation, and ion exchange are the most often utilized physicochemical methods for handling textile effluent (Alrozi, 2010).

Chemical oxidation is typically employed to decompose refractory compounds found in textile wastewater. Direct oxidation procedures with high degrading efficiency are theoretically possible; however, operational conditions, pollutant load, and process limitations primarily dictate which process is deemed acceptable. Common oxidation procedures like as wet air oxidation and catalytic wet air oxidation use oxidizing agents such as ozone ( $O_3$ ), hydrogen peroxide ( $H_2O_2$ ), UV radiation, and permanganate ( $MnO_4$ ) to alter the chemical composition of group compounds, including colors, in wastewater. Ozone is the most used because of its superior dye reactivity. Moreover, it can oxidize phenols, chlorinated hydrocarbons, and aromatic hydrocarbons. The most popular physicochemical methods for handling wastewater from textile industries are adsorption, membrane filtration, chemical precipitation, ion exchange, and sophisticated oxidation procedures (Bello et al., 2011).

Fenton's reagent has the potential to remove color and COD efficiently, however handling iron-contaminated sludge and longer treatment durations are the main drawbacks of this method. Additionally, some commercial dyes, like dispersion and vat dyes, are inappropriate for ozonation because of their longer and slower response times. In addition, some AOPs—like  $O_3$ /UV—had limitations and color removal was not greatly affected by the ozonation process since the dyes absorbed the majority of the UV radiation, which would have produced a small amount of hydroxyl free radicals (Alrozi, 2012).

According to Mahmoodi et al. (2011), nearly every AOP calls for high pressures and temperatures in addition to costly installation and running costs. Waste that has dye in it coagulates and flocculates. Water treatment has been used for many years and is said to be the oldest method of treating wastewater. This procedure destabilizes colloidal particles in the presence of a coagulant; the particles are subsequently flocculated to expand in size into giant flocs. Pre-hydrolyzed metallic salts, which are easily soluble in water, are found to be more effective than hydrolyzing metallic salts, such as aluminum sulfate (alum), ferric sulfate ( $FeSO_4$ ), Ferric Chloride ( $FeCl_3$ ), and Magnesium Chloride ( $MgCl_2$ ), among a variety of coagulants. These salts include Polyaluminium Chloride (PACl), Polyferric Chloride (PFCI), Polyferrous Sulfate (PFS), and Polyaluminium Ferric Chloride (PAFCI) (Bhandare et al., 2015).

However, when this procedure is used, sludge generation always happens; therefore, the right parameters, such as a good choice of flocculant and coagulant, should be selected. In addition, the sludge produced could contain hazardous substances from the treatment, necessitating additional sludge treatment to stop heavy metals from leaking into the environment (Pang et al., 2013).

The utilization of activated carbon derived from agricultural waste, such as *Canarium Odontophyllum* seeds, for dye removal, exemplifies the potential for sustainable solutions in textile wastewater treatment. By repurposing waste materials, this approach not only addresses environmental concerns but also adds value to underutilized resources.

In conclusion, the textile industry's complex manufacturing processes and wastewater generation necessitate robust treatment strategies to mitigate environmental pollution. By integrating various treatment methods and exploring innovative approaches like using agricultural waste for activated carbon production, the industry can move towards more sustainable practices and minimize its environmental footprint.

### 3 Methodology

The dabai (*Canarium Odontophyllum*) seeds were used as a precursor in the production of AC. The pioneer originated in Sibul, Sarawak. The chemicals used are listed in Table 3.1 along with their supplier, purity, and usage. Synthetic dye wastewater was prepared using the qualities of methylene blue (MB); technical nitrogen (purity 99.99 %) and carbon dioxide (purity 99.80%) gases were supplied by Air Product (M) Sdn Bhd.

Table 3.1: List of chemicals

Chemical	Supplier	Purity (%)	Usage
Potassium hydroxide pellet (KOH)	Merck, Germany	85	Activating agent
Hydrochloric acid (HCl)	Merck, Germany	37	Adsorbent wash, pH adjustment
Sodium hydroxide (NaOH)	Essex, UK	99	pH adjustment
Methylene blue (MB)	Sigma-Aldrich (M) Sdn Bhd, Malaysia	82	Adsorbate

A vertical tube reactor made of stainless steel (SS) with a programmable temperature controller makes up the AC preparation rig. The N<sub>2</sub> and CO<sub>2</sub> flow rates fed to the reactor were managed by the gas flow meter. Teflon and SS pipes and fittings made up most of the piping system. The carbonization and activation operations were carried out in a vertical stainless-steel reactor that measured 150 mm in length and 25 mm in inner diameter. To keep the sample intact, an SS wire mesh was placed at the bottom of the tubular reactor. The reactor was stood and placed inside a vertical tubular furnace with a programmable controller (Model Carbolite, USA). The dimensions of the furnace were 500 mm in length and 82 mm inner diameter. A K-type thermocouple was used to measure the temperature of the sample inside the reactor. The maximum tolerance of the thermocouple is 1000 °C. The excess flue gas was released into a condenser.

In conducting batch adsorption investigations, a 250 ml Erlenmeyer flask was filled with 200 ml of Methylene Blue (MB) adsorbate solution, which was introduced with a known initial concentration of 1000 mg/L. The adsorbent's weight was set at 0.3 g for each flask. For a while, a fixed 120 rpm water bath shaker (Model Protech, Malaysia) was employed at a steady temperature. Utilizing a double-beam UV-visible spectrometer (Model Shimadzu UV-1800, Japan), the dye adsorbates' concentration was determined. Beer's law suggests a linear relationship between the concentration of the absorbing species and their absorbance as represented by the equation: -

$$A_i = \epsilon \lambda b c C \quad (3.1)$$

where  $\epsilon \lambda$  is the molar absorptivity coefficient of solute at wavelength  $\lambda$  (nm),  $A_i$  is the measured absorbance for component I,  $C$  is the solute concentration (mg/L) and  $bc$  is the path length of the cell (1 cm). The absorbance,  $A_i$  was obtained by the double-beam UV-Visible spectrophotometer.

The maximum wavelength of the MB was 664 nm. The calibration curve for MB dye concentration was measured to ensure the homogeneity of the absorbance reading. The replication for the calibration curve was done at least three times and the average was used for further experimental work.

The seeds of *Canarium Odontophyllum* samples were washed cleaned and dried in an oven (Model Heraeus Series 6000 Oven, Germany) at a temperature of 120 °C for 2 hours. The dried samples were cut into 2-3 cm and kept in a hermetic container.

The activated carbon preparation procedures were divided into three main stages consists of:

- i) Carbonization of the precursors
- ii) KOH impregnation of char
- iii) CO<sub>2</sub> gasification of the KOH-impregnated chars

A thirty-gram (30 g) of the precursor was put inside a vertical reactor and continuously purged with nitrogen gas at 150 mL/min. The reactor temperature was ramped to 400 °C and held for 2 h. After that, the char produced was cooled down to room temperature. Then they were stored inside a dessicator for about 2 h for further treatment.

The impregnation of char in powder form (250 µm) with potassium hydroxide (KOH) was done in various impregnation ratios (IR) calculated in Eq. 3.2;

$$IR = \frac{w_{KOH}}{w_{char}} \quad (3.2)$$

where is the KOH pellet's dry weight (g) and  $w_{char}$  is the char's dry weight (g). In a 250 mL beaker, a precise quantity of char and KOH pellet was combined with deionized water, contingent on the infrared spectra. After giving the mixture a good stir until all the water was dissolved, it was placed in an oven set to 105 °C for the entire night to dehydrate it.

The KOH-impregnated char was then heat-treated while a steady nitrogen flow of 150 mL/min was applied. The necessary temperature was determined to be raised to 10 °C/min. Carbon dioxide (CO<sub>2</sub>) at a rate of 150 mL/min was added to the nitrogen once it reached the proper activation temperature, and it was then held for the duration suggested by the Response Surface Methodology (RSM) study. After one hour, the CO<sub>2</sub> was replaced with N<sub>2</sub> to allow the sample to reach room temperature.

After that, deionized water and hydrochloric acid were used to wash the AC to achieve pH neutrality. A pH meter (Model Delta 320, Mettler Toledo, China) was used to measure it. For a full day, the AC was dried at 105 °C in an oven. For further adsorption research and characterization, the dried AC was kept in a desiccator.

To optimize the parameters under investigation, this work combined central composite design (CCD) analysis with response surface methodology (RSM). Among the independent factors are:-

- i.  $x_1$ , Activation temperature ( $^{\circ}\text{C}$ )
- ii.  $x_2$ , Activation time (h)
- iii.  $x_3$ , KOH: char (IR)

These variables and their corresponding ranges were selected in light of the literature as well as the results of the preliminary investigations. Regression modeling was done for this investigation, and Design Expert software version 7.1.5 (STAT-EASE Inc., Minneapolis, USA) was used to determine the significance of the results. Table 3.2 shows the range levels of each factor (variable) that is being studied

**Table 3.2: Independent variables and their coded levels for the CCD**

Variables (factors)	Coded variables level				
	$-\alpha$	-1	0	+1	$+\alpha$
Activation temperature ( $^{\circ}\text{C}$ )	514	600	725	850	935
Activation time (hour)	0.32	1.00	2.00	3.00	3.68
IR	0.07	0.75	1.75	2.75	3.43

As a result, the complete design matrix of the experiments is shown in Table 3.3. For three variables, 8 factorial points, 6 axial points, and 6 replicates at the center points were employed, as calculated from Equation 3.3 (Pang et al., 2013).

$$N = 2^n + 2n + n_c = 2^3 + 2 \cdot 3 + 6 = 20 \quad (3.3)$$

Where  $n$  is the number of factors and  $N$  is the total number of experiments.

Alrozi (2010) states that the repeatability of the data and the experimental error are measured using the center points. Three codes,  $x_1$ ,  $x_2$ , and  $x_3$ , denoted the independent variables. The codes for the low and high levels are, respectively, -1 and +1.  $(\pm\alpha, 0, 0)$ ,  $(0, \pm\alpha, 0)$ , and  $(0, 0, \pm\alpha)$  are the locations of the axial points, where  $\alpha$  is the separation between the center and the axial point. The rotatable  $\alpha$  value remained constant at 1.682. To reduce the influence of unrelated variables, the experiment order was randomized. Activated carbon yield ( $Y_2$ ) and MB elimination ( $Y_1$ ) are among the responses. Based on the response, an empirical model was created to establish a relationship between the response and the independent variables. Equation 3.4, which is a second-degree polynomial equation, was applied.

**Table 3.3: Experimental design matrix**

Run	Activated carbon preparation variables		
	Activation temperature, $x_1$ ( $^{\circ}\text{C}$ )	Activation time, $x_2$ (h)	IR, $x_3$
1	600(-1)	1.00(-1)	0.75(-1)
2	850(+1)	1.00(-1)	0.75(-1)
3	600(-1)	3.00(+1)	0.75(-1)
4	850(+1)	3.00(+1)	0.75(-1)
5	600(-1)	1.00(+1)	2.75(+1)
6	850(+1)	1.00(+1)	2.75(+1)
7	600(-1)	3.00(+1)	2.75(+1)
8	850(+1)	3.00(+1)	2.75(+1)
9	514(-1.682)	2.00(0)	1.75(0)
10	935(+1.682)	2.00(0)	1.75(0)
11	725(0)	0.32(-1.682)	1.75(0)
12	725(0)	3.68(+1.682)	1.75(0)
13	725(0)	2.00(0)	0.07(-1.682)
14	725(0)	2.00(0)	3.43(+1.682)
15	725(0)	2.00(0)	1.75(0)
16	725(0)	2.00(0)	1.75(0)
17	725(0)	2.00(0)	1.75(0)
18	725(0)	2.00(0)	1.75(0)
19	725(0)	2.00(0)	1.75(0)
20	725(0)	2.00(0)	1.75(0)

The center points are used to measure the experimental error and the data reproducibility (Alrozi, 2010). The independent variables were coded  $x_1$ ,  $x_2$  and  $x_3$ . The low and high levels are coded as -1 and +1, respectively. The axial points were located at  $(\pm\alpha, 0, 0)$ ,  $(0, \pm\alpha, 0)$  and  $(0, 0, \pm\alpha)$  where  $\alpha$  is the distance between the center and the axial point. The  $\alpha$  value was constant at 1.682 (rotatable). The sequence of experiments was randomized to minimize the extraneous variable effects. The responses include MB removal ( $Y_1$ ) and activated carbon yield ( $Y_2$ ). An empirical model was developed based on the response to correlate the response to the independent variables. A second-degree polynomial equation was used and as given by Equation 3.4:

$$Y = b_0 + \sum_{i=1}^n b_i x_i + \left( \sum_{i=1}^n b_{ii} x_i^2 \right) + \sum_{i=1}^{n-1} \sum_{j=i+1}^n b_{ij} x_i x_j \quad (3.4)$$

where Y is the predicted response,  $b_0$  is the constant coefficient,  $b_i$  is the linear coefficients,  $b_{ij}$  is the interaction coefficients,  $b_{ii}$  is the quadratic coefficients, and  $x_i, x_j$  represents the independent variables. The response removal was calculated based on batch adsorption studies that were performed in 20 sets of 250 mL Erlenmeyer flasks.

The effect of a particular factor is represented by the coefficient with one factor. The interaction between two factors and the quadratic effect is represented by the coefficient with two factors with second-order terms. An analysis of variance (ANOVA) was used to summarize the analysis performed. The “prob > F” value of less than 0.05 indicates that the model is significant (Shaarani and Hameed, 2010). It is desirable to indicate the influence of model terms that have significant effects on the response.

In investigating the adsorption performance of adsorbates on the ACs, batch equilibrium tests were carried out. The effects of contact time and initial adsorbate concentration were investigated. In a 1000 mL volumetric flask, precisely 1 gram of each dye was dissolved in 1000 mL of deionized water (Model USF Maxima version 14.15, England) to provide the stock solutions (1000 mg/L) of MB. To avoid degradation and discoloration from direct sunshine, the stock solutions were kept out of the light. A UV-visible spectrophotometer was used to measure the concentration ( $C_0$  and  $C_e$ ) of the solution at the maximum wavelength of each adsorbate. Equation 3.5 was used to determine the amount of adsorbate adsorbed at equilibrium, or  $q_e$  (mg/g):

$$q_e = \frac{(C_0 - C_e)V}{W} \quad (3.5)$$

where V is the volume of the solution (L),  $C_0$  and  $C_e$  (mg/L) are the liquid-phase concentrations of adsorbate at initial and equilibrium, respectively and W is the mass of adsorbent used (g). The adsorbate percent removal was calculated as:

$$\text{Removal \%} = \frac{C_0 - C_e}{C_0} \times 100 \quad (3.6)$$

## 4 Finding and analysis

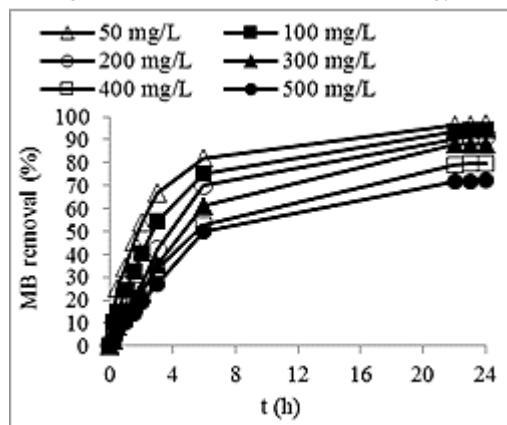
In this study, one set of experimental designs was applied using RSM for the preparation of activated carbons from biomass materials namely CO. The three variables studied were activation temperature ( $x_1$ ), activation time ( $x_2$ ), and KOH/char IR ( $x_3$ ) with two responses; MB removal ( $Y_1$ ), and AC yield ( $Y_2$ ) for synthetic dyes.

High adsorption capacity and high activated carbon yield were highly desired during the preparation process of activated carbon. Nonetheless, low activated carbon output is invariably accompanied by high adsorption capacity. The adsorption capacity was significantly impacted by the activation temperature, activation time, and IR. The best preparation conditions for a high adsorption capacity and a reduced carbon yield were found by optimizing the three variables, although doing so also resulted in a lower carbon yield. The three preparatory variables were kept within the study range, and the parameters were optimized using Design Expert Software version 7.1.5 (STAT-EASE Inc., Minneapolis, USA) with all answers set to maximum values (Rafatullah et al., 2010).

Improved parameters with greater desirability were chosen. Through experimental COAC, ideal preparation conditions were determined and confirmed. The result demonstrates that there was little error between the experimental and projected values. By employing activation temperature, activation duration, and IR of 757 °C, 1.43 h, and 1.83, respectively, the best MB elimination by COAC was achieved. For COAC, the highest percentage of MB reduction that could be achieved was 95.57%.

Figure 4.1 showed that the MB percentage removals were found to increase with time and became constant after 22 hours indicating saturation of dye uptake by the ACs. In the early stage, the surface sites available for adsorption are large in numbers. When the adsorption takes place and starts occupying the available sites, the surface sites remain after some time elapsed, making it difficult for further occupation due to the strong repulsion between the solute molecules of bulk and solid phases.

The adsorption uptakes for MB onto COAC at equilibrium rose from 48.55 to 361.64 mg/g as the starting concentration increased from 50 to 500 mg/L. Greater MB concentration increases the concentration gradient's driving force and, as a result, the adsorption capacity. Large AC surfaces were able to absorb dye at lower concentrations since there was a modest ratio of MB to accessible sites. However, the ratio of MB to available sites increased at increasing concentrations, which decreased the amount of MB removed. The obtained results showed good agreement with the adsorption capacity measured using AC based on coconut husk. Shaarani and Hameed (2010) also found that when oil palm empty fruit was used, a longer contact time was required to adsorb color with a high initial concentration by using oil palm empty fruit bunch-based AC.



**Fig 4.1:** MB Percent Removals Versus Adsorption Time at Various Initial Concentrations

## 5 Conclusion

The physiochemical activation approach was successfully applied to the production of COAC from *Canarium Odontophyllum* seeds. The optimum preparation conditions for COAC were an activation temperature of 757 °C with an activation time of 1.43 h and an impregnation ratio of 1.83. The elimination of MB was 95.57% with optimized COAC, and the COAC's adsorption uptakes rose as the initial concentration and contact time of the adsorbates increased.

## References

1. Ahmad., M.A. and Alrozi., R. (2010). Optimization of preparation conditions for mangosteen peel- based activated carbons for the removal of Remazol Brilliant Blue R using response surface methodology. *Chemical Engineering Journal*, 165, 883–890.
2. Ahmad, M.A. and R. Alrozi (2011). Removal of malachite green dye from aqueous solution using rambutan peel-based activated carbon: Equilibrium, kinetic and thermodynamic studies. *Chemical Engineering Journal*, 171, 510-516.
3. Alrozi, R. 2010. Preparation of Activated Carbon From Tropical Fruit Wastes For The Removal of Basic And Reactive Dyes. MSc Thesis, Universiti Sains Malaysia.
4. Arami-Niya, A., Wan Daud, W.M.A., Mjalli, F.S., Abnisa, F. and Shafeeyan, M.S. (2012). Production of microporous palm shell based activated carbon for methane adsorption: Modeling and optimization using response surface methodology, *Chemical engineering research, and design*, 90, 776-784.
5. Auta, M. and Hameed, B.H. (2011). Preparation of waste tea activated carbon using potassium acetate as an activating agent for adsorption of acid blue 25 dyes, *Chemical Engineering Journal*, 171, 502-509.
6. Bello, O. S., Ahmad, M.A., Ahmad, N. (2011). Adsorptive features of banana (*Musa paradisiaca*) stalk-based activated carbon for malachite green dye removal, *Chemistry, and Ecology*, 28, 153-167.
7. Bhandare, A. M., Vyawahare, N. S. and Kshirsagar, A. D. (2015). Anti-migraine effect of Areca Catechu L. nut extract in bradykinin-induced plasma protein extravasation and vocalization in rats. *Journal of Ethnopharmacology*, 171, 121-124.
8. Chakravarty, P., Sarma, N. S. and Sarma, H. (2010). Biosorption of cadmium (II) from aqueous solution using heartwood powder of Areca catechu. *Chemical Engineering Journal*, 162, 949-955.
9. Hassan, M. M., Wagner, M. H., Zaman, H. and Khan, M. A. (2010). Physico-mechanical performance of hybrid betel nut (*Areca catechu*) short fiber/seaweed polypropylene composite. *Journal of Natural Fibers*, 7, 165-177
10. Mahmoodi, N.M, Hayati, B., Arami, M., Lan, C. (2011). Adsorption of textile dyes on pine cone from colored wastewater: Kinetic, equilibrium and thermodynamic studies. *Desalination*, 268, 117–125.
11. Pang, Y. L. and Abdullah, A. Z. (2013). Current status of textile industry wastewater management and research progress in Malaysia: A review. *Clean – Soil, Air, Water*, N/A-N/A.
12. Rafatullah, M., Sulaiman, O., Hashim, R. and Ahmad, A. (2010). Adsorption of methylene blue on low-cost adsorbents: A review, *Journal of Hazardous Material*, 177, 70–80.
13. Shaarani, F.W. and Hameed B.H. (2010). Batch adsorption of 2,4-dichlorophenol onto activated carbon derived from agricultural waste, *Desalination*, 255, 159–164.

# Analysis and Characterization of Perlis Dolomite Powder and Effect of Binder Addition on Its Sintered Properties

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**Abstract.** Dolomite,  $\text{CaMg}(\text{CO}_3)_2$  is a carbonate mineral that recently caught many attention due to its significant properties including high thermal resistance and great mechanical strength compared to other carbonate rocks. Most previous studies related to dolomite focused on the heat treatment and the characteristics and sinterability of Perlis dolomite are not well established yet. In this study, basic properties of Perlis dolomite powder were analyzed in terms of its physical, structural and chemical properties. Apart from that, sinterability and sintered properties of Perlis dolomite powder were also investigated with the presence of alginate as the organic binder. The dolomite powder was first heat treated, before a ball milling process took place, then being dried overnight. After that, this mixture was uniaxially pressed under 20 MPa and sintered at 1150°C for 4 hours. For samples with binder, 5 wt. % of alginate suspension was added into the mixture before the compaction process. From the powder analysis, dolomite powder has particularly low pore volume and surface area with average pore size of 11.2804 nm. It mainly consists of CaO (65.07%), MgO (23.1%) and  $\text{Na}_2\text{O}$  (8.0%) where they formed hexagonal structure of  $\text{CaMg}(\text{CO}_3)_2$  and anorthic structure of  $\text{NaAlSi}_3\text{O}_8$  phase. It was found that better sample sinterability and sintered properties were achieved with the presence of binder. In brief, Perlis dolomite can be sintered well and showed better physical properties with the presence of alginate as the binder during the powder compaction process.

**Keywords:** Perlis dolomite, alginate binder, sinterability, bioceramic production

## 1 Introduction

Dolomite,  $\text{CaMg}(\text{CO}_3)_2$  is one of a kind of raw minerals that has double carbonate of calcium and magnesium compounds in major with slightly impurities from other elements. Usually, the amount of calcium (Ca) and magnesium (Mg) contents in most of the dolomite minerals are nearly equal but intermittently one element, which is commonly Ca could be higher than the other (Abdullah et al., 2021). Ideally, the theoretical of the chemical composition of dolomite is 45.7%  $\text{MgCO}_3$  and 54.35%  $\text{CaCO}_3$  (Shahraki et al., 2009). It can easily be found in the main constituent of sedimentary rocks called dolostone (Arokiasamy et al., 2022; Cai et al., 2021; Resio, 2023a) which are frequently associated with limestone and chalk carbonates (Mustafa et al., 2022). This mineral was formed naturally by the geological stages through the dolomitization process over decades where the replacement of Mg occurs in calcite (Shahraki et al., 2009). The dolomite is also able to transform into a more stable state through pressure, temperature and chemical changes after a longer period of geological times due to the increasing content of MgO in the dolomite carbonate rocks (Resio, 2023b).

As the dolomite mineral has rich contents of Ca and Mg with unique compositions, this mineral is widely explored globally to facilitate its benefits in a wide range of industries. The dolomite mineral mainly can be exploited for various applications including the soil treatment and fertilizer production in agriculture field, road construction and building materials, and catalyst for fuel reservoir in biomass energy production as well as significant refractory in metallurgy and steel industries (Shahraki et al., 2009). In Malaysia, it has been recorded that the dolomite can be found at several states including Perlis, Perak and also coastal region of northwest Sabah (Hui et al., 2021; Ling et al., 2023; Mohammed et al., 2013). Perlis, the northern area of Peninsular Malaysia has large quarries around Chuping City that reserves an abundance of dolomite mineral and it is locally known as ‘Batu Reput’ (Mohammed et al., 2013). Although Perlis dolomite has an abundant reservoir, it was restricted to limited applications which only focus on fertilizers making, soil conditioning and road making before paving with asphalt (Mohammed et al., 2013; Nazry et al., 2006).

Up to the present time, most of the production involving dolomite material regularly has prime concerns on the thermal behavior of the dolomite as it could be influenced by the chemical composition of the raw material and processing condition. To the best of our knowledge, most of the researchers that studied related to Perlis dolomite are still not deeply explored as their concerns are focused on the heat treatment on the dolomite properties. Nazry Salleh et al. has studied the characteristics of heat treated dolomite at 800°C, 900°C and 1000°C and found out that the mineralogical compositions of the heat treated

by Perlis dolomite has better properties compared to Ipoh dolomite (Nazry et al., 2006). Similarly, the thermal behavior of Perlis dolomite also has been investigated by different calcination temperatures where the dolomite decomposition completely reached 800°C and 1000°C with the formation of CaO and MgO (Abdullah et al., 2021). Meanwhile, the characterization of Malaysian dolomite from three different quarries also has been implemented via a calcination process at 1000°C (Mohammed et al., 2013). Overall, the pattern of the investigations that has been done by previous researchers has strictly focused on the thermal behavior of the dolomite. Nevertheless, the previous findings on the sinterability properties of the dolomite are not well established up to this time around. Besides, the common difficulty that needs to be faced in the production of ceramic is the execution during the formation of green bodies of ceramic samples. This is because the particle bonding issues occur during the compaction process, which is due to the residual stresses introduced by the ejection forces and causing the cracking or chipping of the samples in the early stage of manufacturing. In addition, thermal cracking on the ceramic samples is also one of the typical challenges that have to be faced if involving the sintering process. This is because most of the volatile substances decomposed from the samples due to the applied high temperature. Thus, these problems were encountered by the effect of binder in the mixtures of green bodies before the compaction process.

Hence, the investigation on the sinterability of Perlis dolomite has been carried out by this study. Moreover, the influence of the binder addition also has been studied to evaluate the properties developed by the dolomite samples after the sintering process. Due to the brittleness of ceramic from dolomite-based, hydrogels produced by polymer substances by using alginate as the binders, can promote crucial contributions including cross-linking between the ceramic and polymer structures that impacts the elasticity, Young's modulus and the cell adhesion (Costaa & Diasa, 2021). Besides, the formation of alginate gels with calcium ions could provide great bioactivity and biocompatibility performances, non-toxicity, easy in process handling and low expenses (Sathain et al., 2021). Several testing and characterizations including X-ray fluorescence (XRF), Brunauer-Emmett-Teller (BET), X-Ray Diffraction (XRD) and Fourier-transform infrared spectroscopy (FTIR) have been performed in order to observe the mineralogical properties of the raw materials such as dolomite and silica powder that have been used in this study for the formation of bioceramic. Furthermore, the effect of sinterability of the Perlis dolomite in the form of pallet were analyzed by XRD, FTIR, SEM for the purpose of observing the structural analysis and surface morphology. The weight loss, shrinkage, mechanical strength, density and porosity of the samples also were measured and calculated before and after the sintering process.

## 2 Methodology

The study involved the combination of dolomite and silica powder by the wet mechanical activation method via planetary ball mill. The raw dolomite was heated initially before the milling process in order to obtain rich contents of CaO and MgO while eliminating the impurities in the powder. Then, both of dolomite and silica powder were milled together and deionized water was used as the milling medium in order to mix the powders homogeneously. The milled mixtures were dried and subsequently uniaxially compressed into pallet samples and sintered at 1150°C. The binder was added into the milled powders before the compression for the purpose of determining the influence of binder addition. The raw materials were characterized under mineralogical analysis including XRD, FTIR and SEM. Meanwhile, the sintered pellets were investigated in terms of weight loss, shrinkage, XRD, FTIR, and SEM to evaluate the influence of binder addition on the product of dolomite-based properties.

### 2.1 Raw materials

In this study, Perlis dolomite and silica powder were used as the main raw powders. The dolomite was obtained from the local quarries at Chuping, Perlis meanwhile the silica powder was acquired from Ipoh, Perak. The local dolomite was used in order to obtain the elements of CaO and MgO. The Perlis dolomite was heat treated at 1000 °C for 4 hours with a heating rate of 10 °C/min to enhance the contents of CaO and MgO while eliminating the volatile substances in the dolomite powder. Besides, the implemented heat treatment on the raw materials also aims to decarbonized the carbon contents in the dolomite powders. The heated dolomite powders were sieved in order to filter and obtain fine powder particles of dolomite.

### 2.2 Characterization of raw materials

An analysis via XRF by Philips PANalytical Minipal 4 machine was used to determine the chemical composition that may be obtained in the raw materials. The mineralogical properties of the materials also have been performed via X-ray diffraction (XRD) by Test Instrument Machine Bruker D2 Phaser, German (2010) with the angle diffraction at the range of 10° to 80° (2θ) of step-scanning for loading time of 10 minutes for each sample. The obtained raw data of diffractogram were presented by using X'pert Highscore Plus software to identify and confirm the phase compounds that exist in the powders according to its peak position and intensities that matched with the crystallographic database of ICDD PDF. Fourier transform infrared spectroscopy (FTIR) was also performed by the Perkin Elmer machine in order to recognize the characteristic bands where the data were recorded within 400-4000 cm<sup>-1</sup>. Samples were prepared in powder form by mixing approximately 1wt. % of each sample with 99 wt. % of potassium bromide powder (KBr). Besides, the specific absorption surface area, pore volume and pore size of the dolomite powders also were tested by the approach of BET by using Micromeritics TriStar 3000 analyzer

associated with adsorption of nitrogen gas, N<sub>2</sub> at 77K.

### 2.3 Preparation of Sintered Samples

The heated dolomite and silica powders were milled homogeneously by using planetary milling machine (Mono Mill Pulverisette 6-classic line, Fritsch, Germany) with 250 mL agate milling jar (Fritsch, Germany). The raw powders were wet milled together at 450 rpm of milling speed for 4 hours in total where 4 repetition of grinding cycle of 1 hour with regular direction reversal. The ratio of CaMg(CO<sub>3</sub>)<sub>2</sub> and SiO<sub>2</sub> powders was 3:1 while the deionized water was used as a milling medium with ratio of 3:1 to the powders. Next, the milled mixture was dried in the air oven at 80 °C overnight in order to remove the moisture content. Then, the dried powders were fined by using pestle and mortar and then sieved to create small particles of powders homogeneously. Following that, 0.5 g of alginate and 20 mL of deionized water were mixed and stirred until the solid substances dissolved completely and formed a uniform organic binder solution. For the samples with binder, 5 wt. % of binder was added in the dolomite mixtures before the compaction process in order to determine the influence of binder addition in the dolomite-derived samples. 1g of milled powders were inserted into a high carbon steel of mold to create a compact small disc of pallets with 20 mm diameter and 4 mm thickness for each pellet. The milled powders were compacted by using a hydraulic press machine (Nichi T-61230A) under 20 MPa of loads with loading time of 5 minutes. The pallets were then sintered in the furnace (LT Furnace SIC4-1600) at 1150 °C for 4 hours with a cooling rate of 5 °C/min.

### 2.4 Characterization of Sintered Samples

The weights of the compacted pallets were recorded by using analytical balance before and after the sintering process to calculate the weight loss of the samples. The readings were taken three times in order to obtain precise weight measurement of the samples and averages of the weight were calculated. Then, the weight loss percentage was calculated by using Equation 1. Besides, the diameter and the thickness of the pallets also were measured by using a digital vernier caliper before and after the sintering process. The recorded data were calculated by using the Equation 2 by applying ASTM C356-10 in order to acquire the shrinkage of the pallets once sintered. Density analytical balance was used to measure the weight of the samples to calculate the bulk density and apparent porosity of the sintered samples by applying Archimedes' principle according to ASTM B962-17 (Mohammadi et al., 2018, 2021; Myat-Htun et al., 2021) as shown in Equations 3 and 4.

$$\text{Weight loss (\%)} = \left( \frac{w_1 - w_0}{w_0} \right) \times 100 \quad (1)$$

$$\text{Volume shrinkage (\%)} = \left( \frac{v_1 - v_2}{v_0} \right) \times 100 \quad (2)$$

$$\text{Bulk density (\%)} = \left( \frac{w_1}{w_1 - w_3} \right) \times 100 \quad (3)$$

$$\text{Porosity (\%)} = \left( \frac{w_2 - w_1}{w_2 - w_3} \right) \times 100 \quad (4)$$

Where,  $w_0$  is initial weight of pallet before sinter,  $w_1$  is weight of sintered pellet in air,  $w_2$  is weight of pallet after submerged in water,  $w_3$  is the weight of pallet submerged in water,  $v_0$  is initial volume of pallet before sinter, and  $v_1$  is the volume of pallet after sinter.

The sintered samples were tested by using XRD machine (Test Instrument Bruker, D2 Phaser Germany 2010) where the setup and analysis of the testing were implemented as similar as the setup applied on the raw materials. Scanning Electron Microscopy (SEM) by Philips XL30 SEM was used during morphology testing to investigate the effect of binder addition on the samples of the sintered pellets. The samples were coated with sputter coating (Quorum Q150R). The samples were coated with an extremely thin layer of conductive material which was gold (Au) in order to prevent charging during the testing and also to enhance the quality images of the samples. The magnifications used to observe the surface morphology of the samples were around 500X and 2000X for the purpose of identifying the characteristics on the surface structure of the samples. Energy Dispersive X-ray (EDX) was also performed to analyze the elemental composition on the surfaces of the sintered samples. Moreover, the mechanical strengths of the sintered dolomite samples were tested by using Universal Testing Machine (UTM) of 50 kN of loads by Shimadzu AG-X Plus. The recorded data were analyzed by using material analysis software Trapezium X. The data of load and stroke were used to calculate the value of stress-strain by using Equations 5 and 6.

$$\text{Stress (MPa)} = \frac{\text{Force}}{\text{Area}} \quad (5)$$

$$\text{Strain(\%)} = \frac{\text{Change in thickness}}{\text{Initial thickness}} \quad (6)$$



### 3 Results and discussion

#### 3.1 Characterization of Raw Materials

##### 3.1.1 Chemical compositions

**Table 1** shows the chemical composition of Perlis dolomite. It has proven that the Perlis dolomite consists of major elements of CaO (65.07%), MgO (23.1%) and Na<sub>2</sub>O (8%). Minor impurities from other oxides also exist in the dolomite which including Ag<sub>2</sub>O (1.46%), Al<sub>2</sub>O<sub>3</sub> (1.3%), Sc<sub>2</sub>O<sub>3</sub> (0.482%), SiO<sub>2</sub> (0.25%), SnO<sub>2</sub> (0.24%) and others. The compound concentration percentage changed once the dolomites were heat treated but the dominant compounds are still entitled by CaO (54.55%), MgO (30.5%) and Na<sub>2</sub>O (12%) and followed by other insignificant oxides. Based on the findings, it can be verified that the samples do not consist of any harmful and toxicity elements consequently supporting the potential of dolomite material for the preparation of biomaterials. Even though the raw materials that used in this study have various compounds yet, it shown that the minerals of dolomite in this study has dominant compounds (CaO, MgO, SiO<sub>2</sub>, Ag<sub>2</sub>O and Al<sub>2</sub>O<sub>3</sub>) with its impressively high concentration percentage compared to a study from A. Harrati et al. (Harrati et al., 2022).

**Table 1.** Chemical composition of the raw materials (% by concentration of the compound)

Compound	Raw Dolomite	Heated dolomite	Dolomite
<b>CaO</b>	65.07	54.55	24.86
<b>MgO</b>	23.1	30.5	19.57
<b>Na<sub>2</sub>O</b>	8	12	0.19
<b>Ag<sub>2</sub>O</b>	1.46	0.29	-
<b>Al<sub>2</sub>O<sub>3</sub></b>	1.3	1.2	1.96
<b>Sc<sub>2</sub>O<sub>3</sub></b>	0.482	0.23	-
<b>SiO<sub>2</sub></b>	0.25	0.10	2.46
<b>SnO<sub>2</sub></b>	0.24	0.377	-
<b>Fe<sub>2</sub>O<sub>3</sub></b>	0.177	0.0965	0.90
<b>CuO</b>	0.0375	0.0205	-
<b>SrO</b>	0.025	0.015	-
<b>MnO</b>	0.011	0.0059	-
<b>Au</b>	0.0104	0.0049	-
<b>Lu<sub>2</sub>O<sub>3</sub></b>	0.009	0.005	-
<b>Co<sub>3</sub>O<sub>4</sub></b>	0.0089	0.0068	-
<b>Cr<sub>2</sub>O<sub>3</sub></b>	0.0062	0.0075	-
<b>OsO<sub>4</sub></b>	0.005	0.002	-
<b>ZrO<sub>2</sub></b>	0.003	0.001	-
<b>P<sub>2</sub>O<sub>5</sub></b>	NI	0.05	0.03
<b>SO<sub>3</sub></b>	NI	0.035	-
<b>K<sub>2</sub>O</b>	NI	0.002	0.16
<b>ZnO</b>	NI	0.0009	-
<b>Pr<sub>2</sub>O<sub>3</sub></b>	-	0.014	-
<b>TiO<sub>2</sub></b>	-	-	0.10
<b>Reference</b>	This study	This study	(Harrati et al., 2022)

\* NI is indicated as an identified compound in the quantification values of the sample but it is not available in its intensities.

\* - is indicated as a compound that is not identified in the samples.

##### 3.1.2 Surface area and pore analysis

Table 2 presents the surface area and pore values on Perlis dolomites powder. The acquired BET surface area of raw dolomite was 15.25 m<sup>2</sup>/g, whereas the value calculated by Langmuir method was almost 1.4 folds higher, 21.45 m<sup>2</sup>/g. The pore volume and pore diameter of the dolomite by this study were 0.07 cm<sup>3</sup>/g and 11.28 nm, respectively. From the Table 2, it can be concluded that the specific areas and pore volume of current dolomite were within the values with the other dolomite sources, but shows contradiction values in pore diameter. According to Brennan et al., the specific surface area of the bone mineral is around 80 m<sup>2</sup>/g (Brennan et al., 2021) whereas the dolomites could reach higher specific surface area manifolds once heat treated at certain temperatures (Farhana et al., 2022). The specific surface area, pore size and greater pore volume also can promote significant improvement in adsorption performances (Farhana et al., 2022) which may be appropriate as absorbents

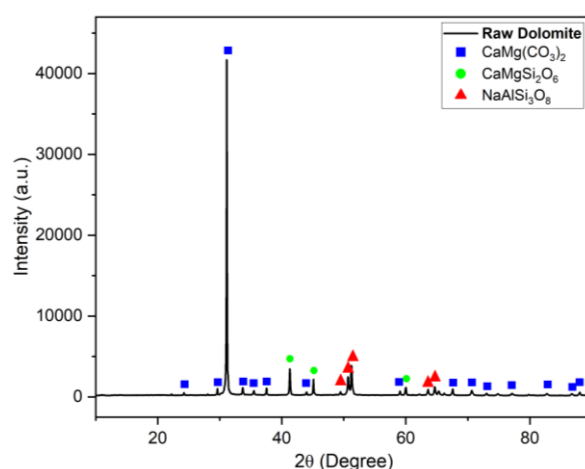
for toxins and bacterial resistance in biomedical applications particularly in wound dressing practices (Kumar et al., 2017). The results of raw dolomite on the adsorption and desorption by the average pore size were 17.97 nm and 17.95 nm, respectively by using Barrett-Joyner-Halenda (BJH) technique. From these results, the micro pores of dolomite particles were expected to promote high adsorption performances which could be advantages in the bone tissue regeneration application and promising rapid recovery in the bone treatment.

**Table 2.** Surface area and pore values of dolomites.

Samples	BET surface area (m <sup>2</sup> /g)	Pore volume (cm <sup>3</sup> /g)	Average pore diameter (nm)	Reference
Perlis dolomite	15.52	0.07	11.28	This study
Dolomite (Bukit Guar Sami quarry)	15.25	0.32	41.6	(Mohammed et al., 2013)
Dolomite (Chuping quarry)	16.85	0.104	23.3	(Mohammed et al., 2013)
Dolomite (Bukit Keteri quarry)	6.16	0.09	21.5	(Mohammed et al., 2013)
Natural Malaysian Dolomite (NMD)	2.25	0.06	109.41	(Hafriz et al., 2018)

### 3.1.3 Phase Analysis

**Fig. 1** presents the diffractogram of Perlis dolomite used in this study. The XRD pattern of Perlis dolomite in Figure 1 has shown high crystallinity of calcium magnesium carbonate,  $\text{CaMg}(\text{CO}_3)_2$  with a hexagonal crystal system that is majorly identical with the database of JCPDS file no. 01-081-8227 where the most outstanding peak is around  $31.148^\circ$  and followed by other peaks at several diffractions at  $29.686^\circ$ ,  $41.314^\circ$ ,  $44.034^\circ$  and  $50.732^\circ$  as similar with previous findings (Abdullah et al., 2021; Sompech et al., 2016). Besides, the Perlis dolomite also has monoclinic structures, formed by calcium magnesium silicate phase,  $\text{CaMgSi}_2\text{O}_6$  (JCPDS file no. 04-008-806) that appears at the diffraction of  $45.088^\circ$  and  $60.014^\circ$ . Meanwhile, some peaks at the diffraction of  $24.28^\circ$ ,  $63.58^\circ$  and  $64.706^\circ$  indicates the sodium aluminum silicate,  $\text{NaAlSi}_3\text{O}_8$  with anorthic structures that clearly shown the minor impurities that exist in the Perlis dolomite which supports the chemical composition by XRF analysis. From this result, Perlis dolomite is able to provide the main phase of CaO and MgO in order to form calcium magnesium silicate as bioceramic material.

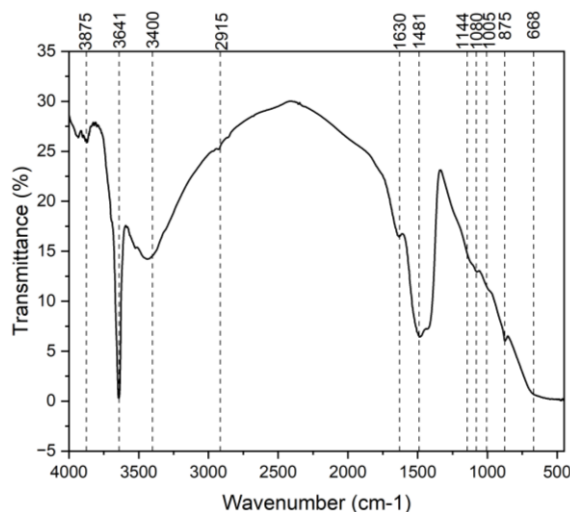


**Fig. 1.** Diffractogram of raw dolomite.

### 3.1.4 Chemical Structural Analysis

Figure 2 shows the infrared spectrum of Perlis dolomite. The Perlis dolomite obviously presented its predominant component of carbonate mineral group from CaO and MgO due to a strong and wide band at the peak of  $1481\text{ cm}^{-1}$  (Abdullah et al., 2021). The strong and deep bands at  $668\text{ cm}^{-1}$  and  $3641\text{ cm}^{-1}$  represented the CaO bonds. Moreover, the band around  $2915$

$\text{cm}^{-1}$  could be recognized as organic matter while the stretching bond of O—H was observed at  $3400\text{ cm}^{-1}$  and  $3875\text{ cm}^{-1}$  bands which, due to the adsorbed water in the dolomite powders (Harrati et al., 2022). The weak bands at the peaks of  $875\text{ cm}^{-1}$ ,  $1005\text{ cm}^{-1}$  and  $1080\text{ cm}^{-1}$  attributed to the Si—O vibration bond which supported the presence of silicate as the minor impurities in the chemical composition analysis (Mohammed et al., 2013). From this result, it shows that the Perlis dolomite does not contain any harmful elements according to the existence of the functional groups consequently promising for the potential of Perlis dolomite to be utilized as the raw materials in the production of biomaterials.

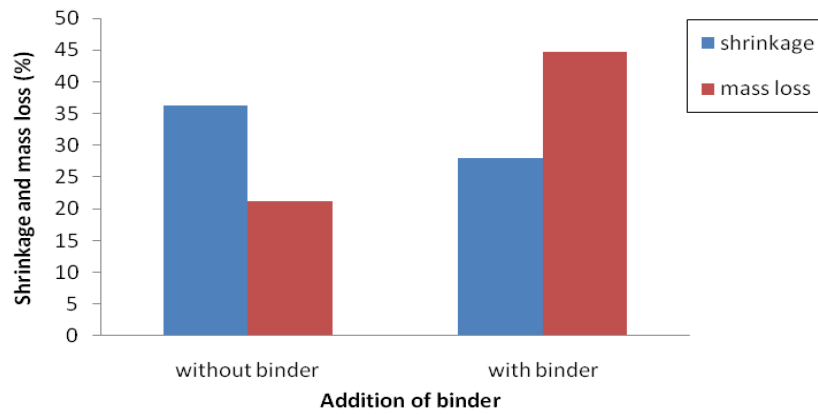


**Fig. 2.** FTIR analysis of Perlis dolomite.

## 3.2 Characterization of Sintered Samples

### 3.2.1 Physical Analysis

The physical analysis on the sintered samples of dolomite-based were observed by determining the weight loss and shrinkage of the samples. **Fig. 3.** illustrates the weight loss and shrinkage of the samples with and without the presence of binder. It found that the sample with binder has a lower shrinkage percentage compared to others which reaches up to 27.96% which has a gap difference around 8.28%. This is due to the addition of binder in the samples that caused the formation of pores (Liu et al., 2016) due to the moisture removal by the decomposition process that restrain the volumetric shrinkage to happen rapidly during sintering. The alginate gelation also could control the rapid thermal reaction as well as provide stable structure established from cross-linked networks through the hydrogen bonding, van der Waals Forces and divalent bonding with calcium ions (Xie et al., 2024) hence reduce the risk of cracks by introducing the porosity in the samples. Meanwhile, the sample with binder addition is considerably higher in mass loss around 23.47% than the sample without binder which could possibly be due to the desorption of moisture content from the binder addition (Venkatesan et al., 2015) by the elements decomposition during the sintering process. According to **Table 3**, it shows a bar chart of density of samples against the presence of binder. It shows that the samples without binder have higher density ( $1.42\text{ g/cm}^3$ ) entirely compared to the samples that have binder ( $1.31\text{ g/cm}^3$ ). This is believed to have close correlation with the greater amount of pores formation during the sintering process by the sample with binder addition. The low density of sample with binder addition can be attributed by the hydrogen molecules from the binder solution which has deabsorbed in the form of water vapor and escaped from the samples during the decomposition and caused the voids formation, consequently produced higher porosity. The both samples were appropriate to mimic for the human bone treatment as the value obtained by the apparent porosity in this study were in the range of the cancellous bone (30-90%) (Mohammadi et al., 2018). Thus, samples with binder found reduce the shrinkage percentage and has lower densities. However, it provides better physical characteristics of green solid samples prior to sintering and after the sintering process.



**Fig. 3.** Percentage of shrinkage and mass loss of the samples.

**Table 3** Densification of samples with binder addition.

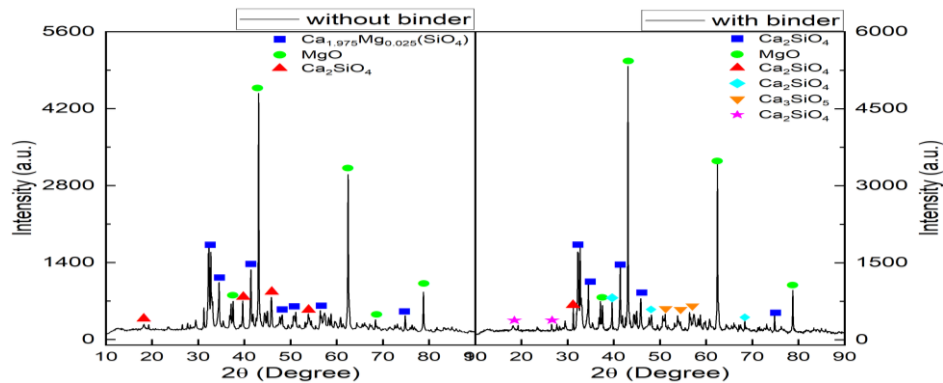
Samples	Bulk density (g/cm <sup>3</sup> )	Apparent density (g/cm <sup>3</sup> )	Relative density (%)	Apparent porosity (%)	Densification
Without binder	325.36	1.42	48.16	56.48	43.52
With binder	323.70	1.31	44.63	59.46	40.54

### 3.2.2 Phase Transformation Analysis

**Fig. 4.** Shows the diffractogram of the sintered pellets. Even though both of the XRD patterns seem alike with each other, it can be observed that there are differences in the value of intensity in which the presence of binder in the sample has higher intensity than the sample without binder. Technically, the higher intensity value presents the larger crystallite size of the samples due to the great number of atoms located on the high diffracted planes. In addition, despite the similarity in the patterns of both diffractograms, the identified phases were mostly mismatched.

The samples without binder were mainly formed by the phases of MgO with cubic type (JCPDS file no. 04-014-7436) followed by a monoclinic type of calcium magnesium silicate,  $\text{Ca}_{1.975}\text{Mg}_{0.025}(\text{SiO}_4)$  (JCPDS file no. 04-024-1422). Meanwhile the rest of the peaks were assigned as calcium silicate oxide,  $\text{Ca}_2\text{SiO}_4$  (JCPDS file no. 00-001-1012). However, for samples with binder addition, all peaks correspond to calcium silicate,  $\text{Ca}_2\text{SiO}_4$  with different crystal systems including monoclinic (JCPDS file no. 00-033-0302, JCPDS file no. 00-009-0351 and JCPDS file no. 00-049-1673) and anorthic type (JCPDS file no. 00-002-0843) There is also a minor phase of calcium silicate oxide,  $\text{Ca}_3\text{SiO}_5$  with anorthic crystal structure (JCPDS file no. 00-014-0693). However, the presence of magnesium oxide phase, MgO with cubic structure (JCPDS file no. 00-045-0946) was notified at the apparent peaks of the diffractogram around  $37.098^\circ$ ,  $43.082^\circ$ ,  $62.462^\circ$ ,  $74.838^\circ$  and  $78.782^\circ$ .

From the results of samples without binder, the  $\text{Ca}_{1.975}\text{Mg}_{0.025}(\text{SiO}_4)$  was observed compared to the samples with binder. It can be expected that formation of this phase has reached the complete crystallite formation by the reactions between dolomite and silica powder through the sintering process. Meanwhile, the absence of the  $\text{Ca}_{1.975}\text{Mg}_{0.025}(\text{SiO}_4)$  phase in the samples with binder was due to the incomplete crystallization between the entire elements of the materials which may require higher sintering temperature to form  $\text{Ca}_{1.975}\text{Mg}_{0.025}(\text{SiO}_4)$  phase. This is because the binders are able to control the thermal reaction and rapid decomposition of the elements in order to prevent sudden thermal shock to the sample. Thus, the addition of binder does affect the formation of phases in sintered samples and slightly increases the crystallization of the samples.

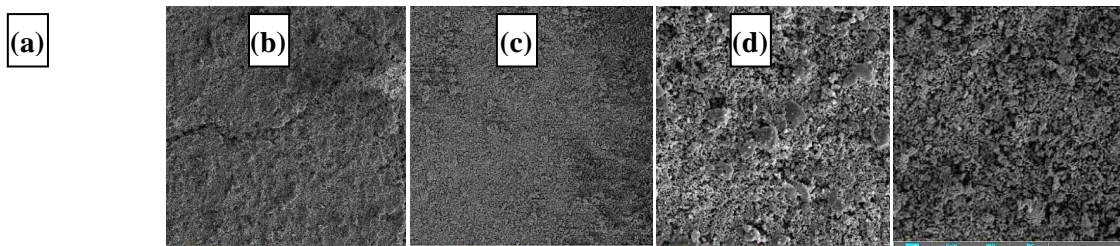


**Fig. 4.** Diffractogram of sintered samples with the effect of binder.

### 3.2.3 Surface Morphology & Elemental Analysis

**Fig. 5** illustrates the surface morphology of sintered dolomite samples by SEM analysis. The images were scanned on the flat surfaces of the samples with 500X and 2000X magnification. For the sample without binder in **Fig. 5 (a)**, it can be observed that there were few cracks formed on the surface with uneven grain morphology. It has dense particles as the porosity of the samples without binder is higher than the sample with binder. Meanwhile, for the samples with binder, the presence of surface microcracks was not clear and also has smooth surface and uniform grain morphology. This suggests that the binder from alginate could promote great binding behavior between each particle during the compaction and sintering process, which forms solid samples without physical defects. It also shows that the sample has an obvious appearance of micropores, due to the decomposition of binder during the sintering process and has corresponded to the low density that leads to the high value of porosity of the sample. This statement has met the agreement with various studies where the alginate can be manufactured with other materials to produce porous three-dimensional (3D) biodegradable networks for tissue engineering applications (Urruela-Barrios et al., 2019). The quantity analysis of elements that have been identified on the surface of the samples by EDX scanning can be referred to in

**Table 4.** The detected elements in both samples emphasize and meet the consistency of the data gained by XRD and FTIR. Thus, using binder in the samples provides better surface morphology with uniform grain and porous structure without the existence of microcracks. Higher porosity in the sample's morphology increases the potential in bone tissue engineering as it is able to mimic closely with the cancellous bone matrix.



**Fig. 5.** SEM micrographs of sintered pallets (a) and (b) at 500X magnification meanwhile (c) and (d) at 2000X magnification. (Noted that (a) and (c) without binder, and (b) and (d) with binder.)

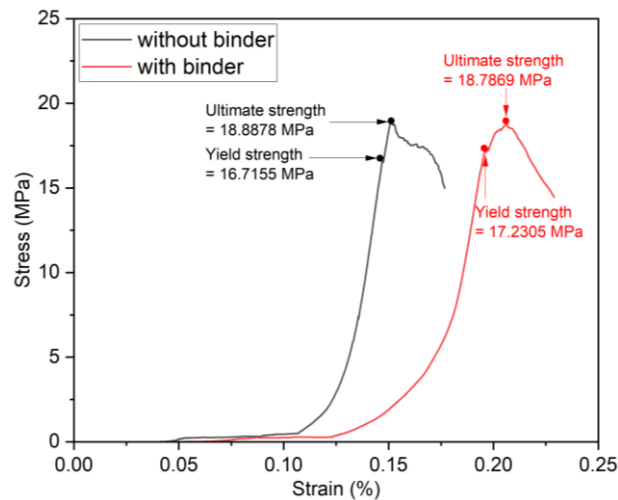
**Table 4.** EDX analysis of sintered dolomite with the effect of binder.

Samples	Qty. (%)	Ca	Mg	Si	O	C	Spectrum
Without binder	Atomic	6.82	14.81	4.36	34.14	39.86	
	Weight	15.36	20.21	6.88	30.67	26.88	
With binder	Atomic	12.75	27.96	3.66	38.14	17.49	
	Weight	24.18	32.15	4.86	28.88	9.94	

### 3.2.4 Mechanical Properties

**Fig. 6** presents the graph of strain against stress on the sintered dolomite samples with and without binder. The ultimate strength of both samples does not show huge differences where the compressive strength values at around 18-19 MPa. The lower compressive strength value shown by the sample with the binder due to the higher porous structures. It can be related with previous results where the sample with binder produced lower density, higher porosity and highly porous morphology structures. However, the sample with binder addition was found to have a slightly higher value of yield strength (17.2305 Mpa) compared to the pallet without binder (16.7155 Mpa). Higher porosities and lower density of samples was suspected to be the factor. Other than that, the binder tends to enhance the hardness of the sample and allow the sample to endure greater forces. Besides, it also demonstrated that the binder has enhanced the strain energy density possibly due to the intense cross-

linked networking by the binder with the dolomite particles (Avila-Ramirez et al., 2021). Moreover, it can be visibly observed that the sample with binder showed excellent results during the extrusion process (Avila-Ramirez et al., 2021) by producing solid faultless pellets while the sample without binder creates minor defects on the surface of the pellets with the characteristics of end capping, similarly encountered by another study which admittedly happened because of the elastic springback's limitation upon the pressure release from the hydraulic compaction during the ejection of green bodies from the mold compaction as the particles cannot resist the stress generated from compaction and ejection (Liyana & Ismail, 2023). Thus, binder application has very minimal impact on the mechanical property of sintered dolomite. Although both types of samples showed similar degree of compressive strength and yield strength, the sintered dolomite with the presence of binder has shown rigid and solid pellets after compaction without any defects as it was easy to handle during the compaction and after the sintering process. Despite that, the compressive strength for both samples still meet the minimum requirements of cancellous bone which is within 10-20 Mpa (Mohammadi et al., 2021). Besides, the compressive strength obtained by this study was almost three times higher than akermanite (5.92 Mpa) (Z. Han et al., 2014) and in the range with the value of hydroxyapatite, Hap (2-100 Mpa) (Eliaz & Metoki, 2017). It also proved that the sample with binder promotes better handling and shaping into rigid bodies (Y. Han et al., 2013; Z. Han et al., 2014; Rallapalli & Ha, 2019; Sathain et al., 2021).



**Fig. 6.** Stress-strain curve of sintered pellets with the presence of binder.

## 4 Conclusion

The aims of this study were successfully accomplished. The preliminary characteristics, properties and sinterability of Perlis dolomite powder with the effect of binder addition were evaluated. It can be concluded that the Perlis dolomite powder has very high content of CaO and MgO compounds without the existence of non-toxicity elements which may encourage the production of bioceramics that are suitable to be used in biomedical related applications. The milled mixture of dolomite and silica powder can be sintered properly either with binder or without binder. However, addition of alginate as binder during the sample's compaction and sintering does affect the dolomite sintered samples properties especially its physical, morphology and phase transformation. Therefore, investigation on the sintered Perlis dolomite with the addition of alginate binder at different sintering temperatures should be carried out for future recommendation.

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## References

1. Abdullah, S. F. A., Saleh, S. S. M., Mohammad, N. F., Idris, M. S., & Saliu, H. R. (2021). Effect of Thermal Treatment on Natural Dolomite. *Journal of Physics: Conference Series*, 2080(1). <https://doi.org/10.1088/1742-6596/2080/1/012009>
2. Arokiasamy, P., Al Bakri Abdullah, M. M., Abd Rahim, S. Z., Luhan, S., Sandu, A. V., Jamil, N. H., & Nabialek, M. (2022). Synthesis methods of hydroxyapatite from natural sources: A review. *Ceramics International*, 48(11), 14959–14979. <https://doi.org/10.1016/j.ceramint.2022.03.064>
3. Avila-Ramirez, A., Catzim-Ríos, K., Guerrero-Beltrán, C. E., Ramírez-Cedillo, E., & Ortega-Lara, W. (2021). Reinforcement of alginate-gelatin hydrogels with bioceramics for biomedical applications: A comparative study. *Gels*, 7(4). <https://doi.org/10.3390/gels7040184>
4. Brennan, M., Monahan, D. S., Brulin, B., Gallinetti, S., Humbert, P., Tringides, C., Canal, C., Ginebra, M. P., & Layrolle, P. (2021). Biomimetic versus sintered macroporous calcium phosphate scaffolds enhanced bone



- regeneration and human mesenchymal stromal cell engraftment in calvarial defects. *Acta Biomaterialia*, 135. <https://doi.org/10.1016/j.actbio.2021.09.007>
5. Cai, W. K., Liu, J. H., Zhou, C. H., Keeling, J., & Glasmacher, U. A. (2021). Structure, genesis and resources efficiency of dolomite: New insights and remaining enigmas. *Chemical Geology*, 573(July 2020). <https://doi.org/10.1016/j.chemgeo.2021.120191>
6. Costaa, H. S., & Diasa, M. R. (2021). Alginate/Bioactive glass beads: Synthesis, morphological and compositional changes caused by SBF immersion method. *Materials Research*, 24(4). <https://doi.org/10.1590/1980-5373-MR-2020-0587>
7. Eliaz, N., & Metoki, N. (2017). Calcium phosphate bioceramics: A review of their history, structure, properties, coating technologies and biomedical applications. *Materials*, 10(4). <https://doi.org/10.3390/ma10040334>
8. Farhana, F., Mustafa, M., Bakri, A., Zamree, S., Rahim, A., Abdul, A., Hidayu, N., Mastura, W., Ibrahim, W., & Victor, A. (2022). *Hydroxyapatite / Dolomite alkaline activated material reaction in the formation of low temperature sintered ceramic as adsorbent materials*. 349(August).
9. Hafriz, R. S. R. M., Salmiaton, A., Yunus, R., & Taufiq-Yap, Y. H. (2018). Green Biofuel Production via Catalytic Pyrolysis of Waste Cooking Oil using Malaysian Dolomite Catalyst. *Bulletin of Chemical Reaction Engineering & Catalysis*, 13(3), 489–501. <https://doi.org/10.9767/bcrec.13.3.1956.489-501>
10. Han, Y., Zeng, Q., Li, H., & Chang, J. (2013). The calcium silicate/alginate composite: Preparation and evaluation of its behavior as bioactive injectable hydrogels. *Acta Biomaterialia*, 9(11), 9107–9117. <https://doi.org/10.1016/j.actbio.2013.06.022>
11. Han, Z., Feng, P., Gao, C., Shen, Y., Shuai, C., & Peng, S. (2014). Microstructure, mechanical properties and in vitro bioactivity of akermanite scaffolds fabricated by laser sintering. *Bio-Medical Materials and Engineering*, 24(6). <https://doi.org/10.3233/BME-141017>
12. Harrati, A., Arkame, Y., Manni, A., Aqdim, S., Zmemla, R., Chari, A., El Bouari, A., El Amrani El Hassani, I.-E., Sdiri, A., Oudrhiri Hassani, F., & Sadik, C. (2022). Akermanite-based ceramics from Moroccan dolomite and perlite: Characterization and in vitro bioactivity assessment. *Open Ceramics*, 10, 100276. <https://doi.org/10.1016/j.oceram.2022.100276>
13. Hui, P. X., Ramkumar, M., Nagarajan, R., Mathew, M. J., & Ng, T. F. (2021). Episodic dolomitization of Paleozoic limestones in the Kinta Valley, Malaysia: Implications on porosity evolution and reservoir properties. *Energy Geoscience*, 2(4). <https://doi.org/10.1016/j.engeos.2020.11.003>
14. Kumar, A., Wang, X., Nune, K. C., & Misra, R. D. K. (2017). Biodegradable hydrogel-based biomaterials with high absorbent properties for non-adherent wound dressing. *International Wound Journal*, 14(6), 1076–1087. <https://doi.org/10.1111/iwj.12762>
15. Ling, S. Y., Asis, J., & Musta, B. (2023). Distribution of metals in coastal sediment from northwest sabah, Malaysia. *Heliyon*, 9(2). <https://doi.org/10.1016/j.heliyon.2023.e13271>
16. Liu, J., Dong, Y., Dong, X., Hampshire, S., Zhu, L., Zhu, Z., & Li, L. (2016). Feasible recycling of industrial waste coal fly ash for preparation of anorthite-cordierite based porous ceramic membrane supports with addition of dolomite. *Journal of the European Ceramic Society*, 36(4), 1059–1071. <https://doi.org/10.1016/j.jeurceramsoc.2015.11.012>
17. Liyana, N. M. R., & Ismail, Y. M. B. (2023). EFFECT OF DIFFERENT COMPACTION PRESSURES ON PHYSICOMECHANICAL PROPERTIES OF AKERMANITE BIO-CERAMICS USING CALCIUM DERIVED FROM DENTAL MOULD WASTE. *Malaysian Journal of Microscopy*, 19(1), 151–160.
18. Mohammadi, H., Baba Ismail, Y. M., Bin Shariff, K. A., & Mohd Noor, A. F. (2018). Synthesis and Characterization of Akermanite by Mechanical Milling and Subsequent Heat Treatment. *Journal of Physics: Conference Series*, 1082(1). <https://doi.org/10.1088/1742-6596/1082/1/012021>
19. Mohammadi, H., Ismail, Y. M. B., Shariff, K. A., & Mohd Noor, A. F. (2021). Microstructure evolution, grain growth kinetics and mechanical properties of Ca<sub>2</sub>MgSi<sub>2</sub>O<sub>7</sub> bioceramics sintered at various temperatures. *Processing and Application of Ceramics*, 15(4). <https://doi.org/10.2298/PAC2104357M>
20. Mohammed, M. A. A., Salmiaton, A., Wan Azlina, W. A. K. G., Mohamad Amran, M. S., & Taufiq-Yap, Y. H. (2013). Preparation and Characterization of Malaysian Dolomites as a Tar Cracking Catalyst in Biomass Gasification Process. *Journal of Energy*, 2013. <https://doi.org/10.1155/2013/791582>
21. Mustafa, A., Alzaki, T., Aljawad, M. S., Solling, T., & Dvorkin, J. (2022). Impact of acid wormhole on the mechanical properties of chalk, limestone, and dolomite: Experimental and modeling studies. *Energy Reports*, 8, 605–616. <https://doi.org/10.1016/j.egyr.2021.11.249>
22. Myat-Htun, M., Mohammadi, H., Noor, A. F. M., Kawashita, M., & Ismail, Y. M. B. (2021). Comprehensive investigation of phase formation mechanism and physico-mechanical properties of ca-mg-silicate. *ASEAN Engineering Journal*, 11(2). <https://doi.org/10.11113/AEJ.V11.16676>
23. Nazry, M. S., Hafiz, F. K., Nizar, K. I., Ruzaidi, C. M., Saad, S. A., & Daud, S. (2006). *Characterization and Application of Dolomite Rock in Perlis*. July, 465–470.
24. Rallapalli, P. B. S., & Ha, J. H. (2019). Preparation of calcium silicate hydrate extrudates and their phosphate adsorption studies. *Applied Chemistry for Engineering*, 30(5), 562–568. <https://doi.org/10.14478/ace.2019.1059>
25. Resio, L. C. (2023a). Characterization of Argentine dolostones with potential application in the manufacture of refractory materials. *Open Ceramics*, 15(May). <https://doi.org/10.1016/j.oceram.2023.100374>
26. Resio, L. C. (2023b). Dolomite thermal behaviour: A proposal to establish a definitive decomposition mechanism in a convective air atmosphere. *Open Ceramics*, 15(June). <https://doi.org/10.1016/j.oceram.2023.100405>

27. Sathain, A., Monvisade, P., & Siriphannon, P. (2021). Bioactive alginate/carrageenan/calcium silicate porous scaffolds for bone tissue engineering. *Materials Today Communications*, 26(February). <https://doi.org/10.1016/j.mtcomm.2021.102165>
28. Shahraki, B. K., Mehrabi, B., & Dabiri, R. (2009). Thermal behavior of Zefreh dolomite mine (Central Iran). *Journal of Mining and Metallurgy, Section B: Metallurgy*, 45(1), 35–44. <https://doi.org/10.2298/JMMB0901035S>
29. Sompech, S., Dasri, T., & Thaomola, S. (2016). Preparation and characterization of amorphous silica and calcium oxide from agricultural wastes. *Oriental Journal of Chemistry*, 32(4). <https://doi.org/10.13005/ojc/320418>
30. Urruela-Barrios, R., Ramírez-Cedillo, E., de León, A. D., Alvarez, A. J., & Ortega-Lara, W. (2019). Alginate/gelatin hydrogels reinforced with TiO<sub>2</sub> and  $\beta$ -TCP fabricated by microextrusion-based printing for tissue regeneration. *Polymers*, 11(3). <https://doi.org/10.3390/polym11030457>
31. Venkatesan, J., Bhatnagar, I., Manivasagan, P., Kang, K. H., & Kim, S. K. (2015). Alginate composites for bone tissue engineering: A review. *International Journal of Biological Macromolecules*, 72, 269–281. <https://doi.org/10.1016/j.ijbiomac.2014.07.008>
32. Xie, F., Gao, C., & Avérous, L. (2024). Alginate-based materials: Enhancing properties through multiphase formulation design and processing innovation. *Materials Science and Engineering R: Reports*, 159(April). <https://doi.org/10.1016/j.mser.2024.100799>



# Implementation of Staff Attendance Recording at Sekolah Kebangsaan (SK) Tanjong Bako Using CFAS System

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**Abstract.** This study was conducted in response to identified issues in the manual recording of staff attendance at Sekolah Kebangsaan (SK) Tanjong Bako. These issues included the lengthy time required to research and analyse attendance data, difficulties in verifying staff attendance in real-time, and the dependency on school management to maintain the attendance record book to prevent loss and damage. Therefore, this study was conducted to assist in making the management of staff attendance recording at the school more systematic. A total of 40 school staff participated as respondents. The CFAS system, utilizing RFID technology, was developed to address these problems. The instruments used to obtain data and information to support this study included document review, observation, and questionnaires. The findings from the use of the CFAS system showed high mean scores for all evaluated aspects and successfully reduced the time required for attendance management operations at the school. Based on the results obtained, the implementation of CFAS has had a positive impact on the school, further propelling the organization towards the era of digitalization.

**Keywords:** Staff Attendance Recording, Sekolah Kebangsaan (SK) Tanjong Bako, CFAS

## 1 Introduction

Sekolah Kebangsaan (SK) Tanjong Bako is a primary school located in the suburbs of Kuching under the administration of the Padawan District Education Office. The school still practices the manual method in recording their attendance in the record book provided by the organization. Due to the fact that there are weaknesses obtained using such methods, such as the occurrence of time wastage and attendance records are easily manipulated, the initiative to transform manual methods with digital systems has been taken aimed at improving operational efficiency and the level of reliable information. By leveraging digital technology that prioritizes computer-run activities rather than using human labor, it becomes an automated and sophisticated operating system with computerized systems that can be read by computers [3].

Therefore, the Contact Free Attendance System (CFAS) system developed in a website version integrated with Radio Frequency Recognition (RFID) technology is paired locally to make it easy for accountable school staff to manage. RFID cards are used as staff self-identification tools that need to be scanned on RFID scanners to be recorded attendance information through the CFAS system and stored on the provided database. An attendance report module that showcases analysis and statistics on staff attendance data is also included to make it easier for administrators to supervise and make reviews. Thus, it helps the management to make decisions that are in accordance with the appropriate actions against staff who are interpreted to have problems with attendance [2].

## 2 Issue of concern / focus of the study

The results of the documentation review of the staff attendance record book at SK Tanjong Bako found that details such as day, date, staff name, time of entry and time of exit should be recorded in writing. If the current sheet is filled, a new or additional sheet will be utilized to fill in the subsequent staff attendance data. In addition, staff who are on vacation or having official business outside the office are also required to record the details through the same record book. Specific instructions relating to the procedure for filling in attendance information are not specified or attached to the record book.

Therefore, the management of the recording of the manual attendance of staff has caused some problems to the officer in charge such as:-

- i. difficulties in verifying the presence of staff at the workstation in real time.
- ii. the waste of time occurs during the process of reviewing and analysing staff attendance records.

- iii. need to ensure the staff attendance record book is in good condition and safe.

Due to such factors, a suitable management system to record staff attendance activities at SK Tanjong Bako should be implemented so that the problems as stated can be improved.

### 3 Objectives of the study

This study aims to launch the management of the recording of staff attendance at SK Tanjong Bako by the administrators and responsible officers. The specific objectives of this study are:

- i. develop a digitally staff-duty attendance management system capable of automatically recording staff entry and exit times at the organization in real time.
- ii. providing staff attendance reports aims to reduce the operating time of reviews and analysis of such records.
- iii. create a database with internal access to support the maintenance of staff attendance records with minimal rates.

### 4 Target group

The study involved 40 staff from SK Tanjong Bako comprising 28 females and 12 males from various levels of staffing.

### 5 Implementation of the study

Several implementations on the studies were:

#### 5.1 Issue Review

The purpose of the problem review is to understand more deeply about the problem identified. Among the methods used are:

- i. Documentation review: A review of the staff attendance record book is carried out before the study to obtain the type of information needed, the transparency of the information provided and the uniformity of the writing format.
- ii. Observation: Observation is carried out to see the actual situation that occurs during the process of recording staff attendance on duty as well as recording the time taken for each staff action.
- iii. Interview: The Headmaster, Senior Assistant for Administration and Clerk from SK Tanjong Bako were informed in advance by the interviewer through a telephone conversation aimed at obtaining consent to be interviewed before the study was conducted. The schedule of the interview session is also given through the WhatsApp application.

#### 5.2 Problem Review Analysis

Here is the analysis from the problem survey:

##### 5.2.1 Documentation review analysis

Figure 1 below shows the duty attendance record book used at SK Tanjong Bako.

Fig. 1. SK Tanjong Bako's duty attendance record book

Every staff member at SK Tanjong Bako is required to register their attendance at school on the duty attendance record book provided. Fields such as name, entry time, exit time and signature need to be filled by staff with correct and accurate information.

The entry and exit times of all Pegawai Perkhidmatan Pelajaran (PPP) and Anggota Khidmat Pelaksana (AKP) are

subject to the enforcement of the regulations set by the school headmaster. Pekeliling ikhtisas KPM bilangan 2/1981: Ketetapan Masa di sekolah-sekolah letter, related to compliance with attendance and not being allowed to leave the school premises before the end of duty hours, has given full authority to the headmaster to determine the duty time and ensure that the officers under his supervision comply with the instructions issued [5].

HARI : 04.02  
TARIKH : 15-1-2019

**REKOD KEHADIRAN GURU**

No	Nama	Masa Masuk	Tandatangan	Masa Keluar	Tandatangan	Catatan
01	Abdullah Latif	0645	[Signature]	1230	[Signature]	
02	Abdullah Latif	0645	[Signature]	1230	[Signature]	
03	Abdullah Latif	0645	[Signature]	1230	[Signature]	
04	Abdullah Latif	0645	[Signature]	1230	[Signature]	
05	Abdullah Latif	0645	[Signature]	1230	[Signature]	
06	Abdullah Latif	0645	[Signature]	1230	[Signature]	
07	Abdullah Latif	0645	[Signature]	1230	[Signature]	
08	Abdullah Latif	0645	[Signature]	1230	[Signature]	
09	Abdullah Latif	0645	[Signature]	1230	[Signature]	
10	Abdullah Latif	0645	[Signature]	1230	[Signature]	
11	Abdullah Latif	0645	[Signature]	1230	[Signature]	
12	Abdullah Latif	0645	[Signature]	1230	[Signature]	
13	Abdullah Latif	0645	[Signature]	1230	[Signature]	
14	Abdullah Latif	0645	[Signature]	1230	[Signature]	
15						
16						
17						
18						
19						

**REKOD KEHADIRAN ANGGOTA KHIDMAT PELAKSANA**

No	Nama	Masa Masuk	Tandatangan	Masa Keluar	Tandatangan	Catatan
01	Abdullah Latif	0645	[Signature]	1230	[Signature]	
02	Abdullah Latif	0645	[Signature]	1230	[Signature]	
03	Abdullah Latif	0645	[Signature]	1230	[Signature]	

**REKOD TIDAK HADIR GURU DAN AKP**

No	Nama	Sebab Tidak Hadir

Disemak : [Signature]

Sekolah Kebangsaan [Signature]

Legend:  
 Name is incomplete or incorrect  
 Time format is inconsistent  
 Information fields are not filled  
 Verification of review is not done

Fig. 2. Incomplete attendance record information

Based on Fig. 2 above, it was found that the details on the attendance record sheet such as the time of departure and the signatures of some staff were not completed and no confirmation of the review was made by the officer in charge. In addition, records of non-uniform time formats were also found.

Such circumstances may cast doubt on the whereabouts of staff at the school as checks and supervision are not carried out on the same day. The level of reliability of the accuracy of the time-of-work cheats is also low due to the high probability of fraud and errors in the cheats [4].

### 5.2.2 Observational Analysis

Table 1. The incident when the attendance record was carried out by the staff of SK Tanjong Bako

Date : 04.02.2022  
 Location : Administration room of SK Tanjong Bako  
 Time : 7.00 am until 7.30 am

Time Block	Action	Time (Seconds)
1	The staff opens the attendance record book and looks for the sheet corresponding to the current date.	40
2	The staff checks the time on their wristwatch or wall clock.	4
3	The staff records the attendance information in the staff attendance record book.	10
Total Time		64

Based on Table 1, in average a staff will take about 64 seconds to record the attendance. It was noted that the staff members displayed a number of behaviors throughout that time, including finding record sheets in the duty attendance record book for attendance records for the day and checking the time of entry to duty carefully before the information is recorded. In addition, filling in information, especially staff names that are quite long, also contributed to the long recording time.

**Table 2.** The incident during the duty attendance check was carried out by the appointed staff at SK Tanjong Bako

Date : 04.02.2022  
Location : Administration room of SK Tanjong Bako  
Time : 7.00 am until 7.30 am

Time Block	Action	Time (Seconds)
1	The staff opens the attendance record book and looks for the attendance sheet corresponding to the current date.	40
2	The staff checks and counts the number of staff currently present at the workstation using the attendance record book.	15
Total Time		55

Table 2 show the observation's result of the staff who are responsible for checking the duty attendance record book filled in by the staff who are present at the school on that day. Such actions have disrupted the operational time and manpower of the staff which should have been used to improve the quality of service in the organization. In fact, it becomes an additional workload that needs to be allocated time to complete tasks outside the scope of the work carried out [7].

### 5.2.3 Interview Analysis

Table 3 summarizes the results of interviews with two (2) SK Tanjong Bako staff who hold the position of Headmaster and Senior Assistant for Administration related to the recording of attendance on duty.

**Table 3.** Summary of the interview with the Headmaster and Senior Assistant for Administration on 04.02.2022 at the SK Tanjong Bako Administrative Office, at 9.00 am

Bil	Interview questions	Summary
1	What is the usual process for recording staff attendance at SK Tanjong Bako?	All staff will fill in the attendance record book provided in the administration office every time they arrive and return to or from school.
2	How are data security measures implemented to ensure transparency and authenticity of staff attendance records?	A staff member is appointed and placed in the administrative office to regulate and ensure attendance is recorded by SK Tanjong Bako staff in order to prevent fraud and manipulation of data from occurring. However, continuous supervision will cause the staff in charge to feel burdened and not focused in carrying out the assigned tasks.
3	What are the challenges faced in carrying out this manual attendance recording?	Some staff forgot to record their attendance at school, causing the recorded attendance time to be inaccurate.  The administrative office is closed outside of office hours is also a factor causing difficulties in obtaining access to the duty attendance record book. This situation has created a situation where staff are late or unable to fill their attendance on the day.  The management needs a minimum of 5 minutes to make a brief analysis of the attendance book by ensuring that all fields are filled in completely by the staff who have been on duty before confirming attendance for the week. The confirmation of attendance is done periodically, once in a week.
4	Where is the previous duty attendance record book located?	All previous duty attendance records are kept in the storeroom for at least five years before they are disposed of. However, due to the relatively small storage space, the storage area could not accommodate the dumping of other official documents at the same location. Therefore, the headmaster's room was used as an alternative location as a temporary document storage center.
5	What is the physical condition of the previous duty attendance record book now?	Some attendance record books are in poor condition because temperature and humidity of the storage room are difficult to control. Apart from that, there are also some attendance record books that have been severely damaged so that it is difficult to analyse the attendance of staff for the previous year.

The analysis of the interviews showed that the manual recording of staff attendance had triggered several problems for the top management of SK Tanjong Bako. Factors such as the appointed staff losing focus on their duties to oversee the

attendance recording process by other staff can lead to falsification of recorded information. In addition, the location of the duty attendance record book is not strategic because access to it depends on the physical presence of the officer holding the key to the administrative office. In addition, the wastage of staff operational time is also influenced by the work of making a brief analysis of the staff's duty attendance which is handled manually every once a week. The storage space for the archived staff attendance record book is also a concern for researchers because it can no longer accommodate the dumping of large amount official documents in physical form.

### 5.3 Actions Taken

Once the real problem is understood, the following actions are taken:

- i. Obtain confirmation of receipt of a letter entitled *Permohonan Bantuan Kepakaran Pembangunan Dan Pemasangan Sistem Kehadiran Staf Sekolah Kebangsaan (SK) Tanjong Bako* with reference number SKTB 100-9/6 (1) dated 21.01.2022 from the Director of the Politeknik Kuching Sarawak, Mr. Hikmatullah bin Hajid Ahmad Khan.
- ii. Check the documents related to the attendance record of SK Tanjong Bako staff to obtain the details of the information needed in the recording.
- iii. Conduct observation methods to research staff behaviour during the process of recording attendance information and analysing staff attendance data.
- iv. Obtain input from the top management of SK Tanjong Bako related to the method of recording staff attendance through the duty attendance record book provided by the organization.
- v. Get feedback on the specifications of computers and mobile phone rigs used by schools and staff.
- vi. Developed a staff attendance system named Contact Free Attendance System (CFAS) in the form of a website that is integrated with RFID technology with local network support.

### 5.4 Implementation of actions and observations/ assessments

A briefing and workshop on the use of the CFAS system was held for all staff involved on 04.07.2022 at SK Tanjong Bako.



**Fig. 3.** Location of computer placement and RFID card scanner device

Referring to Fig. 3 above, the aids for the CFAS system such as computers and RFID scanners are placed inside the administrative office for security reasons. Staff can scan their RFID cards for the purpose of recording unhindered attendance at any time. Table 4 is the results obtained from observations after CFAS system implementation.

**Table 4.** The incident during the recording of attendance on duty by staff at SK Tanjong Bako using the CFAS system

Date : 11.07.2022  
 Location : SK Tanjong Bako  
 Time : 7.00 am until 7.30 am

Time Block	Action	Time (Seconds)
1	Staff scan their RFID cards on the provided RFID scanner.	1
2	Staff check their attendance records on the computer screen.	1
Total Time		2

**Table 5.** The incident during the duty attendance check was carried out by the appointed staff through the CFAS system

Date : 11.07.2022  
Location : SK Tanjong Bako  
Time : 9.00 am

Time Block	Action	Time (Seconds)
1	Staff press the attendance report button on the CFAS system.	1
2	Select the start date and end date for generating the staff attendance report.	1
3	Display of the staff attendance report.	1
Total Time		3

Based on the observations that have been made, the CFAS system has succeeded in reducing the operational time in recording and analyzing staff attendance at SK Tanjong Bako. In fact, with this system, it has helped in easing the workload of the management of SK Tanjong Bako which is also the implementer in ensuring that the regulations related to the attendance of staff are complied with. In addition, access to this system is easy as staff only need their staff cards to be scanned on the RFID scanner without having to record attendance in paper-based form. Therefore, administrators no longer need to keep physical records of previous attendance.

### 5.5 Reflection of the study

The findings of this study provide information related to the implementation of the use of the CFAS system for recording the attendance of staff at SK Tanjong Bako. The mean value of this study is translated according to the following translation:

**Table 6.** Source adapted from Wiersma, 2008

Minimum Interpretation	
1.00 – 2.33	Low
2.34 – 3.67	Medium
3.68 – 5.00	High

- To carry out this study, the researcher conducted a briefing to explain each item carefully to the respondents. It was to ensure that the respondents answered all the items according to the correct understanding.
- A pilot study was conducted before the actual study was conducted. An analysis of the level of reliability of the questionnaire questions was carried out using the Alpha Cronbach test. The results of the pilot study have obtained alpha values as high as 0.9687. Studies that achieved alpha values of 0.6 or above had acceptable question reliability [1].
- The analysis of the questionnaire is divided into parts A to C.
- Part A analysis is the respondent's personal information which is analyzed using descriptive statistical analysis using frequency and percentage distribution.
- The analysis of Part B (form of CFAS system) is as shown in Table 7 - 9.



**Table 7. User friendly**

No.	Item	STS (%)	TS (%)	M (%)	S (%)	SS (%)	Min
1	The use of this system facilitates users in obtaining the required information.	0 0.00	1 2.50	8 20.00	16 40.00	15 37.50	3.53
2	The menu display in this system is presented comprehensively.	0 0.00	1 2.50	6 15.00	20 50.00	13 32.50	4.13
3	The provided menu helps make the system easy to use.	0 0.00	1 2.50	6 15.00	19 47.50	14 35.00	4.15
<b>Overall Mean</b>							<b>3.94</b>
<b>Minimal Interpretation</b>							<b>HIGH</b>

**Table 8. Interactivity**

No.	Item	STS (%)	TS (%)	M (%)	S (%)	SS (%)	Min
4	The selected menu functions as expected.	0 0.00	1 2.50	7 17.50	20 50.00	12 30.00	4.08
5	The usage instructions on this system are clear.	0 0.00	2 5.00	5 12.50	19 47.50	14 35.00	4.13
<b>Overall Mean</b>							<b>4.11</b>
<b>Minimal Interpretation</b>							<b>HIGH</b>

**Table 9. Design**

No.	Item	STS (%)	TS (%)	M (%)	S (%)	SS (%)	Min
6	The menu in the system is well-organized.	0 0.00	1 2.50	7 17.50	18 45.00	14 35.00	4.13
7	The text in the system is easy to understand.	0 0.00	1 2.50	6 15.00	17 42.50	16 40.00	4.20
8	The use of color in this system is appropriate.	0 0.00	1 2.50	6 15.00	19 47.50	14 35.00	4.15
<b>Overall Mean</b>							<b>4.16</b>
<b>Minimal Interpretation</b>							<b>HIGH</b>

The analysis of Part C (uses of the CFAS System) is as shown in Table 10.

**Table 10. Usability**

No.	Item	STS (%)	TS (%)	M (%)	S (%)	SS (%)	Min
9	The CFAS system adheres to organizational standards.	1 2.50	0 0.00	6 15.00	19 47.50	14 35.00	4.13
10	Attendance information is easily accessible and quick.	1 2.50	0 0.00	7 17.50	18 45.00	14 35.00	4.08
11	Attendance recording saves operational time.	1 2.50	0 0.00	6 15.00	14 35.00	19 47.50	4.23
12	CFAS is easily accessible through a smartphone application or website.	2 5.00	0 0.00	8 20.00	17 42.50	13 32.50	3.98
<b>Overall Mean</b>							<b>4.11</b>
<b>Minimal Interpretation</b>							<b>HIGH</b>

The results of the questionnaire showed that the CFAS system was user-friendly, the design of the system was in accordance with the needs of the users and the functions provided met the requirements of the management of SK Tanjung Bako. The mean interpretation score obtained for all aspects investigated was at a high level.

An interview session was also held with several SK Tanjung Bako staff to obtain views related to the management of attendance recording after the action was implemented. The results of the interview can be seen in Table 11 below.

**Table 11.** Summary of the interview with the several staff on 11.07.2022 at the SK Tanjong Bako Administrative Office, at 9.30 am

Bil	Interview questions	Conclusion
1	In your view, does the CFAS system have a positive impact on the management of attendance records for SK Tanjong Bako staff? If so, in what ways has it changed your daily routine?	Yes. Attendance records can be maintained more easily. In addition, administrators do not take along time to analyze staff attendance compared to the methods used previously.
2	What are the features of the CFAS system that benefit you?	A simpler and more systematic method of recording attendance. The system also helps to record the real-time entry and exit times of each staff.
3	Do you experience any difficulties using the CFAS system?	At the beginning of the system implementation, there were several problems that arose due to circumstances outside the control of the school. Among them, the problem of unstable electricity supply that causes this system to not be used efficiently. In addition, the skeptical acceptance of staff towards the use of digital attendance recording systems is also one of the difficulties faced by the school.
4	Has the CFAS system helped in addressing the problem of recording staff attendance in the past?	Yes. Real-time can be recorded, and it can even overcome the problem of unsystematic record maintenance before.

Referring to the analysis of questionnaires and interviews conducted, it is shown that the CFAS system is adopted as a method of recording the attendance of staff at SK Tanjong Bako. In fact, with this system, it can be noted that the time allocation used for attendance records has been reduced by more than 95%. This system has also helped to increase the efficiency of SK Tanjong Bako's management in maintaining staff attendance records because it is digital and easy to use, systematic and efficient. Thus, manipulation of attendance data can be avoided.

## 6 Recommendations for further studies

As a continuation of this study, plans such as the inclusion of an additional module, namely the student attendance module, with automatic electronic mail notifications every 9.00 am every day, which contains a list of absentee students, are geared towards the purpose of updating student attendance records through the *Aplikasi Pangkalan Data Murid* (APDM) system, which is currently in the action of the researchers. This application was submitted by Mr Abang Suuadi bin Abang Haji Yak, the headmaster of Sekolah Kebangsaan (SK) Sungai Maong Hilir through his letter dated 09 September 2023 with reference number SKSMH.100-15/4/1(1). The letter was minuted and noted by the current Director of the Politeknik Kuching Sarawak, Mr. Samsudin bin Mohd. Saleh. The researchers also intend to spread the CFAS system to schools that still rely on manual attendance recording so that the country's vision, towards the era of digitalization based on the industrial revolution 4.0 can be achieved.

## Acknowledgements

Alhamdulillah, and with great gratitude, finally the study of the Implementation of Staff Attendance Recording at Sekolah Kebangsaan (SK) Tanjong Bako using the CFAS system can be carried out successfully. We would also like to take this opportunity to express our immense gratitude to the former Director of the Politeknik Kuching Sarawak, Mr. Hikmatullah bin Hajid Ahmad Khan, the Director of the Politeknik Kuching Sarawak, Mr. Samsudin bin Mohd. Saleh, former Headmaster of SK Tanjong Bako, Mr. Abang Suuadi bin Abang Haji Yak, Senior Assistant of Administration of SK Tanjong Bako, Mr. Mohamad Faizal bin Gapor and the teachers of SK Tanjong Bako, whether directly or indirectly involved throughout the study, for providing cooperation and support to us to ensure that this action study can be implemented.

This study is an action study aimed at smoothing the management of attendance recording of SK Tanjong Bako staff, where before this study was carried out, the recording of attendance on duty at the school was carried out manually. We sincerely hope that with the CFAS system, the procedure for recording staff attendance at SK Tanjong Bako will be more organized and systematic and can improve and overcome the problems faced before.

The CFAS system is expected to be expanded to schools under the administration of the Padawan District Education Office such as Sekolah Kebangsaan (SK) Sungai Maong Hilir Kuching and Sekolah Kebangsaan (SK) Bengoh. Finally, we would like to express our appreciation and gratitude once again for the willingness of all of you to work together to make this action study a success.



## References

1. Abu, M. S. & Tasir, Z. *Pengenalan kepada analisis data berkomputer SPSS 11.5 for windows*. Kuala Lumpur : Venton Publishing. (2003)
2. Daud, E. D. C., & Saad, A. J. *Sistem Maklumat Pengurusan dalam talian di sekolah dalam konteks Malaysia*. In *Seminar Kebangsaan ICT Dalam Pendidikan, Malaysia*. (2013)
3. Danuri, M. *Perkembangan dan transformasi teknologi digital*. Jurnal Ilmiah Infokam. **15(2)**. (2019)
4. Daud, A. F. A., & Ramli, A. A. *Sistem Pengurusan Kehadiran dan Kebenaran Kerja Yacaya Enterprise (PKKKYE)*. Applied Information Technology And Computer Science. **3(2)**. 1604-1617. (2022)
5. 5 Kementerian Pendidikan Malaysia. *Malaysian School Governance (MySG): Garis Panduan Tadbir Urus Sekolah Menengah*. (2020)
6. Nasir, M. R. *Asas Penulisan Laporan Kajian Tindakan & Inovasi : Panduan Mudah Untuk Guru*. Edisi Kedua. MENHAJJ Resources. (2021)
7. Tien, E. C., Hamid, H., & Madar, A. R. *Hubungan Antara Efikasi Kendiri, Beban Tugas dan Masalah Kesihatan Mental dalam Kalangan Pensyarah Kolej Vokasional: Relationship Between Self-Efficacy, Workload and Mental Health among Lecturers in Vocational Colleges*. Online Journal for TVET Practitioners. **7(1)**. 1-7. (2022)
8. Wiersma, W., & Stephen, G. J. *Research Methods in Education: An Introduction*. 9th Edition. Pearson. (2008)

# Numerical Simulations of Combustion Behavior of Ammonia/Hydrogen and Methane

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**Abstract.** Sharing the common challenge of reducing CO<sub>2</sub> emissions to slow down global warming has been a concern. There has been a lot of interest in carbon-free fuels lately. Ammonia (NH<sub>3</sub>), an alternative fuel that is carbon-free and renewable, is less expensive than hydrogen, has a higher volumetric energy density, and is simpler to liquefy, store, and transport. Ammonia is starting to show promise as a green energy source. It is also a possibility to use ammonia/hydrogen mixture fuel in automobiles. However, compared with conventional hydrocarbon fuel, ammonia has a much lower laminar flame speed  $S_L$ , lower adiabatic flame temperature, higher minimum ignition energy, and higher nitrogen oxide (NO<sub>x</sub>) emission which prevent it from being widely used. In terms of in-situ synthesis of hydrogen from ammonia and its proper combustion and controlled NO<sub>x</sub> emissions, it is very challenging and complex. The primary objective of this project is to examine the laminar burning velocity, ignition delay period, quenching distance, and combustible limit of NH<sub>3</sub>/H<sub>2</sub> and NH<sub>3</sub>/CH<sub>4</sub> mixed gas fuels. Investigated will be the variables such as pressure, temperature, mixture concentration, and hydrogen blending ratio that affect the laminar burning velocity, ignition delay period, and quenching distance of the NH<sub>3</sub> and H<sub>2</sub>/CH<sub>4</sub> mixed gas fuel. The governing equations, including the energy equation, the species transport equation, and the Navier-Stokes equation, will be solved through simulation work once a 3D model of the combustion chamber is constructed.

**Keywords :** Carbon free fuels, green energy, Ammonia/hydrogen, combustion

## 1 Introduction

Fossil fuels have become the very main source of energy to us. As far as its importance, facing depletion has become a concern to the world. In addition, fossil fuel also has given us negative impacts such as greenhouse gasses (GHG) and climate change because of its usage in combustion and gas turbines in many areas such as transportation, factories and many more. Many countries have taken steps in reducing their carbon footprint, for example banning deforestation, limiting their industries pollution and sometimes compounding their industries that did not comply with the law. Thus, many power plants and cars are still dependent on hydrocarbon fuels which pollute the environment.

A solution is being searched for and the best answer is to find a clean suitable alternative energy to sustain the current needs. All of humanity now faces the challenge of lowering CO<sub>2</sub> emissions to slow down global warming. Thus, in the past few years, fuels without carbon have gained a lot of attention. Ammonia (NH<sub>3</sub>) is a renewable, carbon-free alternative fuel that is less expensive, easier to liquefy, store, and transport than hydrogen. It also has a higher volumetric energy density. Ammonia is therefore emerging as a potential green energy source. It is also a possibility to use ammonia/hydrogen blend fuel in automobiles. Ammonia is not as widely used as conventional hydrocarbon fuel because of its significantly lower laminar flame speed ( $S_L$ ), lower adiabatic flame temperature, higher minimum ignition energy, narrower flammability limits, and higher nitrogen oxide (NO<sub>x</sub>) emission.

### 1.1 Background Study

One of the most promising alternative fuels that is easy to produce is hydrogen. It is carbon free alternative fuel and can be harvested using renewable energy such as wind turbines and solar energy. This alternative fuel can be used in combustion engines and fuel cells without emitting any CO<sub>2</sub> emission. Although the advantages, there are disadvantages that must be considered. Hydrogen is hard to store and needs a bigger storage unit because of its low density property and difficult to transport from one point to another although hydrogen is explosive posing safety concerns. Considering other options as alternative fuel point out to Ammonia as a good substitute to the problem.

All of humanity now faces the challenge of lowering CO<sub>2</sub> emissions to slow down global warming. Thus, in the past few years, fuels without carbon have gained a lot of attention. Ammonia (NH<sub>3</sub>) is a renewable, carbon-free alternative fuel that is less expensive, easier to liquefy, store, and transport than hydrogen. It also has a higher volumetric energy density. Ammonia is therefore emerging as a potential green energy source. It is also a possibility to use ammonia/hydrogen blend fuel in automobiles. Ammonia is not as widely used as conventional hydrocarbon fuel because of its significantly lower laminar flame speed (SL), lower adiabatic flame temperature, higher minimum ignition energy, narrower flammability limits, and higher nitrogen oxide (NO<sub>x</sub>) emission.

## 1.2 Problem Statement

Reducing CO<sub>2</sub> emissions to slow down global warming has become a common challenge for all mankind. So, carbon-free fuels have attracted much attention in recent years. As a carbon-free and renewable alternative fuel, ammonia (NH<sub>3</sub>) is lower-cost, has higher volumetric energy density and is easier to liquefy, store and transport compared with hydrogen. Therefore, ammonia is becoming a promising green energy carrier. Ammonia/hydrogen mixture fuel also is a viable option to be utilized in vehicles. However, compared with conventional hydrocarbon fuel, ammonia has a much lower laminar flame speed  $S_L$ , lower adiabatic flame temperature, higher minimum ignition energy, narrower flammability limits and higher nitrogen oxide (NO<sub>x</sub>) emission which prevent it from being widely used.

## 1.3 Research Objectives

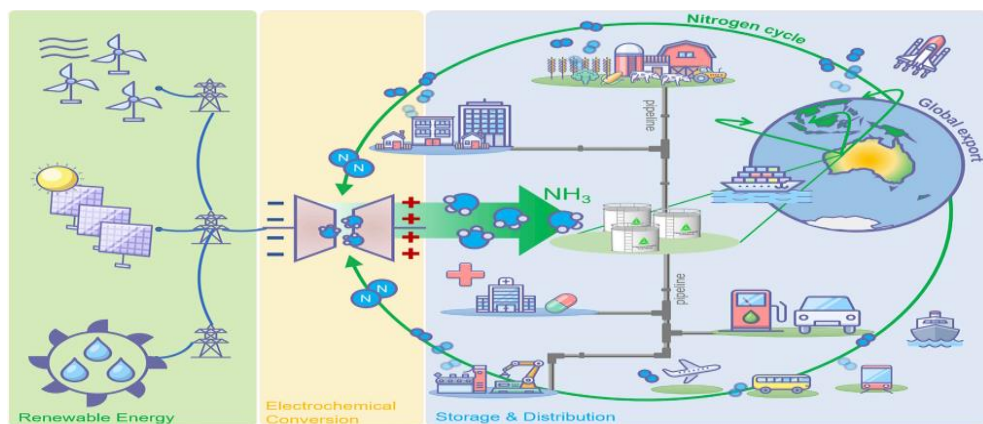
The objectives of the research is:

1. To perform a simulation of ammonia/hydrogen and methane mixes using a swirl and bluff-body stabilized burner.
2. To determine the basic combustion properties of NH<sub>3</sub>/H<sub>2</sub> and NH<sub>3</sub>/CH<sub>4</sub> mixed gas fuels which are the laminar burning velocity and ignition delay period
3. To investigate the influencing factors and changing rules of the laminar burning velocity and ignition delay period of the NH<sub>3</sub> and H<sub>2</sub>/CH<sub>4</sub> mixed gas fuel under various variables.

## 2 Literature Review

Ammonia has higher energy density properties compared to hydrogen. Unlike NH<sub>3</sub>, Ammonia is still a hydrogen carrier which has volumetric density of 45% higher than liquefied hydrogen [1]. It also can be pressurized at -10 bar at room temperature and cooled at -30°C at atmospheric pressure. In addition, it is easy to produce in large quantities and has been used in other sectors such as fertilizer and textile for generations and technology in pipeline and transportation already established. Figure 2-1 shows a vision economy proposed by McFarlane et. al [2] on Ammonia based on nitrogen cycle. Thanks to Haber-Bosch discovery that introduced ammonia to the world centuries ago. The first process generates H<sub>2</sub> from natural gas or coal. After that, combining with N<sub>2</sub> by steam reforming to form ammonia which nitrogen is fed by air and separated by cryogenic process [3]. For the last decade, this method has expanded, and ammonia is produced by water electrolysis and solar thermal cycles, making it low cost and much easier to produce.

In terms of safety, breathing in ammonia could be dangerous. However, even at low concentrations (0.6-53 ppm), it is easily detectable due to its strong, pungent smell. Ammonia concentrations below 300 parts per million are considered Immediately Dangerous to Life or Health (IDLH) [4]. In addition, ammonia disperses into the upper atmosphere more quickly than air because it is lighter than air.



**Fig. 2.1.** Vision of Ammonia Economy in which Energy Sources and Uses are all based on Ammonia [2]

Compared to hydrogen, ammonia has the advantage over safe storage and transportation. However, as a zero-carbon emission alternative fuel, some of its burning characteristic is facing challenge before it can be utilize in combustion chamber such as much lower laminar flame speed  $S_L$ , lower adiabatic flame temperature, higher minimum ignition energy, narrower flammability limits and higher nitrogen oxide (NOx) emission which prevent it from widely used [5]. Table 2.1 shows thermal properties and fundamental combustion characteristic of ammonia, methane and other hydrocarbon fuels at boiling point and condensation point from NIST, Kobayashi et al [6]. Ammonia has the lowest adiabatic flame temperature and lowest maximum laminar burning velocity compared to others.

**Table 2.1.** Thermal properties and fundamental combustion characteristics of ammonia and hydrocarbon fuels from NIST database [6]

Fuel	NH <sub>3</sub>	H <sub>2</sub>	CH <sub>4</sub>	C <sub>3</sub> H <sub>8</sub>
Boiling temperature at 1 atm (°C)	-33.4	-25	-16	-42.
		3	1	1
Condensation pressure at 25 °C (atm)	9.90	N/A	N/A	9.40
Lower heating value, LHV (MJ/kg)	18.6	120	50.0	46.4
Flammability limit (Equivalence ratio)	0.63~1.40	0.10~7.1	0.50~1.7	0.51~2.5
Adiabatic flame temperature (°C)	1800	2110	1950	2000
Maximum laminar burning velocity (m/s)	0.07	2.91	0.37	0.43
Minimum auto ignition temperature (°C)	650	520	630	450

The definition of flammability limits, minimum oxygen concentration, and gas deflagration index, or kg, is made possible by understanding the laminar burning velocity, an essential parameter for the safe design of machinery and processes [7]. A typical hydrogen-air ratio is 3 m/s, while a hydrocarbon ratio is less than 40 cm/s. In contrast, the ignition delay is defined as the interval from the beginning of fuel injection (SOI) to the beginning of combustion (SOC) [8]. It is simple to identify the beginning of injection, but it can be challenging to identify the beginning of combustion. The next feature is the quenching distance, which is defined as the separation between two parallel plates, or flat walls, at which a specific fuel oxidant mixture's flame front will be extinguished [9]. The highest gas concentration that, when combined with air and ignited, will sustain a self-emitting flame is known as the gas's combustion limit [10].

## 2.1 Ammonia as a fuel for combustion system

Fuel is considered as the most important source of energy in life. Fuels plays a crucial role in many applications, from providing heat, small energy related activities to the larger sector such as transportation and power generation. When hydrocarbon fuels, the main source of energy, is facing the world's concern of depletion and pollution, hydrogen has caught everybody's attention as the solution in alternative fuel. But, compared to hydrocarbon performance, hydrogen also has many flaws such as difficulty in storage and solving the problem that leads to finding ammonia as a new alternative solution to replace hydrocarbon fuels in the combustion system. In terms of production, ammonia is widely produced because the operation is easy and 70% of the production is in the agriculture sector as fertilizer [11].

In addition, ammonia offers a higher energy density compared to compressed hydrogen itself. As a fueling vector for upcoming power generation, the practical application of ammonia is limited due to its higher NOx emissions and low reactivity characteristics when compared to typical hydrocarbons [12]. But the urgent need for the energy sector to decarbonize puts ammonia as a carrier and energy vector at the forefront, necessitating the resolution of ammonia utilization issues. Over the past few decades, there has been a lot of interest in the use of so-called "green" hydrogen for the decarbonization of the energy and propulsion sectors.

Hydrogen still has certain limitations when applied directly to power systems like gas turbines, despite advancements. Because of this, a different vector, like ammonia, can be used to distribute and transport green hydrogen while also limiting combustion reactivity in gas turbines to make them more operational than hydrogen. To ensure greater flame stability, more reactive molecules are required to dope with pure ammonia because it exhibits slow and complex reaction kinetics on its own. Ammonia is predicted to replace natural gas (which contains about 90% methane) in power and heat production units in the upcoming years.

This indicates that cofiring ammonia and methane will eventually replace CH<sub>4</sub> as a fossil fuel. There is a clear route to decarbonization using ammonia/hydrogen blends because hydrogen can be obtained from the pre-cracking of ammonia. Thus, a more in-depth examination of the stability, emissions, and flame characteristics is necessary because ammonia, methane, and hydrogen may co-fire at some point in the current combustion units [13]. This will guarantee that the switch from natural gas to e-fuels produced by renewable energy sources, like ammonia and so-called "green" hydrogen, is completed with minimal negative effects on machinery and procedures. Because of this, the analysis of the combustion

characteristics of blends containing ammonia, methane, and hydrogen at various concentrations is presented in this work. A swirl bluff-body stabilized burner design was used with different equivalence ratios and constant power.

## 2.2 Properties of Ammonia

Ammonia is an inorganic chemical compound of nitrogen and hydrogen with the formula of  $\text{NH}_3$ . Initially, the first process was to heat the sub ammonia (ammonium chloride) with lime in 1754 to produce ammonia. Since ammonium chloride was first created in the fourth century from camel dung and the process took place near the temple of Arm Mow, the Egyptian god. After that, the new compound was named after the Egyptian god Arm Mow [14]. Ammonia is a colorless, very irritating gas that has a strong, suffocating smell when it is at room temperature. It is hygroscopic, meaning it readily absorbs moisture, and is known as anhydrous ammonia in its pure form. Table 2.2 shows the anhydrous ammonia properties and Table 2.3 chemical ammonia properties.

**Table 2.2.** Physical Properties of Ammonia [14]

Property	Value or Detail
Molecular Mass	Molecular Mass 17.03 g/mol
Colour	Colourless
Odour	Sharp, irritating
Physical State	Gas (at room temperature)
Melting Point	-77.7°C
Boiling Point	-33.35°C
Flash Point	11°C
Decomposition Point	500°C
Density (gas)	0.7710 g/L
Density (liquid)	0.6818 g/L
Vapour Density	0.5697
Critical Temperature	132.4°C
Critical Pressure	111.3 atm
Heat of Fusion	58.1 kJ/mol
Heat of Vaporization	23.3 kJ/mol
Heat of Combustion	-316 kJ/mol

Ammonia can be made from renewable hydrogen and nitrogen that has been extracted from the air. Ammonia makes up 17.8% of hydrogen by mass. Moreover, ammonia's boiling temperature and condensation pressure are comparable to those of propane, which makes it a desirable hydrogen and energy carrier. For the past 100 years, ammonia has been produced and used as a refrigerant, fertilizer, and raw material in chemicals. According to techno-economic analysis, ammonia is the most affordable fuel when compared to other traditional fuels like hydrogen, methanol, liquefied petroleum gas (LPG), natural gas, and gasoline. Furthermore, liquid ammonia has a volumetric energy density of 12.7 MJ/L, which is higher than that of compressed hydrogen (4.5 MJ/L at 25 °C and 69 MPa) and liquid hydrogen (8.49 MJ/L). At atmospheric pressure, ammonia has a boiling temperature of -33.4 °C. Moreover, the combustion heat of ammonia is substantially higher than that of liquid hydrogen (8.58 MJ/L) at 11.2 MJ/L as shown in Table 2.4.

**Table 2.4.** Detailed physical characteristics of Ammonia [14]

Properties	Unit	Value
Molar mass	g/mol	17.031
Density at STP	kg/m <sup>3</sup>	0.769
Melting point	°C	-77.73
Boiling point at 100 kPa	°C	-33.4
Vapor pressure at 20 °C	kPa	858
Heat of evaporation	MJ/kg	1.371
Auto ignition temperature	°C	650
Critical temperature	°C	132.4

Critical pressure	MPa	11.28
Viscosity at 25 °C	μPa·s	10.07
Heat capacity at constant pressure (101.325 kPa, 15 °C)	kJ/mol·	0.037
Heat capacity at constant volume (101.325 kPa, 15 °C)	kJ/mol· °C	0.028
Heat of combustion	MJ/L	11.2
Critical density	g/mL	0.24
Condensation pressure at 25 °C	MPa	0.99
Flammability limit (equivalence ratio)	-	0.63–1.4
Adiabatic flame temperature	°C	1800
Max. laminar burning velocity	m/s	0.07

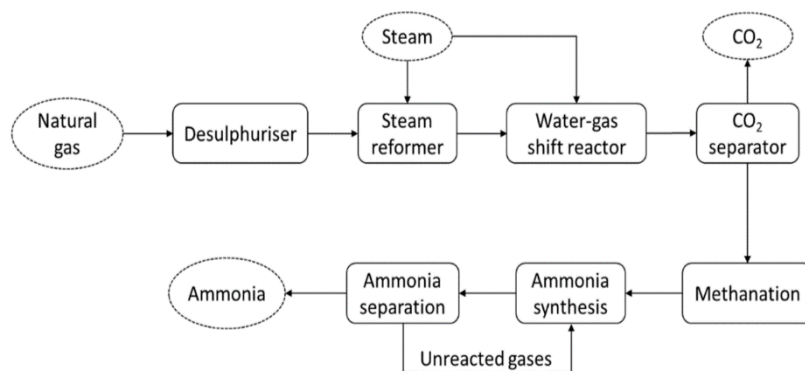
Because gaseous ammonia has a lower density than air (0.769 kg/m<sup>3</sup> versus 1.225 kg/m<sup>3</sup> at STP), it can dissipate in the atmosphere more quickly in atmospheric conditions, reducing the risk of an explosion or fire in the event of a leak. Moreover, ammonia has a lower risk of fire than hydrogen because it has a higher auto ignition temperature (650 °C) than hydrogen (520 °C). Ammonia has limited flammability (15.15–27.35% in dry air and 15.95–26.55% in air with 100% relative humidity), which presents difficulties [15]. As such, during its transportation and storage, it is typically regarded as non-flammable. Furthermore, the use of ammonia, particularly at high temperatures, may result in the formation of NO<sub>x</sub> because nitrogen is the primary component of the gas. That's why controlling ammonia combustion is so important. Although ammonia is combustible, its low flammability, high NO<sub>x</sub> emission, and low radiation intensity present a few combustion-related difficulties. Additional study of the dynamics and chemistry of ammonia flames is necessary to overcome these obstacles.

### 2.3 Ammonia production method

Ammonia is produced by the reaction between nitrogen (N<sub>2</sub>) and hydrogen (H<sub>2</sub>) and the balanced equation is as shown in equation 2.1 below.



Source of Nitrogen is atmospheric air and the following hydrocarbons are generally used as the source of hydrogen. Other, hydrogen sources that were previously employed in the production of ammonia include semi-water gas produced by gasifying coal or coke with steam, Hydrogen generated through water electrolysis and lastly, as a byproduct of producing hydrogen from chlorine [16]. The system that Fritz Haber and Carl Bosch invented approximately a century ago is essentially used in the currently used ammonia production process. As a result, this system is commonly referred to as the Haber-Bosch process.



**Fig. 2.2.** Schematic diagram of ammonia production from natural gas, employing the Haber–Bosch process. [16]

To represent the carbon intensity of various production techniques, the ammonia industry has unofficially adopted a color scheme (Figure 2.3). The terms "brown" and "gray" ammonia describe ammonia that is produced with significant CO<sub>2</sub> emissions using fossil fuel feedstocks, namely coal and natural gas, respectively. Moreover, ammonia derived from fossil fuel feedstocks is referred to as "blue ammonia," which is crucial because it is linked to carbon capture and storage (CCS) technology, which traps generated CO<sub>2</sub> rather than releasing it into the atmosphere. Rather than using hydrocarbon feedstocks to produce H<sub>2</sub>, green ammonia is made via electrolysis powered by renewable electricity, which produces no CO<sub>2</sub> emissions. By 2030, green ammonia production could reach over 3 million metric tons per year thanks to ongoing and planned electrolysis projects [17].

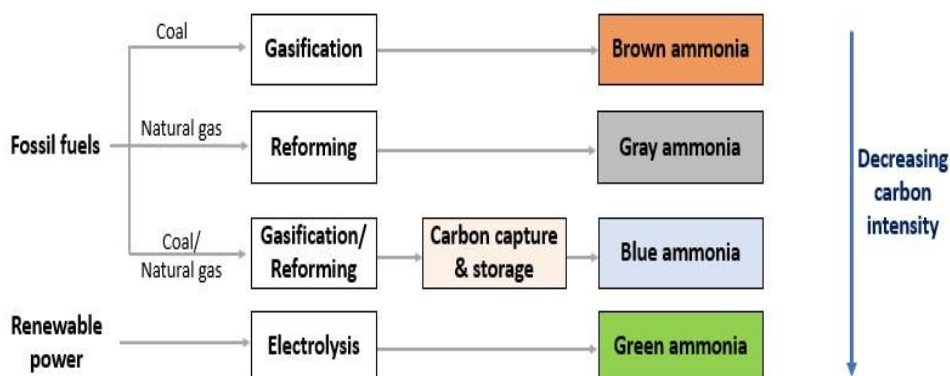


Fig. 2.3. Ammonia production pathways based on carbon intensity [17].

In comparison to other syngas production technologies, natural gas steam reforming which accounts for the largest portion of global production—has generally lower costs, lower CO<sub>2</sub> emissions, and higher energy efficiency. This is because it produces more hydrogen per mole of consumed carbon. However, due to the use of renewable electricity, ammonia synthesis using hydrogen produced from water electrolysis can significantly reduce carbon emissions. On the other hand, this technology's levelized production cost is significantly higher than that of ammonia production utilizing natural gas.

## 2.4 Health and Safety of ammonia

Hazards from ammonia can arise during production, use, and transportation. Farm accidents, unintentional releases at manufacturing facilities, and transportation mishaps can all expose people to ammonia [18]. To reduce the chance of a crisis, a thorough emergency response plan and continual training are essential. Ammonia reacts with the environment to form a hazardous gas.

In humans, ammonia can be fatal in high concentrations, but even at lower exposure levels, the skin, oral cavity, and respiratory system can suffer serious harm. Exposure to ammonia can occur primarily through inhalation, skin contact, and eye contact. Ammonia exposure can result in potentially fatal lung swelling and extreme nasal and throat irritation. Coughing, dyspnea, difficulty breathing, and chest tightness are possible symptoms. Ammonia is an exothermic substance with alkaline corrosiveness that, when concentrated, erodes tissue on contact. Ammonia burns and irritates the skin, eyes, and respiratory system when it is in gas form. Most people believe ammonia to be non-flammable.

Ammonia-related industrial accidents can arise from various situations, such as ruptured seals, over pressurization, and compromised container integrity. They also raise the possibility of product contamination and process disruptions as well as unfavorable off-site effects on neighboring communities. Even though most facilities are built to reduce the possibility of an ammonia leak or release by using proper handling and storage techniques, leaks and accidental releases are still possible. Monitoring tools should be installed to look for indications of gas leaks and take immediate corrective action.

Furthermore, in combustion, the use of ammonia, particularly at high temperatures, may result in the formation of NO<sub>x</sub> because nitrogen is the primary component of the gas. Moreover, since ammonia is a toxic chemical, it is critical to implement the proper hazard management measures to reduce the risk it poses to both people and the environment.

## 2.5 Challenges of Ammonia use in conventional combustion

Internal combustion engines are primarily utilized for transportation and power generation these days. Heavy-duty, marine, and agricultural vehicles frequently use compression ignition (CI) diesel engines because of their high load operation and high efficiency. Nonetheless, GHG emissions like CO<sub>2</sub> are produced by traditional diesel engines. Continuous advancements in diesel engines and after-treatment systems are progressively lowering these emissions. However, burning fossil fuels results in the release of greenhouse gases, mainly CO<sub>2</sub>. Consequently, one way to accomplish this goal could be to use

alternative green fuels like ammonia because it is a carbon free hydrogen carrier containing 30% more volumetric energy than hydrogen. The high ignition energy and temperature, low flame speed, and lower adiabatic flame temperature of ammonia fuel in comparison to diesel fuel present difficulties when utilizing it as an ICE fuel [19].

Moreover, ammonia has a Lower Heat Value (LHV) that is about 60% lower than that of diesel fuel. However, when compared to the stoichiometric mixture of diesel and air, the ammonia/air mixture has nearly the same amount of energy. Compared to conventional hydrocarbon fuels, using ammonia as fuel has disadvantages. For typical hydrocarbon fuels, the maximum laminar burning velocity of an  $\text{NH}_3$ /air flame and the heat of combustion of ammonia are approximately 20% and 40% of each other, respectively [20]. Ammonia also has low flammability, as seen by the  $\text{NH}_3$ /air mixture's smaller flammability range and higher ignition temperature. Because there is less  $\text{CO}_2$  in the products, the ammonia/air flame temperature is lower and the radiation heat transfer from the flame is lower than that of hydrocarbon flames. The high fuel  $\text{NO}_x$  emission of  $\text{NH}_3$ /air combustion presents an additional challenge.

## 2.6 Ammonia application in combustion system

Since the 1940s, attempts have been made to use ammonia as fuel despite the known difficulties involved with this fuel. Ammonia was added to coal gas during World War II, and this mixture powered buses in Belgium and New Orleans that uses reciprocating engine [21]. Far more advanced, using liquid oxygen and ammonia, NASA's X-15 rocket-powered aircraft set a record for the highest manned flight Mach number of 6.7 in the 1960s. Furthermore, a research project by the US Army aimed at creating a gas turbine powered by ammonia was unsuccessful due to the extremely low combustion efficiency [22]. Since then, ammonia has not been sought after as a fuel for combustion systems ; instead, it has been employed in combustion research to look into the chemistry of reduction and the production of  $\text{NO}_x$ . Eventually,  $\text{NO}_x$  is not quite a challenge because it not a final product of the overall reaction of Gibbs free energy of combustion in ammonia which is,

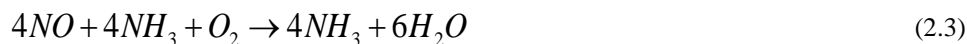


A recent review [23] states that ammonia is mostly used in spark ignition engines (SI) in two different modes : pure ammonia mode and dual fuel mode, where it is blended with other promoter fuels like hydrogen, gasoline, etc. Nevertheless, using pure ammonia in heavy-duty diesel engines necessitates an auto-ignition temperature of 924 K and a high compression ratio (CR) of about 27. Moreover, unburned ammonia by itself may present another difficulty for diesel ammonia dual fuel engines.

## 2.7 Ammonia only operation

The pressing need to decarbonize the world has led to a renewed interest in ammonia during the past few years. Ammonia appears to be the perfect way to lower the world's consumption of fossil fuels and help lower greenhouse gas emissions because it is a fuel that is carbon-free, simple to store, and transport. Remarkably few studies have investigated the feasibility of using spark plug arrays or plasma jet igniters, have been put forth to support neat ammonia as an engine fuel [24]. It was discovered that pure ammonia could be used, mostly at full load, with a sufficiently low cyclic variation [25]. Furthermore, with a stoichiometric air/ $\text{NH}_3$  mixture, no knocking happened at 800 rpm under boosted conditions even with a 14:1 CR. These findings were recently verified in a different contemporary SI engine proposed by Lhuillier [26].

The original standard ignition system with an optimized ignition advance has been used in all studies, except for Mounaïm-Rousselle's [24] study. The higher the part of  $\text{NH}_3$ , the earlier the phasing is compared to TDC. Using HCCI operation, Sandia National Laboratories' Van Blarigan [27] created a free-piston linear generator. The generator was tested using a variety of fuels, one of which being anhydrous ammonia. With efficiencies comparable to those of the hydrogen operation, the ammonia operation displays optimal Otto cycle performance. The author proposed that one of the following reactions could be used to react the exhaust gas and ammonia over a zeolite to eliminate the  $\text{NO}_x$  formation penalty that occurs in ammonia engines.



In a simulation setting, Lee and Song [28] created a premixed-charged combustion strategy with a 35:1 compression ratio and an intake gas temperature appropriate for ammonia combustion, eliminating the need for a secondary fuel. A pilot ammonia injection ( $\phi = 0.1 - 0.3$ ) was incorporated into the PCCI-alike strategy to create a homogeneous lean mixture during the compression stroke. The auto ignition of the lean mixture raises the pressure and temperature inside the cylinder, creating an ideal environment for the primary ammonia spray to burn, which is injected immediately after the combustion begins as shown in Figure 2.4.



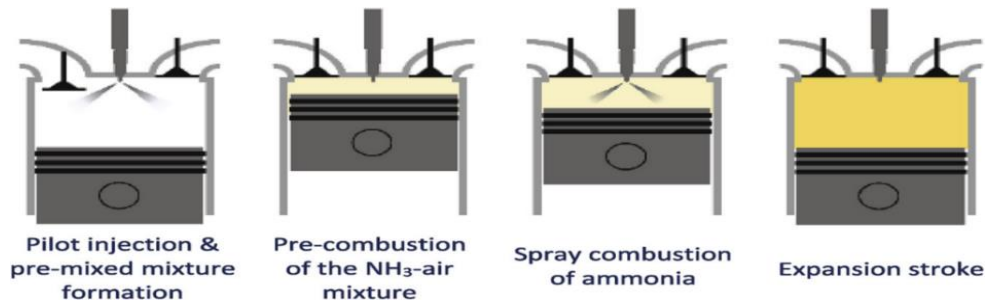


Fig. 2.4. Schematic of the ammonia combustion strategy proposed by Lee [28]

## 2.8 Ammonia Hydrogen operation

Ammonia offers liquefaction at comparatively low atmospheric pressures and temperatures, allowing for easy transportation in an already-existing infrastructure and zero-carbon hydrogen storage. Alternatively, ammonia can be used straight as fuel in gas turbine power plants, avoiding full conversion back to hydrogen. Since it is a relatively non-reactive fuel, it is worthwhile to investigate the possible applications of ammonia/hydrogen blends. The highest load was obtained for a stoichiometric, or even slightly rich, mixture, which was also confirmed for boosted conditions in an existing engine combustion and turbines. The highest efficiency was reached for a lean equivalency ratio. The goal was to determine the minimum volume of  $H_2$  required to ensure engine combustion stability and a higher operating efficiency compared to hydrocarbons.

Valera-Medina et al. [29] conducted preliminary experiments using ammonia/hydrogen at 50/50%, and they discovered that stability was compromised to a very narrow equivalency ratio ( $\phi$ ) range under lean conditions, and  $NO_x$  emissions were prohibitive. These results pave the way for additional testing at equivalence ratios above stoichiometric values, a range where earlier simulations have indicated a decrease in the production of nitrogen oxides. Figure 2.5 above shows schematic design of a swirl burner proposed by Valera-Medina to simulate numerically alongside experimental investigation.

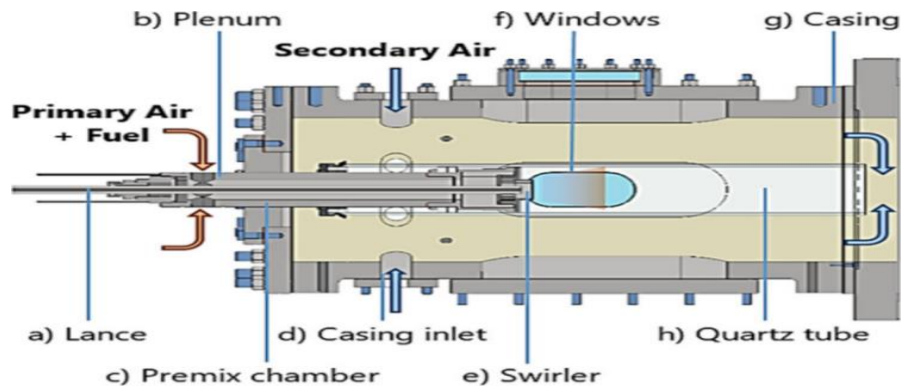


Fig. 2.5. Burner schematic design proposed by Valera-Medina [29]

This study demonstrates that when hydrogen is added using 70% of  $NH_3$  and 30% of  $H_2$  (mol%) blend, ammonia can be used as a fuel in gas turbines with stable combustion operation. The findings demonstrate that OH intensities remain high in rich conditions and that there is an increase in OH consumption at the flame front at high inlet temperatures that are typical of gas turbine operating conditions. Despite its many benefits, ammonia has poor combustion characteristics, a slow rate of combustion, a low ignition limit, and a high ignition energy. The best remedy is to combine hydrogen and ammonia. The combustion characteristics of  $NH_3$  are enhanced by the high burning speed, low ignition energy, and wide ignition limit of hydrogen.

However, hydrogen can be produced by ammonia breakdown in a catalytic reactor, utilizing the benefits of ammonia liquid storage and avoiding the challenging circumstances associated with hydrogen storage and transportation. In addition,  $CH_4$  has been crucial when combined with  $NH_3$ . The current study attempts to investigate the fundamental combustion properties of  $NH_3/H_2$  and  $NH_3/CH_4$  mixed gas fuel, such as the laminar burning velocity, ignition delay period, quenching distance, and combustible limit. Therefore, the purpose of this paper is to present an initial evaluation, based on primary combustion diagnostics such as combustion characteristic, of the suitability of a selected % $NH_3$  plus % $H_2$  (%vol) blend for use within a combustion environment.

## 2.9 Numerical Investigation on Ammonia Combustion

For use in fuel cells and other hydrogen-using applications, ammonia can be readily cracked to release hydrogen. Since it

burns directly and only produces water and nitrogen at low combustion temperatures, it is regarded as a carbon-free green fuel for energy transportation. Mikulčić [30] investigated the chemistry of ammonia combustion numerically in industrially relevant conditions. Following a review of the literature, three ammonia combustion mechanisms, which also involve carbon chemistry were simulated for an experimental premixed swirl burner to assess how well they performed. For catalytic  $\text{NH}_3$  decomposition, Takahashi, and Fujitani [31] built a two-dimensional reactor model based on reaction kinetics and heat and mass transfer. Research was done on reactor designs that reduce the impact of endothermic reactions.

There are several combustion behaviours that need to be clarified on using ammonia in the combustion chamber. As we know ammonia has poor combustion characteristics, a slow rate of combustion, a low ignition limit, and a high ignition energy. Blending with other alternative fuels such as hydrogen or methane will be the changing rule on its characteristic to be the promising future fuel replacing hydrocarbons.

### 2.9.1 Laminar Burning Velocity

Laminar Burning Velocity (LBV) is determined by the combination of a fuel's diffusivity, exothermicity, and reactivity. It is also a key factor in describing flame structures, extinction limits, and stabilization. However, the burning velocity of  $\text{NH}_3$  is usually low around 5 -13 cm/s. This low value has been an obstruction towards using the ammonia as energy devices. Unless ammonia is pairing with  $\text{H}_2$  or  $\text{CH}_4$  as dual fuel blend which has a higher burning velocity will help improving ammonia's laminar burning velocity. Lee et al. [32] investigated the burning velocity and emission characteristics of  $\text{NH}_3$  with  $\text{H}_2$  addition ratio from 0% to 50%. They found that the laminar burning velocity substantially increases with  $\text{H}_2$  addition, and low  $\text{NO}_x$  formation occurs at fuel-rich conditions.

Jin et al [33] conclude that the  $\text{NH}_3/\text{H}_2/\text{air}$  flame's laminar burning velocity rose as temperature and hydrogen ratios increased, but it decreased as pressure increased. The proportion of reactants was the only factor influencing the equivalent ratio of the maximum laminar burning velocity. When  $X_{\text{H}_2} = 0.3$ , the maximum laminar burning velocity's equivalency ratio value ranged from 1.1 to 1.2. At a high hydrogen ratio, pressure and temperature significantly affected the laminar burning velocity of premixed flame.

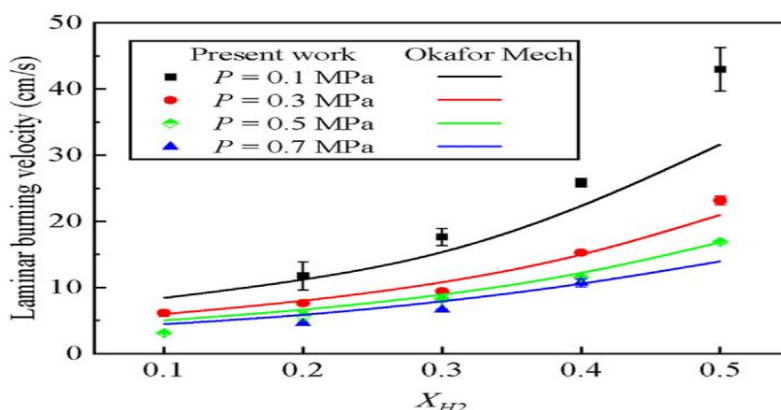


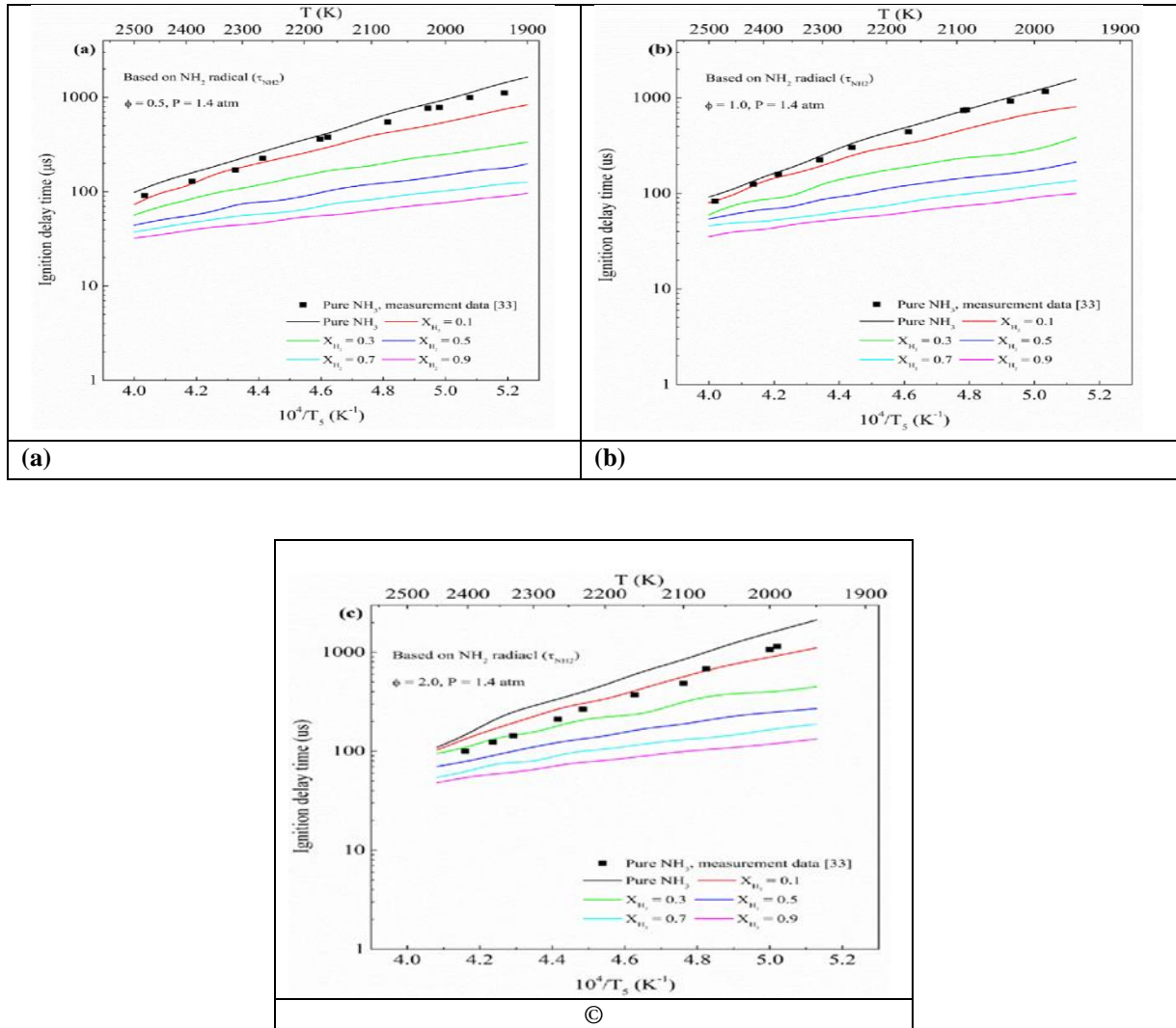
Fig. 2.6. Example Laminar Burning Velocities as a Function of  $X_{\text{H}_2}$  Mixtures in Experimental Work from Jin [33]

### 2.9.2 Ignition Delay Times

For fuel combustion in useful energy devices, ignition delay time is another important characteristic. The development of chemical kinetics relies heavily on this important validation parameter. In practical energy devices, the ignition of fuel is directly determined by the ignition delay time. In a typical shock tube measurement facility, fuel ignition is acknowledged as a zero-dimensional and homogeneous process. The high  $\text{NH}_3$  ignition temperature and energy restrict the use of  $\text{NH}_3$  as a fuel that is practical for combustion.

Li J et al [34] indicates that under all tested conditions, the addition of  $\text{H}_2$  significantly reduces the ignition delay time of  $\text{NH}_3$ . Specifically, the reduction in ignition delay time at a high temperature (1950 K) is 93.2% at  $\phi$  of 0.5 and rises to 93.6% and 93.7% at  $\phi$  of 1.0 and 2.0, respectively. This is shown in Figure 2-7. When  $\phi$  rises from 0.5 to 2.0 for pure  $\text{NH}_3$  mixture, only a small effect is seen. A change in  $\phi$  indicates the effect at high  $X_{\text{H}_2}$ . This result suggests that there is a strong  $X_{\text{H}_2}$  dependence for  $\text{NH}_3$  ignition upon  $\phi$ .  $\text{NH}_3$  ignition is closely related to the  $\text{H}_2$  addition ratio, pressure, and equivalence ratio.

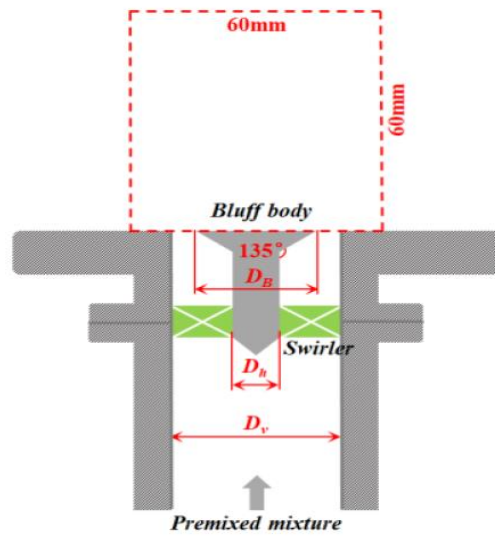
At all equivalency ratios, the reduction ratio of the ignition delay time decreases with rising pressure but increases with an increase in the  $\text{H}_2$  addition ratio. The reduction at high pressure is comparable to that at low pressure and exhibits negligible pressure-dependent effects under fuel-lean and stoichiometric conditions. The pressure-dependent effects on the ignition delay time increase with fuel concentration. The study concludes that pressure and  $\text{H}_2$  addition ratio increases can significantly reduce  $\text{NH}_3$  mixtures' ignition delay times and encourage  $\text{NH}_3$  ignition.



**Fig. 2.7.** Effect of H<sub>2</sub> addition on ignition delay times for NH<sub>3</sub>-O<sub>2</sub> mixture diluted in 99% at various equivalence ratios: (a)  $\phi = 0.5$ ; (b)  $\phi = 1.0$ ; (c)  $\phi = 2.0$  [34]

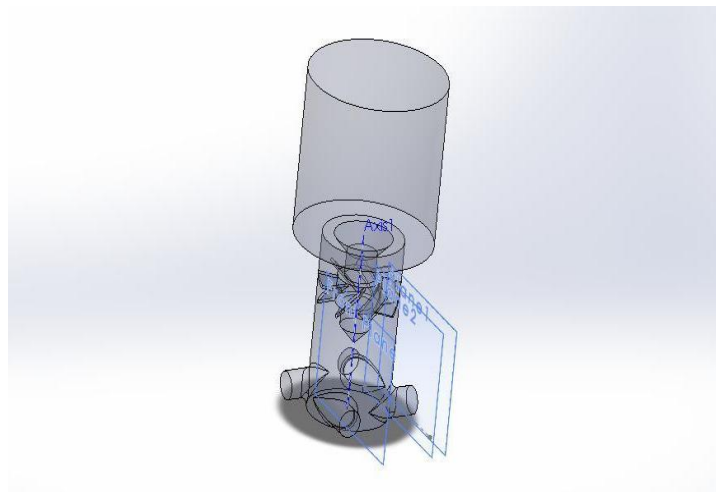
### 3 Methodology

The burner that has been developed is a swirl and bluff body stabilized burner using Solidwork software as a main tool for design. The configuration is based on previous research that has proposed a swirl bluff body, which gives the idea of creating a suitable design for complete combustion. One of ammonia's chemical properties is corrosive, which is believed to do damage to the system when an unburned ammonia mixture is left inside the combustion chamber. Figure 3.1 shows the first idea of burner design. The design consists of three main parts, the bottom body casing, the swirler, and the bluff body combustion.



**Fig. 3.1.** First Swirl with bluff body burner design

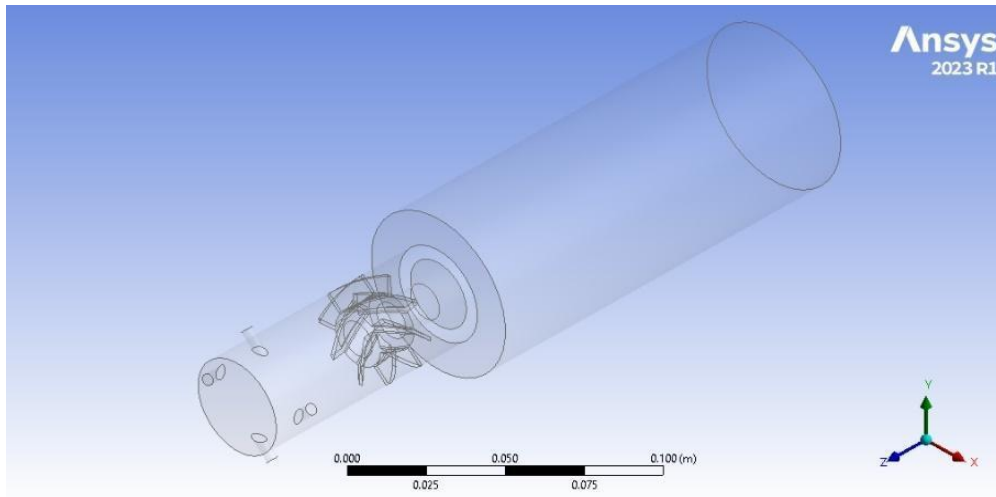
All the parts are assembled as shown in Figure 3.2. However, the simulation that will be done after this is based on the spatial intonation of the body that is affected only. So, modifications have been made to the model to overcome this matter until it was finalized including altering the four inlets at the bottom casing of the model after it has been finalized to use for simulation in the Ansys Fluent.



**Figure 3.2.** Complete Model of Swirl and Bluff body Stabilized Burner

### 3.1 Modification and Boundary Setup

A modification has been made to the model to give a better analysis result in Ansys Software. The initial model has a longer bluff body and is short at the outlet of the combustion zone. The model has been modified to a shorter bluff body and a longer outlet to give a better view of activity on the flame characteristics. For the modified model, the dimension of the outlet has been extended up to 150mm and the length of the bluff body is decreased from 54 mm (initial) to 30 mm (modified) to predict the resulting outcome of the temperature, velocity magnitude, mass fraction of OH and NO as shown in Figure 3.3.

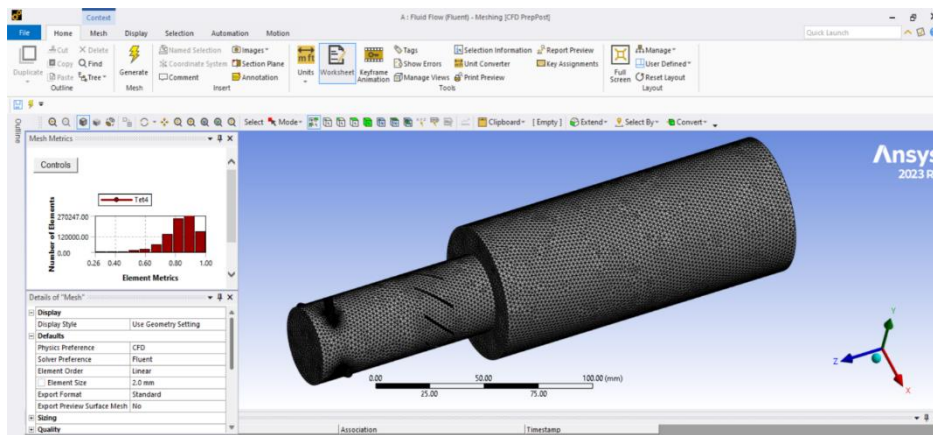


**Fig. 3.3.** The modified model of the swirl burner of geometry setup in Ansys

The first stage in setting up a simulation in Ansys Fluent is geometry. The model can be imported from a SolidWorks assembly file to generate the geometry. At this point, the swirler and bluff body will subtract by establishing the boolean setup, and the outer wall will be defined as fluid. Two boolean settings must be made in the Ansys program because it consists of two components. It has three pieces of geometry at first, but the boolean setup will combine the three into one.

### 3.2 Meshing

The second stage of the simulation is called mesh. A crucial step in the preparation procedure before launching a simulation is meshing. To obtain acceptable geometry mesh quality and reliable simulation results, the meshing size needs to be regulated. The total nodes and elements of the mesh of the model are 169899 and 878992, respectively. The element sizing of the mesh for the model is set to 2.0mm. The skewness and the mesh result are shown in Figure 3.4 below.



**Fig. 3.4.** Meshing of modified model in ANSYS software.

The numerical setup and general solver setup that are set for the simulation include the type of turbulence model, combustion models, inlet velocity, Material, cell zone condition and wall motion are shown in Table 3.2

**Table 0.1.** Summary table for numerical setup simulation.

<b>Solver type</b>	<b>Pressure-Based</b>
Velocity formulation	Absolute
Time solver	Transient
Viscous model	Large eddy simulation (Smagorinsky Lily-Model)
Species Combustion model	Partial premixed combustion (NOx model activated)
Material	Ammonia, Hydrogen, Methane and Air
No. of Inlets	5 inlets including primary air inlets
Inlet velocity, u (m/s)	30
Cell zone condition	Fluid
Wall motion	Stationary wall

### 3.3 Simulation Condition

In this simulation study, we used the table below as a boundary condition. Pure ammonia and several mixtures of gasses will be investigated for their combustion behavior characteristics which are ignition delay period, laminar burning velocity, quenching distance, and combustible limit under various variables such as mixture composition and equivalence ratio. Table 3.4 shows various gas mixtures and pure ammonia that will be studied under several compositions. Table 3.5 is ration of mol percentage and specific fuel for boundary condition.

**Table 3.4.** Percentage (% mol) of  $\text{NH}_3/\text{H}_2$  and  $\text{NH}_3/\text{CH}_4$

Mixture	$\text{NH}_3$	$\text{H}_2$	$\text{CH}_4$
Mixture 1	100%	-	-
Mixture 2	75%	25%	-
Mixture 3	50%	50%	-
Mixture 4	75%	-	25%
Mixture 5	50%	-	50%

**Table 3.5.** Ratio of Mol percentage and species fuel for boundary condition.

Operating pressure	1 atm	
Oxidiser (Mol %)	$\text{O}_2$	21%
	$\text{N}_2$	79%
Fuel (Mol %)	$\text{NH}_3$	100%, 75% and 25%
	$\text{H}_2$	75% and 25%
	$\text{CH}_4$	75% and 25%
Ambient Temperature	300K	

Recap on the problems faced by Geodesy 2 students on implementing instrument calibration site far from PKS and at the same time exercise actual surveying practice, study has come out with the invention of Short EDM Baseline Test Site for Survey Grade Receiver prototype.

Series of observations using GNSS technique that have taken place successfully shown that using this developed prototype is reliable. The observation period which took place for two (2) days in three (3) different sessions had indicated that the result differences obtained were less than 10mm. Obviously, it signifies reliability and consistency of the collected data. Besides, through the observation processes with 50 respondents of students taking subject Geodesy 2, it was recorded that time, cost and energy were less consumed whilst producing accurate and reliable calibration results besides indirectly improve students' psychomotor skills.

Overall, it was found that the provision of this short EDM baseline test greatly benefits students. Students do not need to waste a long time and spend certain cost for the calibration work. Adding more, students can instil and absorb positive work ethics and can have practical work satisfaction. In terms of organization, this study can also be used as a collaboration prototype with external parties in terms of expert services and negotiation advice. This wraps that Short EDM Baseline Test Site for Survey Grade Receiver prototype has successfully benefits both the students and lecturers in their calibration test practical work. For future recommendations based upon this study is to conduct GNSS observation at this short EDM baseline test using CORS system developed by the Land and Survey Department, Sarawak to compare the accuracy.

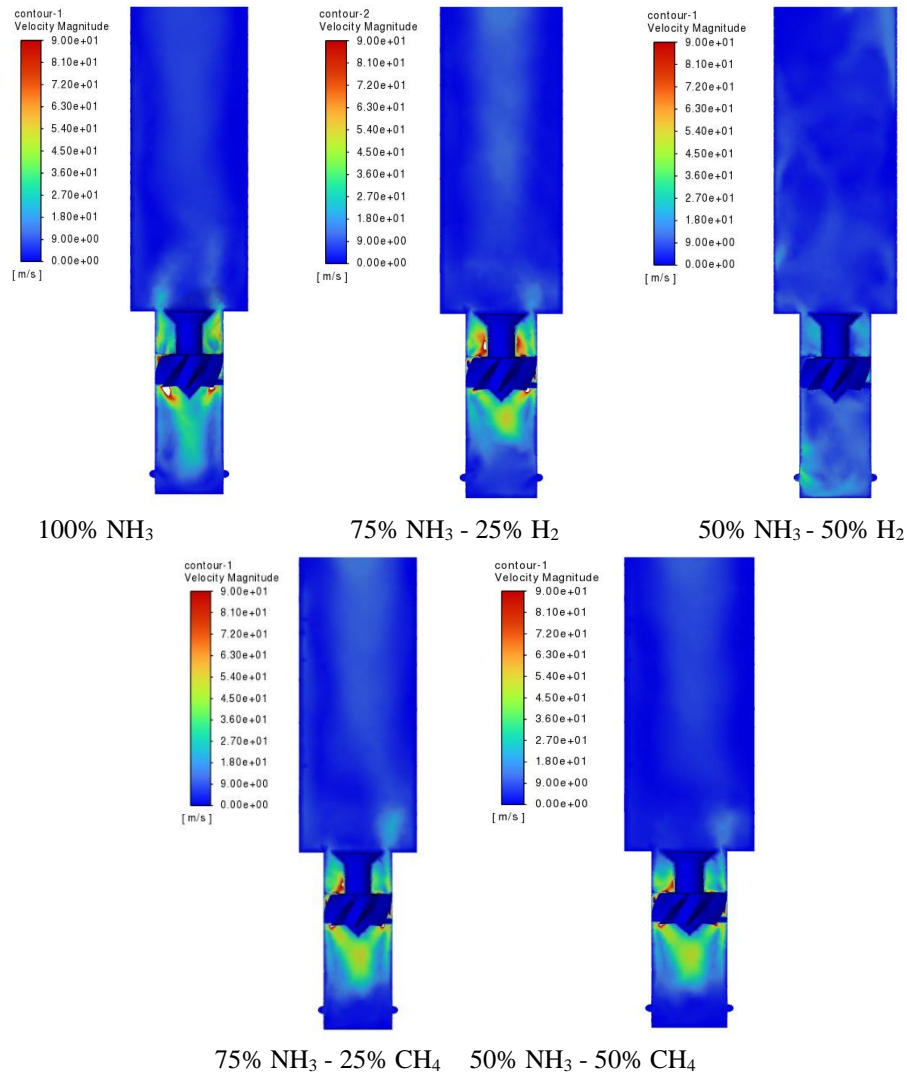
### 4 Result and discussion

For the simulation process, the species fuel that is used for premixed combustion is ammonia, hydrogen, and methane. The comparison between the mixture of ammonia with hydrogen and ammonia with methane were analyzed to choose which mix gives a better solution in the percentage of mol and equivalence ratio. The solutions were discussed in another subchapter compared to previous research.



#### 4.1 Velocity magnitude contour results for 5 mixtures at $\phi = 0.56$

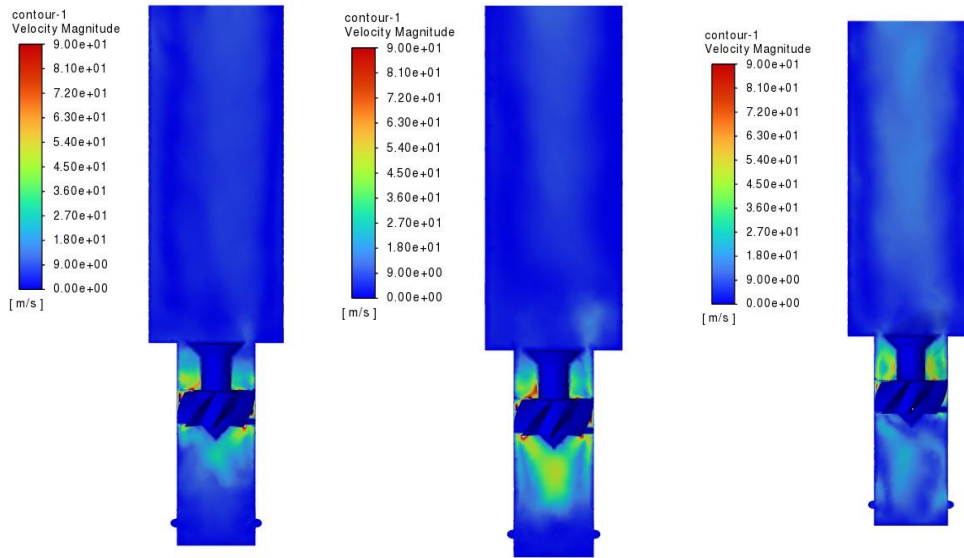
The contour plot is utilized in this study to visualize the swirl chamber's fluid flow velocity. Plotting is done from the X-axis looking at the YZ-plane. In order to obtain the magnitude velocity result for each of the five fuels % compositions, up to or more than 1000 iterations of the solution simulation are required. Five different setup mixtures have their inlet velocity set at 30 m/s to determine the velocity magnitude distribution inside the swirl chamber. Each different species fuel composition will affect the magnitude velocity distribution due to stoichiometric ratio of the fuel with the oxidiser and the rate of reaction kinetic of the fuel. The equivalence ratio is set to 0.56. The velocity magnitude contour of the five setups is as shown Figure 4.2 below.



**Fig. 4.1.** Velocity Magnitude for Five Different Mixtures at equivalence ratio 0.56

#### 4.2 Velocity magnitude for 3 mixtures of Ammonia/Hydrogen at $\phi = 1.0$

Using the same framework of setup in fluent, variables for the equivalence ratio have been changed to  $\phi = 1.0$  to visualize the difference when the equivalence ratio is increased. The figure below shows the result of the velocity magnitude of 3 different mixtures of ammonia/hydrogen in equivalence ratio  $\phi = 1.0$ .



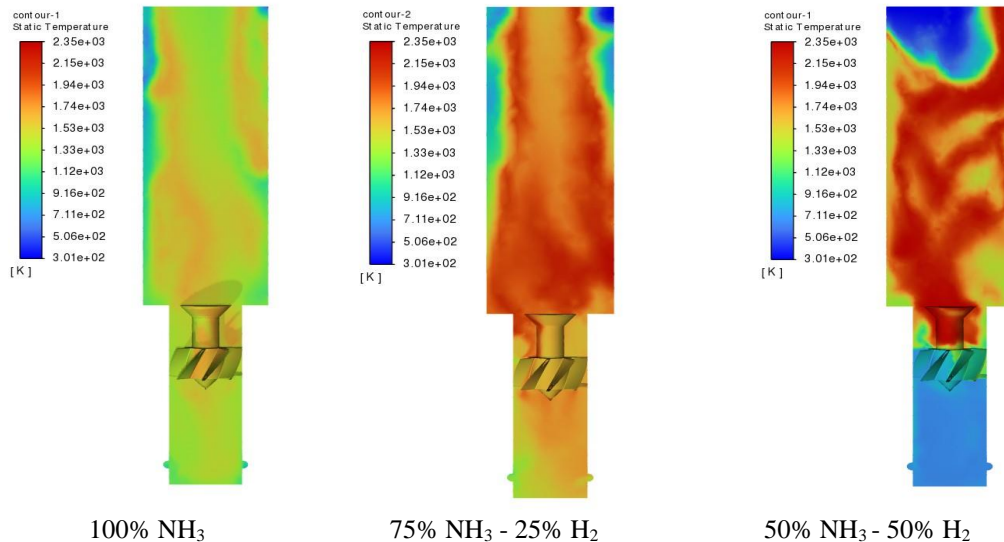
**Fig. 4.2.** Velocity Magnitude for 3 Ammonia/Hydrogen Mixtures at equivalence ratio  $\phi = 1$

The velocity magnitude in the combustion zone represents how much quantities of species are moving without considering their direction. On the other hand, the rules of velocity magnitude depend on the inlet velocity which is 30m/s, and the swirler that gives them turbulence

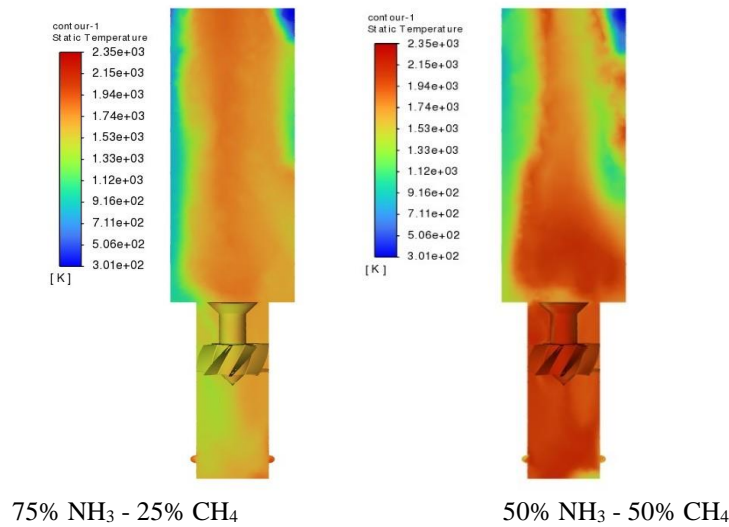
The general good agreement indicates that additional flow dynamics investigation is feasible. Four inlet flows define the swirling flow of the swirler which has uniform flow along its azimuthal direction. All the mixtures that had been studied showed the effect of decreasing in velocity magnitude when the equivalence ratio is increased and with the addition of hydrogen or methane to the ammonia at the first stage.

#### 4.3 Temperature contour results for 5 different mixtures at $\phi = 0.56$

To ascertain the temperature contour distribution and the flame structure within the swirl chamber, five distinct setup mixtures were maintained at a constant ambient temperature of 300 K. The temperature distribution will be impacted by the fuel composition of each distinct species because of the fuel's energy content and flame characteristics. The combustion process releases more heat energy the higher the energy content released, which raises the temperature in the combustion zone. The five sets' temperature contour distributions are depicted in the figures below



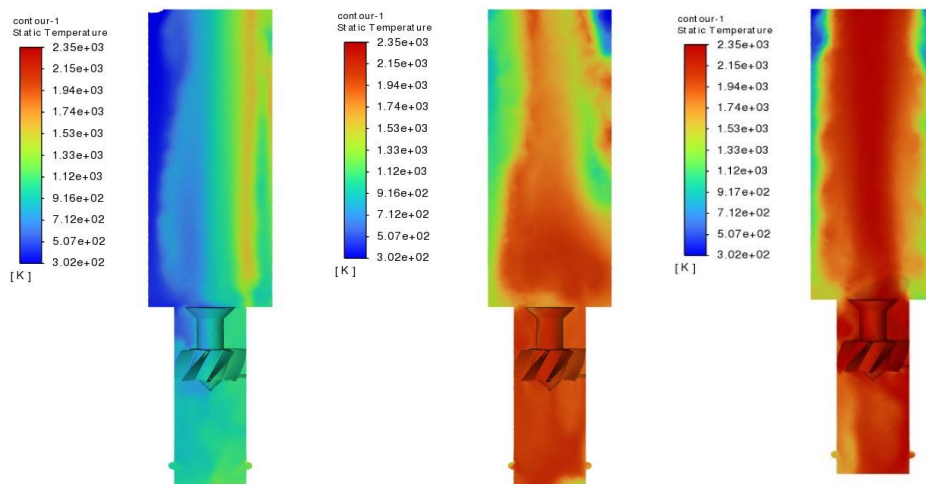




**Fig. 4.3.** Static Temperature for Five Different Mixtures at equivalence ratio 0.56.

#### 4.4 Temperature contour for 3 mixtures of Ammonia/Hydrogen at $\phi = 1.0$

Although ammonia is not combustible, it can catch fire at 924.26K when its vapor concentration is between 15% and 28%. It is also discovered that the distribution of global temperatures is significantly impacted by hydrogen content. The global temperature rises from roughly 1700 K to 2300 K when it increases in hydrogen from 0.25 to 0.5. We see that  $\phi$  has a co-effect on the static temperature, particularly when the hydrogen concentration is large, which corresponds to an increase in  $\phi$  from 0.56 to 1.0. Although the static temperature is slightly lower than the hydrogen content of ammonia, the same effect is seen at methane contents of 0.25 and 0.5.

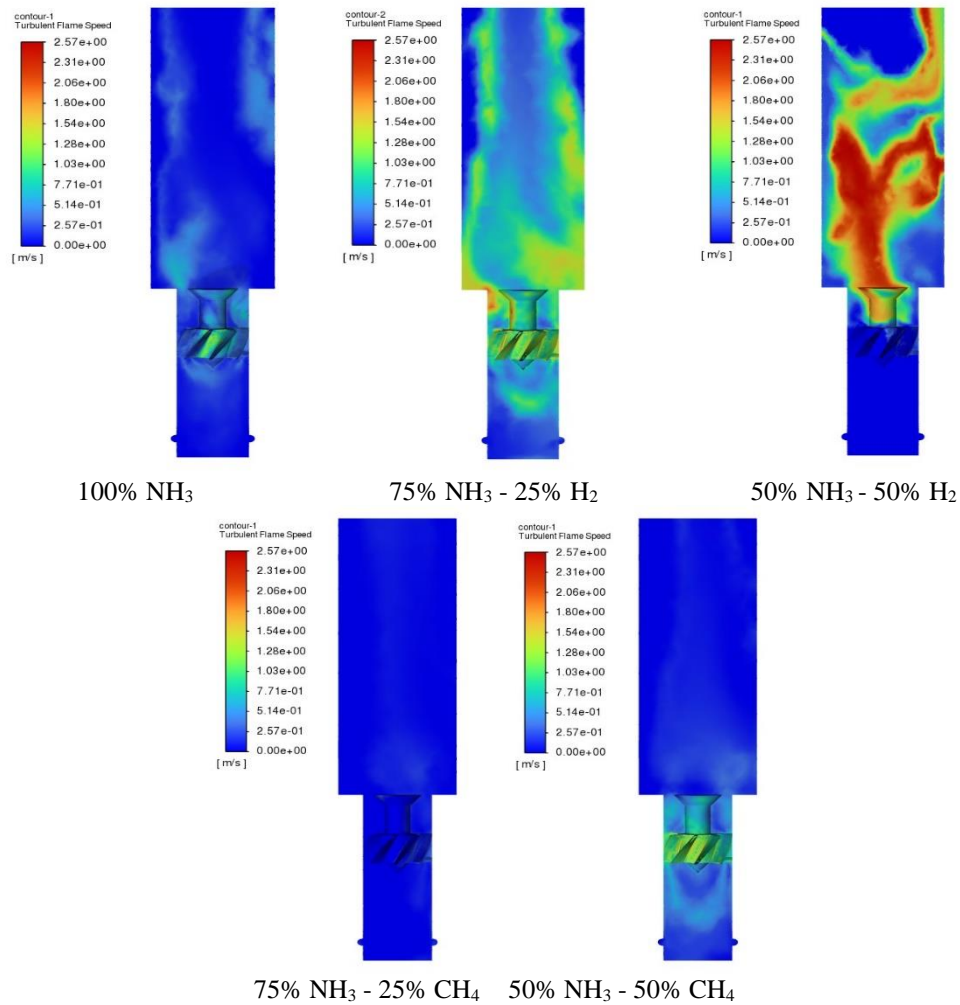


**Fig. 4.4.** Static Temperature for 3 Ammonia/Hydrogen Mixtures at equivalence ratio  $\phi = 1.0$

From the contour, we can visualize that at pressure 1 Mpa and temperature above 1600K can promote ignition to ammonia. The slight addition of hydrogen or methane and increasing the equivalence ratio can reduce ignition delay times boosting ignition enhancement.

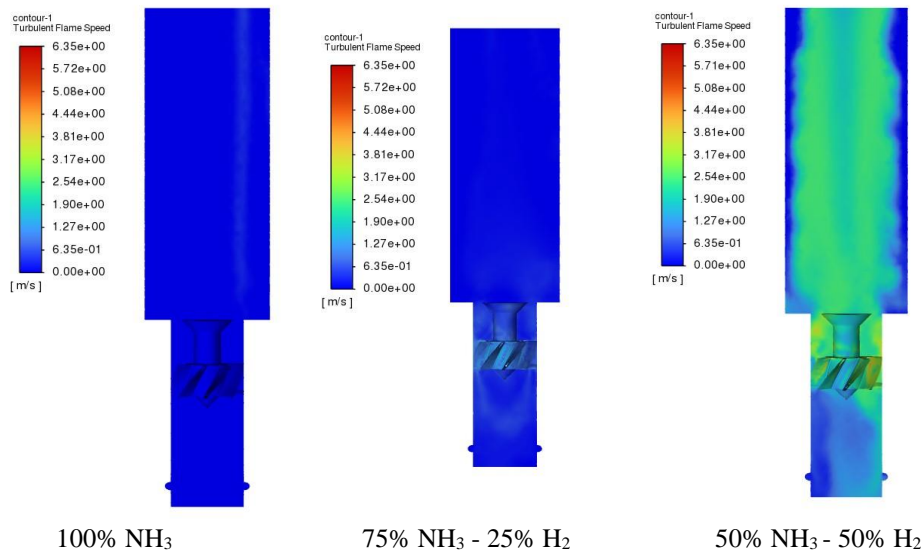
#### 4.5 Turbulence Flame Speed results for 5 different setup mixture

Five alternative turbulence flame speed simulations were run with varying fuel mixture percentages for each species. The simulation's boundary conditions and the fuel species' characteristics determine the turbulence flame speed. The contour distribution simulation for each example is displayed in Figure 4.6 below.



**Fig. 4.5.** Turbulence Flame Speed for Five Different Mixtures at equivalence ratio 0.56.

#### 4.6 Turbulence Flame Speed for a mix of Ammonia/Hydrogen at $\phi = 1.0$



**Fig. 4.6.** Turbulence Flame Speed for 3 Ammonia/Hydrogen Mixtures at equivalence ratio  $\phi = 1$

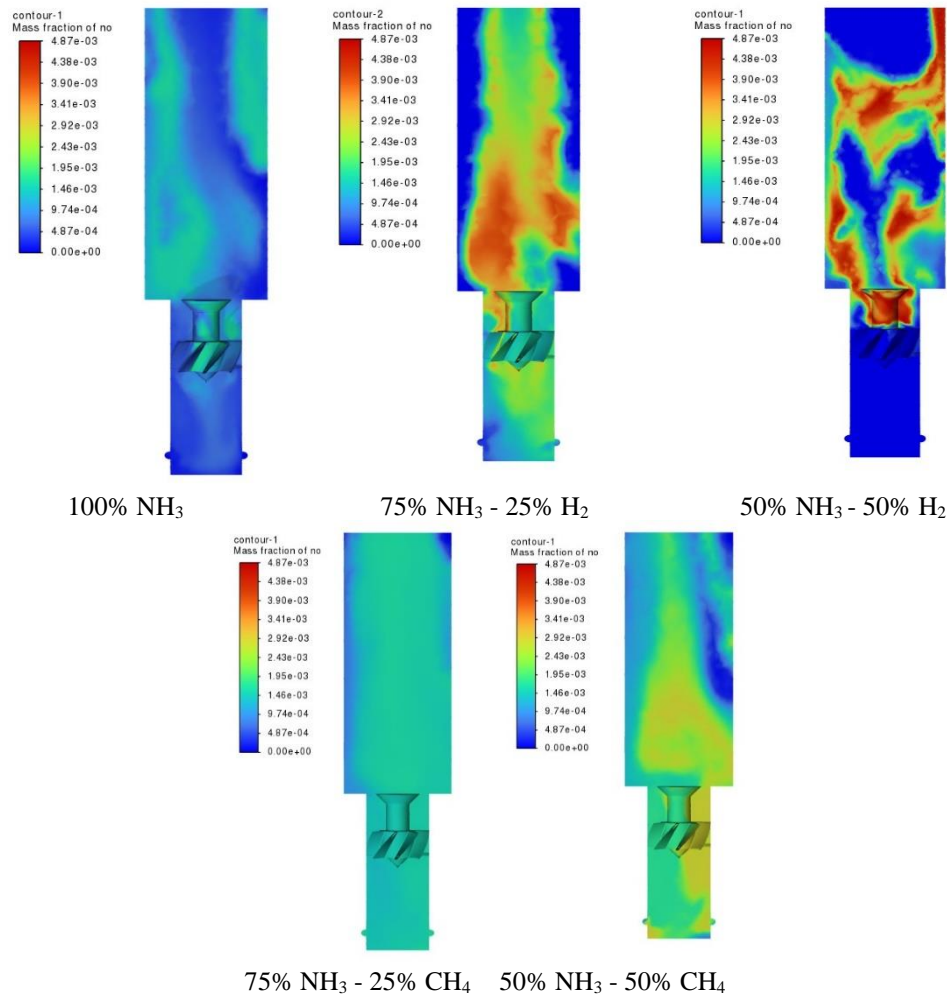
Turbulence flame speed (TFS) in combustion typically characterizes turbulence intensity and the integral length scale which refers to Large Eddies leads the flame surface to wrinkle, changing the flame structure, increasing local reactant transport, and enlarging the flame. The mixture's reactivity was increased and turbulent combustion was improved by the addition of H<sub>2</sub> better than CH<sub>4</sub> which shows less wrinkle. Specifically, with lean mixtures, the flame surface exhibits more wrinkly

structures than with stoichiometric and rich mixtures. The combination of turbulence and thermal diffusion instability can explain why a more wrinkled flame surface resulted in a lower effective Large Eddy, while the lean instance had the highest TFS. It also increases with the increment of static temperature.

In high-turbulence situations, fuel-lean flames are more sustained than fuel-rich ones. The Lewis number ( $Le$ ), which is less than unity, explains this, and the diffusional-thermal instability may encourage the local burning velocity. Conversely, when  $Le > 1$ , the local burning velocity of the fuel-rich  $NH_3$ /air mixture does not rise, resulting in a low extinction limit which explains why  $H_2$  is more suitable than  $CH_4$  as a blend partner to ammonia.

#### 4.7 Mass Fraction of pollutant NO for 5 different setup mixtures

Five alternative mass fractions of pollutant NO simulations were run with varying fuel mixture percentages for each species. The simulation's boundary conditions and the fuel will be initialized to verify the mass fraction of NO. The contour distribution simulation for each example is displayed in Figure 4.8 below.

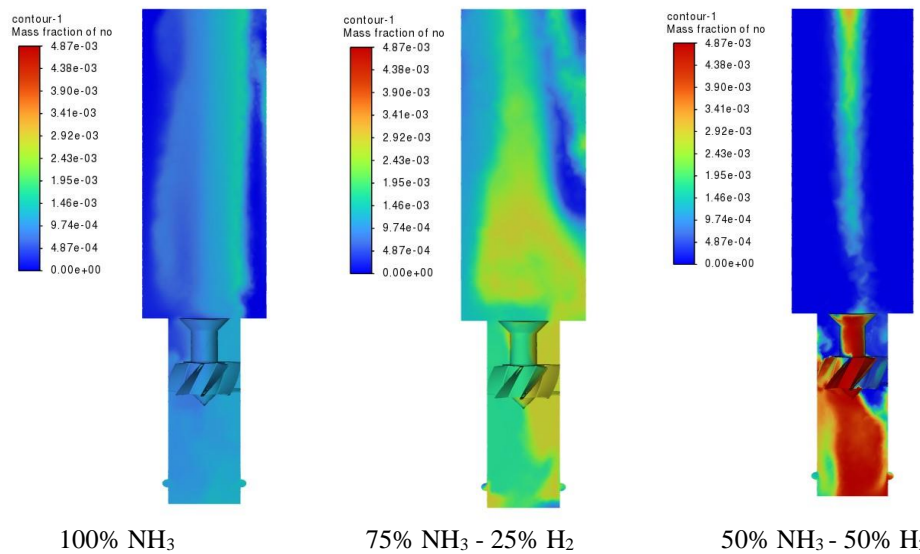


**Fig. 4.7.** Mass Fraction of Pollutant NO for Five Different Mixtures at equivalence ratio 0.56.

The result of simulation of mass fraction of pollutant NO from 100% of  $NH_3$  at  $\phi = 1.0$  is stated as  $1.087142e-7$  and the mixture of 75% of  $NH_3$  and 25% of  $H_2$  gives the result of  $3.769831e-3$ . While the other mixture of 50% of  $NH_3$  and 50% of  $H_2$  gives the maximum mass fraction of pollutant NO for  $4.791628e-3$ . It shows that NO increases when mass of hydrogen and equivalence ratio increases.

#### 4.8 Mass Fraction of Pollutant NO for 3 Ammonia/Hydrogen Mixtures at equivalence ratio $\phi = 1$

The figure below shows the result of ammonia mixtures at 100, 50, and 25% with hydrogen at an equivalence ratio of 1.0.



**Fig. 4.8.** Mass Fraction of Pollutant NO for 3 Ammonia/Hydrogen Mixtures at equivalence ratio  $\phi = 1$

The two main mechanisms through which NO<sub>x</sub> is formed during ammonia combustion are fuel NO<sub>x</sub> and thermal NO<sub>x</sub>. The oxidation of nitrogen atoms in ammonia produces fuel NO<sub>x</sub>, but temperatures above 1800 K cause atmospheric nitrogen (N<sub>2</sub>) to oxidize into NO<sub>x</sub>, which produces thermal NO<sub>x</sub>. The 100% of NH<sub>3</sub> mixtures contribute less NO, without blending with hydrogen or methane. The design of swirl and bluff body stabilized burner, investigation of NH<sub>3</sub>/H<sub>2</sub> swirling turbulent flames under fuel-lean and fuel-rich at  $\Phi = 0.56$  and  $\Phi = 1.0$  conditions, respectively, will have the production and reburn routes of fuel NO<sub>x</sub>. In this case, all the result maintains an ultra-low of pollutant NO but the lowest of hydrogen addition is 75% of NH<sub>3</sub> and 25% of H<sub>2</sub> at an equivalence ratio,  $\phi = 0.56$ .

NH<sub>3</sub> reacts with OH to produce NH<sub>2</sub> and NH radicals, a process that occurs in both lean and rich burns. The main source of NO in ammonia fires, hydroxyl (HNO), is created when these radicals combine with O radicals. Furthermore, the generated NO combines with NH radicals to form N<sub>2</sub>O, which can then be transformed into N<sub>2</sub> by a third-body reaction: N<sub>2</sub>O(+M) ← N<sub>2</sub>+O(+M). The chain branching reaction NH<sub>2</sub>+NO←NNH+OH and the terminating reaction NH<sub>2</sub>+NO←N<sub>2</sub>+H<sub>2</sub>O are two more significant routes for NO reduction.

## 5 Discussion

Due to its high volumetric energy density and ease of distribution and storage, ammonia has garnered fresh interest in the energy sector as a potential renewable energy carrier. The concept of using ammonia as fuel dates back to the early 20th century, and might be challenging to identify its original use because of its many variations over time. Table 4.1 below shows the result of values in different contours that is simulated for the study in Ansys Fluent. This subsection will be pointing on the objective of this research based on the result from the simulation. The investigation is projected on influencing factors and changing rules that can be negotiated on using ammonia freely although the formation of NO in ammonia combustion is way more dangerous than CO<sub>2</sub>.

**Table 0.2** Result of Min and Max value in different contours of 5 mixtures on Ansys Fluent Simulation

Mixtures	Factors/contour	$\phi = 0.56$		$\phi = 1.0$	
		Min	Max	Min	Max
100% NH <sub>3</sub>	Velocity magnitude	0	166.4561	0	97.3421
	Static temperature	303.512	1693.545	301.323	1761.442
	Turbulence flame speed	1.0745e-4	2.28354	2.7345e-4	0.545287
	Pollutant of NO	0	4.0345e-8	0	1.0872e-7
75% NH <sub>3</sub> 25% H <sub>2</sub>	Velocity magnitude	0	168.3212	0	140.7613
	Static temperature	300.00	2285.232	305.7421	2183.491
	Turbulence flame speed	1.41e-4	1.601957	1.5746e-4	1.548832
	Pollutant of NO	0	1.89e-4	6.7773e-8	3.7698e-3
50% NH <sub>3</sub> 50% H <sub>2</sub>	Velocity magnitude	0	154.4496	0	112.5806
	Static temperature	302.00	2354.432	303.1469	2343.514

	Turbulence flame speed	2.01e-4	2.57013	3.0101e-4	2.509478
	Pollutant of NO	0	4.04e-4	1.3516e-8	4.7916e-3
75% NH <sub>3</sub> 25% CH <sub>4</sub>	Velocity magnitude	0	81.38327	-	-
	Static temperature	306.5383	2123.531	-	-
	Turbulence flame speed	7.0839e-5	0.403579	-	-
	Pollutant of NO	0	4.2731e-5	-	-
50% NH <sub>3</sub> 50% CH <sub>4</sub>	Velocity magnitude	0	145.1574	-	-
	Static temperature	303.8394	2188.765	-	-
	Turbulence flame speed	3.7319e-4	1.058341	-	-
	Pollutant of NO	9.6622e-8	3.2527e-3	-	-

Studying the reaction processes of ammonia-premixed flames requires knowledge of thermodynamics, chemical kinetics, and species transport, all of which are covered in great detail in the LBV. The speed of flame propagation is typically faster for fuels with higher LBV values. LBV is defined by the following equation:

$$v = \sqrt{\alpha w / \rho}$$

Where,  $\alpha$  = thermal diffusivity (cm<sup>2</sup>/s),  $w$  = empirical rate of the reactant mixture conversion and  $\rho$  = density of the combustion mixture (g/cm<sup>3</sup>).

In this case, LBV has a connection on Turbulent Flame Speed from the contour showing that the propagation of flame in turbulence flame speed improved its laminar burning velocity. The flames in the combustion zone become large because of the wrinkle and stretching in turbulence influenced by swirler and the inlets position in the design. The other factor improving LBV is density, which small density causes higher LBV which depends on the proportion of ammonia/hydrogen and ammonia/methane blends. It is obvious that hydrogen is lighter than methane in terms of density. But in other terms of diffusivity, the highest LBV is not the best case scenario because it will lead to extinction limits and decrease the flame stability. Increasing equivalence ratio and temperature rise significantly under lean mixture is a good option to increase the flame stability and decreased flame extinction limits but will lead to another problem, which is the formation of NO. The prior-ignition duration of a homogenous mixture under specific pressure and temperature circumstances is identical to the ignition delay time, which is a crucial measure for assessing fuel combustion performance. The ignition delay is a crucial indicator of fuel reactivity and combustion reaction, much like other fundamental aspects of combustion. It is widely utilized in the development of chemical kinetic mechanisms and the prediction of famous behaviors under specific conditions. Ammonia has a higher ignition temperature and ignition energy than common hydrocarbon fuels (such as gasoline, diesel, methane, etc.), which presents difficulties for real-world applications.

This research is investigating its combustion properties from the contour of simulation using static temperature and the variable of equivalence ratios and addition of hydrogen or methane increment proposition. Ignition delay period will be decreased proportionally when temperature and equivalence ratio is increased. In terms of hydrogen versus methane, hydrogen seems to have better results than methane addition because the static temperature is slightly higher than the static temperature of methane. Furthermore, the research has demonstrated that variables like temperature, pressure, and equivalence ratios also have an impact on the quantitative degree to which hydrogen promotes ignite. For example, the presence of hydrogen was found to be more effective in reducing mixture ignition delay times at high temperatures; this is thought to be related to the various fuel ignition chemistries that predominate at high and medium low temperature ranges. For the result, 25% of hydrogen to ammonia will usually boost up the ignition delay period of ammonia which is high in pure species.

## 6 Conclusion

A Numerical simulation is performed by using ANSYS Fluent to determine the basic combustion properties of ammonia/hydrogen and methane mixes using 3D a swirl and bluff-body stabilized burner model. The model is based on experimental work done by previous researchers. Five different fuel mixtures have been analyzed which are ammonia with 0, 25, and 50% hydrogen and ammonia with 25 and 50% methane. The analysis is based on four graphical contours which are velocity magnitude, static temperature, turbulence flame speed, and mass fraction of pollutant NO.

The basic combustion properties of NH<sub>3</sub>/H<sub>2</sub> and NH<sub>3</sub>/CH<sub>4</sub> mixed gas fuels which are the laminar burning velocity, ignition delay period, quenching distance, and combustible limit have been investigated. LBV has a connection to Turbulent Flame Speed from the contour showing that the propagation of flame in turbulence flame speed improved its laminar burning velocity. The flames in the combustion zone stretch because of the wrinkle and by swirler and the inlets at 30m/s. Small density causes higher LBV which depends on the proportion of ammonia/hydrogen and ammonia/methane blends which is

hydrogen is lighter than methane in terms of density. But in other terms of diffusivity, the highest LBV will lead to extinction limits and decrease the flame stability. Increasing the equivalence ratio and temperature rise significantly under a lean mixture is a good option to increase the flame stability and decrease flame extinction limits but will lead to another problem, which is the formation of NO.

The ignition delay period will be decreased proportionally when the temperature and equivalence ratio is increased. In terms of hydrogen versus methane, hydrogen seems to have better results than methane addition because the static temperature is slightly higher than the static temperature of methane. The thickness of the quenching layer, consequently, has a major influence on emissions of unburned species. The addition of hydrogen at 50% has better turbulence flame speed contour and then the addition of 50% of methane which is 2.57013m/s and 1.058341m/s. It is show that methane has a longer quenching distance that causes turbulence flame speed decreases rapidly and more heat loss than hydrogen addition. The design of swirl and bluff body stabilized burner, investigation of NH<sub>3</sub>/H<sub>2</sub> swirling turbulent flames under fuel-lean and fuel-rich at  $\Phi = 0.56$  and  $\Phi = 1.0$  conditions, respectively, will have the production and reburn routes of fuel NO<sub>x</sub>. In this case, all the result maintains an ultra-low of pollutant NO but the lowest of hydrogen addition is 75% of NH<sub>3</sub> and 25% of H<sub>2</sub> at an equivalence ratio,  $\phi = 0.56$ .

## References

1. Aziz, M., Wijayanta, A. T., & Nandiyanto, A. B. D. (2020). Ammonia as effective hydrogen storage: A review on production, storage and utilization. *Energies*, 13(12), 3062.
2. MacFarlane, D. R., Cherepanov, P. V., Choi, J., Suryanto, B. H., Hodgetts, R. Y., Bakker, J. M., ... & Simonov, A. N. (2020). A roadmap to the ammonia economy. *Joule*, 4(6), 1186-1205.
3. Khademi, M. H., & Lotfi-Varnoosfaderani, M. (2021). Sustainable ammonia production from steam reforming of biomass-derived glycerol in a heat-integrated intensified process: Modeling and feasibility study. *Journal of Cleaner Production*, 324, 129241.
4. Bragge, H., & Chantongjaroen, C. (2021). The future fuels of marine engines.
5. Sahito, M. S., Soomro, S. A., & Abro, M. Investigation of combustion behavior of ammonia with hydrogen and methane through numerical simulations.
6. Kobayashi, H., Hayakawa, A., Somarathne, K. K. A., & Okafor, E. C. (2019). Science and technology of ammonia combustion. *Proceedings of the Combustion Institute*, 37(1), 109-133.
7. Jithin, E. V., Raghuram, G. K. S., Keshavamurthy, T. V., Velamati, R. K., Prathap, C., & Varghese, R. J. (2021). A review on fundamental combustion characteristics of syngas mixtures and feasibility in combustion devices. *Renewable and Sustainable Energy Reviews*, 146, 111178.
8. Aldhaidhawi, M., Chiriac, R., & Badescu, V. (2017). Ignition delay, combustion and emission characteristics of Diesel engine fueled with rapeseed biodiesel—A literature review. *Renewable and Sustainable Energy Reviews*, 73, 178-186.
9. Beyler, C. (2016). Flammability limits of premixed and diffusion flames. *SFPE handbook of fire protection engineering*, 529-553.
10. Keçebaş, A., & Kayfeci, M. (2019). Hydrogen properties. In *Solar Hydrogen Production* (pp. 3-29). Academic Press.
11. Ghavam, S., Vahdati, M., Wilson, I. A., & Styring, P. (2021). Sustainable ammonia production processes. *Frontiers in Energy Research*, 9, 34.
12. Valera-Medina, A., Xiao, H., Owen-Jones, M., David, W. I., & Bowen, P. J. (2018). Ammonia for power. *Progress in Energy and combustion science*, 69, 63-102.
13. Sami, M., Annamalai, K., & Wooldridge, M. (2001). Co-firing of coal and biomass fuel blends. *Progress in energy and combustion science*, 27(2), 171-214.
14. Kolmetz, K. *Kolmetz Handbook Of Process Equipment Design Ammonia Plant Selection, Sizing and Troubleshooting*.
15. Javaid, R., & Nanba, T. (2022). Effect of texture and physical properties of catalysts on ammonia synthesis. *Catalysis Today*, 397, 592-597.
16. Grigoriev, S. A., & Fateev, V. N. (2017). Hydrogen production by water electrolysis. *Hydrogen production technologies*, 231-276.
17. Jabarivelisdeh, B., Jin, E., Christopher, P., & Masanet, E. *Ammonia Production Processes from Energy and Emissions Perspectives: A Technical Brief*.
18. Crolus, S., Pugh, D. G., Morris, S., & Valera-Medina, A. (2021). Safety Aspects. *Techno-Economic Challenges of Green Ammonia as an Energy Vector*, 221-257.
19. Nadimi, E., Przybyła, G., Lewandowski, M. T., & Adamczyk, W. (2023). Effects of ammonia on combustion, emissions, and performance of the ammonia/diesel dual-fuel compression ignition engine. *Journal of the Energy Institute*, 107, 101158.
20. Okafor, E. C., Naito, Y., Colson, S., Ichikawa, A., Kudo, T., Hayakawa, A., & Kobayashi, H. (2018). Experimental and numerical study of the laminar burning velocity of CH<sub>4</sub>-NH<sub>3</sub>-air premixed flames. *Combustion and flame*, 187, 185-198.
21. Valera-Medina, A., Amer-Hatem, F., Azad, A. K., Dedoussi, I. C., De Joannon, M., Fernandes, R. X., ... & Costa, M. (2021). Review on ammonia as a potential fuel: from synthesis to economics. *Energy & Fuels*, 35(9), 6964-7029.



22. Cardoso, J. S., Silva, V., Rocha, R. C., Hall, M. J., Costa, M., & Eusébio, D. (2021). Ammonia as an energy vector: Current and future prospects for low-carbon fuel applications in internal combustion engines. *Journal of Cleaner Production*, 296, 126562.
23. Kurien, C., & Mittal, M. (2022). Review on the production and utilization of green ammonia as an alternate fuel in dual-fuel compression ignition engines. *Energy Conversion and Management*, 251, 114990.
24. Mounaïm-Rousselle, C., & Brequigny, P. (2020). Ammonia as fuel for low-carbon spark-ignition engines of tomorrow's passenger cars. *Frontiers in Mechanical Engineering*, 70.
25. Koike, M., & Suzuoki, T. (2019). In-line adsorption system for reducing cold-start ammonia emissions from engines fueled with ammonia and hydrogen. *International Journal of Hydrogen Energy*, 44(60), 32271-32279.
26. Lhuillier, C., Brequigny, P., Contino, F., & Rousselle, C. (2019). Performance and emissions of an ammonia-fueled SI engine with hydrogen enrichment (No. 2019-24-0137). *SAE Technical Paper*.
27. Van Blarigan, P., & Keller, J. O. (1998). A hydrogen fuelled internal combustion engine designed for single speed/power operation. *International Journal of Hydrogen Energy*, 23(7), 603-609.
28. Lee, D., & Song, H. H. (2018). Development of combustion strategy for the internal combustion engine fueled by ammonia and its operating characteristics. *Journal of Mechanical Science and Technology*, 32, 1905-1925.
29. Valera-Medina, A., Pugh, D. G., Marsh, P., Bulat, G., & Bowen, P. (2017). Preliminary study on lean premixed combustion of ammonia-hydrogen for swirling gas turbine combustors. *International Journal of Hydrogen Energy*, 42(38), 24495-24503.
30. Mikulčić, H., Baleta, J., Wang, X., Wang, J., Qi, F., & Wang, F. (2021). Numerical simulation of ammonia/methane/air combustion using reduced chemical kinetics models. *International Journal of Hydrogen Energy*, 46(45), 23548-23563.
31. Takahashi, A., & Fujitani, T. (2021). Kinetic-model-based design of industrial reactor for catalytic hydrogen production via ammonia decomposition. *Chemical Engineering Research and Design*, 165, 333-340.
32. Lee, J. H., Kim, J. H., Park, J. H., & Kwon, O. C. (2010). Studies on properties of laminar premixed hydrogen-added ammonia/air flames for hydrogen production. *international journal of hydrogen energy*, 35(3), 1054-1064.
33. Jin, B. Z., Deng, Y. F., Li, G. X., & Li, H. M. (2022). Experimental and numerical study of the laminar burning velocity of NH<sub>3</sub>/H<sub>2</sub>/air premixed flames at elevated pressure and temperature. *International Journal of Hydrogen Energy*, 47(85), 36046-36057.
34. Li, J., Huang, H., Kobayashi, N., Wang, C., & Yuan, H. (2017). Numerical study on laminar burning velocity and ignition delay time of ammonia flame with hydrogen addition. *Energy*, 126, 796-809.

# Instant Foxtail Millet Puri with Curry

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**Abstract.** This research focuses on developing an instant foxtail millet puri with curry, aiming to create a gluten-free alternative to traditional puri. Puri, an unleavened bread, is a staple in South Asian cuisine, typically made from wheat flour, salt, and water, and deep-fried until golden brown. The gluten in wheat flour provides the characteristic elastic and stretchy texture necessary for shaping and frying. However, traditional wheat puri is unsuitable for individuals with celiac disease or gluten intolerance due to its gluten content, which can cause digestive discomfort and inflammation. The primary goal of this study is to develop a gluten-free puri using foxtail millet and to determine the best formulation through sensory evaluation tests. The development process involved three variants: F1 (60% foxtail millet flour: 40% chickpea flour), F2 (50%:50%), F3 (90%:10%), and a control (100% foxtail millet flour). Sensory evaluations based on color, taste, texture, oil absorption, and overall acceptability indicated that formulation F1 was the best option. ANOVA test results showed P-values greater than 0.05, indicating significant differences between samples. This study highlights the potential for creating nutritious and appealing gluten-free millet-based products to enhance dietary diversity and support food security.

**Keywords:** foxtail millet, puri, celiac disease, gluten free

## 1 Introduction

Puri, a traditional unleavened bread, is a staple in South Asian cuisine, particularly in India, Pakistan, and Bangladesh. It is typically made from wheat flour, salt, and water, and is deep-fried until golden brown. The gluten in wheat flour provides the characteristic elastic and stretchy texture, essential for shaping and frying (Peng et al., 2021). While delicious and rich in carbohydrates, traditional wheat puri is unsuitable for individuals with celiac disease or gluten intolerance due to its gluten content, which can cause adverse reactions such as digestive discomfort and inflammation (Aljada et al., 2021).

The development of gluten-free instant foxtail millet puri aims to provide a nutritious alternative to traditional wheat puri, particularly for those with gluten intolerance. By incorporating hydrocolloids and chickpea flour, it is possible to improve the texture and nutritional value of millet-based puri. This study focuses on creating a gluten-free foxtail millet puri, evaluating its sensory attributes, and determining the best formulation for consumer acceptability. By expanding the availability of millet-based products, this research aims to promote dietary diversity and support sustainable agriculture.

## 2 Literature review

The exploration of gluten-free replacements for conventional wheat-derived food products is of great interest given the increasing occurrence of celiac disease and gluten sensitivity. A fundamental component of South Asian culinary culture, the traditional puri is commonly prepared using wheat flour, which imparts the requisite gluten for its distinct texture. Nevertheless, alternatives devoid of gluten are imperative for individuals unable to tolerate this protein. This article centers on the creation and assessment of gluten-free instant puri made from foxtail millet.

### 2.1 Foxtail Millet as a gluten-free alternative

Foxtail millet (*Setaria italica*) is a historical cereal acknowledged for its nutritional advantages, encompassing a high fiber content, essential amino acids, and minerals (Sharma et al., 2021). Research has illustrated the capacity of foxtail millet to develop gluten-free products owing to its nutritional perks and appropriateness for individuals with gluten sensitivity (Patel & Rao, 2020). The cereal's modest glycemic index and notable antioxidant properties render it a valuable component for enhancing dietary variety and ensuring food sustainability (Gupta & Chauhan, 2019). Overall, incorporating foxtail millet



into food products can significantly contribute to improving food and nutrition security, offering a wide array of health benefits and culinary applications (Jyothish Madambikattil Sasi, Paramananda Barman & Charu Lata, 2023).

## 2.2 Formulation and sensory evaluation

The development of gluten-free products often involves the combination of various flours to achieve desirable sensory and nutritional properties. In the context of foxtail millet puri, formulations incorporating different ratios of foxtail millet flour and chickpea flour have been explored. Studies have shown that the combination of these flours can enhance the texture, taste, and overall acceptability of the final product (Rathi & Verma, 2018). Sensory evaluations are crucial in determining the best formulation, focusing on attributes such as color, taste, texture, and oil absorption (Singh & Jain, 2022).

## 2.3 Nutritional and health benefits

The inclusion of foxtail millet in gluten-free diets offers numerous health benefits. Foxtail millet is rich in dietary fiber, which aids in digestion and helps prevent constipation. Additionally, it contains essential minerals such as magnesium, iron and calcium, which contribute to overall health (Meena & Kumar, 2020). The high antioxidant content in foxtail millet also plays a role in reducing oxidative stress and inflammation, making it a valuable ingredient for health-conscious consumers (Fasano & Catassi, 2019). Studies have shown that foxtail millet can play a significant role in preventing malnutrition and type 2 diabetes due to its high resistant starch content and low predicted glycemic index, making it suitable for diabetics (Arora et. al., 2023). Furthermore, research indicates that foxtail millet supplementation can help alleviate non-alcoholic fatty liver disease (NAFLD) by reducing hepatic fat accumulation, inflammation, and oxidative stress, potentially through modulating gut microbiota composition (Tongshuai et al. 2022). Overall, foxtail millet emerges as a promising gluten-free alternative with diverse culinary applications and substantial health. There is availability of huge literature on the millets like Pearl millet and Sorghum but less emphasis has been given on Foxtail millet. So, the current investigation was focused on development and nutritional analysis of Foxtail millet-based food products, so as to provide a healthier dietary option to the vulnerable population (Arora et. al., 2023). Due to its low cost and excellent functional properties of flour and protein concentrate, foxtail millet can be considered as good candidate for replacing animal protein foods. (Niharika et al., 2021)

**Table 1.** Nutritional in Foxtail Millet.

Nutritional	Value in Percent (%)
Protein	11
Carbohydrate	59.1
Fat	3.9
Dietary Fiber	19.1
Ash	7.0
Phenolic compounds	6.6 mg/100g

Sources: Das et. al, 2019

## 3 Methodology

### 3.1 Materials and ingredients

Foxtail Millet flour and chickpea flour are procured from local supplier (Ritika Fresh Mart, Seremban). Other ingredients such as salt, baking soda, xantham gum and oil for frying were procured from local supplier at Pagoh, Johor.

### 3.2 Experimental design

The development of instant foxtail millet puri involved creating three different formulations by varying the proportions of foxtail millet flour and chickpea flour. A control sample using 100% foxtail millet flour was also prepared. The formulations were as follows:

**Table 2.** Formulation of Instant Foxtail Millet Puri

	F1	F2	F3	Control
Foxtail Millet Flour	60%	50%	90%	100%
Chickpea Flour	40%	50%	10%	-

### 3.3 Preparation of dough

The ingredients were weighed accurately according to the formulations. Then, the flours were mixed with salt, baking soda and xanthan gum in a mixing bowl. Water was added gradually to the mixture while kneading until a smooth and elastic dough was formed. The dough was covered with a damp cloth and allowed to rest for 20 minutes.

### 3.4 Shaping and frying

The rested dough was divided into small equal portions. Each portion was rolled out into a flat, circular shape using a rolling pin. The rolled dough pieces were deep-fried in hot oil (180°C) until they turned golden brown and puffed up. The entire process from rolling to frying was conducted under controlled conditions to ensure repeatability and consistency across all batches.

### 3.5 Sensory evaluation

A sensory assessment was implemented to ascertain the optimal formulation. Hence, in order to guarantee the standard of instant foxtail millet puri, a sensory evaluation is carried out, as highlighted by Karaca (2019). The sensory characteristics that were evaluated included color, taste, texture, oil absorption, and overall acceptability. A group of 40 semi-trained assessors from the Politeknik Tun Syed Nasir Syed Ismail took part in the assessment. The assessment involved evaluating color based on visual representation, taste assessed on flavor and palatability, texture evaluated through mouthfeel and crispiness, oil absorption judged on the greasiness of the puri, and overall acceptability determined by the general acceptance of the product. The products were rated on a Likert scale ranging from 1 to 5, where 1 represents “dislike extremely,” and 5 represents “like extremely.”

### 3.6 Statistical analysis

The sensory evaluation data were subjected to Analysis of Variance (ANOVA) to determine significant differences between the formulations. A significance level of  $P < 0.05$  was considered for all statistical tests. Mean and standard deviation for the various parameters were computed. All the statistical analyses were performed by using SPSS software (SPSS version 17, Inc., USA).

## 4 Finding and analysis

The data provided discusses the sensory evaluation results and ANOVA test outcomes for different formulations of instant foxtail millet puri. The formulations tested included three variants: F1 (60% foxtail millet flour, 40% chickpea flour), F2 (50% foxtail millet flour, 50% chickpea flour), F3 (90% foxtail millet flour, 10% chickpea flour), and a control sample (100% foxtail millet flour).

### 4.1 Sensory evaluation

The sensory characteristics of instant foxtail millet puri are presented in Table 3. Among them, F1 obtained the highest overall acceptability score of  $4.77 \pm 0.430$  followed by F2 ( $3.00 \pm 1.259$ ), Control ( $2.97 \pm 1.033$ ) and F3 ( $2.67 \pm 0.959$ ).

The mean values for color ranged from 3.30 to 3.97 (Table 3). Highest values were reported for F1 followed by F3, control and F2. The mean values of color for F1, F2, F3 and control were comparable to each. The difference may be due to the increased levels of mixture of foxtail millet flour and chickpea flour in the mix providing an undesirable dark brown crust owing to the increase in the sugar content resulting in non-enzymatic browning during baking process and hence less appealing to the panelists. This approved that color of noodles becomes darker (from light brown to brown) while increasing level of millet flour blend. (Sree Varsha et al., 2022).

The taste refers to the sweet sensation caused in the mouth by contact with the product due to its sweetening effect. The mean values for taste ranged from 2.67 to 4.37 (Table 3). Highest values were reported for F1 and lowest for F2. Texture is the quality of puri that is decided by touch and feel and involves the degree roughness or smoothness, hard or soft. The mean values for texture ranged from 2.50 to 4.53 (Table 3) with highest values recorded for F1 and lowest for F2. The hardness values increased with the increase in level of water mixture flour. The increase in hardness may be attributed to high fibrous nature of foxtail millet and chickpea flour. Similar results were observed with carrot powder incorporated in cookies (Kumar and Kumar, 2011).

The sensory evaluation assessed various attributes, including color, taste, texture, oil absorption, and overall acceptability. Formulation F1 was identified as the best option based on these criteria. The panelists preferred F1 due to its balanced combination of foxtail millet and chickpea flour, which provided an appealing color, favorable taste, desirable texture, and moderate oil absorption.

#### 4.2 ANOVA Test

The ANOVA test results indicated significant differences between the formulations for several sensory attributes, with P-values greater than 0.05. This suggests that the variations in the proportions of foxtail millet and chickpea flour significantly affected the sensory characteristics of the puri. F1's sensory scores were significantly higher than the other formulations, confirming it as the optimal choice (Table 3).

The mean color score of F1 is significantly higher than F2, F3, and Control as indicated by the different superscript (a vs. b). This suggests that the color of F1 is perceived as better compared to the other formulations and control. F1 has a significantly higher mean taste score compared to F2, F3, and Control (Table 3). This indicates that the taste of F1 is preferred over the other samples. F1 also scores significantly higher in texture compared to F2, F3, and Control, indicating a better texture perception for this formulation. According Table 3, The mean oil absorption score of F1 is significantly higher than that of F2, F3, and Control, suggesting that F1 might have a more desirable oil absorption characteristic. The overall acceptability of F1 is significantly higher than F2, F3, and Control. This comprehensive measure indicates that F1 is the most preferred formulation among the tested samples.

The results of the ANOVA examination conducted on Instant Foxtail Millet Puri indicate that formulation F1 demonstrates a significant superiority in terms of color, taste, texture, oil absorption, and overall acceptability compared to F2, F3, and the control sample.

**Table 3.** Sensory Evaluation of Instant Foxtail Millet Puri

	Color	Taste	Texture	Oil Absorption	Overall Acceptability
F1	3.97 ± 1.033 <sup>a</sup>	4.37 ± 0.964 <sup>a</sup>	4.53 ± 0.730 <sup>a</sup>	3.67 ± 1.155 <sup>a</sup>	4.77 ± 0.430 <sup>a</sup>
F2	2.83 ± 1.020 <sup>b</sup>	2.63 ± 1.066 <sup>b</sup>	2.50 ± 0.938 <sup>b</sup>	2.93 ± 1.081 <sup>b</sup>	3.00 ± 1.259 <sup>b</sup>
F3	3.17 ± 1.020 <sup>b</sup>	2.83 ± 1.147 <sup>b</sup>	2.50 ± 1.009 <sup>b</sup>	2.77 ± 0.971 <sup>b</sup>	2.67 ± 0.959 <sup>b</sup>
Control	3.03 ± 1.033 <sup>b</sup>	2.67 ± 1.061 <sup>b</sup>	2.57 ± 0.971 <sup>b</sup>	2.83 ± 1.020 <sup>b</sup>	2.97 ± 1.033 <sup>b</sup>

F1 (60% foxtail millet flour:40% chickpea flour), F2 (50% foxtail millet flour:50% chickpea flour), F3 (90% foxtail millet flour:10% chickpea flour) and Control (100% foxtail millet flour)

Values are expressed as Mean±SD of triplicates

Values having different alphabetical superscripts represent significant difference ( $p \leq 0.05$ ) among the various sensory characteristics.

#### 5 Conclusion

The data highlights the effectiveness of the F1 formulation in achieving a gluten-free puri with desirable sensory qualities. This formulation successfully balanced the textural and taste properties, making it a preferred choice over the other variants and the control sample. The use of statistical analysis further validated these findings, underscoring the potential of F1 in producing a nutritious and appealing gluten-free alternative to traditional puri. The puri developed using the foxtail millet flours incorporated with chickpea flours helps in new product formulations with ambient nutrients and health benefits. Like most millet varieties, foxtail millet remains under-utilized as a food source. It is however receiving increased research and commercial attention, especially because its cultivation is not too demanding from point of view of agricultural inputs and it can grow in difficult terrains. It would be reasonable to surmise that foxtail millet has a promising role to play in enhancing nutritional and food security.

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## References

1. Aljada, B., Zohni, A., & El-Matary, W. (2021). The gluten-free diet for celiac disease and beyond. *Nutrients*, 13(11), 3993.
2. Arora, L., Aggarwal, R., Dhaliwal, I., Gupta, OP., & Kaushik, P. (2023). Assessment of sensory and nutritional attributes of foxtail millet-based food products. *Front. Nutr.* 10:1146545. <https://doi.org/10.3389/fnut.2023.1146545>
3. Fasano, A., & Catassi, C. (2019). Gluten-Free Diet: Safety and Nutritional Quality. *Nutrition Reviews*. <https://doi.org/10.1093/nutrit/nuy047>
4. Gupta, A., & Chauhan, N. (2019). Utilization of Foxtail Millet in Traditional and Novel Foods. *International Journal of Food Science & Technology*. <https://doi.org/10.1111/ijfs.14132>
5. Jyothish Madambikattil Sasi, Paramananda Barman & Charu Lata. (2023). Nutraceutomics of Foxtail Millet (*Setaria italica* L.): Insights. pp 1–15
6. Kumar and Kumar. (2011). Development Of Carrot Pomace And Wheat Flour Based Cookies. *Journal Of Pure And Applied Science And Technology*;1:5-1
7. Ma, K.; Zhao, X.; Lu, B.; Wang, Y.; Yue, Z.; Zhang, L.; Diao, X.;Yuan, X. (2024). Effect of Ecological Factors on Nutritional Quality of Foxtail Millet (*Setaria italica* L.). *Agronomy* 2024, 14, 387. <https://doi.org/10.3390/agronomy14020387>
8. Ma Q, Wang J, Cheng L, Li Y, Zhang Q, Li H, Han Y, Zhen X, Zhang B. (2022). The Potential Function of SiLOX4 on Millet Discoloration during Storage in Foxtail Millet. *Agriculture*; 12(8):1283. <https://doi.org/10.3390/agriculture12081283>
9. Meena, S., & Kumar, V. (2020). The Role of Millets in Food Security and Nutritional Quality. *Agricultural Reviews*. <https://doi.org/10.18805/ag.R-1876>
10. Niharika, Sachdev., Sangeeta, Goomer., Laishram, Rajenderkumar, Singh. (2021). Foxtail millet: a potential crop to meet future demand scenario for alternative sustainable protein. *Journal of the Science of Food and Agriculture*, doi: 10.1002/JSFA.10716
11. Patel, S., & Rao, S. (2020). Sensory and Nutritional Evaluation of Millet-Based Gluten-Free Bread. *Food Chemistry*. <https://doi.org/10.1016/j.foodchem.2020.126755>
12. Peng, J., Zhu, K. X., Guo, X. N., & Zhou, H. M. (2021). The impact of phosphates on the fibrous structure formation of textured wheat gluten. *Food Hydrocolloids*, 119, 106844
13. Rathi, A., & Verma, P. (2018). Formulation and Characterization of Gluten-Free Products Using Millets. *Journal of Cereal Science*. <https://doi.org/10.1016/j.jcs.2018.06.014>
14. Renganathan, V. G., Vanniarajan, C., Karthikeyan, A., & Ramalingam, J. (2020). Barnyard millet for food and nutritional security: current status and future research direction. *Frontiers in genetics*, 11, 500.
15. Sachdev, N., Goomer, S., & Singh, L. R. (2021). Foxtail millet: a potential crop to meet future demand scenario for alternative sustainable protein. *Journal of the Science of Food and Agriculture*, 101(3), 831-842.
16. Saini, S., Saxena, S., Samtiya, M., Puniya, M., & Dhewa, T. (2021). Potential of underutilized millets as Nutri- cereal: an overview. *Journal of Food Science and Technology*, 1- 13.
17. Sharma, N., & Niranjana, K. (2017). Foxtail millet: Properties, processing, health benefits, and uses. *Food Reviews International*, 34(4), 329–363. <https://doi.org/10.1080/87559129.2017.1290103>
18. Sharma, R., Kumar, A., & Singh, J. (2021). Development and Evaluation of Gluten-Free Foxtail Millet-Based Products. *Journal of Food Science and Technology*. <https://doi.org/10.1007/s13197-021-04849-0>
19. Singh, S., & Jain, R. (2022). Comparative Analysis of Nutritional and Sensory Properties of Millet-Based Snacks. *Food Research International*. <https://doi.org/10.1016/j.foodres.2022.111351>
20. Sree Varsha S. M., Valliammai M., & Radhapriya D. (2022). Optimization and Functionality of Millet Flours in Development of Noodles and Fryum. *International Journal for Research in Applied Science & Engineering Technology*. <https://doi.org/10.22214/ijraset.2022.48446>
21. Tongshuai, Yang., Sen, Ma., Jingke, Liu., Binghua, Sun., Xiaoxi, Wang. (2022). Influences of four processing methods on main nutritional components of foxtail millet: A review. doi: 10.1016/j.gaost.2022.06.005

# Level of understanding in Green Technology and their impact on creative activities and innovation among students

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**Abstract.** Green technology refers to equipment designed to simplify tasks while enhancing product development and minimizing energy consumption and natural resource usage. Young people, especially students, play a critical role in understanding and implementing green technology projects. Currently, the most effective channels for introducing students to Green Technology knowledge and awareness are the media and educational institutions. However, the question of whether they truly comprehend green technology arises due to varying methods and suitability for different individuals. Consequently, this study had two main objectives: a) to assess students' understanding of green technology, and b) to identify the level of concern among students at Politeknik Muadzam Shah regarding creative and innovative activities. The study involved 121 respondents from Politeknik Muadzam Shah who completed online questionnaires. Descriptive analysis revealed that overall, the respondents had a high level of understanding about green technology. Most students possessed good knowledge of green technology and recognized its importance in environmental conservation efforts. Additionally, students actively engaged in creative and innovative activities related to green technology. These findings highlight not only students' awareness of green technology issues but also their practical efforts to reduce negative environmental impacts, even at home.

**Keywords:** Green Technology, level of understanding, creative and innovative activities

## 1 Introduction

Environmental sustainability is largely driven by green technology (Hassan et al., 2017). The internet has made it easy to access information about green technology, as it places all relevant knowledge at our fingertips (Hussin & Hafit, 2018). Many industrial sectors, which are major contributors to pollution, are now integrating green technology into their products. This shift is guided by rules and guidelines issued by the Malaysian government to reduce environmental waste and pollution (Yang & Zhao, 2011). According to Hussin & Hafit (2018), the Malaysian government has made numerous attempts, but the adoption of green technology is still not at an optimal level. This is since Malaysian culture is still unfamiliar with green technologies. Many people are still unaware of the importance of green technology in daily life. To create awareness, efforts should be made at both the school level and higher education institutions. Subjects related to green technology are now included in the syllabus, allowing students ample time to conduct research.

Given this situation, research is necessary to determine the extent of student understanding on this matter. This will enable educational institutions to improve the methods of teaching and delivering green technology. Moreover, to achieve environmental sustainability, several initiatives have been implemented at higher education institutions to promote Green Technology. These initiatives include energy-saving campaigns, the collection of used oil waste, final year project competitions, and Green Technology-based innovation contests. (Salim et al., 2019). Additionally, a variety of teaching and learning methods employed by lecturers, such as leading group discussions and encouraging problem-solving in experiments, aim to foster critical and creative thinking about green technology (Kassim & Zakaria, 2015). Consequently, when students grasp the concepts related to green technology, they are more likely to think creatively and strive to develop innovative products that can reduce material and energy consumption, benefiting both themselves and the public.

It is vital to evaluate students' comprehension of green technology since it plays a critical role in reducing environmental problems like pollution, resource depletion, and climate change. Knowing how much they already know can help educators create more effective curriculum that will raise future generations' understanding of the environment. This study also makes

it possible to pinpoint gaps in the teaching of green technologies and to create more effective plans for raising students' awareness of and proficiency with tackling environmental issues on a global scale.

### 1.1 Objectives of the Study

This study was conducted with two objectives:

- a. To assess the level of understanding of green technology among students at Politeknik Muadzam Shah.
- b. To identify the level of concern among students at Politeknik Muadzam Shah regarding creative and innovative activities.

## 2 Literature Review

Green technology, also known as environmentally friendly technology, is essential for our nation's progress. The primary purpose of technology is to develop methods that do not harm or deplete the Earth's natural resources (Kaliappan & Hamid, 2022). Therefore, the adoption of green technology varies based on individual understanding and concern. Consequently, extensive research has assessed public awareness of green technology in Malaysia. For example, in a study by Manaf et al. (2021) among Universiti Tenaga Nasional lecturers, 90% of respondents were aware of the availability of green technology items. Their mean knowledge score of 4.08 indicates a strong understanding of green technology and its products. A similar pattern emerged in a survey conducted by Hussin and Hafit (2018) among IIUM employees. Although most respondents had a good understanding of green technology, their actual usage remained moderate.

According to research conducted by Kaliappan and Hamid (2022), students enrolled in the Malaysian Vocational Certificate and Malaysian Vocational Diploma programs demonstrated a moderate level of knowledge (mean=3.07) about green technology. However, they exhibited a high level of attitude (mean=3.60) and practice (mean=4.00) regarding the subject. A study by Mustapha et al. (2019) sampled 40 final-year university students from the Department of Engineering Technology. The findings revealed that while most respondents reported having a fairly high awareness of green technology, their daily use of it remained only moderate. Interestingly, 25% of respondents acknowledged that they had no idea what green technology was when asked to name some examples. Moreover, over 50% of the participants reported that Malaysians possess a comparatively low level of understanding regarding green technology (Mustapha et al., 2019). However, Yusoh et al.'s (2022) research on the influence of green practice activities on knowledge of green technology subjects revealed that this influence is quite high. This is because green practice activities, as opposed to conventional chalk-and-talk learning methods, are more effective at promoting rapid understanding.

## 3 Methodology

This study adopts a survey-focused design to assess students' awareness of innovative and creative green activities, as well as their understanding of green technology in a clear and detailed manner. The study's results are analyzed using a quantitative questionnaire approach. The questionnaire was distributed to students from all semesters in Politeknik Muadzam Shah's Department of Commerce. According to Memon et al. (2020), a sample size of 50–100 is adequate for general survey analysis. Therefore, the researcher's sampling of 121 students from all semesters and programs in the Department of Commerce is considered sufficient. Only descriptive analysis was performed in order to determine the mean values for two purposes; a) To assess the level of understanding of green technology among students at Politeknik Muadzam Shah and b) To identify the level of concern among students at Politeknik Muadzam Shah regarding creative and innovative activities. Following the methodology used in the Ngadiman et al. (2019) study, the mean value will be interpreted as follows: 1.00–1.99 (Weak), 2.00–2.99 (Low), 3.00–3.99 (Moderate), and 4.00–5.00 (High)

## 4 Finding and Analysis

### a) Background of the respondent

Table 1 presents the respondents' backgrounds. Among the students, 33.1% are male, and 66.9% are female. Regarding semesters, most students are enrolled in the second (52.1%), fifth (18.2%), and sixth (9.9%) semesters. Research indicates that 33.1% of students have a GPA in the range of 2.00 to 2.99, while 30.6% have a GPA in the range of 3.00 to 3.33. The data suggests that a significant number of students come from lower economic backgrounds, particularly those classified as B40. More precisely, 76.9% of students come from households with an income of RM4360 or less.

**Table 1.** Respondent background

Item		n	%
Gender	Man	40	33.1
	Women	81	66.9
Semester	1.00	9	7.4
	2.00	63	52.1
	3.00	8	6.6
	4.00	7	5.8
	5.00	22	18.2
	6.00	12	9.9
CGPA	2.00 - 2.99	40	33.1
	3.00 - 3.33	37	30.6
	3.43 - 3.67	26	21.5
	3.68 - 4.00	9	7.4
	Semester 1 (No CGPA yet)	9	7.4
Household income	RM4360 and below	93	76.9
	RM4360 - RM9619	19	15.7
	RM9619 and above		7.4

**b) The understanding of green technology among students at Politeknik Muadzam Shah**

**Table 2.** The percentage of respondents that correctly answered the questions

Item	% Correct Responses
1. Is green technology a term you are familiar with?	<b>90.1<sup>1</sup></b>
2. Can solar power be considered a green technology?	79.3
3. Do electric cars contribute to lessening air pollution?	<b>88.4<sup>3</sup></b>
4. Is the treatment of wastewater a green technology?	62.0
5. Do green buildings have lower energy and carbon footprint designs?	78.5
6. Is wind energy regarded as a renewable energy source?	82.6
7. Is recycling of waste materials a part of solid waste management	78.5
8. Can green technology aid in lowering the amount of non-renewable natural resources used?	76.9
9. Does the energy savings from LED lighting outweigh that of conventional incandescent lighting?	66.9
10. Is the preservation of mangrove forests regarded as a green technology project?	81.0
11. Does putting up solar panels' lower monthly electricity costs at home?	85.1
12. Does water-saving technology contribute to a decrease in household water use?	78.5
13. Is recycling solid waste a viable approach to implementing green technology?	82.6
14. Does driving an electric car lessen reliance on fossil fuels?	85.1

15. Does the environment need to be protected by reducing the use of single-use plastics? **89.3<sup>2</sup>**
- a. Is agriculture the only industry that uses green technology? 24.0
16. Do reusable bags or single-use plastic bags have a greater environmental impact? 29.8

*Note: <sup>1</sup>First highest percentage; <sup>2</sup>Second highest percentage; <sup>3</sup>Third highest percentage*

Referring to Table 2, the percentage of respondents who provided accurate answers indicates the level of student understanding about green technology in this study. Overall, Table 2 demonstrates that respondents had a high degree of knowledge. Item 1 (90.1%) had the highest correct response rate, followed by Item 15 (89.3%) and Item 3 (88.4%). Although questions 16 and 17 had incorrect answers, the data shows that most students are knowledgeable about green technology and recognize its significance for environmental conservation efforts.

This study suggests that students have a fair understanding of environmental issues and green technology, as evidenced by the high percentage of students who answered correctly on several question items, such as the reduction of air pollution with electric vehicles and the significance of reducing single-use plastics for environmental sustainability. It follows that raising future levels of education and understanding in this area will help to encourage more creative and successful solutions to the world's environmental problems.

### c) The Concern Level of Politeknik Muadzam Shah Students About Innovative and Creative Green Technology Projects

**Table 3.** Students' Concern Levels Regarding Innovative and Creative Green Technology Activities

Item	Mean*	S.D
1. I think of new ways to save electricity at home.	3.570	1.31
2. I try various ways to reduce water usage at home.	<b>3.752<sup>2</sup></b>	1.011
3. I attempt to create my own green tools/devices.	3.116	1.205
4. I find new uses for unused items at home to be environmentally friendly.	3.479	1.104
5. I tried several ideas to reduce waste at home.	<b>3.810<sup>1</sup></b>	0.934
6. I think of innovations to help the environment.	3.545	1.072
7. I create creative home decorations using eco-friendly materials.	3.463	1.133
8. I find ways to reduce air pollution at home.	<b>3.661<sup>3</sup></b>	1.061
9. I carry out gardening projects to add greenery to the residential environment.	3.504	1.177
10. I have green products for community use.	3.091	1.348
11. I seek eco-friendly transportation alternatives such as cycling.	3.521	1.134
12. I create products from recycled materials.	3.413	1.188
13. I create inventions using waste materials.	3.405	1.159

*Note: \*All items have a mean at the moderate level; <sup>1</sup>Highest mean; <sup>2</sup>Second highest mean; <sup>3</sup>Third highest mean*

Table 3 illustrates the level of concern among students regarding engagement in creative and innovative green technology projects. The item with the highest mean (3.810) pertains to students' notable efforts to apply waste-minimization strategies at home (item 5). Students actively employ various approaches to conserve water at home (item 2), as indicated by the mean score of 3.752. Item 8, related to air quality and pollution's harmful impacts, has an average score of 3.661, making it the third most concerning item. Students seek strategies to mitigate pollution within their home environment.

Overall, while all items received a moderate mean score, these findings indicate that students possess both awareness of green technology issues and a proactive approach to reducing negative environmental impacts at the household level.

According to the study, most respondents have a positive attitude toward incorporating eco-friendly activities into daily life and developing innovative solutions for environmental sustainability. The respondents are actively involved in activities like cutting back on energy, water, and waste usage as well as looking for ways to use waste materials and make green products, as seen by the high mean scores on each question item. It follows that more pro-environmental activities can be identified and encouraged, which will increase their commitment to environmental sustainability and lead to more innovative and successful solutions.



## 5 Conclusion

Green technology fosters sustainable energy practices and contributes to higher living standards in the future by nurturing intelligent and innovative cultures. Achieving sustainability in life requires people, especially students (the younger generation), to deepen their understanding of environmental protection, draw inspiration from the natural world, and actively contribute as imaginative citizens who embrace green technology innovation.

Two goals of the study were to: a) to assess students' understanding of green technology, and b) to identify the level of concern among students at Politeknik Muadzam Shah regarding creative and innovative activities. The findings indicate that although students' engagement in innovative green technologies and creative endeavours is modest, their comprehension is strong. These results suggest that students are likely to look for different ways to cut down on household waste, which can be focused on cutting down on waste, energy, water, and expenses. This motivates students to use their imaginations and critical thinking skills to produce new ideas, especially when it comes to green technology in Malaysia. These kinds of endeavours really assist students in coming up with the newest inventions and concepts for their final projects. Graduating students' awareness of the environment, their care for it, and the value of green technology these days propels the creation of graduates with more critical and creative thinking.

## Acknowledgment

We sincerely thank each respondent who helped to make this study a success by being directly involved and exhibiting exceptional cooperation. We also thank all the instructors and students of Politeknik Muadzam Shah, Pahang's Department of Commerce, for their indirect but important contributions to this study's successful completion.

## References

1. Hassan, N., Salamon, H., & Rahman, H. A. (2017). Peranan aplikasi teknologi hijau dalam konteks melestarikan alam sekitar menurut perspektif Islam. *E-jurnal Penyelidikan dan Inovasi. E-Jurnal Penyelidikan dan Inovasi. rmc. kuis. edu. my/jpi/e-ISSN*, 2289-7909.
2. Hussin, N., & Hafit, A. (2018). Green Technology: Awareness among Academic Library Employees. *International Journal of Academic Research in Progressive Education and Development*, 7(3), 161–177.
3. Kaliappan, A., & Hamid, H. (2022). Green Technology and Vocational College: A Preliminary Study. *Online Journal for TVET Practitioners*, 7(1), 49-60.
4. Kassim, N., & Zakaria, E. (2015). Integrasi kemahiran berfikir aras tinggi dalam pengajaran dan pembelajaran matematik: Analisis keperluan guru. In *Conference: Prosiding Seminar Education Graduate Regional Conference (EGRC 2015)*.
5. Manaf, N. A., Razak, M. Z. A., Abd Razak, S. F. F., Muslim, N. A., Nawang, D., Azman, F., ... & Arshad, N. S. M. (2021). Awareness and Knowledge Level of School Teachers on the Use of Green Technology Products: A Pilot Study. *Global Business & Management Research*, 13.
6. Memon, M. A., Ting, H., Cheah, J. H., Thurasamy, R., Chuah, F., & Cham, T. H. (2020). Sample size for survey research: Review and recommendations. *Journal of Applied Structural Equation Modeling*, 4(2), 1-20.
7. Mustapha, R. A. M. L. E. E., Nashir, I., & Maarof, N. (2019). Awareness of green technology among engineering technology students. *Journal of engineering science and technology*, (special issue on ICEES2018), 1-8.
8. Ngadiman, D. W. T., Yacoob, S. E., & Wahid, H. (2019). Tahap Harga Diri Kumpulan Berpendapatan Rendah yang Berhutang dan Peranan Organisasi dalam Sektor Perladangan. *Melayu: Jurnal Antarabangsa Dunia Melayu*, 12(2), 238-254.
9. Salim, N., Jabor, M. K., & Musta'amal, A. H. (2019). The implementation of green technology among polytechnic students. *International Journal of Recent Technology and Engineering (IJRTE)*, 8(4).
10. Yang, C., & Zhao, H. (2011, September). Barriers to Green Technology Innovation in Large and Medium-Sized Enterprises. In *2011 International Conference of Information Technology, Computer Engineering and Management Sciences* (Vol. 4, pp. 175-178). IEEE.
11. Yusoh, M. P., Rosli, N. H., Marzuki, M., Mapjabil, J., Hanafi, N., Nordin, M. N., ... & Idris, N. H. (2022). The Effect of Green Practice Activities on the Understanding of Green Technology Topics in the Secondary School Geography Curriculum. *INTERNATIONAL JOURNAL OF SPECIAL EDUCATION*, 37(3s).<https://doi.org/https://doi.org/10.1016/j.measurement.2019.04.044>
12. Tupek, A., & Zrinjski, M. (2024). ABSOLUTE GNSS RECEIVER ANTENNA CALIBRATION AT THE FACULTY OF GEODESY – UNIVERSITY OF ZAGREB. *9th International Conference Contemporary Achievements in Civil Engineering, Subotica, SERBIA, May*. <https://doi.org/10.14415/CACE2024.52>
13. Tupek, A., Zrinjski, M., Švaco, M., & Barković, Đ. (2023). GNSS Receiver Antenna Absolute Field Calibration System Development: Testing and Preliminary Results. *Engineering Proceedings*, 58(1), 1–21. <https://doi.org/10.3390/ecsa-10-16227>

# IoT-Based Smart Electricity and Power Usage Monitoring System

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**Abstract.** In the world with high-demand capacity where the population has already reached a total of 8 billion lives, the demand for energy and supplies is expected to increase year to year. Since energy sources are limited and it has become our need to save as much energy as possible, in this scenario, a smart electricity meter comes into the picture. The smart electricity meter captures units consumed in a specific time frame, displays results, and consequently provides real-time inputs to the billing unit. Arduino and Wi-Fi based smart energy meters for advanced metering and billing systems can read and send data via wireless protocol, capable of managing the meters as well as the line connections. Smart Electricity Meter uses Wi-Fi to send the data to the cloud so that users can access the data room module via apps and websites. It is said that smart meters are far better than the electromechanical meters used previously by customers, and it is safe and easy to use, and user-friendly. This system proposes an IoT-based smart monitoring system in which it requires Wi-Fi to access the monitored data and billing in real-time. This means that it will be controlled via NodeMCU Esp8266 v3 and a PZEM-004T sensor, while the data will be displayed in two ways, either via the 16x2 LCD with I2C bus, and Blynk app, enhancing user accessibility and control. This metering system implements and offers cheap components which will decrease the overall cost of the equipment, increasing its affordability and penetration in non-metered areas as compared to traditional electromechanical meters.

**Keywords:** Smart Electricity Meter, NodeMCU Esp8266, Blynk App

## 1 Introduction

Nowadays, we live in the age of technology whereby accessing real-time information of, generally everything, is only via the tips of our hands. The Internet of Things (IoT) has been playing a significant part in our daily lives in terms of intelligence and automation of conventional devices. With the advancement of technology, IoT's automated management system is increasingly being applied in essential infrastructures such as electricity, gas, and water management, enhancing convenience for individuals and organizations.

This can address the challenges of human error and efforts in terms of controlling and managing electricity. In Malaysia, the energy demand has been steadily increasing in years to come in Hassan (2021), due to rapid growth of urbanization, industrialization expansion as well as population growth. Thus, it is critical to consider monitoring and assessing the electric systems or appliances that are used daily in residential and business facilities. In the past, traditional meters were used to measure electricity, with aluminium discs to access power. Although digital meters have replaced the role of analogue meters, the limitation still exists. Conventional meters are unreliable as consumers must budget for their monthly power bills, and the billing process requires human intervention. In addition, electrical energy consumption from consumers in certain areas is monitored and estimated during frequent field visits by technicians from the electricity department to calculate energy pricing. This is a time-consuming task as there will be thousands of houses in one location. Therefore, a smart energy meter, unlike a regular traditional energy meter, detects a consumer's energy usage and provides additional information to the utility supplier. As a result, extensive research has been carried out to facilitate the inspection, monitoring, analysis, and computation of energy fares.

A variety of smart electricity monitoring systems have been developed, each with unique features and benefits. Gill (2012) and Juhana (2016) both focus on residential applications, with Gill's system using wireless sensor networks to monitor and control household appliances, and Juhana's system employing non-intrusive sensors and a server for real-time monitoring and appliance state disaggregation. Loganthurai (2017), Chaudhari (2017) and Mir (2019) proposed the use of GSM technology for bidirectional communication and data transmission to modernize the billing system and monitor power consumption in real-time. The system in Loganthurai (2017) is able to implement a warning system based on tariff when the number of units consumed exceeds a certain limit but is unable to display the bill amount, load shedding time, power factor, voltage and current.

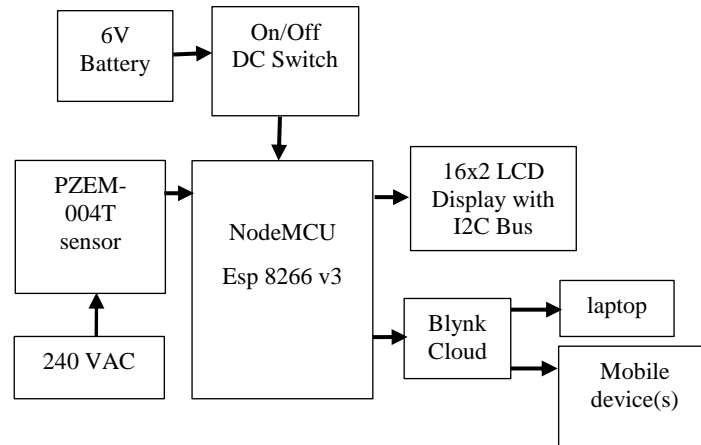
Chaudhari (2017) further improved the GSM-based incorporate with an embedded controller, Arduino to transmit data such as energy in kWh, bill generation and security services over the GSM mobile network without requiring workforce. It is suggested that the system be improved by including the incorporation of renewable energy sources, monitoring and controlling other parameters such as voltage, current, power factor, and harmonics, and integrating advanced communication technologies such as IoT for real-time monitoring and control of energy consumption. The systems enable consumers to monitor their home power consumption at any time and from any location, while continuously monitoring the energy meter and transmitting data via SMS when requested by the service provider. Mir (2019) further modified the GSM technology for reliability and safety, as well as potential complications due to network strength issues for the GSM module.

Kabalci et al. (2019) further proposed the integration of IoT and microcontrollers such as Arduino and Arduino Uno. On the other hand, Ay (2019) introduces a system that integrates Arduino, WIFI, and GSM to provide real-time data for optimization and power consumption reduction, with the added feature of a motion sensor for automatic power supply cutoff that benefits domestic consumers. As technology evolves rapidly, Hasan (2021) proposed a smart monitoring and control system (SMACS) that performed effectively in measuring and monitoring current, voltage, and power usage, making it easier for consumers to view rates in real-time. Additionally, the control mechanism raises awareness of electricity consumption. The proposed system provides 0.6% current errors for the hairdryer appliance as the study includes voltage assumptions in the absence of a sensor. These studies collectively demonstrate the potential of WIFI-enabled smart electricity monitoring systems in improving energy efficiency and user convenience. Rahul (2022) proposed an electrical monitoring system based on IoT, which is one of the most recent emerging communication technologies. It consists of data acquisition, processing, transmission, and storage stages to provide a more robust and efficient communication system. The IoT technology provides various advantages over traditional communication systems. One of these is its capacity to provide a wide range of distinct communication and network topologies for complex and diverse communication scenarios. Another advantage is that it is able to increase device efficiency by lowering power consumption and costs.

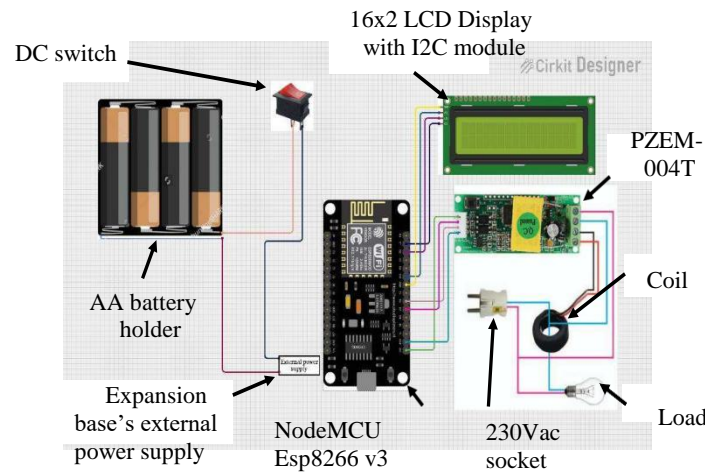
This manuscript describes the development of an IoT-based electricity monitoring system powered by only a 1.5Vx4 AA size battery and a solar system. The system consists of a 6V DC supply via AA batteries, which is connected to a NodeMCU Esp8266 v3 as the microcontroller, and all the monitoring action will be done by the PZEM-004T sensor, which measures and monitors different electricity parameters, including voltage, current, power, and energy consumption. The system is then programmed to measure the cost in RM, according to the tariff set as the default value, in which it is programmed to calculate the cost in RM ( $\text{Cost} = \text{EnergyConsumption} \times \text{tariffRate}$ ), and all these data will be displayed in the 16x2 LCD for every 12 seconds, OR via Blynk app. The Blynk app acts as the mobile application for remote monitoring and control of the energy meter. This manuscript is organized as follows: Section 1 provides an overview of the proposed system. Section 2 covers the system outline, while Section 3 presents the results and discussion. Finally, Section 4 summarizes the findings and suggests future recommendations. annually, or more frequently if it is exposed to harsh weather, vibration, shock, or frequent handling. An EDM baseline test should be conducted annually or before any major survey campaign to verify the proper functioning of the receiver and data processing software. Surveyors have the task and duty to report reliable measurement results and reasonable accuracy data. GNSS receivers are essential sensors for modern global positioning, navigation, and timing applications (Tupek & Zrinjski, 2024). For high-precision GNSS positioning based on carrier-phase measurements, knowledge of the GNSS receiver antenna electrical signal reception characteristics, i.e., phase center, is crucial (Tupek et al., 2023). The GNSS antenna phase centre is a function of the direction of the incoming signal, and it is different for each antenna (Kallio et al., 2019). Efforts to improve the level of knowledge and skills of Geomatics Diploma graduates, PKS from time to time therefore our view is that it is very necessary for students to be directly exposed to the ways of performing calibration according to actual surveying practice. In the current situation, students of the Geomatics program are facing problems to implement one of the practical's found in the DCG50173 Geodesy 2 course. The instrument calibration site or EDM Test Base Kuching established by the Land and Survey Department, Sarawak is the closest to PKS is at which is approximately 10 KM with a travel time of approximately 12 minutes from PKS. The bus travel time to reach this far distance will have an impact on the cost of transportation, movement time and student safety while outside the PKS area. This causes Geomatics students at PKS do not have the opportunity to carry out GNSS survey equipment calibration practice. In addition to the location of the calibration site being far from PKS, another problem that arises every time they want to do calibration work is that students have to wait for their turn with Licensed Land Surveyor survey party who also does calibration work on the same site. Based on this consideration, it is necessary for PKS to create a prototype of short EDM Baseline test for survey grade receiver that can be used for student teaching and learning so that the graduates produced will be more competent and competitive in the current market. Considering the negative impact on transportation costs, practical time, student safety and the safety of government assets while outside the PKS area, this innovation was developed.

## 2 System development

The IoT-based smart electricity and power usage monitoring system block diagram and circuit diagram are depicted in Figure 1 and Figure 2, respectively.



**Fig. 1.** Block diagram of the IoT-based smart electricity and power usage monitoring system.



**Fig. 2.** Circuit diagram of the system

Based on Figure 1 and Figure 2, the hardware setup includes a NodeMCU Esp8266 v3, PZEM-004T, 16x2 LCD with 12 C bus, the circuit connections. The software setup that consists of Arduino Integrated Development Environment (IDE), Blynk App and Cloud Server. The Arduino IDE is integrated to program the NodeMCU. Additionally Blynk App is configured on a smartphone to receive data from the NodeMCU. The NodeMCU is connected to a stable Wi-Fi network to ensure continuous data transmission. Cloud Server is then set up in the Blynk server to store and process the transmitted data.

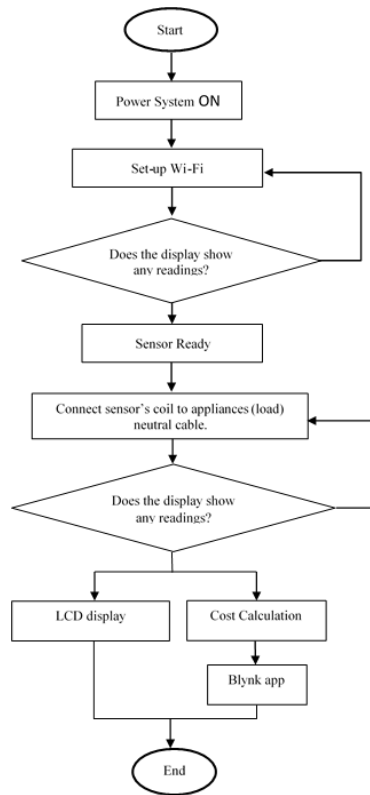
For the billing calculation process, the board is programmed to calculate the cost in Ringgit Malaysia (RM), according to the data, either power, W, or energy consumption, kWh referring to the tariff cost set. At the same time, it can also send the measured and monitored data into the Blynk cloud so that the data can be shown in the Blynk app in real-time.

For the supply of the system, a 1.5V\*4 battery will be the input or supply to the system. These AA-sized batteries had their holder and are linked or connected to the Esp8266's external power supply of the expansion base via the battery holder's jack. In between this connection, there is a DC switch linked to the supply, and then the switch is connected to the Esp8266. The switch's primary function is to regulate the Esp8266's power supply, which may be turned off or on using the Esp8266 itself. The external power supply of the expansion base has a minimum voltage of 6V, and the maximum voltage is 24V.

The Peacefair PZEM-004T is a sensor that measures and monitors electricity parameters, including voltage, current, power, and energy consumption. This sensor is supplied by a 230Vac. The sensor has a current transformer (CT), which is a type of "instrument transformer" that generates current in its secondary coil proportionate to the current flowing in its primary coil. The CT is clamped around the appliances' Neutral (N) cable. The current induced in the secondary coil is then measured by the PZEM-004T. The monitored data is then sent to Esp8266 so that the data can be sent into the 16x2 Liquid Crystal Display (LCD) and the Blynk app.

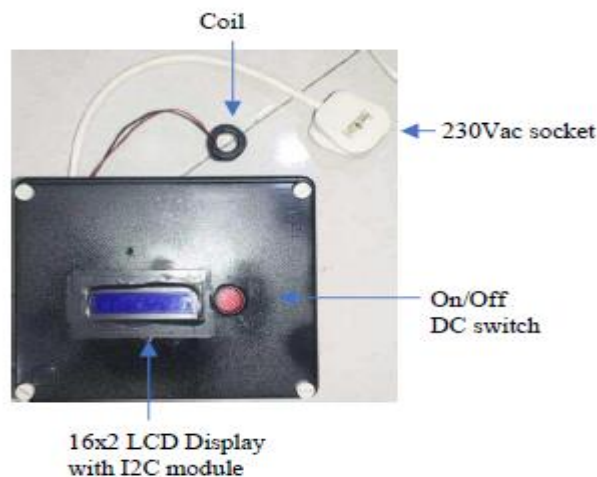
The Peacefair PZEM-004T's data output is shown on a liquid crystal display using an I2C interface module (LCD I2C). This type of LCD has its own I2C port, which is attached to the pins of the LCD 1602. Furthermore, this LCD also has its contrast adjustment to control the LCD's lighting. These LCDs are perfect for showing only text/characters and have only four pins connecting them to the outside world: GND, VCC, SDA, and SCL. A 16x2-character LCD, with an LED backlight, can display 32 ASCII characters in two rows of 16 each.

Figure 3 shows the flow chart for the IoT-based smart electricity and power usage monitoring system. The data will be displayed for every 12 seconds through the LCD and wirelessly via Blynk app after the system is switched ON.

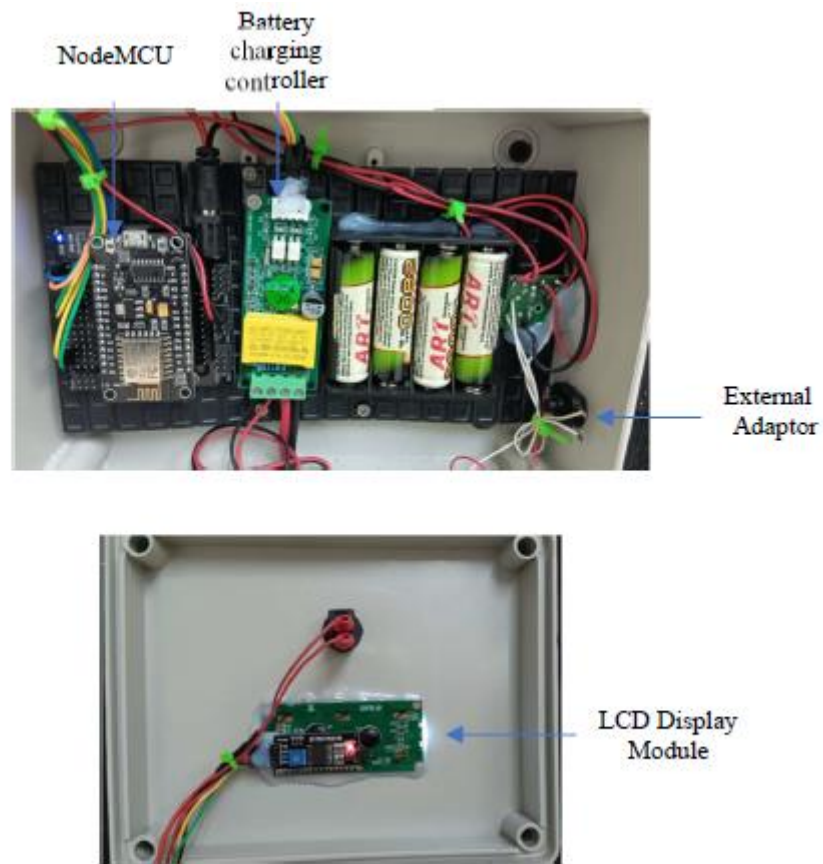


**Fig. 3.** Flowchart of the IoT-based smart electricity and power usage monitoring system

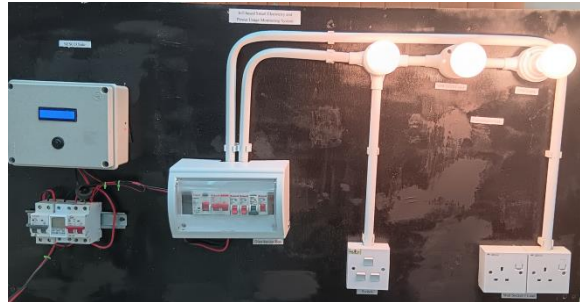
Figure 4 and Figure 5 show the implementation of the project. The system consists of an ON/OFF DC switch that controls the 6V supply into the Esp8266. The system also has a 230Vac plug or socket that is specifically for the PZEM-004T. The casing is 15cm in length and 19cm wide dimension. The output of the project is the I2C LCD that displays all the data measured by the sensor. The power source is from an AA sized of 1.5V, by using in total of four (4) AA sized batteries. The system is then installed to the residential wiring panel with distribution box, 3 lamp, wall sockets and switch as depicted in Figure 6 where it can measure electricity consumption.



**Fig. 4.** Prototype housing or casing top view



**Fig. 5.** Prototype housing internal view.



**Fig. 6.** Connection of the IoT-based Smart Electricity and Power Usage Monitoring System to the load

### 3 Results and discussion

Figure 7 shows the steps or “quick start” to the system.



**Fig. 7.** System monitoring display via LCD






**Fig. 8.** System Monitoring via Blynk

When the button shown in Figure 7 is pressed, the LCD screen activates, indicating that the system is ON. However, for the system to receive all previously specified parameters, the PZEM-004T sensor must be powered on by connecting it to any available plug or 230VAC socket. Additionally, the load's neutral cable is inserted into the coil before powering on the sensor. Following this, connect the system to Wi-Fi or any internet connection.

If all steps or precautions mentioned are correctly followed, then the value should be displayed via LCD screen and via the Blynk application as depicted in Figure 8. Specifically, V denotes voltage, A indicates current, E represents energy consumption measured in kilowatt- hours (kWh), P stands for power in Watt (W), and the cost is shown in Malaysian Ringgit (RM). This system calculates the cost in two ways: by referring to energy consumption or power. Table 1 and Table 2 below show the results and analysis for two different parameters used by the system.

**Table 1.** Analysis of the system's results according to various loads of energy consumption, kWh

Parameters		Type 1	Type 2	Type 3
Load, categorized with power (W)				
		10W	16W	67W
Energy consumptions (kWh) measured with time	30 minutes	0.000	0.005	0.02
	1 hour	0.002	0.01	0.04
Cost (RM) for	30 minutes	0.00	0.0005	0.002
	1 hour	0.0002	0.001	0.004

**Table 2.** Analysis of the system's results according to power, W




Parameters		Type 1	Type 2	Type 3
Load, categorized with power (W)				
		10W	16W	67W
Power (W) measured		24.5	29.0	69.5
Cost (RM)		2.45	2.95	6.95

Table 1 shows the analysis of the system reading uses energy consumption as its parameter for calculation purpose for 3 types of loads, 10W bulb, 16W bulb and 67W while Table 2 uses power as the parameter. This is done due to the relatively low in Watt, the load itself. The loads used for testing the system 10W and 16W lamp, as well as a 67W charging brick. As depicted in Table 1, even for a period of time, the value of energy consumption measured is still what is described as only 'fraction'. Thus, to demonstrate how the system should work, the parameter utilized in the system is changed to power, in



watts, rather than energy usage, in kilowatt per hour (kWh). The formula that the system used to calculate the cost in RM is  $\text{Cost} = \text{EnergyConsumption} * \text{tariffRate}$ , where the tariff rate is set to a default value of 0.05. Referring to Table 1, the 10W and 16 W bulbs represent low-power consumption, while the 67W charging brick represents a moderately higher consumption. It shows that the smart system has the ability to accurately capture energy consumption across this range. It is crucial as for the validation of its versatility and precision. According to Table 1, the energy consumption as well as the cost of appliances operation are directly correlates with the power rating of the load and the operation duration. It shows that higher power loads and longer operation times result in greater energy consumption. On the other hand, for short duration 30 minutes operation, the energy consumption remains relatively low, particularly for lower power loads like the 10W and 16 W bulbs. It is also observed that the 67W charging brick, despite being used for the same duration, incurs a significantly higher cost compared to the 10W and 16W bulbs due to its higher power consumption.

The data from Table 1 and Table 2 shows the overall performance of the smart meter system. High accuracy and consistency across both energy consumption, power measurements as well as the cost indicate the reliability of the developed system. By providing the precise energy consumption data and cost in real-time environment, the users are well informed on their electricity usage patterns and identify the opportunities such as substituting high-power appliances with more energy-efficient ones for energy saving and cost savings over time. This feature is especially beneficial and potential for managing energy consumption and cost reduction in non-metered areas.

## 4 Conclusion and Future Recommendation

In conclusion, the system is designed for users, primarily to reduce, or better yet, overcome the time-consuming process of monitoring each house's electricity. This system significantly reduced the need for human intervention as the system is made for real-time monitoring of the electricity parameters including energy consumption, kWh, and cost, RM. The use of IoT allows for accessible data via the web or smartphones, making it particularly useful for non-metered areas. The system's implementation enhances efficiency, accuracy and user convenience in energy monitoring. The project can be further developed and expanded by adding a solar system to power the main board of the system, replacing 6V lithium batteries to promote sustainability and support green technology. Additionally, this system can incorporate advance data analytic and machine learning algorithms to provide predictive insights on energy consumption patterns and cost-saving recommendations.

## References

1. Chaudhari, S., Rathod, P., Shaikh, A., Vora, D., & Ahir, J. (2017, May). Smart energy meter using Arduino and GSM. In 2017 International Conference on Trends in Electronics and Informatics (ICEI) (pp. 598-601). IEEE
2. Devadhanishini, A. Y., Malasri, R. K., Nandinipriya, N., Subashini, V., & Gowri, P. P. (2019, March). Smart power monitoring system using IoT. In 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS) (pp. 813-816). IEEE.
3. Gill, S. P. S., Suryadevara, N. K., & Mukhopadhyay, S. C. (2012, December). Smart Power monitoring system using wireless sensor networks. In 2012 Sixth International Conference on Sensing Technology (ICST) (pp. 444-449). IEEE.
4. Hasan, M. K., Ahmed, M. M., Pandey, B., Gohel, H., Islam, S., & Khalid, I. F. (2021). Internet of Things-based smart electricity monitoring and control system using usage data. *Wireless Communications and Mobile Computing*, 2021, 1-16.
5. Juhana, T., & Irawan, A. I. (2016, October). Smart non-intrusive power consumption monitoring system. In 2016 10th International Conference on Telecommunication Systems Services and Applications (TSSA) (pp. 1-4). IEEE.
6. Loganthurai, P., Shalini, M., Vanmathi, A., Veeralakshmi, M., & Vivitha, V. (2017, March). Smart energy meter billing using GSM with warning system. In 2017 IEEE International Conference on Intelligent Techniques in Control, Optimization and Signal Processing (INCOS) (pp. 1-4). IEEE.
7. Rahul, J., Sharma, S., Saxena, M., Chapola, R., & Yadav, R. K. (2022). GSM Based Smart Energy Meter Using Arduino Uno. *International Research Journal of Modernization in Engineering Technology and Science*, 4, 2088-2092.
8. Tupek, A., & Zrinjski, M. (2024). ABSOLUTE GNSS RECEIVER ANTENNA CALIBRATION AT THE FACULTY OF GEODESY – UNIVERSITY OF ZAGREB. *9th International Conference Contemporary Achievements in Civil Engineering, Subotica, SERBIA, May*. <https://doi.org/10.14415/CACE2024.52>



# Proximate Characteristics of Pegaga Leaves Grown in High Carbon Dioxide

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**Abstract.** Daily human activities have lead to an increase in anthropogenic carbon dioxide in the atmosphere. A method that can be used to utilize carbon dioxide and transform it into useful substances is plants. Plants use carbon dioxide during photosynthesis and convert it into substances needed by plants such as carbohydrates, proteins and others. Thus, this study was conducted to determine the effect of cultivation in high carbon dioxide conditions on the characteristics of pegaga (*Centella asiatica*) leaves. This experiment was carried out at two levels of carbon dioxide which were control (500 ppm) and 800 ppm, at a growing period of two weeks where the samples were collected every week. Proximate analysis was carried out to determine the moisture content, protein, fat, ash, crude fiber, and carbohydrate of pegaga leaves that is planted in high carbon dioxide air. The cultivation of *Centella asiatica* at high carbon dioxide levels showed a significantly higher growth of pegaga in terms of diameter and number of leaves ( $p < 0.05$ ). It was found that the content of protein and ash decreased significantly with increasing time ( $p < 0.05$ ). It was also found that there was no significant change in the level of moisture content, crude fiber and carbohydrates. Also, there was no significant decrease in the amount of fat found in pegaga leaves. In conclusion, utilizing a higher level of carbon dioxide during the growth of pegaga produced better growth but reduced protein and ash content with increasing time while moisture, fat, crude fiber and carbohydrate did not changed.

**Keywords:** High Carbon Dioxide, Centella Asiatica, Proximate Analysis, Growth, Protein

## 1 Introduction

It is well known that the increase in carbon dioxide gas in the Earth's surface atmosphere is negative to human life and health. Parallel to the progress of the world, the development and expansion of the world economies is being carried out rapidly. Daily human activities such as deforestation and the release of fumes from industries and transportation became one of the main causes of the increase in anthropogenic carbon dioxide gas (Smith *et al.* 2003).

Efforts have to be amplified in increasing the utilization of carbon dioxide to reduce its impact on the environment. More ideally if the utilization of carbon dioxide produces beneficial effects such as food production. As carbon dioxide is required for photosynthesis in plants, exposing the plants to high carbon dioxide may produce improved attributes in the yield. High carbon dioxide gas has been reported to affect plant nutrients such as protein and minerals (Ziska 2022). Therefore, this study was conducted to determine the effect of growing in high carbon dioxide on proximate properties using pegaga (*Centella asiatica*) as the experimental plant.

## 2 Literature review

Carbon dioxide is an important compound in the photosynthesis process for plant growth and for the existence of animal life (Tedesco 2022). Carbon dioxide is a naturally colorless and odorless gas. This gas has a boiling point of  $-70^{\circ}\text{C}$ , a density of  $1.53 \text{ kg/m}^3$  and is slightly soluble in water. Carbon dioxide gas plays an important role in regulating the earth's temperature (Goel & Agarwal 2014). Carbon dioxide is also known as carbonic gas which has a central carbon atom bound to two oxygen atoms through a covalent double bond (Bakhtyari *et al.* 2020).

Daily human activities such as industrial activities, transportation and development can cause environmental pollution and the greenhouse effect. This is due to the increase in carbon dioxide gas in the earth's atmosphere. An increase in carbon dioxide gas is a danger to human. The increase in the use of hydrocarbons has caused a 30% increase in the concentration of carbon dioxide since the beginning of the pre-industrial era (Bakhtyari *et al.* 2000). However, it can be turned into a benefit by using plants that is through the process of photosynthesis using the concept of Carbon Capture and Storage (Sharma 2021).

Pegaga is a type of herb that comes from the Apiaceae family and is also known by other names such as Gotu Kola (Thakurdesai 2021). Pegaga has various properties and also its own benefits. Pegaga is often used in traditional treatments and made into side dishes to eat. This is because pegaga is known as a good anti-aging agent (Arora *et al.* 2013). Hamzah

(2013) stated that pegaga has become one of the herbal plants with commercial potential. This is because pegaga is a type of plant that is easy to grow and its great health benefits have been proven through research. According to Banerjee *et al.* (2021), pegaga leaf extract is used as a cure for dysentery and helps in improving memory. In addition, pegaga has also been found to help in reducing depression (Pandey *et al.* 2022). Pegaga is also known as a herbal plant that contains high antioxidant content and various nutrients such as carbohydrates, proteins, fats, carbohydrates, vitamins and minerals (Chandrika & Prasad Kumara 2015).

### 3 Methodology

Pegaga saplings with roots of similar size were planted using organic compost soil and coconut coir (Green Star Valley, Petaling Jaya) in 8 small polybags with the size of 8.0 cm x 10.0 cm. Pegaga was planted in a planting box which is a plastic storage box that has been modified with channels for the supply of water and carbon dioxide. For the control, pegaga was grown using atmospheric air while for elevated CO<sub>2</sub>, CO<sub>2</sub> was pumped into the storage boxes to achieve an initial CO<sub>2</sub> level of 800 ppm. The pegaga was watered with 25 ml of water daily through the tube. Samples of the pegaga was planted for 1 and 2 weeks as the time period was adequate for sampling. Two replications for each combination of CO<sub>2</sub> level and growing period were prepared.

Proximate analysis which consisted of moisture content, crude protein, fat content, ash, crude fiber, and carbohydrate was determined according to *Association of Official Agricultural Chemist* (AOAC 2016) methods. Growth of the pegaga was determined based on the number and diameter for all pegaga leaves of each treatment. Measurements from all 8 polybags in each storage box were averaged.

### 4 Finding and Analysis

#### 4.1 Growth

Table 1 shows the leaf diameter of the pegaga for weeks 0, 1 and 2 for the 500 and 800 ppm carbon dioxide levels. Meanwhile, Table 2 shows the number of leaves of for weeks 0, 1 and 2 for the 500 ppm carbon dioxide level and 800 ppm.

**Table 1.** Pegaga leaf diameter (cm) at different growth weeks and CO<sub>2</sub> levels

Week	CO <sub>2</sub> level (ppm)	
	500	800
0	2.40 ± 0.14 <sup>c</sup>	2.30 ± 0.28 <sup>c</sup>
1	2.85 ± 0.07 <sup>c</sup>	3.20 ± 0.28 <sup>bc</sup>
2	4.05 ± 0.50 <sup>b</sup>	5.25 ± 0.21 <sup>a</sup>

<sup>a-c</sup> Means from any column and row with different alphabets are significantly different ( $p < 0.05$ ).

At weeks 0 and 1, the average diameter of the leaves of the control and 800 ppm carbon dioxide levels were seen to have no significant changes. However, the leaf diameter of the control carbon dioxide level in week 2 was seen to be significantly lower ( $p < 0.05$ ) compared to the leaf diameter of the control carbon dioxide level of 800 ppm.

**Table 2.** The number of leaves in the week of growth and different CO<sub>2</sub> levels.

Week	CO <sub>2</sub> level (ppm)	
	500	800
0	71 ± 1 <sup>d</sup>	71 ± 0 <sup>d</sup>
1	80 ± 1 <sup>c</sup>	95 ± 1 <sup>b</sup>
2	97 ± 3 <sup>b</sup>	139 ± 3 <sup>a</sup>

<sup>a-d</sup> Means with different alphabets are significantly different ( $p < 0.05$ ).

At week 0, the number of leaves of pegaga for the control carbon dioxide level and 800 ppm was seen to have no significant changes. However, the number of leaves for the 500 ppm carbon dioxide level in weeks 1 to 2 was seen to be significantly lower ( $p < 0.05$ ) compared to the number of leaves for the 800 ppm carbon dioxide level. This result is supported by the study of Lamichaney *et al.* (2021). According to Lamichaney, the increased concentration of carbon dioxide in the air has increased the rate of photosynthesis. This leads to an increase in plant growth.

#### 4.2 Crude protein

The protein content in pegaga leaves was recorded as in Table 3.

**Table 3.** Protein content (%) of pegaga leaves at different growth weeks and CO<sub>2</sub> levels

Week	CO <sub>2</sub> level (ppm)	
	500	800
0	4.16 ± 0.17 <sup>ab</sup>	4.61 ± 0.58 <sup>a</sup>
1	3.35 ± 0.21 <sup>abc</sup>	2.69 ± 0.54 <sup>a</sup>
2	3.08 ± 0.73 <sup>abc</sup>	2.01 ± 0.10 <sup>c</sup>

<sup>a-c</sup> Means from any column and row different alphabets are significantly different ( $p < 0.05$ ).

The protein content of pegaga leaves grown in the control carbon dioxide air did not show significant changes in weeks 0 to 2. In contrast to the protein content at the carbon dioxide concentration of 800 ppm which showed a significant decrease until the second week ( $p < 0.05$ ). However, cultivation at the control level and 800 ppm did not show significant changes in the protein content of pegaga leaves at weeks 0, 1 and 2.

According to Taub *et al.* (2008), plants that grow in high carbon dioxide air areas have lower protein values. Dilution by increased non-structural carbohydrates has been proposed as a mechanism to explain the decrease in N and protein concentrations (Gifford *et al.* 2000).

### 4.3 Ash

The amount of ash or mineral content in pegaga leaves grown at two levels of carbon dioxide of 500 and 800 ppm is shown in Table 4. In weeks 0,1 and 2, the ash content of pegaga leaves grown in control carbon dioxide air did not show significant changes. The ash content at a carbon dioxide air concentration of 800 ppm also did not show significant changes but up to the first week. However, it was seen that there was a significant decrease in ash content ( $p < 0.05$ ) when planting in high carbon dioxide concentration of 800 ppm for the second week.

**Table 4.** Ash content (%) at different growth weeks and CO<sub>2</sub> levels

Week	CO <sub>2</sub> level (ppm)	
	500	800
0	2.01 ± 0.03 <sup>ab</sup>	2.80 ± 0.25 <sup>a</sup>
1	1.75 ± 0.28 <sup>b</sup>	1.82 ± 0.38 <sup>ab</sup>
2	1.32 ± 0.33 <sup>bc</sup>	0.51 ± 0.02 <sup>c</sup>

<sup>a-c</sup> Means with different alphabets are significantly different ( $p < 0.05$ ).

### 4.4 Moisture content, fat content, crude fiber and carbohydrate

No significant differences were observed for moisture content, fat content, crude fiber and carbohydrate.

## 5 Conclusion

Based on the results of this study, the use of high carbon dioxide during the growth of pegaga showed significantly higher growth ( $p < 0.05$ ). However, proximate parameters which include moisture content, crude protein, fat content, ash, crude fiber and carbohydrate did not show any significant differences compared to the 500 ppm level of carbon dioxide. The inexistence of significant differences for the proximate parameters suggested no adverse effect when using high carbon dioxide levels during the cultivation of pegaga (*Centella asiatica*).

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## References

1. Association of Official Analytical Chemists (AOAC). 2016. *Official Methods of Analysis*. 20th ed. USA: AOAC Inc.
2. Arora, R., Sharma, J., Selvamurthy, W., Shivashankara, A.R., Mathew, N. & Baliga, M.S. 2013. Chapter 23 - Asian Medicinal Remedies for Alleviating Aging Effects. In. Watson, R.R. & Preedy, V.R. (Eds.). *Bioactive Food as Dietary Interventions for the Aging Population*, Pp. 305-320. San Diego: Academic Press.
3. Bakhtyari, A., Mofarahi, M. & Lee, C.H. 2020. Chapter 9 - CO<sub>2</sub> adsorption by conventional and nanosized zeolites. In. Rahimpour, M. R., Farsi, M. & Makarem, M.A. (Eds.). *Advances in Carbon Capture*, Pp. 193-228. Woodhead Publishing.
4. Banerjee, A., Pavane, M.S., Banu, L.H., Gopikar, A.S.R., Elizabeth, K.R. & Pathak, S. 2021. Chapter 20 - Traditional medicine for aging-related disorders: Implications for drug discovery. In. Pathak, S. & Banerjee, A. (Eds.). *Stem Cells and Aging*, Pp. 281-297. Academic Press.
5. Chandrika, U.G., & Prasad-Kumara, P.A. 2015. Gotu Kola (*Centella asiatica*): Nutritional Properties and Plausible Health Benefits. *Advances in food and nutrition research* 76:125–157.

6. Pandey, P., Awasthi, R., Dhiman, N., Sharma, B. & Kulkarni, G.T. 2022. Chapter 23 - Ethnopharmacological reports on herbs used in the management of tuberculosis. In. Sarwat, M. & Siddique, H. (Eds.). *Herbal Medicines*, Pp. 501-523. Academic Press.
7. Smith, K. A., Ball, T., Conen, F., Dobbie, K. E., Massheder, J. & Rey, A. 2003. Exchange of greenhouse gases between soil and atmosphere: interactions of soil physical factors and biological processes. *European Journal of Soil Science* 54(4): 779-791.
8. Gifford, R. M., Barrett, D. J. & Lutze, J. L. 2000. The effects of elevated CO<sub>2</sub> on the C: N and C: P mass ratios of plant tissues. *Plant and Soil* 224: 1-14.
9. Goel, S. & Agarwal, D. 2014. Carbon Dioxide. In. Wexler, P. (Eds.). *Encyclopedia of Toxicology (Third Edition)*, Pp : 675-677. Oxford: Academic Press.
10. Hamzah, N.M. 2013. Growth and yield performance of Pegaga (*Centella asiatica*) to different types of organic fertilizer and levels of planting media. Proceedings for KONAKA Academic Conference 2013. Universiti Teknologi Malaysia (UiTM). Gambang, Pahang, 28-29th October.
11. Lamichaney, A., Tewari, K., Basu, P.S., Katiyar, P.K. & Singh, N.P. 2021. Effect of elevated carbon-dioxide on plant growth, physiology, yield and seed quality of chickpea (*Cicer arietinum* L.) in Indo-Gangetic plains. *Physiology and Molecular Biology of Plants* 27(2): 251-263.
12. Sharma, S., Rana, V.S., Prasad, H., Lakra, J. & Sharma, U. 2021. Appraisal of Carbon Capture, Storage, and Utilization Through Fruit Crops. *Frontiers in Environmental Science* 9: 700-768.
13. Taub, D.R., Miller, B. & Allen, H. 2008. Effects of elevated CO<sub>2</sub> on the protein concentration of food crops: a meta-analysis. *Global Change Biology* 14(3): 565-575.
14. Tedesco, S. A. 2022. Chapter 3 - Geology of helium, carbon dioxide, and nitrogen case histories and sources. In. Tedesco, S. A. (Eds.). *Geology and Production of Helium and Associated Gases*, Pp: 61-251. Elsevier.
15. Thakurdesai, P.A. 2021. Chapter 21 - *Centella asiatica* (Gotu kola) leaves: potential in neuropsychiatric conditions. In. Ghosh, D. (Eds.). *Nutraceuticals in Brain Health and Beyond*, Pp. 307-328. Academic Press.
16. Ziska, L. H. 2022. Rising Carbon Dioxide and Global Nutrition: Evidence and Action Needed. *Plants (Basel)* 11(7): 10000.

# A Digital Evaluation System for Final Year Projects Using Google Workspace

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**Abstract.** The rapid advancement of digital technologies, especially in education, has led to the widespread adoption of electronic evaluation (e-evaluation) systems. These systems, which incorporate information and communication technologies (ICT), offer several advantages over traditional methods, such as improved efficiency, accuracy, and scalability. One such system, the FJK Digital Evaluation System for Final Year Projects at Polytechnic Kuching Sarawak, demonstrates this transition by simplifying project registration, evaluation, and data management processes. The system utilizes Google Workspace digital tools like Google Forms, Google Sheets, Google Drive, and Google Docs to create an integrated platform for managing evaluation. Additionally, the use of QR codes enhances efficiency by providing easy access to digital evaluation forms. Despite these benefits, challenges like user training and data security need to be addressed for successful implementation. Thus, this system represents a significant advancement in student project evaluation, overcoming the limitations of traditional evaluation methods and fostering continuous improvement in education.

**Keywords:** Digital Technologies, E-evaluation Systems, ICT (Information and Communication Technologies), Google Workspace Tools, QR Codes

## 1 Introduction

The integration of digital technologies into education has significantly transformed various aspects of academic processes, especially in evaluation methods. Electronic evaluation (e-evaluation) systems, which leverage information and communication technologies (ICT), have gained attention due to their enhanced efficiency, accuracy, and scalability (Castillo-Manzano, J. I. et. al., 2023). These systems offer a modern solution to the limitations of traditional evaluation methods, making them highly relevant in today's educational environment. Previous research has highlighted the benefits of digital tools in education, including improved data management and more efficient processes, which enhance the overall effectiveness of educational systems (Abbad, M., & Jaber, F., 2014).

Despite their benefits, e-evaluation systems encounter various challenges, including the need for user training and ensuring data security, which may hinder their successful adoption of the system. Polytechnic Kuching Sarawak requires a comprehensive e-evaluation system specifically designed for final year projects. The absence of an integrated, user-friendly system highlights the need to develop a solution that fills these gaps and improves the evaluation process overall.

The main objective of this paper is to design and develop the FJK Digital Evaluation System for Final Year Projects at Polytechnic Kuching Sarawak. The study aims to design and develop an effective system that simplifying evaluation procedures and enhancing overall efficiency. This system is important because it offers a scalable and flexible solution that other educational institutions can use to tackle similar issues.

The rest of the paper is divided into four parts after this introduction. In Section 2, the literature review is presented examines existing research on e-evaluation systems and identifies gaps. In Section 3, the methodology section details the system block diagram and system design. Results and discussion of the design system are presented in Section 4. Lastly, the conclusion is outlined in Section 5.

## 2 Literature review

Previous literature indicates that electronic evaluation systems enhance the efficiency and precision of evaluation procedures. Specifically, digital tools such as Google Forms and Google Sheets enable rapid data collection and real-time analysis, which minimizes the errors often linked with manual data entry (Akcil et al., 2021).

E-evaluation systems improve scalability and accessibility, enabling educational institutions to effectively handle large numbers of student assessments. The utilization of Google Workspace tools has proven especially advantageous in developing scalable solutions that are easily accessible to both students and educators (Martín-Herrera, 2021).

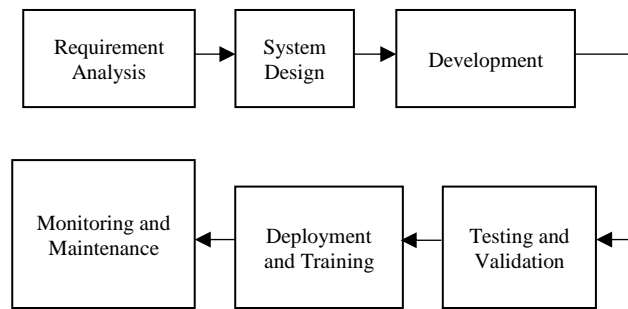
Although there are advantages, training users and getting them to adopt new systems are still major challenges. To successfully implement e-evaluation systems, comprehensive training programs are essential to ensure users can effectively use digital tools. Previous studies emphasize the need for continuous support and training to tackle these challenges (Giannakos et al., 2022).

The analysis of the literature reviewed suggests that e-evaluation systems bring various advantages, but they also come with implementation challenges. The incorporation of Google Workspace tools has been well-received, leading to enhanced efficiency and user satisfaction. However, there is a need to tackle concerns regarding data security and user training to fully exploit the capabilities of these systems (Ventayen & Estira, 2023).

### 3 Methodology

#### 3.1 Block diagram

The Digital Evaluation System was developed and implemented using a structured approach to ensure its effectiveness and acceptance by users. The process shown in Figure 1.



**Fig. 1.** Block Diagram representing the Methodology for the Digital Evaluation System

During the requirement analysis stage, a series of interviews and surveys were administered to a diverse group of stakeholders, such as students, supervisors, evaluators, and administrators, to collect extensive requirements. This approach facilitated the identification of crucial functionalities, user roles, and system limitations. The gathered data was subsequently organized into a comprehensive requirement specification document, which detailed the system's features and performance standards, ensuring the fulfillment of all stakeholders' needs and expectations.

In the system design phase, a system architecture diagram was created to outline the structure and elements of the digital evaluation System. Database schemas were developed to efficiently manage user data, project information, and assessment records. Additionally, sketches and user interface designs were created to ensure the system was user-friendly, promoting ease of use for all participants.

During the development phase, Google Workspace tools, including Google Forms, Google Sheets, Google Drive, and Google Docs, were employed for rapid development and deployment. Secure authentication and authorization measures were put in place to safeguard user information. Custom scripts were written for QR code generation, data processing, and automated report creation. Iterative testing was carried out throughout this phase to confirm the system's functionality, usability, and performance.

The testing and validation phase involved conducting unit tests on individual components and features. Subsequently, system testing was performed to verify the integration and interaction of these components. A pilot group of users participated in testing to identify and fix any issues. Feedback from these testing stages was used to refine and improve the system, ensuring it met all specified requirements.

In the deployment and training phase, the system was launched on the institution's network, ensuring secure access and scalability. Training sessions were conducted for students, supervisors, and evaluators to help them become familiar with the system. User manuals and support resources were provided to assist users in navigating and utilizing the system effectively, ensuring a smooth transition.

During the monitoring and maintenance phase, mechanisms were established to monitor system performance and user activity. Regular maintenance schedules were implemented to continuously update and enhance system features. A technical administrator were available to address user queries and technical issues, ensuring the system remained efficient and reliable over time.

#### 3.2 System design of FJK digital evaluation system

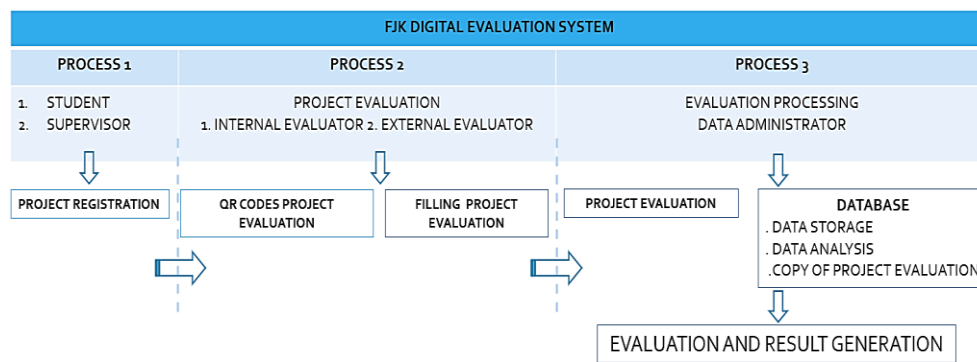
The FJK digital evaluation system is a comprehensive system designed to enhance the evaluation process for student projects.

The system consists of three main processes which are Project Registration, Project Evaluation, Evaluation Processing as shown in Figure 2.

The Project Registration process involves students and project supervisors. It includes an online registration portal accessible via the institution's intranet or website. The portal features secure login and authentication mechanisms for students and supervisors. User-friendly registration forms are integrated with a database to store project details. Additionally, the system includes confirmation and notification features to inform users of successful registration.

Involving internal and external assessors, the Project Evaluation process includes the generation of unique QR codes for each project. These codes enable evaluators to easily access project details and evaluation forms. The system utilizes digital evaluation forms created using Google Forms, ensuring a standardized format. It also provides secure access for evaluators to evaluate projects, with built-in validation to ensure the completeness and consistency of evaluations. Real-time data submission and storage to the central database are also part of this process.

Involving data administrators, this evaluation processing process includes automated data processing scripts to aggregate and analyze evaluation data. The system integrates with Google Sheets for data analysis and reporting. It ensures secure data storage using Google Drive, ensuring data integrity and accessibility. Additionally, the system features tools for generating comprehensive evaluation reports and results.



**Fig. 2.** A FJK Digital Evaluation System Design Flow Process

## 4 Results and discussion

Figure 3 illustrates the process of registering a project by a student or project supervisor. It starts with filling out the Confirmation E-Form Template, which captures basic project details and serves as a formal declaration for registration. After confirmation, the project undergoes evaluation using the Evaluation E-Form, where evaluators assess the project's rubric. Upon passing evaluation, a unique Project Registration QR Code is generated for easy access to the project's registration details, ensuring all necessary information is readily available and easily verifiable. This approach aligns with best practices in digital record-keeping (Ramasamy, L. K., & Khan, F. ,2024), ensuring that all necessary information is readily available and easily verifiable.

Figure 4 shows the Project Evaluation by Internal Evaluator and External Evaluator process. The evaluation process involves both an internal and an external evaluator and starts with the Project Registration QR Code. This QR code makes it easy to access project details, ensuring all necessary information is easily available. Both internal and external evaluators use this QR code to retrieve project data. After this, the Evaluator ID Entry step requires each evaluator to input their unique ID, confirming their identity and authorization for project assessment. This step ensures that the evaluation process is accountable and that it can be easily tracked or traced. The Student Project Information Section provides details about the student's project. Next, in the Evaluation Section, both internal and external evaluators provide their assessments.

The Individual Evaluation Process, shown in Figure 5, starts with completing the evaluation. After that, the results are recorded on the Project Evaluation Data Sheet. This sheet ensures that everything is systematically documented and easy to reference. Next, the evaluation data is securely stored in Google Drive, making it accessible to authorized personnel and safe from loss. The following step is system verification, where the stored data is cross-checked for accuracy and integrity, ensuring reliable results. Finally, an Individual Evaluation E-Form is used to compile and formalize the data, making it ready for review and further action. This structured approach ensures thorough documentation, secure storage, and accurate verification of each evaluation.

The Consolidation Evaluation Process, shown in Figure 6, starts with the Evaluation Consolidation Process. This involves consolidating evaluation forms from both internal and external evaluators. The goal of this step is to ensure that all relevant information is consistently captured across different evaluations. Once the Consolidation Individual Evaluation E-Form is completed, a copy is made to ensure data integrity and to provide a backup. This approach simplifies the evaluation workflow, promotes consistency, and improves the accuracy and reliability of the consolidated outcomes.

Figure 7 shows the E-Folders and System E-Documents used in project management. These folders and documents are crucial for organizing and storing project information effectively. The Consolidation Evaluation E-Folder contains Consolidation Evaluation E-Forms, which summarize evaluations from various sources. The Individual Evaluation E-Folder

stores evaluations from specific evaluators. The Project Registration E-Folder stores Project Registration Confirmation E-Forms, formal declarations for project registration. Specific templates and forms like the Consolidation Evaluation E-Form Template, Individual Evaluation E-Form

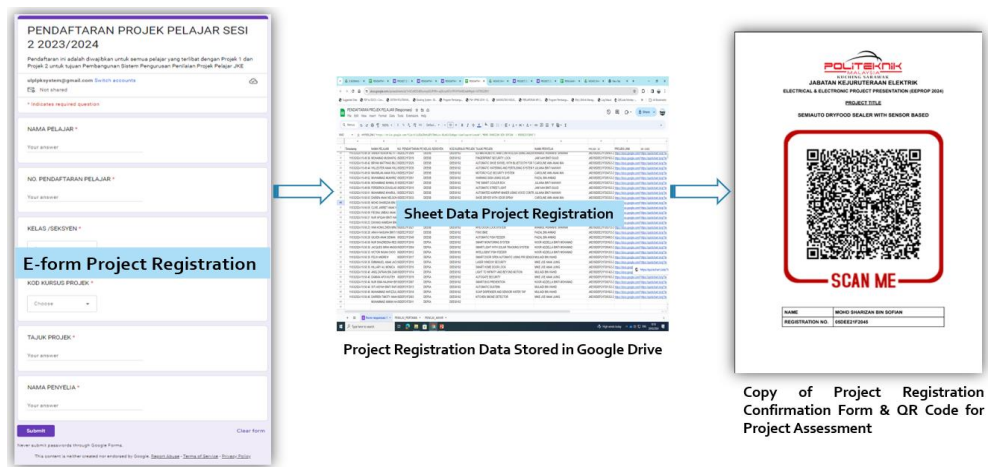


Fig. 3. Project Registration by Student or Project Supervisor

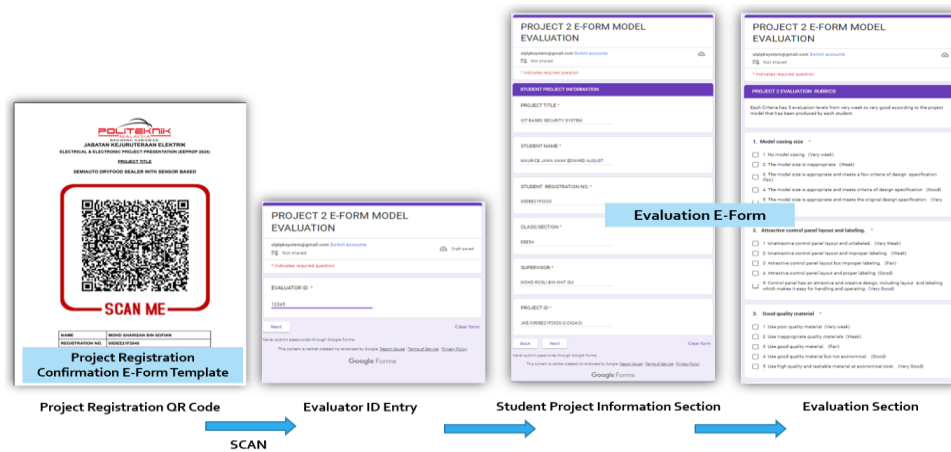


Fig. 4. Project Evaluation by Internal Evaluator and External Evaluator

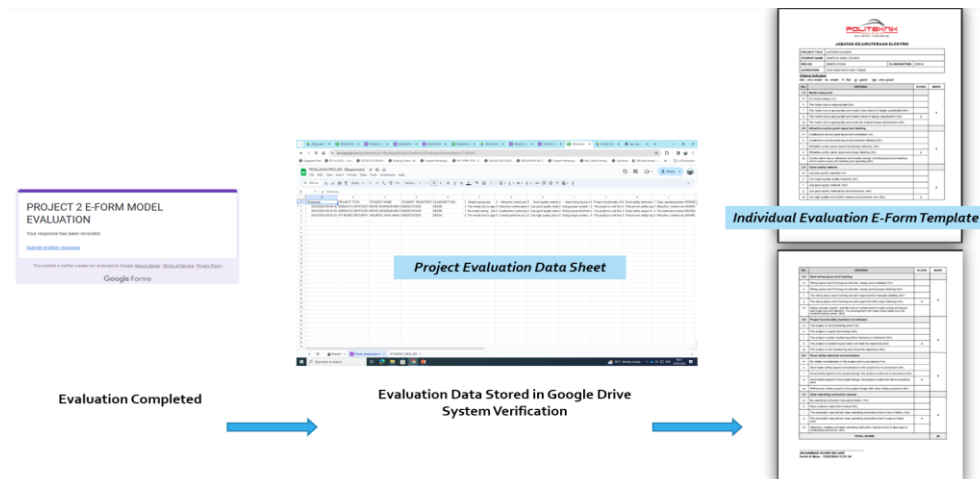
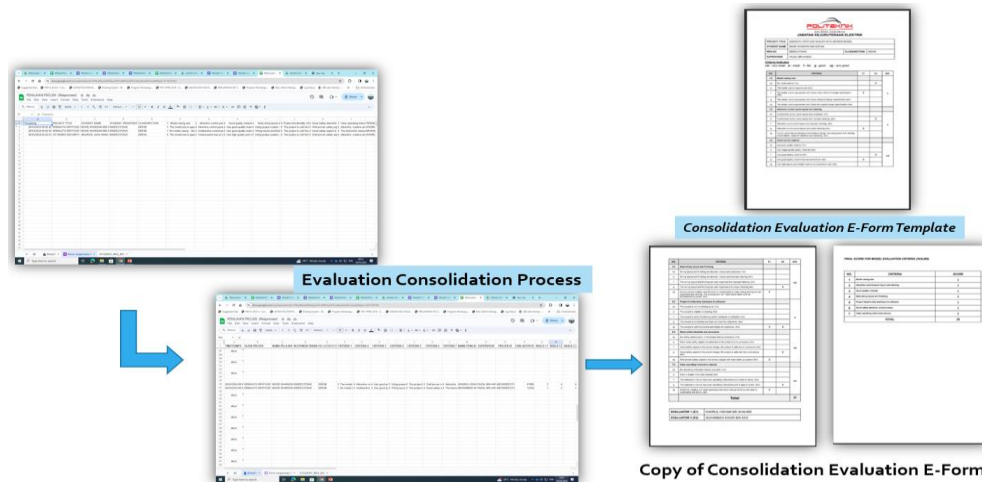
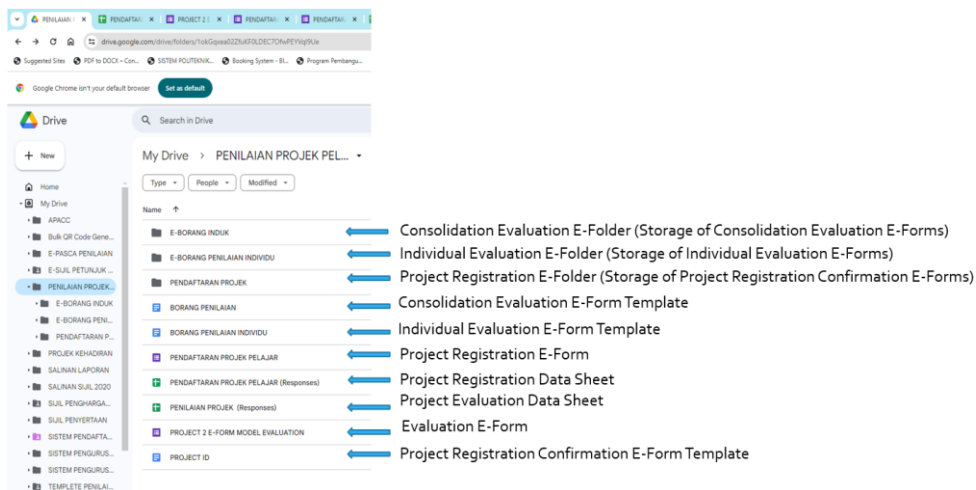


Fig. 5. Individual Evaluation Process





**Fig. 6.** Consolidation Evaluation Process



**Fig. 7.** List of E-Folders and System E-Documents

Template, Project Registration E-Form, and others serve specific purposes in project management. These documents and folders ensure project information is well-organized and easily accessible throughout the project lifecycle.

The structured approach to project registration and evaluation outlined in this system significantly enhances the efficiency, accuracy, and accountability of the project management process (Khalid, M. I. et. al., 2022). By leveraging digital tools and systematic documentation practices, this FJK Digital Evaluation System supports the successful management and evaluation of student projects (Saihi, A. et. al., 2023).

## 5 Conclusion

The FJK Digital Evaluation System for Final Year Projects, using Google Workspace tools, represents a significant advancement in evaluating student projects in education. Its implementation demonstrates how e-evaluation systems can improve efficiency, accuracy, and scalability over traditional methods. This system simplifies project registration, evaluation, and data management, making administrative tasks easier and providing a more user-friendly experience for students and evaluators.

Despite these benefits, challenges like user training and data security must be addressed for successful implementation. Solving these challenges is crucial for maximizing the benefits of such systems in education. Future design systems could focus on integrating digital technologies to enhance user experience and tackle emerging challenges. Expanding the system's capabilities to cover more aspects of project management and evaluation could also improve its effectiveness. It is also recommended to conduct surveys with students and evaluators in the future to assess the reduction in administrative workload, the increase in evaluation speed, and the improvement in user satisfaction rates. In summary, the FJK Digital Evaluation System reflects the changing landscape of student project evaluation, emphasizing the importance of adopting digital tools for continuous improvement in education. Its successful use highlights the transformative impact of digital technologies in modern educational practices.

## References

1. Castillo-Manzano, J. I., Castro-Nuño, M., López-Valpuesta, L., Sanz-Díaz, M. T., & Yñiguez, R. (2023). Evaluating the design of digital tools for the transition to an e-continuous assessment in higher education. *Journal of Computing in Higher Education*, 1-19.
2. Abbad, M., & Jaber, F. (2014). Evaluating E-learning systems: An empirical investigation on students' perception in higher education area. *International Journal of Emerging Technologies in Learning (Online)*, 9(4), 27.
3. Akcil, U., et al. (2021). Integration of Technology to Learning-Teaching Processes and Google Workspace Tools: A Literature Review. *Sustainability*, 13(9), 5018.
4. Giannakos, M. N., et al. (2022). Systematic Literature Review of E-Learning Capabilities to Foster Competency-Based Learning. *Journal of Educational Technology*, 34(2), 123-137.
5. Martín-Herrera, I. (2021). Google Workspace as a b-learning platform. Analysis of the perceptions of the Degrees in Communication. *Apuntes*, 34(1), 112-135.
6. Ventayen, R. J. M., & Estira, K. L. B. (2023). Usability Evaluation of Google Classroom: Basis for the Adaptation of GSuite E-Learning Platform. *Semantic Scholar*, 45(1), 89-102.
7. Ramasamy, L. K., & Khan, F. (2024). Secure and Transparent Educational Data Record-Keeping with Blockchain. In *Blockchain for Global Education* (pp. 147-164). Cham: Springer Nature Switzerland.
8. Khalid, M. I., Iqbal, J., Alturki, A., Hussain, S., Alabrah, A., & Ullah, S. S. (2022). [Retracted] Blockchain-Based Land Registration System: A Conceptual Framework. *Applied Bionics and Biomechanics*, 2022(1), 3859629.
9. Saihi, A., Awad, M., & Ben-Daya, M. (2023). Quality 4.0: leveraging Industry 4.0 technologies to improve quality management practices—a systematic review. *International Journal of Quality & Reliability Management*, 40(2), 628-650. *Internet of Thing. 5th FIRST T1 T2 2021 International Conference (FIRST-T1-T2 2021)*,

# Economic Evaluation of Aerobic Windrow Composting Facilities for Food Waste Management Using Life Cycle Costing Analysis

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**Abstract.** Given the substantial financial investments in waste disposal in Malaysia, it is imperative to reassess and rigorously monitor legislative compliance and implementation. Effective waste management is contingent on robust supervision, regulation, and precise cost evaluations. However, there is a scarcity of detailed cost analysis tailored to Malaysian conditions, with limited studies addressing this issue comprehensively. Not all waste management strategies, such as aerobic windrow composting (Sc1) or integrated systems combining windrow and landfill (Sc2), have been thoroughly investigated. This article proposes a comprehensive framework for evaluating the economic performance of two distinct food waste (FW) treatment scenarios (Sc1 and Sc2) using life cycle costing (LCC) analysis. This focus is particularly relevant as FW constitutes the highest proportion of Malaysian municipal solid waste. The LCC methodology employs the present worth method with a 10% discount rate over a 15-year period to compare the economic viability of these scenarios. The findings indicate that the integrated aerobic windrow with landfill (Sc2) is the most economically viable option, with a net LCC of RM41 per ton of FW, attributed to its higher treatment capacity of 1800 tons per day over the 15-year lifespan. Conversely, aerobic composting methods are crucial for the long-term treatment of organic and FW, as they biologically stabilize FW into bio-fertilizer as by-products. The windrow method is identified as the second most economical alternative, with a net LCC of RM66 per ton of FW. This research facilitates decision-making in Malaysia by providing a comprehensive LCC analysis, focusing on the establishment of a systematic, on-site, and real-scale organic waste treatment system.

**Keywords:** life cycle costing analysis, waste dispose, aerobic windrow composting, landfill composting

## 1 Introduction

Food waste (FW) has become a global issue, drawing significant concern due to its economic impacts. Effective FW management through prevention, valorization, and management strategies can mitigate these impacts. Life cycle thinking approaches, such as life cycle costing (LCC), are effective tools for evaluating these strategies' sustainability (De Menna et al. 2018; Brenes-Peralta et al. 2020). LCC analysis assesses a project's economic aspects, encompassing all costs from initiation to decommissioning, including operation, maintenance, and energy expenses, discounted over the same period (Sharma & Chandel, 2021). Despite its importance, the lack of real cost data and limited literature make economic analysis challenging, highlighting the need for further research in this area (Sharma & Chandel, 2021).

Research on FW management using LCC frameworks supports decision-making. For example, Abduli et al. (2011) found landfill scenarios to be economically preferable in Tehran, while Sharma & Chandel (2021) identified a combination of recycling and sanitary landfill as the most viable option in India.

Recent years have seen increased research on FW treatment technologies, such as aerobic and anaerobic methods, in Malaysia. Studies by Keng et al. (2020), revealed that aerated static piles for FW treatment on a university campus in Malaysia cost MYR 5018 per year. Lim et al. (2019), Zulkepli et al. (2017), Lim et al. (2017), and Bong et al. (2017) have examined disposal methods like landfilling, anaerobic digestion (AD), and composting in Selangor, Johor Bahru, and Kulai. Aerobic windrow systems are cost-effective if space is available, particularly for composting large volumes of waste (>10 tons), due to minimal capital expenditures for site construction and equipment (Lim et al. 2017).

Anaerobic digestion systems, such as single-stage dry continuous and wet high-rate systems, effectively treat organic waste with lower water and power usage (Van et al. 2020). The dry continuous system is more suitable for urban areas with limited space due to its compact reactor, minimal wastewater discharge, and efficient waste composting (Van et al. 2020). However, AD systems particularly in Malaysia are technically complex and costly, requiring precise management (Zulkepli et al. 2017). Challenges in Malaysia include financial constraints, plant-to-grid distances, and a lack of skilled professionals (Keng et al. 2020).

Given the significant funds invested in Malaysian waste disposal, it is crucial to reassess legislative compliance and conduct detailed cost analyses (Pavlas et al. 2010). This study aims to perform an LCC analysis using the present worth method to identify the most cost-effective of the existing commercial scale for Malaysian FW management option. The goal is to determine whether aerobic windrow or integrated aerobic windrow with landfill systems offer financial benefits, aiding policy-making and supporting the development of a circular economy in Malaysia.

## 2 Literature review

### 2.1 Types of LCC

Table 1 reviews studies on LCC. The standardization of LCC methodologies is still in its early stages due to a lack of consensus on definitions and approaches (De Menna et al. 2018). Research on the LCC of FW is limited and generally focuses on FW management rather than prevention or valorization of specific flows. Effective FW prevention, valorization, and management require consistent integration of LCC and life cycle assessment (LCA) to avoid trade-offs between environmental and economic impacts. De Menna et al. (2018) identify three primary LCC methods: conventional (C-LCC), environmental (E-LCC), and societal (S-LCC), which differ in perspective, expenses included, and potential applications. This categorization has been used in subsequent research (Sharma & Chandel, 2021; De Menna et al. 2020; Edwards et al. 2018; Martinez-Sanchez et al. 2015), as summarized in Table 1.

**Table 1.** LCC studies of various conditions reviewed

Treatment Technology	Country	Topic	Summary of LCC studies of Waste Management						Ref.
			Approach	LCC Analysis	Formula Applied	Discount Rate	Inflation rate	Life span	
Mrf-Slf, Mrf-Com-Slf, Mrf-AD-Slf, Mrf-Com-AD-Slf, Mrf-Com-Inc, Mrf-Inc	Mumbai, India	MSW	LCCA	PWM	$LCC (INR/tonne) = \text{Capital Cost (INR/tonne)} + (\text{O\&M cost (INR/tonne)} \times \frac{UPWF}{E})$ $UPWF = \left( \frac{1+r}{i-r} \right) \left[ 1 - \left( \frac{1+r}{1+i} \right)^n \right]$	11.25%	7.61%	20-years	(Sharma & Chandel, 2021)
Demineralized water plant in the Netherlands, Coal mine discharge in Poland, Textile industry in Turkey, Silica industry in Spain	Sweden, Netherlands, Spain	The treatment of brine wastewater	Eloc	NA	NA	NA	NA	20 years	(Harris et al. 2021)
Conventional (CV) scenario, On-site composting (OC) scenario, Centralized composting (CC) scenario	The southern part of Shiga, Japan	FW	S-E LCC	The induced gross value added and employment inducement effect	$E_o = E - E_d$ $L_o = L - L_d$	NA	NA	Fully serves for spinach cultivation only	(Yoshikawa et al. 2021)
HS-AdD, incineration, composting, and landfilling, with and without gas use	Hillsborough County, Florida in the U. S. A	Organic fraction of municipal solid waste FW, YW	LCCA	UPV* is a non-uniform present value factor	$LCC = \{G + (C_{O\&M} \times UPV^*) + (C_{CH} \times UPV) + (C_{EL} \times UPV) - (C_{R\&B} \times UPV) - (C_{R\&D} \times UPV) - (C_{R\&E} \times UPV^*)\} / RU$	1.89%	0.65%	20-years	(Lee et al. 2020)
LF: Landfill, AD1: Anaerobic Digestion in a centralized plant, AD2: Anaerobic Digestion in a semi-centralized alternative, CP1: Takakura Composting in a centralized plant, CP2: Takakura Composting in a semi-centralized alternative	Five universities located in and nearby the Central Valley of Costa Rica in Latin America	FW from a consortium of five universities	ELCC	NA	NA	NA	NA	Yearly FW treatment	(Brenes-Peralta et al. 2020)
Community-scale aerated static pile composting system	University of Nottingham, Malaysia	FW	ELCC	Economic analysis	NA	NA	NA	6-4/month organic waste treatment system	(Keng et al. 2020)
RS1_Prevention, RS2_Side flow valorization, RS3_Valorization, RS4_End of life treatment	Italy	EW_school canteen	ELCC	Tree cost analysis	NA	NA	NA	NA	(De Menna et al. 2020)
Aerobic windrow composting, Landfill	Johor Bahru, Malaysia	FW	CLCC	Cost and benefit analysis	NA	NA	NA	The cost to produce 1 kg of compost for the community-composting plant	(Lim et al. 2019)
NA	Sheffield, UK	-	ELCC	NPV	$T_{ELCC} = \sum_{Raw\ materials} C_n X_n + \sum_{Manufacturing} C_n X_n + \sum_{Distribution} C_n X_n + \sum_{External} C_n X_n$ $NPV = \sum_{t=0}^n \frac{C_t}{(1+i)^t}$	NA	NA	NA	(Miah et al. 2017)

Anaerobic Digestion, In-Vessel Composting, Incineration and Landfilling	United Kingdom	FW	LCC	NA	$LCC = C_A + C_O + C_C$ (€/t FW) where: LCC total life cycle costs of waste treatment option (€/t FW) $C_A$ costs to the local authority (€/t FW) $C_O$ cost to the operator of treatment facility (€/t FW) $C_C$ costs to the consumer (€/t FW).	NA	NA	NA	(Slorach et al. 2019)
Aerobic Windrow, Landfill		FW	CLCC	NA	NA	NA	NA	NA	(Bong et al. 2017)
WWTP	Melton city council, Sutherland shire council	FW	E-LCC, S-LCC	NA	NA	NA	NA	One years' worth of SS generated at the local WWTP	(Edwards et al. 2018)
Scenarios (A1, A3, A4, A5) consisting of several measures that might reduce potato losses, scenarios (A2) that might hold total losses constant but could improve the environmental performance of the whole supply chain, combined four out of these five scenarios (A2 and A3 were conflictive) to get the most powerful loss reduction scenario (Mix)	Switzerland	FW	E-LCC	ROI	Net profit Total production cost (PC) Income variability Dramatic yield loss Invested capital (IC) Return on investment (ROI) $Net\ profit_{LC} = Net\ profit_A + Net\ profit_W$ $PC_{LC} = PC_A + (PC_W - CoP_W) * (PC_A - CoP_A)$ $\Delta I = I_{total} - I_{lost}$ with $I_{total, lost} = \frac{I_{total, lost}}{I_{total, lost}}$ $Good = Mean_{good} - 3 \cdot d_{defects}$ $Bad = Mean_{bad} + 3 \cdot d_{defects}$ Share of defected tubers per parcel > 50% $IC_{LC} = IC_A + (IC_W - CoP_W) * (IC_A - CoP_A)$ $+ (IC_W - CoP_W)$ $ROI = \frac{Net\ profit_{LC}}{IC_{LC}}$	NA	NA	NA	(Willersinn et al. 2017)
Landfill, Composting plant, AD plant	Felda Taib Andak Kuala, Johor Malaysia	FW	CBA	NA	NA	NA	NA	NA	(Zulkepli et al. 2017)
In-vessel composting, A closed and aerated windrow composting, A traditional composting	Taiwan	FW	CBA	A cost/benefit analysis	NA	NA	NA	NA	(Chen, 2016)
Lignocellulosic feedstock-based bioethanol	Istanbul, Turkey	FW	E-LCC	NA	NA	NA	NA	NA	(Daylan & Ciliz, 2016)
Olive mills solid waste pellet plant - design and development	The pilot olive mills solid waste pellet plant in Xeni, Cyprus	FW	C-LCC	NA	NA	NA	NA	NA	(Christoforou et al. 2016)
Incineration of food waste with mixed municipal solid waste (MSW) (Scenario Sc-DN), Source segregation of food waste (along with other organic waste found in the MSW) and subsequent co-digestion with manure, and incineration of non-segregated food waste along with the residual MSW (Scenario Sc-CD), Source segregation of VFW and treatment to be used as animal fodder (Scenario Sc-AF), Prevention of 100% of the edible food waste	Denmark	FW	E-LCC, S-LCC	NA	NA	4%	NA	The consequences for persons' welfare of re-allocating scarce resources in society (i.e., land, real capital, and labor) to provide the FU (i.e., management of food waste)	(Martinez-Sanchez et al. 2016)
and incineration (Scenario Sc-PR)									
Landfill, Composting plus landfill	Tehran, Iran	SWM	CLCC	NA	NA	5%	NA	25 years	(Abdoli et al. 2011)

Solid Waste Management (SWM); Municipal Solid Waste (MSW); Household Food Waste (HFW); HS-dG; High-Solids Anaerobic Co-Digestion of sewage sludge (biocodis); Conventional Life Cycle Costing (C-LCC); Environmental Life Cycle Costing (E-LCC); Social Life Cycle Costing (S-LCC); UNEF; Uniform Present Worth Factor with Inflation Rate; PWM: Present Worth Method; NPV: Net Present Value; ~~ILCC~~; Financial Life Cycle Costing; NA: Not Applicable

The term "Conventional" refers to the long-established C-LCC, which originated in the 1930s when the US General Accounting Office included operation and maintenance expenses in public procurement. Most C-LCCs analyze options involving items or projects requiring significant initial capital from a single stakeholder, such as a producer or customer. Recently, the Society of Environmental Toxicology and Chemistry (SETAC) established E-LCC to integrate cost assessment into LCA, estimating expenses over the life cycle of goods, services, and technologies, aligning with LCA's scope as per ISO standards 14040/44. E-LCC considers multiple stakeholders' perspectives and may account for externalities. S-LCC expands the analysis to include total direct and indirect costs borne by society in a broader context (De Menna et al. 2018).

Different costing approaches result in diverse applications and perspectives. C-LCC focuses on the economic viability or impact of investment costs without considering environmental implications (Mohamad et al. 2014). E-LCC, conducted alongside LCA, can illustrate the distribution of net costs or savings within the supply chain (Schmidt Rivera et al. 2014). S-LCC is useful for estimating broader welfare impacts (Martinez-Sanchez et al., 2015).

E-LCC studies assess costs and benefits for the external system, and the distribution of costs among different bearers is only calculated in E-LCC studies, such as those by Martinez-Sanchez et al. (2016, 2015). Revenues are used to estimate income or profits in some cases. Willersinn et al. (2017) assessed profit distribution, and Sharma & Chandel (2021) calculated life cycle differentials between scenarios. Cost categorization and assessment techniques should be chosen based on the goal and scope of the analysis.

## 2.2 Synthesis of LCC in composting and other methods of solid waste disposal

Lim et al. (2019) found that, compared to landfill, the savings and revenues from the aerobic windrow composting scenario amounted to MYR 59,881.60 per month. Abduli et al. (2011) indicated that, under the current circumstances in Tehran, the landfill scenario is superior both environmentally and economically compared to integrated waste management (aerobic composting combined with landfill). Their cost analysis showed that the unit costs per ton of waste for the two scenarios were 15.28 and 26.40 US dollars, respectively.

Slorach et al. (2020) conducted an LCC study on four existing FW treatment methods in the UK: (1) in-vessel composting, (2) moving-grate incineration with energy recovery, (3) anaerobic digestion (AD), and (4) landfill with energy recovery. Incineration cost data were derived from an operational facility with a 300,000-ton annual capacity, while cost data for composting, AD, and landfilling were sourced from published literature. Among these methods, incineration had the highest LCC but also generated the most income, making it the most cost-effective alternative with a net LCC of 71 euros per ton. In contrast, landfilling was the most expensive option with a net LCC of 123 euros per ton.

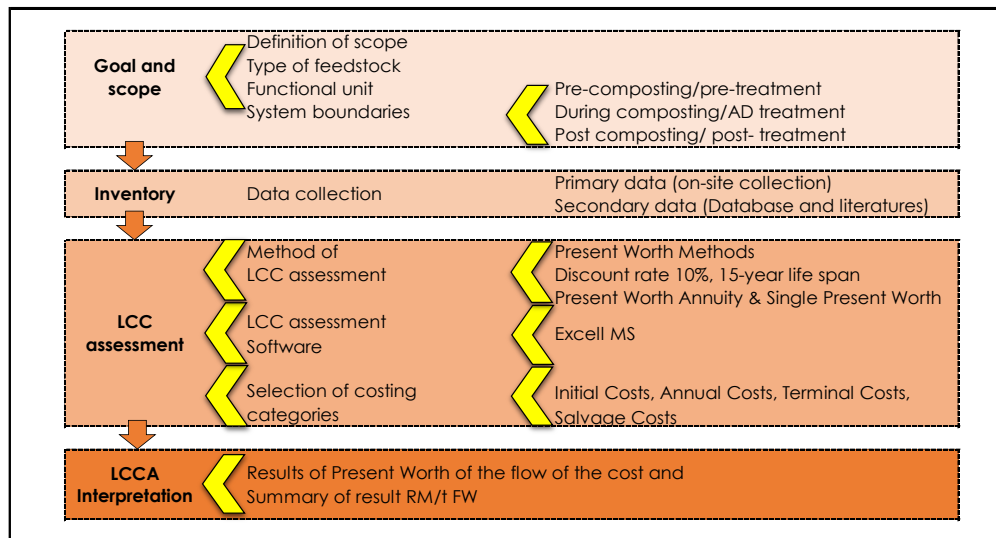
Lee et al. (2020) applied LCC analysis to six waste disposal scenarios in Hillsborough County, USA, including high-solids anaerobic co-digestion (batch type) with equal (1:1:1) and varying fractions (0.8:1.7:0.5) of a mix of FW, yard waste, and biosolids; landfills with and without energy conversion; windrow composting; and mass-burn incineration. They found the composting system to be the most favorable choice with a net LCC of 40 USD per ton, whereas incineration was the least desired due to high initial costs, resulting in a net LCC of 160 USD per ton.

Sharma & Chandel (2021) conducted an economic evaluation of municipal solid waste (MSW) treatment scenarios in India from a life cycle perspective. The scenarios included recycling, composting, anaerobic digestion (AD), incineration with electricity generation, and landfill with biogas recovery. Over a 20-year lifespan, they assessed operations and maintenance (O&M) costs and generated income using an 11.25% discount rate. Incineration was found to be the most expensive option due to high capital costs, with a net life cycle cost (LCC) of 38 USD per ton of MSW. Conversely, the combination of recycling and sanitary landfill emerged as the most financially feasible alternative, with a net LCC of 19 USD per ton of MSW, attributed to lower operational costs.

## 3 Methodology

### 3.1 An LCC analysis using present worth method in comparative FW treatment methods

The use of LCC approaches for food products or FW streams is limited and no common methodological approach exists in the literature (De Menna et al. 2018). The LCC methodology has been employed in conducting an economical comparison of the developed scenarios and it is divided into four steps: (1) goal and scope definition, (2) life cycle costing inventory, (3) assessment of the life cycle costing, and (4) interpretation (as shown by Figure 1).



**Fig. 1.** LCC analysis framework for all scenarios assessed

#### 3.1.1 Goal and Scope Definition

The goal of the study is to perform LCC analysis for two facilities using the present worth method to determine the most cost-effective option for FW management. The management of FW using selected waste disposal facilities for a 15-year life span is used as functional unit (FU). The system boundary of waste treatment begins when the FW arrives to the plant, until

the recovery of recyclables, biofertilizers, and energy. The two scenarios selected for the assessment: (a) Sc1\_aerobic windrow (actual plant Sutera Folo, Tanah Sutera Development Sdn. Bhd, and Folo Farm, Ban Foo Ulu Tiram, Johor), and (b) Sc2\_integrated aerobic windrow combined landfill. This study is curbed to Johor Bahru, Malaysia, focusing on local economic conditions, environmental policies, infrastructure, stakeholder involvement, and specific local needs, with data sourced locally to evaluate the project's environmental, economic, and social impacts, providing context-specific insights for improving local practices and policies.

### 3.1.2 Life Cycle Costing Inventory

The LCC analysis of the two scenarios (Sc1 and Sc2) considered capital or investment costs (initial costs), operations and maintenance (O&M) costs, terminal costs, and salvage costs. Land costs, which can vary by location and may sometimes be provided by the local government (Sharma & Chandel, 2021), were not included except for landfill scenarios. Life cycle costs for aerobic windrow composting were sourced from Lim et al. (2019) and onsite data from the real-scale Folo Farm in Ulu Tiram Johor. Costing for sanitary landfills was derived from Abduli et al. (2011), Berge et al. (2009), and Baldasano et al. (2003), while Sc2, combining windrow composting and landfilling, was based on integrated treatment values. These costs vary due to the differing properties of MSW landfilled under various conditions (Sharma & Chandel, 2021). Each scenario involved distinct material flows with different properties into various treatment systems. Operational days were assumed to be 7 days per week for all treatment systems, including for the sanitary landfill, which requires more time to operate. Sc2 has a capacity of 1800 t/d, and Sc1 has a capacity of 5 t/d.

### 3.1.3 Life Cycle Cost Assessment for Facilities

The two most commonly used LCC analysis methods for facilities are the present worth method and the annualized method (Dell'Isola & Kirk, 2003). The present worth method and a 10% discount rate are selected for the LCC analysis to ensure accurate, standardized, and comparable cost evaluations by accounting for the time value of money, inflation, risk, and facilitating decision-making across different projects.

The capital cost, also known as the initial cost, includes expenses for civil, mechanical, electrical, and other relevant elements during the construction of the treatment plant. O&M expenses cover labor, energy, repair, maintenance, and replacement of electro-mechanical devices throughout the plant's operation. The uniform present worth annuity factor, considering the inflation rate, was used to estimate the annual costs of O&M, laboratory testing or inspection, and general administration.

The treatment systems were assumed to have an operational lifespan of 15 years, with a discount rate of 10%. Terminal costs, such as component replacement, were assumed to be 15% of the total capital cost for 5 years and 20% for 10 years. Using the present worth method, the revenue earned by each scenario was also computed and discounted to its present value. The net LCC for all scenarios was determined by subtracting the discounted revenue earned from recycling, biofertilizers, and energy recovery. The overall cost of each phase for each scenario was estimated by multiplying the present worth factor by the unit cost at that stage. The total cost of all stages equals the cost of the scenario.

The average inflation rate was taken as 4.5% based on statistical data from The Bank Negara of Malaysia for the years 2018-2022 (The Bank Negara of Malaysia, 2022). All costs in United States Dollars (USD) were converted to Malaysian Ringgit (MYR) using a currency exchange rate of US\$1 = MYR 4.75 (Bank Negara Malaysia (BNM), 2022). The cost numbers were adjusted to the year 2022, considered the base year, using an online currency converter (<http://googlecurrency2022>). An example of the LCC of scenarios is provided in Table 2.

**Table 2.** Formulae used for calculating of Present Worth Method for FW management facilities

<b>Present Worth of Annuity</b>	
$PWA = \frac{(1+i)^n - 1}{i(1+i)^n}$	(1)
<b>and Single Present Worth</b>	
$PW = \frac{1}{(1+i)^n}$	(2)
The symbol used in these formulas are: i: interest rate per period; n: number of interest periods; P: present amount; F: future amount, A: uniform sum of money in each period.	
The PWA factor may be used where a present amount at i% interest is returned in n equal periodic installments. PWA represent uniform present worth, A represents the uniform sum of money in such time period, and P, the present worth of the instalments, is the unknown. Note that PWA is the reciprocal of PP.	
$P = A \times PWA$	(3)
$P = F \times PW$	(4)
$PW = IC + \sum_{t=0}^{t=n} pwaf[O\&MC + FC + LC + GAC] + \sum_{t=0}^{t=n} pwf[FR1C + FR2C] + pwf[SC]$	(5)

IC: Initial cost; O&MC: Operation & Maintenance cost; FC: Fuel cost; LC: Laboratory cost/testing/Inspection; GAC: General & Administration cost; FRC: Future Replacement cost; SC: Salvage cost; n: years; pwaf: present worth annuity factor; pwf: present worth factor			
e.g., manually calculation:			
Life cycle cost	Present worth annuity and single present worth factor	P=A x PWA and P=F x PW factor	Present worth
Initial cost	1	P= MYR10,000 x 1	10,000
Energy cost $P = A \times PWA$ (15 years, i=10%)	$PWA = \frac{(1+i)^n - 1}{i(1+i)^n}$ = 7.606	P= MYR750 x 7.606	5,704.5
Maintenance cost $P = A \times PWA$ (15 years, i=10%)	$PWA = \frac{(1+i)^n - 1}{i(1+i)^n}$ = 7.606	P= MYR500 x 7.606	3,803
Replacement cost $P = F \times PW$ (5 years, i=10%)	$PW = \frac{1}{(1+i)^n}$ = 0.6209	P= MYR3000 x 0.6209	1,862.7
Salvage cost (-) $P = F \times PW$ (15 years, i=10%)	$PW = \frac{1}{(1+i)^n}$ = 0.2394	P= MYR2000 x 0.2394	-478.8
Present worth of the flow of the cost			MYR 20,891.4
Annual Worth analysis			
The annual worth can be calculated from either the present worth or the furture worth. Whwn utilizing the present worth (P -> A), the official name is capital recovery, and the notation is (A/P,i,n). the standard notation equation is $A=P(A/P,i,n)$ , and the equation with the factor formula is shown in Equation 6.			
$AW = \frac{PW}{\frac{(1+i)^n - 1}{i(1+i)^n}}$		(6)	
Real capacity of treatment/yearly			
Real capacity = t/day x 365 days		(7)	
RM/t FW			
RM/t FW = AW/Real capacity		(8)	

## 4 Finding and Analysis

### 4.1 Result of an LCC analysis for facilities management and interpretation

For ease of discussion, these expenses are classified as initial costs, annual costs, terminal costs, and salvage value. In most LCC analyses, initial project investment, energy, operation and maintenance, and replacement costs are identified as both significant and substantial. Other types of expenses, such as change costs, design or redesign costs, terminal costs like downtime costs, and functional usage costs, are typically determined on a case-by-case basis. Table 3 presents the breakdown of costs for two scenarios derived from the present worth calculation (see Appendixes Table (a) and Table (b)). The scenarios are compared using life cycle costing analysis, and their breakdown costs are illustrated in a column chart, as shown in Figure 2(a-b).

**Table 3.** The calculation of two breakdown costs of the scenarios

Types of costing	Abbreviations		
		Sc1	*Sc2
Initial Cost	IC	RM700,000	\$10,954,122
Annual Cost	AC	RM107,625	\$60,767,499
Terminal Cost	TC	RM119,165	\$5,521,104
Salvage Cost	SC	RM-11,357	\$-33,990,061
<b>Total LCCA of all scenarios (MYR)</b>		<b>915,432</b>	<b>** 205,298,769</b>



## 4.2 Life Cycle Costing Analysis for Facilities of Scenarios Considered.

*Sc1\_aerobic windrow composting LCC analysis.* The life cycle costing for facilities of aerobic windrow was the lowest as presented in Table a (*see Appendixes*). Data on capital costs for windrow composting treating the FW fraction of MSW were obtained from the actual aerobic windrow Folo Farm Ban Foo Ulu Tiram, Johor. The initial costs include facilities and equipment cost such as conveyor, trommel, gravity separator, etc. While the other initial costs that related to material handling cost includes the cost of vehicles for instance tractor, screener, shredder, bobcat, waste collection bin, chimney system, tilling machine etc.

The equipment installation cost and their life as assumption of the estimate useful life of machine is 15 years. O&M cost was considered as (i) labour cost such as composting process monitoring and farming; (ii) fuel cost including transportation (diesel, L/mth) and on-site machinery (diesel, L/mth), and; (iii) miscellaneous cost such as laboratory analysis and other utility cost (electricity and water bill and maintenance fee).

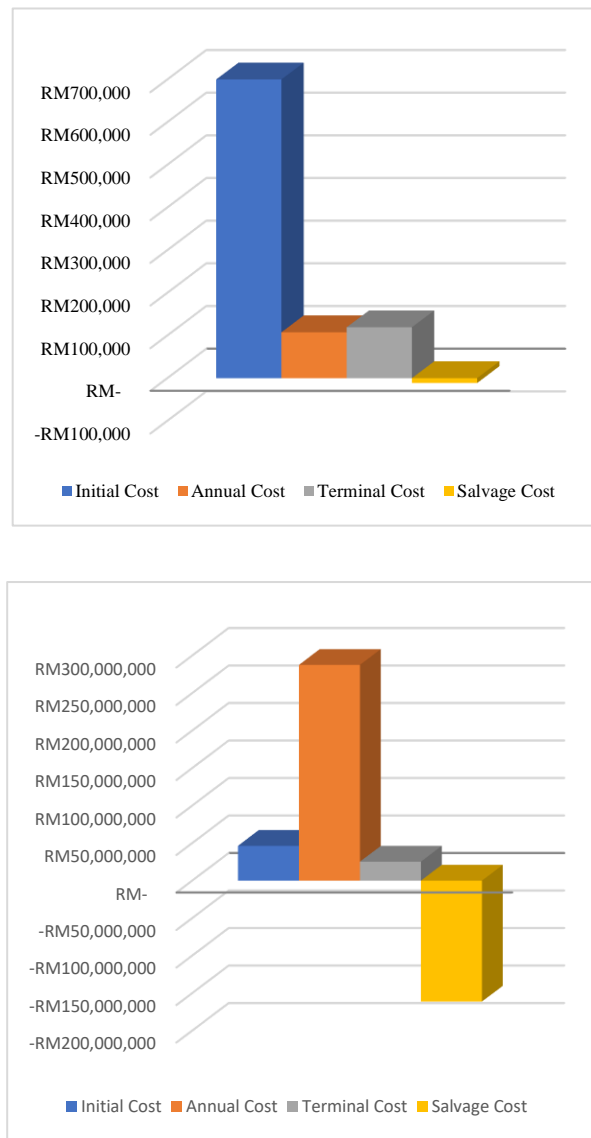
O&M costs for composting system were calculated and used the discount rate at 10% years respectively to perform LCC analysis. Saving from compost utilization such as chemical fertilizer and its price were assumed as (MYR-506.8) and pesticide and herbicide (MYR-300). Compost generation and its price were assumed as MYR 120/50kg fertilizer while fertilizer application rate in Malaysia was 1,689.40 kg/hectare land in 2015. Several of facilities built on a large scale (> 10 tons) is operating effectively in various cities around Johor, such as those managed by Folo Ban Foo Ulu Tiram and Sutera Folo Tanah Sutera Development Sdn. Bhd.

*Sc2\_integrated aerobic windrow composting combining landfill LCC analysis.* The findings of the LCC analysis for two facilities are shown in Figure 2. Sc2 have the highest present worth of the flow costing analysis for facilities as ~ MYR 205 298 of MSW that result of the high capital and operating and maintenance costs needed to construct an integrated landfill facility (Table b, see Appendixes). Despite composting having little revenue, the system was economically advantageous due to inexpensive initial and operating costs. The composting system was built using a windrow method, a low-cost method. When comparing integrated landfill scenarios with other options, landfilling with landfill gas (LFG) earned the highest revenue from power, yet, it just offset 45.7% of the entire upfront cost.

## 4.3 Comparison with other LCC research findings.

Through all studies (Figure 2 a-b), positive numbers denote the LCC, whereas negative values specify the profits earned by each scenario. While the Sc1 was the most affordable alternative, with life cycle costing analysis for facilities as ~ MYR 914, 432 (99% lower than Sc2) because of the low initial and operational expenses associated in aerobic windrow. The results suggest that Sc1 the aerobic windrow has the lowest net life cycle costing analysis for facilities (MYR 915,432). As a conclusion, Sc1, are the most economically viable options in terms of life cycle costing analysis for FW followed by Sc2, respectively (Figure 2 a-b).

The results reported by Sharma & Chandel, (2021), and Abduli et al. ( 2011), differ significantly from those reported here, which could be attributed to differences in the scenarios and assumptions considered, such as the discount rate used, interest formulas applied (such as present worth of annuity, PWA or single present worth, SPW), the life span of technology, and so on. Furthermore, determining the reason of this variation was problematic because previous research was unable to offer LCC-calculation parameters. According to the literature review, the life cycle cost differs by country (Sharma & Chandel, 2021).



**Fig. 2(a-b).** The findings of the LCC analysis for two facilities

In spite of this, the prices calculated in this study for treatment systems were discovered to be within the acceptable range of values reported in Malaysian published studies such as Lim et al. (2019), Zulkepli et al. (2017) and on-site data gathered from an existing aerobic windrow composting plant in Johor. Nevertheless, Lee et al. (2020) shared the similar conclusion with this study that suggested, the composting system was considered to be the most favorable choice in economic standpoint. A negative waste management strategy (Sc2 integrated composting and landfill) may have greater environmental impacts than landfilling, which should be discouraged in waste management decisions (Abduli et al. 2011).

#### 4.4 Summary of LCC Result RM/t FW

The results RM/t FW for Sc2 integrated aerobic windrow combining sanitary landfill was the cheapest viable option with a net LCC ranging RM41 per ton of FW due to comparative higher real capacity treatment 1800t/d for a 15-year life span. Landfill is the most common method of solid waste disposal currently being used in many parts of the world. The versatility and simplicity of it in terms of technical requirements, environmental and socio-economic aspects make it popular than other known techniques, for examples incineration and biological composting. Landfilling can be considered as the cheapest method to run (Table 4). This is true because landfilling can manage massive amounts of FW, requires fewer initial costs such as less acquisition cost of high-technological equipment and machineries to operate (Malek & Shaaban, 2008).

Comparatively, in search of a long-term treatment for organic and FW, composting methods either aerobic or anaerobic treatments, or a combination of the two, can play an important role because of the biological stabilization of food waste into bio fertilizer and biogas by-products. Diverting organics from the waste stream to composting or AD has proven to be beneficial for the municipalities and areas in which they are located. Composting contributes to the reduction of CO<sub>2</sub> and CH<sub>4</sub> harmful emissions when food wastes are diverted from landfill. Sc1 is the second best with a net LCC of RM66 per ton of FW. Sc1 windrow treatment offers low capital costs, eliminates a significant volume of biodegradable waste (> 10 tons)

and provides compost fertilizer. On the other hand, windrow practice is associated with significantly higher levels of human health risks (Al-Rumaihi et al. 2020).

**Table 4.** Summary of result RM/t FW for two scenarios considered in (MYR)

Treatment Capacity		Real cap: 5t/d		Real cap:1800t/d	
Scenarios		Sc1		Sc2	
PW of the flow of the cost 15 years	RM	915,432	RM	205,298,769	
Annual Worth	RM	120,357	RM	26,991,687	
(Real cap. † for 365 days in 1 year)		1825		657000	
<b>The Annual Worth (RM/t FW)</b>		<b>RM 66</b>	<b>RM</b>	<b>41</b>	

\*cap: capacity, t: ton, PW: Present Worth, FW: Food Waste,  
 RM:Ringgit Malaysia  
 \*The Annual Worth:  
 \*n :15, i :10%  
 \*Real capacity = t/day x 365 days  
 \*RM/t FW = AW/Real cap. † for 365days in 1 year

## 5 Conclusion

The results of this study underscore the importance of a comprehensive approach in evaluating food waste management technologies. By employing life cycle costing analysis using the present worth method, it is evident that while sanitary landfills with biological treatment (Scenario 2) offer the lowest net life cycle cost (RM 41/t FW) due to their high capacity, aerobic windrow composting (Scenario 1) also presents a cost-effective alternative (RM 66/t FW). Additionally, considering land costs could further refine scenario preferences. The insights provided by this study are crucial for decision-makers in Malaysia, offering guidance on optimal investments in waste treatment systems and supporting legislative efforts towards a circular economy. Future research should expand to include environmental benefits, social acceptability, technological availability and readiness level, as well as its occupational, safety and health aspects for a more comprehensive evaluation, aiming to establish a circular and sustainable waste management system.

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## References

1. Abduli, M. A., Naghib, A., Yonesi, M., & Akbari, A. (2011). Life cycle assessment (LCA) of solid waste management strategies in Tehran: Landfill and composting plus landfill. *Environmental Monitoring and Assessment*, 178(1–4), 487–498. <https://doi.org/10.1007/s10661-010-1707-x>
2. Amienyo, D., & Azapagic, A. (2016). Life cycle environmental impacts and costs of beer production and consumption in the UK. *International Journal of Life Cycle Assessment*, 21(4), 492–509. <https://doi.org/10.1007/s11367-016-1028-6>
3. Al-Rumaihi, A., McKay, G., Mackey, H. R., & Al-Ansari, T. (2020). Environmental impact assessment of food waste management using two composting techniques. *Sustainability (Switzerland)*, 12(4). <https://doi.org/10.3390/su12041595>
4. APO. (2007). Report of the APO Survey on Solid-Waste. In *Asian Productivity Organization (APO)*. [www.apo-tokyo.org](http://www.apo-tokyo.org)
5. Baldasano, J. M., Gassó, S., & Pérez, C. (2003). Environmental performance review and cost analysis of MSW landfilling by baling-wrapping technology versus conventional system. *Waste Management*, 23(9), 795–806. [https://doi.org/10.1016/S0956-053X\(03\)00087-4](https://doi.org/10.1016/S0956-053X(03)00087-4)
6. Berge, N. D., Reinhart, D. R., & Batareseh, E. S. (2009). An assessment of bioreactor landfill costs and benefits. *Waste Management*, 29(5), 1558–1567. <https://doi.org/10.1016/j.wasman.2008.12.010>
7. Bong, C. P. C., Goh, R. K. Y., Lim, J. S., Ho, W. S., Lee, C. T., Hashim, H., Abu Mansor, N. N., Ho, C. S., Ramli, A. R., & Takeshi, F. (2017). Towards low carbon society in Iskandar Malaysia: Implementation and feasibility of community organic waste composting. *Journal of Environmental Management*, 203(2016), 679–687. <https://doi.org/10.1016/j.jenvman.2016.05.033>
8. Bong, C. P. C., Lim, L. Y., Ho, W. S., Lim, J. S., Klemeš, J. J., Towprayoon, S., Ho, C. S., & Lee, C. T. (2017). A review on the global warming potential of cleaner composting and mitigation strategies. *Journal of Cleaner Production*, 146, 149–157. <https://doi.org/10.1016/j.jclepro.2016.07.066>
9. Brenes-Peralta, L., Jiménez-Morales, M. F., Campos-Rodríguez, R., De Menna, F., & Vittuari, M. (2020). Decision-making process in the circular economy: A case study on university food waste-to-energy actions in Latin america. *Energies*, 13(9). <https://doi.org/10.3390/en13092291>

10. Chen, Y. T. (2016). A cost analysis of food waste composting in Taiwan. *Sustainability (Switzerland)*, 8(11). <https://doi.org/10.3390/su8111210>
11. Christoforou, E., Kylili, A., & Fokaides, P. A. (2016). Technical and economical evaluation of olive mills solid waste pellets. *Renewable Energy*, 96, 33–41. <https://doi.org/10.1016/j.renene.2016.04.046>
12. Daylan, B., & Ciliz, N. (2016). Life cycle assessment and environmental life cycle costing analysis of lignocellulosic bioethanol as an alternative transportation fuel. *Renewable Energy*, 89, 578–587. <https://doi.org/10.1016/j.renene.2015.11.059>
13. De Menna, F., Davis, J., Östergren, K., Unger, N., Loubiere, M., & Vittuari, M. (2020). A combined framework for the life cycle assessment and costing of food waste prevention and valorization: an application to school canteens. *Agricultural and Food Economics*, 8(1). <https://doi.org/10.1186/s40100-019-0148-2>
14. Edwards, J., Burn, S., Crossin, E., & Othman, M. (2018). Life cycle costing of municipal food waste management systems: The effect of environmental externalities and transfer costs using local government case studies. *Resources, Conservation and Recycling*, 138(February), 118–129. <https://doi.org/10.1016/j.resconrec.2018.06.018>
15. Keng, Z. X., Chong, S., Ng, C. G., Ridzuan, N. I., Hanson, S., Pan, G. T., Lau, P. L., Supramaniam, C. V., Singh, A., Chin, C. F., & Lam, H. L. (2020). Community-scale composting for food waste: A life-cycle assessment-supported case study. *Journal of Cleaner Production*, 261, 121220. <https://doi.org/10.1016/j.jclepro.2020.121220>
16. Lee, E., Oliveira, D. S. B. L., Oliveira, L. S. B. L., Jimenez, E., Kim, Y., Wang, M., Ergas, S. J., & Zhang, Q. (2020). Comparative environmental and economic life cycle assessment of high solids anaerobic co-digestion for biosolids and organic waste management. *Water Research*, 171, 115443. <https://doi.org/10.1016/j.watres.2019.115443>
17. Lim, L Y, Bong, C. P. C., Lee, C. T., Klemeš, J. J., Sarmidi, M. R., & Lim, J. S. (2017). Review on the current composting practices and the potential of improvement using two-stage composting. *Chemical Engineering Transactions*, 61, 1051–1056. <https://doi.org/10.3303/CET1761173>
18. Lim, Li Yee, Lee, C. T., Bong, C. P. C., Lim, J. S., & Klemeš, J. J. (2019). Environmental and economic feasibility of an integrated community composting plant and organic farm in Malaysia. *Journal of Environmental Management*, 244(September 2018), 431–439. <https://doi.org/10.1016/j.jenvman.2019.05.050>
19. Malek, M. I., & Shaaban, M. G. (2008). Landfill Common Method and Practices of Solid Waste Disposal in Malaysia. *ISWA World Congr.*
20. Martinez-Sanchez, V., Tonini, D., Møller, F., & Astrup, T. F. (2016). Life-Cycle Costing of Food Waste Management in Denmark: Importance of Indirect Effects. *Environmental Science and Technology*, 50(8), 4513–4523. <https://doi.org/10.1021/acs.est.5b03536>
21. Miah, J. H., Koh, S. C. L., & Stone, D. (2017). A hybridised framework combining integrated methods for environmental Life Cycle Assessment and Life Cycle Costing Internal Rate of Return. *Journal of Cleaner Production*, 168, 846–866. <https://doi.org/10.1016/j.jclepro.2017.08.187>
22. Pavlas, M., Tou, M., Bébar, L., & Stehlík, P. (2010). Waste to energy - An evaluation of the environmental impact. *Applied Thermal Engineering*, 30(16), 2326–2332. <https://doi.org/10.1016/j.applthermaleng.2009.10.019>
23. Sharma, B. K., & Chandel, M. K. (2021). Life cycle cost analysis of municipal solid waste management scenarios for Mumbai, India. *Waste Management*, 124, 293–302. <https://doi.org/10.1016/j.wasman.2021.02.002>
24. Slorach, P. C., Jeswani, H. K., Cuéllar-Franca, R., & Azapagic, A. (2020). Assessing the economic and environmental sustainability of household food waste management in the UK: Current situation and future scenarios. *Science of the Total Environment*, 710, 135580. <https://doi.org/10.1016/j.scitotenv.2019.135580>
25. Tamburini, E., Pedrini, P., Marchetti, M. G., Fano, E. A., & Castaldelli, G. (2015). Life cycle based evaluation of environmental and economic impacts of agricultural productions in the Mediterranean area. *Sustainability (Switzerland)*, 7(3), 2915–2935. <https://doi.org/10.3390/su7032915>
26. Van, D. P., Fujiwara, T., Tho, B. L., Toan, P. P. S., & Minh, G. H. (2020). A review of anaerobic digestion systems for biodegradable waste: Configurations, operating parameters, and current trends. *Environmental Engineering Research*, 25(1), 1–17. <https://doi.org/10.4491/eer.2018.334>
27. Willersinn, C., Mouron, P., Mack, G., & Siegrist, M. (2017). Food loss reduction from an environmental, socio-economic and consumer perspective – The case of the Swiss potato market. *Waste Management*, 59, 451–464. <https://doi.org/10.1016/j.wasman.2016.10.007>
28. Yoshikawa, N., Matsuda, T., & Amano, K. (2021). Life cycle environmental and economic impact of a food waste recycling-farming system: a case study of organic vegetable farming in Japan. *International Journal of Life Cycle Assessment*, 0123456789. <https://doi.org/10.1007/s11367-021-01879-0>
29. Zulkepli, N. E., Muis, Z. A., Mahmood, N. A. N., Hashim, H., & Ho, W. S. (2017). Cost benefit analysis of composting and anaerobic digestion in a community: A review. *Chemical Engineering Transactions*, 56, 1777–1782. <https://doi.org/10.3303/CET1756297>

## Appendixes

**Table (a)** LLC of Aerobic Windrow

			PWA	PW	(RM)
<b>Initial Cost</b>					
(1)	Site, Infrastructure, Machine at cost (acquisition cost)	RM	700,000	1.000 RM	700,000
<b>Annual Cost</b>					
<i>(Present Value of Annuity)</i>					
(2)	Operational Cost	RM	10,000	7.606	RM 76,060
(3)	Fuel Cost (Transportation/Onsite Machinery)	RM	1,100	7.606	RM 8,367
(4)	Laboratory Quality Control Cost	RM	1,050	7.606	RM 7,986
(5)	General & Administration Cost	RM	2,000	7.606	RM 15,212
<b>Terminal Cost</b>					
<i>Present Value</i>					
(6)	Major replacement cost - Component 1 (5th year)	RM	105,000	0.621	RM 65,195
(7)	Major replacement cost - Component 2 (10th year)	RM	140,000	0.386	RM 53,970
<b>Salvage Cost</b>					
<i>(Present Value of Annuity)</i>					
	Cost saving from compost utilization	-RM	807	7.606	-RM 6,137
<i>Present Value</i>					
	Scrap Value	-RM	21,807	0.239	-RM 5,221
					<b>RM 915,432</b>

\*The present worth method and a 10% discount rate are selected for the Life Cycle Cost (LCC) analysis to ensure accurate and standardized cost comparisons over the project's lifespan. The present worth method accounts for the time value of money, providing a consistent basis for comparing costs by converting future costs and benefits to their present values, thus simplifying decision-making. A 10% discount rate, commonly used in many industries, reflects the average cost of capital, accounts for inflation and risk, and facilitates comparative analysis across different projects. These selections ensure a realistic, robust, and comparable evaluation of the economic viability of projects.

\*The scope of this study is confined to Johor Bahru, Malaysia, focusing on several key aspects within this area. The analysis and data collection are limited to Johor Bahru, considering local economic conditions, environmental policies, and regulations. The study assesses the existing infrastructure and resources relevant to project implementation and sustainability, involves local stakeholders including government agencies and the community, and addresses the specific needs and preferences of the local population. All data used will be sourced from Johor Bahru to ensure relevance and accuracy, and the environmental, economic, and social impacts of the project will be evaluated in this context. This geographical focus aims to provide detailed, context-specific insights to improve local practices and policies.

**Table (b)** LLC of Aerobic Windrow\_Landfill

	Price as at January 2011 (USD)	Present Value	Estimation price at 2022	PWA	PW	(USD)
<b>Initial Cost</b>						
(1) Sites construction, Infrastructures, Machine at cost (acquisition cost)	\$ 6,459,250	1.70	\$ 10,954,122		1.000	\$ 10,954,122
<b>Annual Cost</b>						
(2) <i>(Present Value of Annuity)</i> Operational Cost (estimate)	\$ 80,000	1.70	\$ 135,671	7.606		\$ 1,031,910
(3) Maintenance Cost (estimate)	\$ 7,000	1.70	\$ 11,871	7.606		\$ 90,292
(4) Leachate Treatment	\$ 4,069,920	1.70	\$ 6,902,102	7.606		\$ 52,497,386
(5) General & Administration Cost	\$ 552,000	1.70	\$ 936,127	7.606		\$ 7,120,179
(6) Fuel cost (Onsite transport and machinery)	\$ 1,100	1.70	\$ 1,865	7.606		\$ 14,189
(7) Laboratory quality control	\$ 1,050	1.70	\$ 1,781	7.606		\$ 13,544
<b>Terminal Cost</b>						
(8) <i>Present Value</i> Major replacement cost - Component 1 (5th year)	\$ 392,913	1.70	\$ 666,333		0.621	\$ 413,726
(9) Major replacement cost - Component 1 (10th year)	\$ 1,291,650	1.70	\$ 2,190,485		0.386	\$ 844,432
(10) Closure cost	\$ 10,500,020	1.70	\$ 17,806,789		0.239	\$ 4,262,945
<b>Salvage Cost</b>						
<i>(Present Value of Annuity)</i> Energy production from Methane	\$ -2,632,681	1.70	\$ -4,464,715	7.606		\$ -33,958,621
<i>Present Value</i> Cost saving from compost utilization	\$ -807	1.70	\$ -1,368	7.606		\$ -10,407
Scrap Value	\$ -51,807	1.70	\$ -87,858		0.239	\$ -21,033
						<b>\$ 43,252,664</b>
						Current Exchange value
						RM 4.75
						<b>RM 205,298,769</b>

**Remark:** Data abstracted from Abduli et al., (2011); Berge et al. (2009); and Baldasano et al. (2003). As noted in main manuscript, the LCC data in Appendix (b)-Sc2 is outdated, dating back to 2009 and 2003, and it is not specific to Malaysia. However, the system used corresponds to that of Seelong Landfill in Johor Bahru, Johor Malaysia. Based on a review of literature, researchers have encountered obstacles in collecting real-time costing data, such as when approval is not granted by the facilities involved (SWM Environment SDN. BHD.). In such cases, past studies have advocated for utilizing similar systems and relying on literature data for cost calculations (Abduli et al., 2011; Sharma & Chandel, 2021). To address the outdated data issue, the values from 2009 and 2003 were converted to their present worth using the following formula:  $\text{Present Value} = (1+0.045)^{12} (\text{Dell 'Isola \& Kirk, 2003})$ . Then estimation price at year 2022 = Price as at January 2011 (USD) x Present value. The calculations have been done as shown by the Table (b) LCC analysis of Sc2 scenario by total present worth of the cost flow with costing breakdown. The reasons for not taking data from Seelong Landfill have been justified.

The justifications are as follows:

- Data Availability:** Current data from Seelong Landfill may not have been readily accessible or available due to restrictions or limited cooperation from the landfill authorities.
- Data Relevance:** The specific parameters or aspects of data required for the study might not have been comprehensively documented or accessible from Seelong Landfill records.
- Data Consistency:** The consistency and reliability of historical data from Seelong Landfill might be questionable, especially if significant changes or upgrades have occurred in their systems or operations since the data was collected.
- Comparative Analysis:** Utilizing data from different sources allows for a broader comparison and validation of results, ensuring a more comprehensive understanding of the topic beyond a single data point.

# Coordinate comparison of Geocentric Datum between Datum BT68 & SGED20 using GNSS method

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**Abstract.** This study was initiated to study the comparison between two geocentric datum systems. The Land & Survey of Sarawak has laid out a new conceptual framework and historical context of the triangulation system, datums, and transformation plans to modernize the geodetic datum for Sarawak called Datum SGED20. However, it has yet to be officially gazetted by the Sarawak state government. A comprehensive study is imperative in order to assess the accuracies and educational institutions such as Polytechnic Kuching Sarawak will actively participate in this research endeavour. A series of GNSS observations will be conducted on established survey control points in Polytechnic Kuching. The subsequent calculations and data processing will be served as the baseline with data samples from Land & Survey Department and Sarawak Land Consolidation and Rehabilitation Authority (SALCRA).

**Keywords:** SGeD20, GNSS observations, Geodetic Datum

## 1 Introduction

Datum BT68, an older geodetic datum, has been widely used in historical geospatial datasets, whereas Datum SGeD20 represents a modern and more accurate reference frame. Understanding the relationship between these two datums and establishing precise transformation parameters are essential for accurate coordinate converting.

The term "SCTS" is present for Sarawak Coordinate Transformation Software refers to a specialized software program designed for changing on geographic coordinates within the Sarawak region of Malaysia. In geospatial and surveying applications, this software is frequently used in converting coordinates from one coordinate systems or datum to another. In Sarawak, the SCTS program in transforming coordinates across various datums and coordinate systems, ensuring the accuracy and consistency of geographic data for various uses.

Presently, Sarawak's Lands and Surveys Department is effectively establishing CORS on the 11th Malaysian Plan. The department used these new active infrastructures as a key component in the development of multidisciplinary applications. It serves as the foundation for the department's technological adaptation and human resource development. The construction of CORS is difficult; it needs a good location, network architecture, electricity, telecommunications service, and a monument that can be either on the ground or on a roof.

Tenure and land ownership, the suitability of the site foundation, access to accessible electricity and communications, potential changes to sky visibility due to tree growth and development at nearby sites, access restrictions or site security difficulties, and other factors must all be considered throughout the site selection process.

## 2 Problem Statement

This research aims to use Global Navigation Satellite System (GNSS) observations to conduct a comprehensive comparison between geographic coordinates derived from Datum Borneo Triangulation 1968 (BT68) and Datum Sarawak Geocentric Datum 2020 (SGeD20). The study seeks to identify differences in coordinates and provide insights into the implications of choosing one datum over the other for other surveying and mapping applications.

Additionally, to meet the research conditions set by the Land and Survey Department for the legal gazetted and trial testing of Sarawak Geocentric Datum 2020 (SGeD20). The project aims to solve the legal and technical aspects required for the publishing of SGED20 data in accordance with the regulations of the Land and Survey Department.

### 3 Objective

This study aims to ensure that the coordinates at each Kuching Polytechnic station are effective to obtain accurate accuracy values. Therefore, the following goals are:

- to test the necessary datum transformation converting coordinate from Datum BT68 to SGeD20 using software Sarawak Coordinate Transformation Software 2020 (SCTS).
- to collaborate with Land and Survey Department Sarawak to successfully implement the live trial CORS system.
- to compare the coordinate accuracies between of Datum BT68 and SGeD20 to do observation from 3 reference station to collect data for every station at Polytechnic Kuching, Sarawak.

### 4 Scope of Research

#### 4.1 Data

This study was initiated to investigate the comparison between two geocentric datum systems. The Land & Survey of Sarawak SGeD20 has laid out the conceptual framework and historical context of the triangulation system, datums, and transformation plans to modernize the geodetic datum for Sarawak. The geographic scope for our working area is Polytechnic Kuching, Sarawak. Observations will be systematically collected at every control station within Polytechnic Kuching Sarawak such as in Figure 1.



**Fig. 1.** View of every control station

At the same time the station CORS at Bau, Samarahan and Santubong will be as reference stations such as in figure 2.



**Fig. 2.** Three reference station of CORS at Bau, Samarahan and Santubong connected in PKS 10 (left)

#### 4.2 Technology

This study employs a comprehensive approach to coordinate processing and generation using multiple technologies such as Trimble Pivot Web, Magnet Tool, and Sarawak Coordinate Transformation Software 2020 (SCTS). Initially, the Magnet Tool is used to get WSG84 Latitude, Longitude, and Cartesian XYZ coordinate values. Additionally, the Trimble Pivot Web is used to order data sourced from the Continuously Operating Reference Station (CORS). SCTS, used in geospatial applications, is employed to seamlessly convert coordinates between different coordinate systems. For instance, the conversion of data obtained from the control point at Polytechnic Kuching, originally in the BT68 datum, to the SGeD20 datum.



## 5 Literature review

This research mainly compares the coordinates between datum BT68 and datum SGeD20 using the GNSS observation method. There are two local geodetic reference systems in Malaysia: The Malayan Revised Triangulation (MRT) for Peninsular Malaysia and the Borneo Triangulation System 1968 (BT68) for Sabah and Sarawak. But then, Sarawak wants to introduce the new coordinate, datum SGeD20, a semi-dynamic datum of Sarawak. But the coordinate still needs to be used. This is because the coordinate is still ongoing trial mode. In 1948, the Directorate of Colonial Surveys, which subsequently became the Directorate of Overseas Survey (DOS), had responsibility for readjusting all triangulations. The Timbalai Datum and Modified Everest Ellipsoid were then published. A sequence of triangulation chains was built, and then, until 1968, a protracted process of extra measurements and recalculations led to the creation of the Borneo Triangulation 1968 (BT68) system. The BT68 integrated geodetic control left out the Kalimantan side (Jawan et al., 2024).

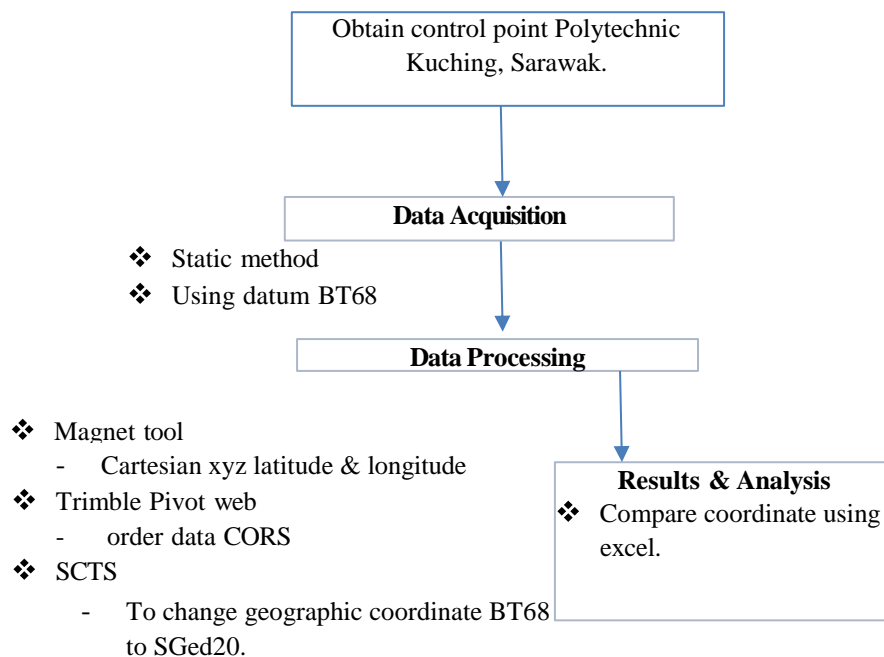
To align coordinates from various reference systems, datum transformations are crucial. Data transformations can result in discrepancies, especially when working with regional or legal datums. Observations have transformed geodetic positioning from the Global Navigation Satellite System (GNSS). Due to the lack of implementation in widely used commercial software, users may find it difficult to apply the deformation model at this time. Applications of the deformation model to observations are provided by LINZ, along with the SNAP software, which is mainly used for geodetic and engineering surveys (Blick G & Donnelly N, 2016).

Teunissen's (2017) study covers incorporating GNSS technology into datum transformations. GNSS observations in the WGS84 datum provide a common reference point for converting coordinates between different datums. For precise datum transformations, geodetic software tools are indispensable. The conventional datum BT68 cannot support the system's satellite-based positioning. Sarawak's new geocentric datum has been aligned with the satellite system, allowing for high-precision measurement and mapping in Cadastre Sarawak's modernization (Joanes et al., 2023).

It is essential to assess the standard of transformed coordinates. The errors spread during datum transformations and offer techniques for judging the precision of the transformed coordinates (Rangelova et al., 2017). It emphasizes how crucial it is to comprehend the uncertainties brought on by the transformation process. The effect of datum differences on GNSS positioning and navigation is examined in the study by Deng (2020). To ensure the dependability of location-based services, the authors emphasize the necessity of ongoing datum shift monitoring.

Nowadays, Sarawak's Lands and Surveys Department is successfully building up CORS on the 11th Malaysian Plan. For the department to develop multidisciplinary applications, these new active infrastructures became essential. The department can also build on it as a basis to improve its human resources and adapt technology. Building CORS is difficult; you need a good location, a network design that works, electricity, telecoms service, and a monument that can be either on the ground or the sky. Identification of land tenure and ownership, adequacy of the site foundation, accessibility to electricity and communications, possible alterations to sky visibility due to tree growth and development at nearby sites, and access limitations or site security concerns are all necessary considerations when selecting a location. Infrastructures like CORS are therefore in line with the capacity situation. In bureaucracy, it is extremely difficult to build a profession like geodesists. Experts in one or more geodesy areas take years, if not decades, to become proficient in. The department should therefore constantly assist and motivate its officer who has gained experience in the sector to keep up that work (Manesh et al., 2020).

## 6 Methodology



**Fig. 3.** General of Methodology

The general methodology is shown in figure 6.1, from the figure this project started by obtaining control points that ranged from PKS10 to PKS90. The next phase is using GNSS to gather data using the static method. An hour was spent observing each of the nine control points that were found. After then, the GNSS receiver was used to retrieve the gathered data. To enhance precision, three reference stations (SANT, SMHN, and BAUU) were sourced from Trimble Pivot Web through CORS data.

Moving to data processing, where the Magnet Tool software was quite important. In the Borneo\_RSO projection, it made the converting of Cartesian (XYZ) and Latitude- Longitude coordinates easier. Using the Sarawak Coordinate Transformation Software (SCTS), a transformation from Borneo\_RSO to SGeD20 was carried out to match the data comparison between these two datums.

The processed data was then carefully compared in coordinates between SGeD20 and the Polytechnic control points. The purpose of this Excel-based comparison was to find differences in Northing and Easting coordinates. The comparison's conclusions greatly help in achieving the main objective of the study, which is to coordinate comparison of geocentric datum between Datum BT68 & SGeD20 using GNSS method.

## 7 Result and Analysis

From the analysis, the comparison between BT68 and SGeD20 datums using GNSS methods produced a minimal difference in both easting and northing coordinates. The observed is closely with the data obtained by Land and Survey Department Sarawak. Figure 4 shows the RSO coordinates that have been take in this study. While Figure 5 shows the coordinates in SGeD 20

POINT	2D_RSO_COORDINATE	
	EASTING (X)	NORTHING (Y)
PKS10	2056161.694	5180634.711
PKS20	2055985.593	5180635.655
PKS30	2055931.035	5180593.312
PKS40	2055905.769	5180535.273
PKS50	2055903.615	5180402.912
PKS60	2055992.566	5180314.695
PKS70	2056075.032	5180265.262
PKS80	2056161.671	5180282.373
PKS90	2056171.999	5180518.056

**Fig. 4.** RSO coordinates

POINT	2D_SGeD20_COORDINATE	
	EASTING (X)	NORTHING (Y)
PKS10	2056539.525	5180585.818
PKS20	2056363.404	5180586.754
PKS30	2056308.193	5180543.298
PKS40	2056282.914	5180485.249
PKS50	2056280.771	5180352.882
PKS60	2056369.713	5180264.654
PKS70	2056452.181	5180215.213
PKS80	2056538.83	5180232.317
PKS90	2056549.807	5180469.175

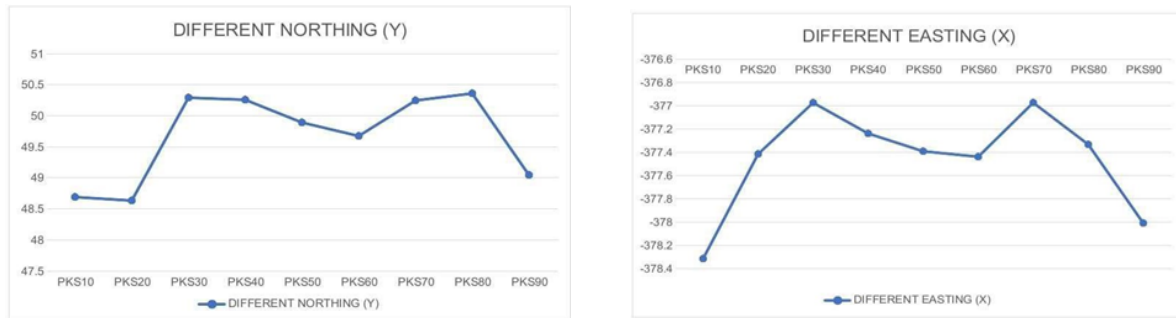
**Fig. 5.** SGeD20 coordinates

POINT	DIFF_2D_RSO & SGeD20	
	EASTING (X)	NORTHING (Y)
PKS10	-377.831	48.893
PKS20	-377.811	48.901
PKS30	-377.158	50.014
PKS40	-377.145	50.024
PKS50	-377.156	50.03
PKS60	-377.147	50.041
PKS70	-377.149	50.049
PKS80	-377.159	50.056
PKS90	-377.808	48.881

**Fig. 6.** Different RSO and SGeD20 coordinates

From the observation data, the differential coordinates have been shown in figure 6. The value is consistent with easting(x) and northing(y) (377,50). This is evident the SGeD20 can be used for surveying work in Sarawak.

The difference also can be shows in chart for better understanding such as in figure 7.



**Fig. 7.** Comparison Easting & Northing Coordinate

## 8 Conclusion

This project fulfils its goal of comparing coordinate of geocentric datums and provides foundations for further research on datum transformations. We successfully transformed data from the Borneo\_RSO projection to the SGeD20 datum using the Sarawak Coordinate Transformation Software (SCTS), allowing for a meaningful comparison.

## References

1. Blick G, Donnelly N (2016) *From static to dynamic datums: 150 years of geodetic datums in New Zealand*. *N Z J Geol Geophys* 59(1):15–21.
2. Deng, S., Gao, Y., Li, Y., & Zhang, Y. (2020). *Analysis of datum biases on GNSS positioning and navigation*. *Measurement*, 157, 107701.
3. Jawan, J., Musa, T. A., Wan Aris, W. A., Putit, R., Abdillah, R., & Mohamad Usop, M. I. (2024). Borneo triangulation 1968: a review and the way forward. *Survey Review*, 56(395), 153-164.
4. Joanes J., Tajul A. M., Wan A. W. A., Rozlan P., Ramzi A. & Mohd. Iskandar M. U. (2023). *Borneo Triangulation 1968: A Review and The Way Forward*.
5. Manesh, T., and Bigyan, B., 2020. *Realization of geocentric for Nepal*. *Journal of geoinformatics*, 19, 43–47.
6. Rangelova, E., Fotopoulos, G., & Delikaraoglou, D. (2017). *Error propagation in 2D and 3D datum transformations*. *ISPRS International Journal of Geo-Information*, 6(9), 277.
7. Teunissen, P. J. (2017). *GNSS observation and geodesy*. Springer.

# The Effect of Incorporating Fibers as Additional Material in Concrete Mixture

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**Abstract.** Cracks in the building structure are a severe problem that must be addressed immediately. Various factors cause cracks in building structures, such as improper design, soil sedimentation, and hydrostatic pressure. Fiber is a material that has a veined and stringy physical texture that can function as a binding agent that can reduce cracking problems. Coconut fiber is a natural fiber with high tensile strength, while glass fiber is a synthetic fiber made from manufactured material. Adding glass fiber to the concrete mix increases the compressive strength of the concrete. A study was conducted to combine these two types of fibers in a concrete mix. This study was conducted to determine fiber's suitability in a concrete mix. This paper aims to analyze whether fiber can be an effective material for improving the properties of ordinary concrete. A Sample of 1% (C1), 3% (C3), and 5% (C5) fibers was mixed into the concrete mix and tested for slump and compressive strength. Thirty-six (36) mixture samples, size 150x150x150 mm, have been produced. This sample was tested for strength on the 7<sup>th</sup>, 14<sup>th</sup>, and 28<sup>th</sup> day. The results on day 28 showed that sample C1 (1% fiber) had reached a compressive strength almost equal to the control sample (22.81 MPa), which is 22.44 MPa. While sample C3 (3% fiber) only reached a compressive strength of 10.96 MPa, and Sample C5 (5% fiber) could only support a strength of 4 MPa. This research shows that the more fiber is mixed it will reduce the compressive strength of concrete. However, fiber can still be mixed into the concrete in small quantities.

**Keywords:** Coconut Fibers, Glass Fibers, Compressive Strength

## 1 Introduction

### 1.1 General

Concrete is the most widely used building material in the world. Various additives used to improve the properties and strength of concrete include mineral additives such as micro silica, chemical additives such as calcium chloride, fiber additives such as steel fibers, and additives for pozzolanic reactions such as fly ash. Ordinary concrete is a brittle material with low tensile strength. Concrete containing fiber material is known as fiber-reinforced concrete.

Fiber-reinforced concrete may contain steel, glass, synthetic, and natural fibers, which give different properties to concrete. Fibers serve as resistance to cracking in concrete. The percentage contribution of certain fibers in concrete to the flexural strength is smaller than the strength provided by rebar. However, it is still important to prevent crack growth in building structures.

### 1.2 Problem Statement

Inadequate compressive strength of concrete to bear the load can be a serious problem if not properly addressed. The most significant effect is the existence of cracks on the concrete surface. Therefore, to overcome this problem, researchers have tried to modify concrete strength by adding natural fibers (coconut coir) and synthetic fibers (glass fiber) to upgrade the properties of concrete. Therefore, this research examined the effect of incorporating fibers as additional material in a concrete mixture. Adding fibers improves tensile strength, flexural strength, and durability. Incorporating fibers can also reduce the cracking and shrinkage of concrete.

### 1.3 Objectives

- i) To compare the compressive strength of concrete incorporating fiberglass and coconut coir fiber to ordinary concrete.

### 1.4 Scopes

This research is focused on studying if fiber can be an effective material for increasing the strength of concrete. The fiber used in this study is coconut fiber and glass fiber. The fiber size used is between 1cm to 5cm. This research aims to observe the difference in strength between ordinary concrete and incorporating fiber as a concrete mixture by producing the concrete mixing with the fiber of 1%, 3%, and 5% to concrete ratio at 7 days, 14 days, and 28 days. The concrete mixing ratio is 1:2:4. The water-cement ratio is 0.6, and the aggregate used is 20mm.

## 2 Literature review

Plain concrete is a brittle material with low tensile strain and strength capacities. Using short, discontinuous fibers allows the researchers to strengthen and toughen such material. Fibers are not generally added to concrete to increase its strength. Still, the main role of the fibers is to bridge across the matrix cracks that develop as concrete is loaded and, thus, provide some post-cracking ductility [1]. Generally, fiber mixed into the concrete mixture is intended to improve the properties of the concrete. Additionally, fibers reduce cracking from plastic by drying shrinkage and restrict the permeability of concrete [2]. Fiber can be categorized into three types. There is steel, glass, synthetic and natural fiber [3]. Some mechanical properties are improved when fibers are added to concrete [4]. These properties include compressive strength, flexural strength, tensile strength, durability, and crack resistance. However, multiple parameters, including fiber percentage, diameter, and length, can affect these characteristics [5].

Many studies have been done regarding fiber mixes in concrete. One of them is using carbon fiber as a mixture. Carbon-fiber reinforced concrete is a composite product consisting of carbon fiber, which provides strength and stiffness, and polymer, which holds the fibers together in a matrix [6]. Adding carbon fiber gradually reduces the workability of concrete [5-8]. This is because it can cause the fiber to clump. This situation occurs due to the hindrance of interaction between concrete particles by existing fibers [9]. Due to agglomeration, lower concrete strength is shown when 1% fiber is mixed into it [10-11].

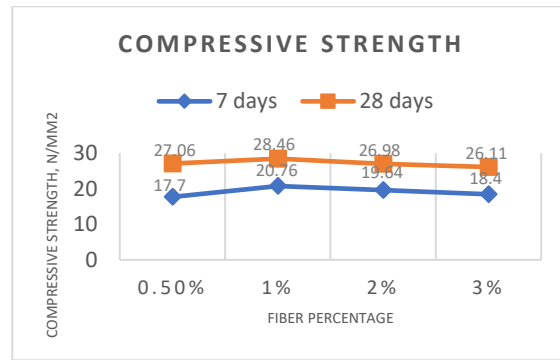
Besides carbon fiber, some researchers use glass and coconut fiber separately as additional ingredients in the concrete mix. The effect of glass wool fibers on the mechanical properties of concrete is that glass wool fiber can increase the strength of concrete compared to conventional concrete at a lower cost. The strength parameters of concrete, such as compressive strength and tensile strength, were studied by varying the percentage of fiber from 0.025% to 0.075% of the weight of concrete. They've concluded that as the percentage of fiber content by total weight of the concrete increases from 0.025%-0.075%, the compressive strength of the concrete also increases from 5.15% to 15.68% at 28 days [12].

Glass fiber insulates the concrete and strengthens it. The glass fiber also helps prevent the concrete from cracking over time due to mechanical or thermal stress [2]. Glass fiber has high tensile strength and fire-resistant properties, thus reducing the loss of damage during fire accidents. They conducted compressive strength tests, split tensile strength, and Flexible strength tests, which showed that adding these fibers into concrete can dramatically increase the concrete's compressive strength, tensile strength, and split tensile strength. In this study, tests were done for concrete with glass fiber of 0.5%, 1%, 2%, and 3% of cement by adding it as an admixture [13].

Some studies use coconut fiber as an additive in a concrete mix. Table 1 and Figure 1 show that concerning compressive strength, incorporating a small amount of coconut fiber 2% enhances the performance of concrete, as expected, and counters harmful shrinkage effects in concrete. The recommended value of fiber content that will benefit the long-term durability of the concrete in all environments is 2.0%. The properties can increase or decrease depending on fiber length and its content. As a result, the strength of CFRC (coconut fiber reinforced concrete) can be greater than plain concrete's [14]. Fiber-reinforced concrete uses natural fibers, such as hay or hair. While these fibers help the concrete's strength, they can weaken it if too much is used [2].

**Table 1.** Compressive Strength Data [J.D Chaitanya Kumar et al. (2016)]

S. NO	M20 + Glass Fiber	COMPRESSIVE STRENGTH (N/mm <sup>2</sup> )	
		7 days	28 days
1	0.5%	17.7	27.06
2	1%	20.76	28.46
3	2%	19.64	26.98
4	3%	18.4	26.11



**Fig. 1.** Fiber Percentage vs Compressive Strength [14]

The compressive strength of the concrete decreased as the fiber volume percentage of the coconut increased in the concrete mix. Experimental results also demonstrated that the coconut fiber concrete performed satisfactorily on the growth of cracks and crack widths compared with conventional concrete. It is stated that the compressive strength of plain concrete after the 28-day curing period is 31.57 N/mm<sup>2</sup>. However, concrete compressive strength with 3% coconut fiber volume is between 18.85 N/mm<sup>2</sup> at the curing age of 28 days, and it satisfies the structural requirement of lightweight concrete. Finally, it is concluded that using coconut fiber has great potential in producing lightweight structural concrete, especially in constructing low-cost concrete structures [15].

The combination of fibers is often called hybridization. Using two or more types of fibers in a suitable combination may improve the overall properties of concrete and result in performance concrete. The type of fiber that will be used is glass fiber and coconut coir fiber as natural fiber to produce concrete test subjects to test the aftereffects of incorporating fibers as additional material in the concrete mixture. Hybrid composites with synthetic and natural fibers are a good choice in composites, as they combine the good mechanical performance of synthetic fibers with the advantage of natural fibers. This study's polymeric hybrid composites are associated with glass fiber and natural fibers [16]. Coconut fiber and glass fiber are cheap and easy to obtain locally. Combining coconut fiber and glass fiber in the concrete mixture is hoped to achieve results that can create quality concrete with better properties.

### 3 Methodology

This chapter will discuss the research method and procedures. The materials used are sand, coarse aggregate, coconut fiber, glass fiber, and water mixed in a 1:2:4 ratio. The tests to be conducted are sieve analysis, slump test, and compressive strength test.



**Fig. 2.** Coconut fiber



**Fig. 3.** Glass fiber

This research aims to study if fiber can be an effective material for concrete. Therefore, there will be a design of 4 types of samples of concrete mixture cubes by partially replacing some of the coarse aggregates for 0% fiber, 1% fiber, 3% fiber, and 5% fiber. The concrete cube with 0% fibers is named Control (CT) and set as a control sample, which will eventually act as a reference for the research. Before mixing, the aggregate needs to be sifted using a sieve analysis test. During the mixing



process, some samples of the concrete will be taken out to do a slump test. The total number of concrete cube samples is 36 for the compressive strength test. Then, the cubes produced will undergo 7,14, and 28 days of wet curing. After the curing, the cubes will be tested for compressive strength.

**Table 2.** Mix ratio per concrete cube

MIX	Percentage of fiber (%)		Mix ratio per concrete cube			Water Cement Ratio	Number of samples
	Coconut fiber	Glass fiber	Cement	Sand	Coarse Aggregate		
CONTROL (0% OF FIBERS)	0	0	1 (1157 g)	2 (2314 g)	4 (4628 g)	0.6	9
1% OF FIBERS	0.5%	0.5%	1 (1157 g)	2 (2314 g)	3.93 (4547 g) 0.07 (81 g) <i>Replace by fiber</i> 40.5 g Coconut Fiber    40.5 g Glass Fiber	0.6	9
3% OF FIBERS	1.5%	1.5%	1 (1157 g)	2 (2314 g)	3.79 (4385 g) 0.21 (243 g) <i>Replace by fiber</i> 121.5 g Coconut Fiber    121.5 g Glass Fiber	0.6	9
5% OF FIBERS	2.5%	2.5%	1 (1157 g)	2 (2314 g)	3.65 (4223 g) 0.35 (405 g) <i>Replace by fiber</i> 202.5 g Coconut Fiber    202.5 g Glass Fiber	0.6	9
TOTAL OF SAMPLE							36

The sieve analysis test helps determine coarse aggregates' particle size distribution. This test procedure is carried out according to BS 812: Testing Aggregate : Part 103 and MS EN 12620 : Aggregate for Concrete. The sieve sizes are 50mm, 37.5mm, 28mm, 20mm, 14mm, and 10mm.



**Fig. 4.** Sieve Analysis Test

The concrete mix is designed to achieve the minimum grade of M15 (15MPa compressive strength) by using 1:2:4 as the nominal mix. The study produced four types of concrete mixtures: a control mixture, a concrete mixture with 1% fiber, a concrete mixture with 3% fiber, and a concrete mixture with 5% fiber.



**Fig. 5.** Concrete Mixing

The slump test measures the consistency and workability of freshly poured concrete. It helps determine the correct water content and consistency of a high-workability concrete mix for specific applications. This test procedure is carried out according to BS 1881-2: Method of Testing Fresh Concrete, MS 26-1-1: Testing Fresh Concrete—Part 1 : Fresh Concrete—

## Section 2 : Slump Test.



**Fig. 6.** Slump Test

**Table 3.** Concrete Slump Range (ASTM C143)

SLUMP (mm)	DEGREE OF WORKABILITY	APPLICATION
0 - 25	Very Low	Very dry mixes in paving machines with high-powered vibration
25 - 50	Low	Low-workability mixes used for foundations with light reinforcement; Pavements consolidated by hand-operated vibration
50 - 100	Medium	Medium workability mixes manually consolidated flat slabs. Normal reinforced concrete manually placed; heavily reinforced sections with mechanical vibration
100 - 175	High	High workability concrete for sections with congested reinforcement. May not respond well to vibration.

The curing test for this study will follow BS 1881: Testing Concrete, Part 111: Method of Normal Curing of Test Specimens, which describes the method of normal curing of concrete specimens at 20 °C for strength tests.



**Fig. 7.** Curing Test

Compressive strength is a mechanical test measuring the maximum compressive load a concrete sample can bear before fracturing. A 36-mixture sample size 150x150x150 mm, has been tested. There are samples of 1% fiber, 3% fiber, and 5% fiber. This sample was tested for strength on the 7th, 14th, and 28th day. This test procedure is carried out according to BS 1881 : Testing Concrete, Part 116: Method for Determination of Compressive Strength of Concrete Cube and MS EN 12390: Testing Hardened concrete, Part 3 : Compressive Strength of Test Specimens.



**Fig. 8.** Compressive Strength Test

## 4 Data and Results

### 4.1 Sieve Analysis



Sieve analysis for aggregates is a commonly used method of determining the particle size distribution of coarse and fine aggregates. This process involves placing a sample of the aggregate material on a series of nested sieves, which are then shaken mechanically or by hand to separate the material by size. This research uses aggregate retained on a sieve size of 20mm. The 20mm aggregates are typically the most common size of aggregate used in construction. It creates a great concrete mix when blended with cement in the proper proportions.

**Table 4.** Sieve Analysis Data

Sieve Size (mm)	Sieve Weight (g)	Sieve Weight + Aggregate (g)	Weight Retained (g)	Accumulative Retained (g)	Percentage Mass Retained (%)	Percentage Cumulative Passing (%)
50mm	1948	1948	0	0	0	100
37.5mm	1444	1444	0	0	0	100
28mm	1554	1554	0	0	0	100
20mm	1114	1462	348	348	5.84	94.16
14mm	1366	2912	1546	1894	31.81	68.19
10mm	1014	2784	1770	3664	61.54	38.46
Pan	708	2988	2290	5954	100	0
Total Weight Retained (g)			5954			



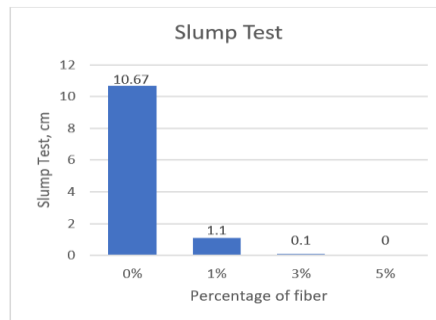
**Fig. 9.** Coarse Aggregate 20mm size

## 4.2 Slump Test

The Concrete Slump Test is a measurement of concrete's workability or fluidity. It's an indirect measurement of concrete consistency or stiffness. A slump test is a method used to determine the consistency of concrete. The consistency, or stiffness, indicates how much water has been used in the mix. Table 5, Figure 10, and Figure 11 show how fibers affect concrete workability. Concrete with a mixture of 1% and 3% fiber slump 11cm and 10cm, respectively. For concrete with a mixture of 5% fiber, it was found that there was no slump at all. These three samples can be categorized as zero slump and very low workability. Concrete in corporate with fibers has low workability because the slump is zero. Zero slump means the concrete retains its shape completely. This shows that the mix is very dry. Fibers added to the concrete mix can cause the fibers to grip the aggregate, resulting in more friction. When fibers hold the concrete in place, a slump might not even occur. This means that the 0.6 water-cement ratio is unsuitable for this concrete mixer. Due to coconut fiber, which absorbs water, it was found that the more percentage of fiber is mixed, the higher water-cement ratio is needed. Compared to the sample that was not mixed with fiber, it has a 10.67cm slump. It is categorized as a true slump and high-workability concrete

**Table 5.** Slump Test Data

MIX	SLUMP VALUE (cm)			AVG (cm)	TYPE OF SLUM P	DEGREE OF WORKABILITY	WATER- CEMENT RATIO
	TE ST 1	TE ST 2	TE ST 3				
CONT ROL	10 .0	11. 0	11. 0	10.67	True Slump	High workability concrete	0.6
1% OF FIBER S	1. 10	1.1 0	1.1 0	1.10	Zero Slump	Very low workability. Very dry mixes	0.6
3% OF FIBER S	1. 00	1.0 0	1.0 0	1.00	Zero Slump	Very low workability. Very dry mixes	0.6
5% OF FIBER S	0. 00	0.0 0	0.0 0	0.00	Zero Slump	Very low workability. Very dry mixes	0.6



**Fig. 10.** Percentage of fiber vs Slump Graph



**Fig. 11.** Zero slump for 1% fiber

#### 4.4 Compressive Strength Test

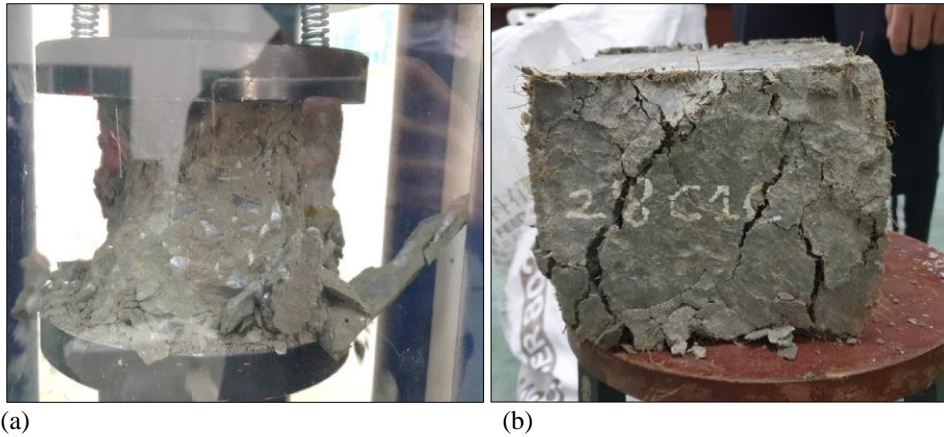
Compressive strength is a test measuring the maximum compressive load a concrete can bear before fracturing. A gradually applied load compresses the test piece, usually a cube or cylinder, between the platens of a compression-testing machine. This research used a cube size of 150mm x 150 mm x 150 mm. A total of 36 samples were tested to obtain the compressive strength of the concrete produced, which is recorded in Table 6 and Figure 13.

From the fiber percentage vs compressive strength graph (Figure 14), it was found that on the 7th day, the compressive strength of the 1% fiber sample was higher compared to the other samples, which was 4.3 MPa. On the 14th day, it was found that the 0% fiber concrete mix was higher than other samples, which was 21.4 MPa. Likewise, on the 28th day, it was found that the control sample (0% fiber) had a higher strength than the other samples, which was 22.8 MPa. Even so, it was found that the 1% fiber sample also reached almost the same strength as the control sample (0%), which was 22.4 MPa. The 0% fiber and 1% fiber samples exceeded the minimum strength to be achieved, which was 15 MPa.

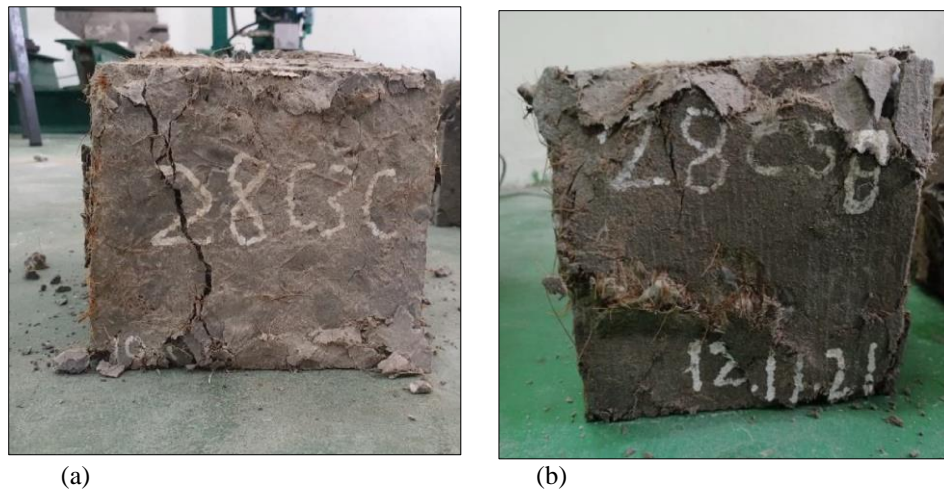
The concrete strength from the 7<sup>th</sup> day to the 14<sup>th</sup> day, the strength increased dramatically for the control sample (0%) which was 17.5 MPa, followed by the 1% fiber sample (9.8 MPa), the 3% fiber sample (8.2 MPa) and Sample 5% fiber (2.4 MPa). In contrast to the strength from day 7 to day 14, it was found that the 1% fiber sample had a higher increase of 8.4 MPa, followed by the 0% fiber sample (1.4 MPa), the 5% fiber sample (0.7 MPa) and 3% fiber sample (0.3 MPa)

**Table 6.** Compressive Strength Test

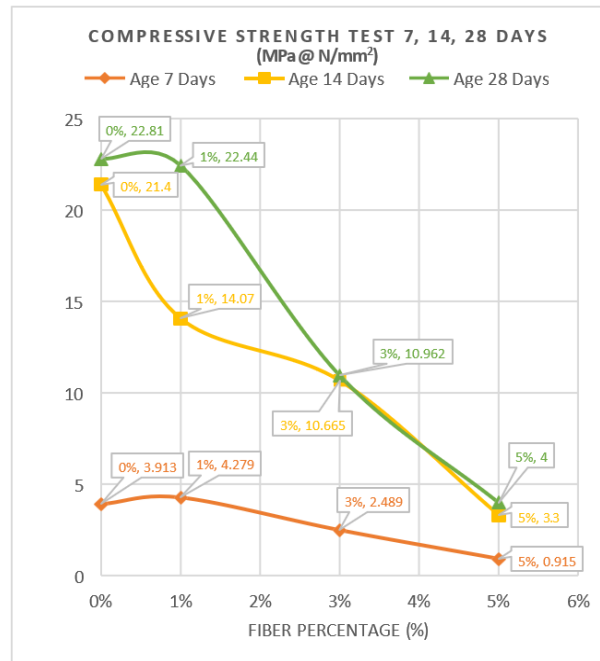
NAME OF SPECIMENS	PERCENTAGE FIBER (%)	AGE (DAYS)	COMPRESSIVE STRENGTH (MPa)			AVERAGE (MPa)
			TEST 1	TEST 2	TEST 3	
7CT	0%	7	3.627	4.391	3.722	3.913
7C1	1%		4.494	3.794	4.55	4.279
7C3	3%		2.939	2.327	2.2	2.489
7C5	5%		0.955	0.774	1.018	0.915
14CT	0%	14	23.11	21.33	19.77	21.4
14C1	1%		14.44	12.889	14.889	14.07
14C3	3%		12	9.556	10.44	10.665
14C5	5%		3.5	2.4	4	3.3
28CT	0%	28	20.44	21.11	26.889	22.81
28C1	1%		25.33	20	22	22.44
28C3	3%		9.778	14.22	8.889	10.962
28C5	5%		3.778	3.556	4.667	4



**Fig. 12.** Concrete Sample at 28 days failure mode (a) Control Sample. (b) 1% of fiber.



**Fig. 13.** Concrete Sample at 28 days failure mode (a) 3% of fiber. (b) 5% of fiber.



**Fig.14.** Fiber percentage vs Compressive Strength Graph

The time taken for the concrete fiber incorporated to deform is also longer because fibers can hold the concrete in place, withstanding stresses until it fails. Besides that, when comparing ordinary concrete and concrete with fibers incorporated, the workability of concrete with fibers tends to be lower than ordinary concrete. Workability is affected by the water-cement ratio and the fibers inserted.

With a 22 MPa compressive strength for concrete of 1% fiber, this design mix is suitable for designing structures with a minimum strength class of C20/30 to be used for exposure class XC1 in dry or permanently wet environments, as per MS EN 1992-3: Eurocode 2—Design of Concrete Structures (2021).

From Figure 12 and Figure 13, it was also found that the cracks in the concrete also decreased with the increase in the amount of fiber mixed. This clearly shows that fiber can reduce cracks in concrete.

## 5 Discussion

Incorporating fibers as additional material in the concrete mixture will affect the properties of concrete. Compressive strength decreased while fiber increased. Incorporating 1% fiber decreased 1.6% of compressive strength of concrete. Incorporating 3% fiber decreased 51.9% of compressive strength of concrete. Incorporating 5% fiber decreased 82.5% of compressive strength of concrete. Fiber also performed satisfactorily on the growth of crack width compared to plain concrete. Concrete that has been incorporated with fibers requires a longer time to deform. Fibers can sustain the tensile and compressive stress at any point imposed onto the concrete. Concrete with 1% of fibers has achieved the same strength as ordinary concrete (22 MPa). It is suitable for use in structure design, meaning that a 1% to the concrete ratio is the best option for using fibers in the concrete. Besides that, adding fibers to the concrete will also affect the concrete's workability. So, further study should be conducted on improving workability. Since this design mix is based on replacing a certain ratio of aggregates for fibers, it could reduce the concrete cost and maintain the same strength as ordinary concrete. Further research on the actual market price is required.

Based on the findings and studies of this research, the following recommendations are to improve the design mix of concrete incorporated with fibers as an additional mix. Plasticizers like Lignosulphonates and Hydro Carbolic Acid Salts should be added to this design mix to achieve a higher strength by decreasing the water-cement ratio. This will increase the workability. The sequence of materials added to the mix impacts the concrete produced. When fibers are added to the concrete mixture without a sequence, they have a high chance of balling up, and the cement will also have very little bonding with them. Cement should be the first material to be in the mix. Next, slowly add in fibers, such as glass fiber and coconut fiber. This ensures that the fibers are more or less covered by cement. Then, mix with sand and aggregates. Using a cement mixing machine will definitely produce a better-quality concrete mix because it is more powerful than manual mixing and constantly in motion to prevent the concrete from hardening. It can also produce longer mixing times compared to manual mixing.

## References

1. Giovanni Plizzari, Sidney Mindess 2, *Developments in the Formulation and Reinforcement of Concrete (Second Edition)*. Woodhead Publishing Series in Civil and Structural Engineering, 257-287 (2019) <https://www.sciencedirect.com/science/article/pii/B9780081026168000113>
2. Ragavendra S, Reddy IP, Dongre DA, *Fibre reinforced concrete - a case study. Proceedings of the Architectural Engineering Aspect for Sustainable Building Envelopes*, Khairatabd, Hydreabad, India, 10-11 (201)
3. ASTM C 1116/C 1116M Part 6 – *Standard Specification for Fibre-Reinforced Concrete*. ASTM International. West Conshohocken (2007)
4. Thakur P, Singh K., A review: *Effect of carbon fibre on different mixes of concrete. International Research Journal of Engineering and Technology (IRJET)*, 5(3): 3996-3999 (2018)
5. Elizer Nevall Anthony, Ahmad Nurfaidhi Rizalman, Anand Ryan Thurairajah, S.M Iqbal S. Zainal and Muhd Fauzy Sulaiman, *Mixing Sequence Effect of Cement Composites with Carbon Fibres*. (2024) [https://www.researchgate.net/publication/377058833\\_MIXING\\_SEQUENCE\\_EFFECT\\_OF\\_CEMENT\\_COMPOSITES\\_WITH\\_CARBON\\_FIBRES](https://www.researchgate.net/publication/377058833_MIXING_SEQUENCE_EFFECT_OF_CEMENT_COMPOSITES_WITH_CARBON_FIBRES)
6. John Caulfield, Senior Editor, *The world's first building made from carbon-fiber reinforced concrete starts construction in Germany* (2024) <https://www.bdcnetwork.com/world%E2%80%99s-first-building-made-carbon-fiber-reinforced-concrete-starts-construction-germany>
7. Wang Z, Ma G, Ma Z, Zhang Y., *Flexural behavior of carbon fibre reinforced concrete (RC) beams under impact loading*. Cement and Concrete Composites, 118: 103910. doi: <https://doi.org/10.1016/j.cemconcomp.2020.103910> (2020)
8. Abbas N, Saad M, Habib M., *Impact of carbon fibres on mechanical and durability properties of self-compacting concrete*. Engineering Proceedings, 22(1): 9. (2022) doi: <https://doi.org/10.3390/engproc2022022009>.
9. Aljalawi NMF, Al-Jelawy HM., *Possibility of using concrete reinforced by carbon fibre in construction. International Journal of Engineering and Technology*, 7(4.20): 449-452 (2018)
10. Salama AHES, Edris WF., *Performance of carbon fibre filament reinforcing cement mortar. Civil Engineering Journal*, 7(10): 1693-1701. (2021) doi: <https://doi.org/10.28991/cej-2021-03091753>.
11. Li YF, Yang TH, Kuo CY, Tsai YK., *A study on improving the mechanical performance of carbon-fibre-reinforced cement. Materials*, 12(17): 2715. (2019) doi: <https://doi.org/10.3390/ma12172715>
12. Deore SM, Bodke JS, Aware RV, Ahire CV, Kamble PM, Pendhari AR., *Addition of carbon fibre in concrete with partial replacement of sand by waste foundry sand. International Research Journal of Engineering and Technology (IRJET)*, 4(4): 2017-2079 (2017)
13. R.Gowri, M.AngelineMary. "Effect of glass wool fibres on mechanical properties of concrete". International Journal of Engineering Trends and Technology (IJETT). V4(7):3045-3048 Jul 2013. ISSN:2231-5381. [www.ijettjournal.org](http://www.ijettjournal.org). published by seventh sense research group.
14. J.D.Chaitanya kumar ,G.V.S. Abhilash , P.Khasim Khan , G.Manikanta sai , V.Taraka ram. Volume-5., *Experimental Studies on Glass Fiber Concrete" American Journal of Engineering Research (AJER)*, pp-100-104. (2016) [http://www.ajer.org/papers/v5\(05\)/O05050100104.pdf](http://www.ajer.org/papers/v5(05)/O05050100104.pdf)
15. Shafi, Siddiqui Saquib ,Hamza Sayyed Hasham Ali, Shaikh Shamsuddoha Mohd Umar., *Effects of coconut fiber in concrete and to improve the workability by incorporating an admixture*, (2016) <https://www.slideshare.net/HSAAMHSAAM/effect-of-coconut-fibre-in-concrete-and-to-improve-the>
16. Noor Md. Sadiqul Hasan, Habibur Rahman Sobuz, Md. Shiblee Sayed and Md. Saiful Islam., *The Use of Coconut Fibre in the Production of Structural Lightweight Concrete*. Volume: 12 Issue: 9 Journal of Applied Sciences (2012). [https://www.researchgate.net/publication/258659021\\_The\\_Use\\_of\\_Coconut\\_Fibre\\_in\\_the\\_Production\\_of\\_Structural\\_Lightweight\\_Concrete](https://www.researchgate.net/publication/258659021_The_Use_of_Coconut_Fibre_in_the_Production_of_Structural_Lightweight_Concrete)
17. Thakur P, Singh K. (2018) A review: effect of carbon fibre on different mixes of concrete.
18. International Research Journal of Engineering and Technology (IRJET), 5(3): 3996-3999. Wang Z, Ma G, Ma Z, Zhang Y. (2021) Flexural behavior of carbon fibre reinforced concrete (RC) beams under impact loading. Cement and Concrete Composites, 118: 103910. doi: <https://doi.org/10.1016/j.cemconcomp.2020.103910>
19. Wang Z, Ma G, Ma Z, Zhang Y. (2021) Flexural behavior of carbon fibre reinforced concrete (RC) beams under impact loading. Cement and Concrete Composites, 118: 103910. doi: <https://doi.org/10.1016/j.cemconcomp.2020.103910>
20. Deore SM, Bodke JS, Aware RV, Ahire CV, Kamble PM, Pendhari AR. (2017) Addition of carbon fibre in concrete with partial replacement of sand by waste foundry sand. International Research Journal of Engineering and Technology (IRJET), 4(4): 2017-2079



**SARAWAK**

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## **SECTION**

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**SOCIAL SCIENCE & BUSINESS MANAGEMENT**

# The Influence of ISO 21001 Educational Organization Management System on Staff Satisfaction: A Qualitative Study on Private Higher Education Providers in Malaysia

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**Abstract.** Staff satisfaction is among the factors that cause high turnover in the education sector. This qualitative research investigates the influence of ISO 21001 Educational Organization Management System (EOMS) certification on the staff satisfaction of private higher education providers (PHEPs) in Malaysia. The study used semi-structured interview, site observation and document analysis to examine the implications of ISO 21001 EOMS adoption by private universities and/or colleges on staff satisfaction level. Seventeen informants were purposefully sampled from four PHEPs in Malaysia that are already certified to the ISO 21001 EOMS standard to provide insights on the influences. Thematic analysis was applied to interview transcripts, observation notes, and documents to identify patterns and themes. The findings of this study showed that 65% of informants working at ISO 21001 EOMS certified institutions reported a staff satisfaction level of more than 70%. This finding revealed a positive correlation between ISO 21001 EOMS implementation and the principles of the Job Characteristics Model (JCM) contributing to the staff satisfaction level. Additionally, this also contributes to the institution's operational efficiency and quality of services to students and related stakeholders. The findings offer valuable insights for educational institutions seeking to enhance their competitiveness through ISO 21001 EOMS adoption. Recommendations for further research and potential areas for improvement are also discussed

**Keywords:** ISO 21001 EOMS, staff satisfaction, Job Characteristics Model, operational efficiency, quality of services, competitiveness

## 1 Introduction

Private Higher Education Providers (PHEPs) in Malaysia have encountered severe challenges during the Covid-19 pandemic that caused the elimination of resources and a sharp decline in student enrollment. PHEPs in Malaysia operate in a highly competitive environment as compared to public higher education institutions, where their success lies in their abilities to improve and sustain business performance. One of the significant aspects of the business performance domain is staff satisfaction, which is closely associated with job satisfaction, work conditions, and the well-being of the staff. The satisfaction and retention of staff are crucial for operational efficiency and quality of service and are often hindered by inadequate working conditions as well as a lack of support from management systems. Job satisfaction is crucial for the well-being of the workforce because it represents how individuals feel about their work [15]. Bloomfield [2] posited that job satisfaction is how employees perceive their work and is influenced by a variety of factors, both internal and external to the individual. Noraani [14] emphasized that satisfaction among academicians in higher learning institutions is influenced by elements like salaries, additional benefits, educational policies, and administration, working conditions, opportunities for advancement, and job responsibilities. Therefore, an organization needs to create a conducive working environment since it is related to staff satisfaction, which will influence their motivation level and, in turn, increase productivity and reduce staff turnover issues. The challenges to staff satisfaction were further strained by Covid-19 pandemic and social disruptions, which impacted these PHEPs to maintain satisfactory working conditions and job satisfaction. The ISO 21001 Educational Organizations Management System (EOMS) has been identified as the potential framework and predicted to have positive alignment with Job Characteristics Theory or Model (JCM) for potential job enrichment leading to a more motivated, productive, and satisfied workforce in the educational organization. However, the specific influence of ISO 21001 EOMS on staff satisfaction of PHEPs in Malaysia remains a substantial gap in the current research.

There were few empirical studies on JCM and employee satisfaction (Dominic, A. S. and John, V. M. [4]; Raihan Tarik [16]; Hassim, A. A., & Abu Bakar, S. N. [6]; Andrew, Leviana., et al., [1]; Lou Fan, et al. [9]; Leblanc, C.M. [8]; Mat Ali, et al. [11]) but all these studies did not address the interaction between the ISO management system and JCM and did not provide how specific characteristics of certified ISO 21001 EOMS higher education institution's jobs align with or differ from JCM that will impact the employee satisfaction level. Applying JCM to determine the extent of the impact of ISO 21001 EOMS on staff satisfaction levels working at PHEPs in Malaysia could enhance the relevance of the literature knowledge to the Malaysian educational context.



## 2 Objectives of the study

The objective of this study is to identify and examine how staff satisfaction levels change before and after ISO 21001 EOMS certification and the alignment between ISO 21001 EOMS and JCM in influencing staff satisfaction levels within PHEPs in Malaysia. This study aims to explore the effectiveness of implementing ISO 21001 EOMS in enhancing staff satisfaction within the JCM framework, thus improving operational efficiency, quality of education, and service to students and other stakeholders in Malaysian PHEPs. The goal is to provide actionable insights that can help improve the sustainability and competitiveness of these institutions.

## 3 Literature review

In Hackman and Oldham's Job Characteristics Theory, it is stated that the clarity of tasks will lead to greater job satisfaction because it creates a working environment whereby everyone in an organization is clear with their role and responsibility, and hence the employees will be more satisfied, more committed, and more involved in their work [12]. The Job Characteristic Model proposes that when three critical psychological states are present in an employee, a positive personal and work outcome will be produced, such as high internal work motivation, high quality work performance, and high satisfaction with work, as shown in Figure 1 below. This study also intends to look at the effect of ISO 21001 EOMS on the job characteristics of staff and job satisfaction as one of the work outcomes in a private higher education provider setting in Malaysia. The ISO 21001 EOMS certification is seen to have positive alignment on all the job characteristics elements of an employee, which comprise skill variety, task identity, task significance, autonomy and feedback as postulated by Hackman and Oldham [5].

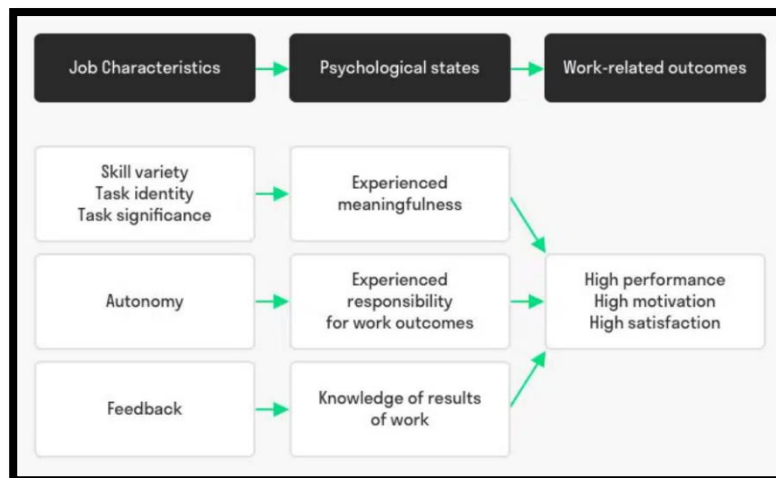


Fig. 1. Job Characteristics Model by Hackman and Oldham (Source: Hackman & Oldham (1976))

In today's competitive market, many organizations, including higher education institutions, are striving to improve their human capital performance and productivity, and one of the main elements is to ensure that the organization receives the most support from their employees. In order to get support from the employees, the employee or staff themselves must first be satisfied with their job and this will lead to better performance and quality work output to customers. Staff satisfaction on job is therefore an important factor that can contribute to the overall business performance of an organization. Hassim & Abu Bakar [6] conducted a research study to determine the relationship between the JCM dimension and job satisfaction at Shah Alam City Council by distributing a questionnaire to 310 respondents using the quota sampling technique. 53% respondent data was collected and analysed using Pearson correlation. The result showed that the JCM dimensions (skill variety, task identity, task significance, and autonomy) have a significant relationship with job satisfaction level. The existing study focuses on job satisfaction in a municipal context, and there is a gap in understanding how the relationship between JCM dimensions and job satisfaction applies to employee in ISO 21001 EOMS certified PHEPs in Malaysia.

In another study conducted by Muwanguzi et al. [13] on applying JCM in the analysis of job satisfaction at Makerere University using a descriptive cross-sectional survey design, quantitative data was collected from 304 academic staff using an adapted closed - ended questionnaire. Data were analyzed using descriptive statistics and a multiple regression analysis technique and revealed that the job characteristics element, i.e., autonomy and task significance, were the most important influential variables on job satisfaction at Makerere University, while other elements were found to have an insignificant effect on job satisfaction. While Muwanguzi et al. [13] focus on Makerere University and JCM elements like autonomy and task significance, there is a gap in the literature regarding the contextualization of ISO 21001 EOMS interaction with JCM in the Malaysian PHEPs context. Additionally, there is a literature gap in the lack of qualitative approaches to exploring the detail and subjective experiences of staff working in ISO 21001 EOMS certified institutions. Therefore, the study on exploring the interaction between ISO 21001 EOMS and JCM in shaping staff satisfaction levels at PHEPs in Malaysia can



provide another interesting insight on whether the ISO 21001 EOMS certification will help in improving the staff satisfaction level in relation to JCM, which in turn positively influences work outcomes at the institution.

Dominic, A. S. and John, V. M. [4] performed a study on job satisfaction and characteristics among staff of public higher educational institutions in Ghana using a quantitative approach. The study employed cross-sectional survey design with data collected from three (3) categories of survey, comprising background characteristics of the respondent, job satisfaction, and job characteristics from four (4) public universities. The theoretical framework of the study drew upon Herzberg's motivation-hygiene theory and the Job Characteristics Model. A total of 452 respondents' results were analyzed, and it was noted that social status, recognition, remuneration, and a conducive working environment are the key factors contributing to job satisfaction among the staff at these public universities. Additionally, the study also noted that the dimensions characterizing the jobs of the staff include task variety, feedback, task significance, autonomy, and task identity. Furthermore, the study reveals a significant positive relationship between job satisfaction and job characteristics, indicating that well-designed jobs with specific characteristics tend to lead to higher job satisfaction and motivation whereby a workplace that features five job characteristics is associated with elevated job performance and motivation, ultimately contributing to increased job satisfaction. While the study reveals a workplace that featured five job characteristics can lead to elevated job performance and motivation which eventually leading to job satisfaction, there is literature gap in understanding the effect of ISO 21001 EOMS in influencing job design and activities of certified private higher educational organizations that can closely align with JCM, contributing to higher job or staff satisfaction level.

Hussein, B., et al. [7] performed a study to test the JCM in a Lebanese university through a standard job diagnostic survey conducted on 294 academic faculty members at the Lebanese International University (LIU), one of the largest private universities in Lebanon. The study aims to compare the elements that stimulate job satisfaction and motivation among non-management academic staff of instructors, lecturers, assistant professors, associate professors, and professors at LIU teaching in the School of Education and School of Engineering. An analysis of the Motivating Potential Score (MPS) at LIU revealed that the JCM is applicable for enhancing the job setting at the university with the conclusion that JCM remains relevant in the educational sector where satisfaction is a crucial factor in the delivery process.

## 4 Materials and method

In-line with the purpose of the study, this is a qualitative research in nature to gain insights into the phenomena with regards to what participants think and believe of the new ISO 21001 standard influences on the higher education institution's staff satisfaction level. Semi-structured interview approach has been used as the primary method to collect data. According to Magaldi and Berler [10], semi-structured interview is an effective tool to explore the participant's sentiments and opinions about a phenomenon and at the same time, can elicit more information as the interview can be a good platform for in-depth exploratory discussions. A semi-structured questionnaire form was employed as the instrument. In addition, passive observation technique was used in the participating observation whereby open engagement and interaction with academic and non-academic staff of the educational organization of which researcher made himself present on site as per scheduled appointment site visit date. Besides that, documents such as staff satisfaction survey form, previous literature, and other related useful documents were collected as appropriate to complement and support further data from interviews and site observations. According to Creswell [3], documents serve as valuable information within a qualitative research framework. This research was conducted at four (4) private higher education institutions certified to ISO 21001 EOMS standard located in Klang Valley and Nilai, Negeri Sembilan state of Malaysia. A total of seventeen (17) informants were successfully interviewed via physical face-to-face mode at their respective institution premises and on-line virtual meeting mode.

Informants or participants as shown in table 1 below consisted of registrar, accreditation and quality directors/representatives, academic and non-academic staff working in these chosen ISO 21001 EOMS certified private higher institutions. Purposive sampling was chosen as a non-probability sampling technique to assist in determining the selection of participants through proper judgment to identify and select participants that could provide information-rich cases related to the influence on staff satisfaction level in connection with JCM before and after the ISO 21001 EOMS certification obtained by these private higher education institutions [17]. All the data collected from the interviews were triangulated with the data collected from other sources, such as the staff satisfaction survey form, previous literature, the institution's management review minutes, etc., and physical site observations while performing interviews at the premises of the institution or via a virtual meeting. The study analyzed data based on transcribing, coding, segregating into themes and sub-themes or codes, and lastly, reporting the analytical themes.

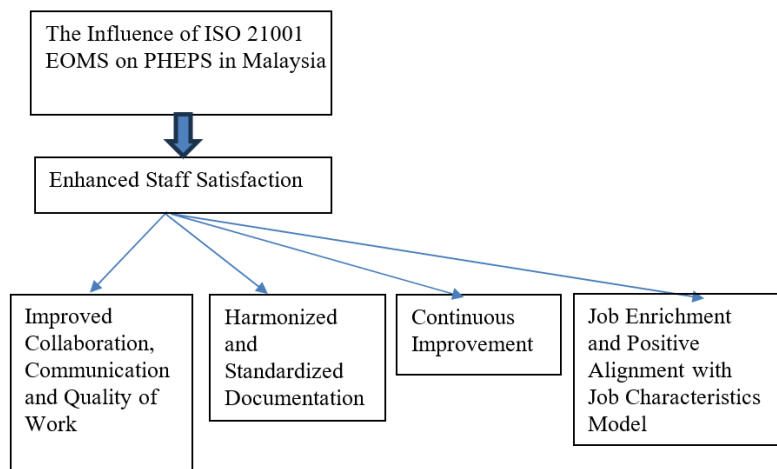
**Table 1:** Selected Informants and Positions in the PHEPs

Participants or Informants	Position in the PHEPs
P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, and P17	QA Head, Deputy Registrar & Head of Admission, Risk Officer, Lecturer, A. QA Director, Admin Officer (QA), Senior A. Registrar, Deputy Dean, QA Acting Head, Deputy Manager (Marketing & Student Enrollment), Senior Executive (Admission & Record Unit), Lecturer, Lecturer, Lecturer, Manager (Admission Department), Senior Lecturer (Director of Enrolment & Marketing), Compliance Officer

## 5 Results and discussion

### Key themes

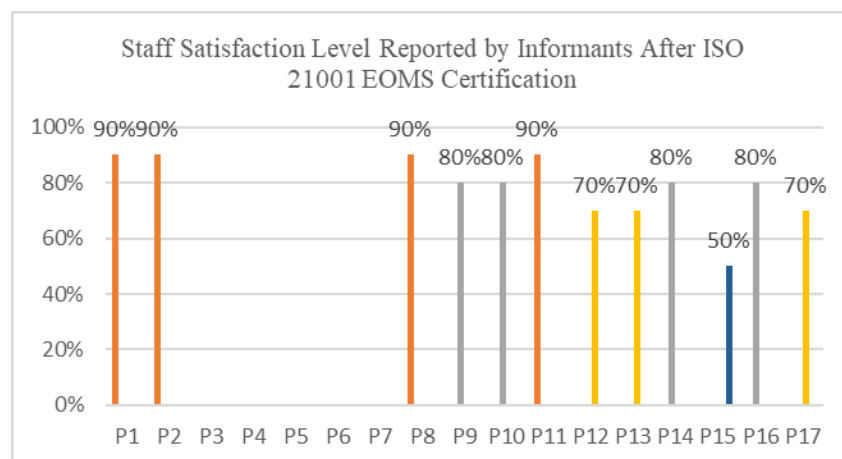
The thematic analysis identified enhanced staff satisfaction as the key theme that emerged from the informants' responses, as shown in Figure 2 below. The enhanced staff satisfaction theme consisted of 4 sub-themes derived from the transcription of the interviews done with the informants, and these include improved collaboration, communication, and quality of work, harmonized and standardized documentation, continuous improvement; job enrichment and positive alignment with JCM. These themes highlighted the reasons for the diverse influences of ISO 21001 EOMS on various processes of PHEPs in Malaysia, which led to a higher staff satisfaction level before and after ISO 21001 EOMS certification.



**Fig. 2.** Summary of Findings with Key Theme and Sub-themes

### Enhanced staff satisfaction

From the institution staff's perspective, the majority of the interviewed informants fully agreed that ISO 21001 EOMS improved their satisfaction level at the workplace. Figure 3 below shows the staff satisfaction level reported by informants during the semi-structured interview session. Despite a high overall satisfaction level expressed by 11 informants, representing 65% of the sample size, there was one (1) informant rated below 50%, citing his dissatisfaction with ISO 21001 EOMS implementation in his sales and marketing activities, where he perceived it as a burden to his work. Informant P3 to P7, while expressing overall satisfaction, did not provide a specific rating score, suggesting a potentially mixed perspective on the influence of ISO 21001 EOMS certification on their satisfaction level.



**Fig. 3.** Staff Satisfaction Level Reported by Informants

The enhanced staff satisfaction theme consisted of 4 sub-themes derived from the transcription of the interviews done with the informants, and these include improved collaboration, communication, and quality of work, harmonized and standardized documentation, continuous improvement, job enrichment and positive alignment with JCM.

### **Improved Collaboration, Communication and Quality of Work**

Insights from some informants revealed that ISO 21001 EOMS will improve collaboration both internally and externally, as driven by the standard's requirements. Informant P2 mentioned that ISO 21001 EOMS helped their institution utilize various existing platforms of the organization to freely share their ideas, and staff, being the process owner, have better autonomy to improve the existing system for the institution. When their ideas were accepted by management, the staff will feel more responsible for the work outcomes. Informant P3 said she was very satisfied with her job because the nature of the education activities in her institution enables her to explore and gain many experiences, especially communication with parents and students on student related issues. Through effective and efficient service quality implementation, internal customers/employees can complete their tasks efficiently, which helps their job satisfaction level.

### **Harmonized and Standardized Documentation System**

For this sub-theme, around 24% of the respondents had described similar feedbacks on harmonized and standardized documentation system sub-theme when asked about the influence of ISO 21001 EOMS on staff satisfaction level before and after the institution obtained the ISO 21001 EOMS certification. Informant P12, who joined from industry to a private higher education institution, lamented that there was a lack of standard operating procedures (SOP) being established in the university before the implementation of ISO 21001 EOMS. In relating how she is now more satisfied with her job comparatively before and after ISO 21001 EOMS implementation, she said one of the best things in ISO 21001 was the standardization of documents that will make every university's staff more disciplined in providing services to students. As for informant P6, she said ISO 21001EOMS helps the university working environment to be more systematic, and she felt very satisfied from work-life balance perspective. P13 said that her institution previously had 3 schools, and they were using different forms and documentation in accordance with their respective school design and format. With ISO 21001 EOMS, they now have a more standardized, harmonized, and proper documentation system, and regarding this establishment, she was 70% satisfied with her current job role. The standardized and harmonized documentation system brought quality to her institution's work and/or processes. Clear, standardized, and harmonized documentation directly empowers staff to perform their roles effectively, and this explained the results of high staff satisfaction among the interviewees working at the ISO 21001 EOMS certified institutions.

### **Continuous Improvement**

For this sub-theme, around 12% of the respondents had described similar feedbacks on continuous improvement sub-theme when asked about the influence of ISO 21001 EOMS on staff satisfaction level before and after the institution obtained the ISO 21001 EOMS certification. Informants also shared how ISO 21001 EOMS helped their institution incorporate continuous improvement activities aligned with the ISO 21001 EOMS standard's principle. Informant P9 said that ISO 21001 EOMS guides the process owner to review, revise, and continuously improve the processes and/or procedures in their working area that will ensure consistency and systematic operation control. The high staff satisfaction level was also shared by informant P10, who said that ISO 21001 EOMS helps her department continuously improve their departmental processes to provide better results or services to students and parents. A culture of continuous improvement will be established in their certified institution, promoting a more positive working environment. The staff members who are the process owners of their respective working areas are allowed to propose and/or make changes for improvement purposes. Staff members will feel that their efforts are contributing to the organization's growth and improvement, creating a sense of pride, and belonging. Therefore, a certified ISO 21001 EOMS higher education provider will strive to continuously improve to ensure effective levels of performance, make changes in response to its internal and external conditions, and create new opportunities as appropriate.

### **Job Enrichment and Positive Alignment with Job Characteristics Model**

In this study, Job Characteristics Model (JCM) developed by Hackman and Oldham (1976) was used for the prediction of staff satisfaction experienced by the employees working in a certified ISO 21001 EOMS private higher education institution in Malaysia. Around 53% of the respondents had described similar feedbacks on job enrichment and positive alignment with JCM sub-theme when asked about the influence of ISO 21001 EOMS on staff satisfaction level and relationship with JCM before and after the institution obtained the ISO 21001 EOMS certification. Informant P1 fully agreed ISO 21001 EOMS helped her institution's business be more significant and impactful to society and therefore confirmed the present of task significance in her current job role, and she said she will rate her satisfaction level at more than 95%. Informant P3 shared her significant task characteristics in her current role,

*"Yes, I am very proud working here because our institution helps to develop people or student to become somebody like nursing programme and they become good nurses to treat people out there".*

Informant P5 said that the autonomy characteristic is somehow mandatory at each job function because it leads to the staff's responsibility for the work outcomes. According to informant P8, she was very satisfied with her job, and from her

perspective, ISO 21001 EOMS did facilitate her working condition to have all five job characteristics as mentioned by Hackman and Oldham's Job Characteristics Model. Informant P11 fully agreed that he attained all the job characteristics while working for the ISO 21001 EOMS certified institution except autonomy, which is not a full autonomy function based on his current position. Informant P14 said ISO 21001 EOMS makes her institution's policies and processes more organized, defined, and endorsed by senior management. Informant P16 said that if an organization followed holistically all the ISO 21001 EOMS requirements, the level of staff satisfaction would increase, though ISO 21001 EOMS was not the sole factor in the increase. From the informant P17 perspective, ISO 21001 EOMS helped her attain all except autonomy characteristics at her workplace. She rated herself as 70% satisfied working at an ISO 21001 EOMS certified higher learning institution. There is a symbiotic relationship between ISO 21001 EOMS and JCM job characteristics in the context of PHEPs in Malaysia. The ISO 21001 EOMS did influence job characteristics of JCM such as skill variety, task identity, task significance, autonomy, and feedback, as responded by most of the informants. The positive correlation between ISO 21001 EOMS certification and staff satisfaction enhancement is objectively evidenced by a high level of job satisfaction ranging from 70% to 90%, rated by almost 65% of the informants. The JCM on skill variety, task identity, task significance, and feedback gave them a sense of significance, contribution, and satisfaction, although autonomy was not consistently experienced by some of them. The results obtained were consistent with results from previous research (Dominic, A. S. and John, V. M. [4], Hassim & Abu Bakar [6], Hussein, B., et al. [7], Muwanguzi et al. [13]) indicating a positive correlation between either all or specific dimensions of the JCM and job satisfaction across various industries.

## 6 Conclusions

In conclusion, the study's findings have shed light on the positive influence of ISO 21001 EOMS on staff satisfaction levels at PHEPs in Malaysia. The results of this research demonstrated that most staff members agreed with the several core job characteristics postulated by Hackman & Oldham present in their working place, which indicates positive connections between ISO 21001 EOMS and JCM, contributes to a job enrichment working condition that will lead to a higher staff satisfaction level. This study has laid the foundation for further exploration in several areas. This study has made no attempt to generalize the findings to a wider population. Future research should focus on other public and private higher education providers in Malaysia with a more in-depth study to close the knowledge gaps via an appropriate research approach in the related area of interest. This study contributes to the body of knowledge of ISO 21001 EOMS and offers a promising avenue for addressing the challenges of staff satisfaction in Malaysian PHEPs.

## References

1. Andrew, Leviana., Haris, N., Zakariah, H., et al. (2016). Job Characteristics and Job Satisfaction Among Employees: A Case Study At Craun Research Sdn. Bhd., Kuching, Sarawak. *International Academic Research journal of Business and Technology* 2 (2). pp 165-171. [https://www.iarjournal.com/wp-content/uploads/IARJBT2016\\_2\\_165-171.pdf](https://www.iarjournal.com/wp-content/uploads/IARJBT2016_2_165-171.pdf)
2. Bloomfield, C. (2014). *The Facts about Job Satisfaction*. [https://www.studymode.com/essays/The-Facts-About-Job-Satisfaction1843001.html#google\\_vignette](https://www.studymode.com/essays/The-Facts-About-Job-Satisfaction1843001.html#google_vignette)
3. Creswell, J. W. (2011). *Educational Research: Planning, conducting, and evaluating quantitative and qualitative research*. (Fourth Edition). Boston: Person.
4. Dominic, A. S., and John, V. M. (2023). Job satisfaction and characteristics among staff of public higher educational institutions in Ghana. *Cogent Education*, **10**:2, 2226457. <https://doi.org/10.1080/2331186X.2023.2226457>
5. Hackman, J. R., & Oldham, G. R. (1976). Motivation through the design of work: Test of a theory. *Organizational Behavior and Human Performance*, **16**, 250-279. [https://doi.org/10.1016/0030-5073\(76\)90016-7](https://doi.org/10.1016/0030-5073(76)90016-7)
6. Hassim, A. A., & Abu Bakar, S. N. (2017). The Relationship between Job Characteristic Model Dimension and Job Satisfaction at Shah Alam City Council. *International Journal of Novel Research in Humanity and Social Sciences*. Vol 4, Issue 4, pp. 1-6.
7. Hussein, B., et al. (2016). Measuring the Motivating Potential Score of Academic Staff at the Lebanese International University. *Athens Journal of Mediterranean Studies*, **2**(2), pp. 161-174. <https://www.athensjournals.gr/mediterranean/2016-2-2-3-Hussein.pdf>
8. Leblanc, C. M. (2013). *The Relationships Between Job Characteristics and Job Satisfaction Among Call Center Workers*. [EdD Dissertation, St. John Fisher University]. [https://fisherpub.sjf.edu/cgi/viewcontent.cgi?article=1200&context=education\\_etd](https://fisherpub.sjf.edu/cgi/viewcontent.cgi?article=1200&context=education_etd)
9. Lou Fan, et al. (2014). Job characteristics model and job satisfaction. *International Journal of Education and Research*, Vol. 2 (11). <https://www.ijern.com/journal/2014/November-2014/20.pdf>
10. Magaldi, D., Berler, M. (2020). Semi-structured Interviews. In: Zeigler-Hill, V., Shackelford, T.K. (eds) *Encyclopedia of Personality and Individual Differences*. Springer, Cham. [https://doi.org/10.1007/978-3-319-24612-3\\_857](https://doi.org/10.1007/978-3-319-24612-3_857)
11. Mat Ali, S. A., Said, N. A., et al. (2013). Hackman and Oldham's Job Characteristics Model to Job Satisfaction. *International Conference on Innovation, Management and Technology Research*. <https://www.semanticscholar.org/paper/Hackman-and-Oldham%27s-Job-Characteristics-Model-to-Ali-Said/08459656363ea66e2b259a2743b5368233b9f99f>

12. Moynihan, D.P., & Pandey, S.K. (2007). *Finding workable levers over work motivation comparing job satisfaction, job involvement and organizational commitment*. [https://www.researchgate.net/publication/28627494\\_Finding\\_Workable\\_Lever\\_Over\\_Work\\_Motivation\\_Comparing\\_Job\\_Satisfaction\\_Job\\_Involvement\\_and\\_Organizational\\_Commitment](https://www.researchgate.net/publication/28627494_Finding_Workable_Lever_Over_Work_Motivation_Comparing_Job_Satisfaction_Job_Involvement_and_Organizational_Commitment)
13. Muwanguzi, E., Ezati, B., & Mugimu, C.B. (2022). Applying Hackman and Oldham (1975) Job Characteristic Model in the analysis of Job Satisfaction at Makerere University: An Empirical Paper. *IOSR Journal of Research & Method in Education*. Vol 12, Issue 1. <https://www.iosrjournals.org/iosr-jrme/papers/Vol-12%20Issue-1/Ser-4/B1201042027.pdf>
14. Noraani, M. (2013). The Influence of Financial Reward on Job Satisfaction among Academic Staffs at Public Universities in Kelantan, Malaysia. *International Journal of Business and Social Science*, 4 (3). [https://ijbssnet.com/journals/Vol\\_4\\_No\\_3\\_March\\_2013/27.pdf](https://ijbssnet.com/journals/Vol_4_No_3_March_2013/27.pdf)
15. Raja Zirwatul A.R.I., Keis, O., Mazidah, M.D., & Azlina, A.B. (2014). Job Satisfaction among Malaysian Employees: An Application of Spector's Job Satisfaction Survey in the South East Asian Context. *Jurnal Pengurusan*, 41, 69-79.
16. Raihan Tarik (2020). Role of Job Characteristics Model on Employee Job Satisfaction-An Empirical Study. *Research Gate*.
17. Sarantakos, S. (2013). *Social research* (4th ed.). New York, NY: Palgrave Macmillan.

# Academic Workload and Learning Facilities; Is ChatGPT is Harmful or Helpful, A Preliminary Insights

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**Abstract.** The rapid evolution of artificial intelligence (AI) technology has significantly impacted various sectors, including education. This study investigates the mediatory role of ChatGPT in managing academic workloads and learning facilities among students at polytechnique, with a focus on assessing its overall impact, whether positive or negative. Drawing from a diverse range of scholarly literature, including its applications within both Technical and Vocational Education and Training (TVET) contexts and higher education. The study's primary objectives include evaluating students' perceptions of academic workload and learning facilities, alongside the helpfulness or harmfulness of ChatGPT as a support tool. Utilizing a quantitative research design, data were collected from 119 students at Polytechnique Sultan Idris Shah through structured online questionnaires. The study found that academic workload is a key driver of ChatGPT use, which in turn shapes students' perceptions of its helpfulness. However, the mediation analysis shows that any change in the quality of learning facilities can help improve students' academic activities without being affected by the full use of ChatGPT. This study contributes to future studies on the ethical implications and pedagogical effects of using ChatGPT in student learning environments.

**Keywords:** ChatGPT, academic workload, learning facilities

## 1 Introduction

The integration of artificial intelligence (AI) technology in many industries has significantly transformed the landscape of education. Among the most popular innovations in the education sector are AI-driven by Chatbots, especially OpenAI's-ChatGPT. It has evolved as a powerful instrument capable of enriching the educational experience by delivering individualized guidance, assisting in the acquisition of information, and supporting academic activities. (Adıgüzel et al., 2023). However, considering that educational institutions adopt this technology to improve student outcomes, the impact needs to be critically evaluated on academic workload and learning facilities (Sallam, 2023). Although AI chatbots have the potential to streamline educational processes and meet diverse learning needs, concerns about academic integrity, authenticity of student work and reliance on automated systems have been raised (Watts et al., 2023). The quality of learning facilities, including access to appropriate learning materials, library resources, classroom environment, and academic support services, plays an important role in shaping student outcomes (Bernstein et al., 2023).

The extent to which ChatGPT can effectively support these facilities across different academic disciplines remains underexplored. The research carried out at the Polytechnic aims to evaluate whether the integration of ChatGPT as a mediator is ultimately helpful or harmful in managing academic workload and accessing learning resources and can provide an overview of the impact of various aspects of ChatGPT on education (Adıgüzel et al., 2023) through two objectives. (a) to examine the level of perception of academic workload, learning facilities and ChatGPT for student learning activities. (b) to examine the integration of ChatGPT as mediator are helpful or harmful for student learning activities. This can lead to a more discussion on the ethical implications and practical uses of AI in the academic field. (Adıgüzel et al., 2023). As AI technology continues to advance, understanding its implications in the education sector becomes important (Dempere et al., 2023). Although this technology offers opportunities for development, it also poses ethical challenges that need to be addressed (Kooli, 2023). Educators, administrators, and policy makers must be equipped with proper training to use AI tools effectively and ethically such as chatbots in educational settings (Abdelhafiz et al., 2024). The responsible AI technology integration in education necessitates a detailed analysis of its effects on student learning, academic workload, and learning facilities.

## 2 Literature review

The landscape of higher education has dramatically significantly changed in recent years, driven by rapid advancements in technology and changing pedagogical approaches. There are several factors that can influence student success in their academic achievement. The critical areas such as academic workloads, learning facilities, and the integration of advanced technologies like ChatGPT were focused on this study. This literature review aims to explore the existing body of research on these key elements and their collective impact on student academic achievement. The review will examine how the efficient management of academic workloads, the quality and accessibility of learning facilities, and the incorporation of artificial intelligence tools, such as ChatGPT, contribute to enhancing the learning experience and outcomes for students. Findings from recent studies will be analysis to understand how these elements interact and offer best practices for using technology and resources to support student success in higher education.

### 2.1 Overview of ChatGPT

ChatGPT innovation was dispatched in November 2022, and it saw prompt and broad adoption. The chatbot amassed 1 million clients (about the population of Delaware) in a week (Mollman, 2022). Less than 2 months afterward, the number of dynamic clients expanded to over 100 million. ChatGPT, where GPT stands for generative pretrained transformer. Through interactions with users that appear natural, generative models may produce text that appears human-like. They can also execute a wide range of tasks that can be customized by users to suit their own needs (Saville, N.,2023).

According to Rahman et al. (2023), OpenAI developed the world's most powerful chatbot call ChatGPT and it has transformed people's interactions with technology. The authors stated that ChatGPT is frequently used among educators, students, and researchers. By providing the system with natural language commands and instructions, it generates a quick and prompt response and facilitates the command. In addition, Osiro (2023), stated that the system will provide specifics on the user's command request as well as grammatical correction and enhancement.

For learning purposes, students will receive a comprehensive set of writing with perfect content for their assessment. ChatGPT had provided fantastic support throughout their learning experience (Montenegro et al., 2023). This study focuses on the impacts of ChatGPT on educational processes and its implications for students' learning activities. From the standpoint of student integration with learning process with chatbot technologies had enchase learning process. The utilization of ChatGPT had enhanced the students' support to complete the assessment given in higher education. According to Winkler & Söllner (2018), ChatGPT had help the student achievement in higher education and it also promote the student happiness and motivation while using the system. Similarly, a study by Abd Rahim et al.(2023), explored the UiTM students' perception using the ChatGPT as language learning tool showed that their writing skill are improved by using ChatGPT and make the learning session more enjoying. It is supported by Javaid et al. (2023), When an idea is overtaken and no one knows how to respond, ChatGPT has been quite helpful in settling the situation. ChatGPT can also assist with creative writing and provide numerous alternatives. It is supported by Tate et al. (2023), ChatGPT also can give students personalized learning support as a teachable agent that encourages students to learn by text-based conversation. This includes tutoring in all subjects, study assistance, instructions for completing activities, explanations of complex topics in easier to understand language, and typed notes on text.

### 2.2 Learning Facilities

The quality and accessibility of learning facilities in higher education are crucial for student success and engagement. Curriculum-aligned materials, including textbooks and digital resources, significantly enhance student comprehension and engagement in their academics (Khan et al., 2020). The integration of Open Educational Resources (OER) has democratized access to educational content, reducing costs for students and promoting inclusivity (Abdullayeva, 2023). Academic libraries have evolved into dynamic learning hubs, offering vast digital resources, research support, and quiet study spaces that cater to diverse learning needs (Hidayat & Sutrisno, 2023). Technologically equipped classrooms have transformed traditional teaching methods, creating interactive and engaging learning environments through smart technology and blended learning models (Prabowo et al., 2022).

The physical and psychological environment of educational institutions also plays a significant role in student well-being and academic performance. A campus environment that supports and nurture a sense of belonging and a harmonious community is essential to student success (Kang & Recard, 2023). The design of educational spaces, including green areas and accessible facilities, contributes to a positive learning experience (Nepal & Rogerson, 2020). Comprehensive service support such as counselling and academic advising is important for student retention and success in higher education (Korkealehto et al., 2021). The synergy between these elements can create a conducive learning environment that promotes student engagement and academic achievement. Incorporating active learning strategies like outcome-based education and gamification enhances student engagement, motivation, and learning performance in higher education (Solihah et al., 2022). Engaging students through multimedia learning materials and peer interactions fosters academic achievement and cognitive engagement.

The role of academic libraries in reforming the higher education system and contributing to student wellness is increasingly recognized (Nugraheni et al., 2022; Gaol et al., 2022). By integrating technology, academic libraries enhance

students' digital literacy and technological skills (Rafi et al., 2019). The impact of academic libraries on student success has been underscored by studies that have shown a positive impact between students' use of library resources and their academic achievements. (Scoulas & Groote, 2019). Overall, creating engaging learning environments through a combination of quality learning materials, supportive campus environments, and comprehensive service support is essential for fostering student success and academic achievement in higher education.

### **2.3 Academic Workload**

The rising academic demands on students have raised concerns about how academic workload affects their performance and well-being. According to studies by Jones et al. (2019) and Smith and Brown (2020), the excessive amount of coursework and the high expectations from lecturer are key contributors for significant stress and anxiety among students. This heavy workload often results in burnout and a loss of motivation, negatively affecting both the mental health and academic achievements of students. These research findings underscore the critical necessity of addressing the root causes of stress related to workload in higher education.

Lecturers play a crucial role in this dynamic, with many studies indicating that the volume of work assigned by instructors is often unmanageable within the given timeframes. Doe and Roe (2018) noted that students frequently report an excessive number of assignments, leading to difficulties in balancing multiple courses. Johnson and Lee (2020) further observed that poor coordination among faculty regarding assignment deadlines exacerbates the problem, as students are often faced with overlapping submission dates. This lack of synchronization increases stress levels and diminishes students' ability to produce quality work, underscoring the necessity for better planning and communication among educators.

The negative effects of a heavy academic workload extend to students' time management skills and their overall grade point average (GPA). Regarding Allen et al. (2017) and Taylor and Francis (2019), they found that students often struggle with time management due to the high volume of assignments, leading to incomplete or rushed submissions. Williams and Thompson (2018) emphasized that meeting deadlines is a persistent challenge, often resulting in procrastination and further delays. According to Smith et al. (2019) and Brown and Taylor (2020), the constant worry about maintaining a good CGPA makes these difficulties worse. The stress associated with high academic expectations and workload overload negatively impacts students' overall academic performance and well-being, indicating a critical need for institutions to develop supportive strategies and interventions

### **2.4 Helpful/harmful**

As with any other technological advancement, ChatGPT comes with both benefits and disadvantage, presenting various risks and opportunities. Unfortunately, technology is often adopted in society and educational settings without careful examining. According to Akgun and Greenhow (2022), while ChatGPT can be beneficial in education, it can also negatively impact student privacy and autonomy, create systemic bias and discrimination, increase student monitoring and surveillance, and introduce new forms of inequality.

Based on Cu & Hochman (2023), it was found that five percent of over 4000 students in Stanford University said they submit 100 percent of document generated from ChatGPT without any further editing. This made it simple for people to cheat in academic settings. With a few clicks, you may get complete term papers, accurate exam answers, and working code. The amount of learning that students should do can be significantly decreased by having such easy access to the right answers.

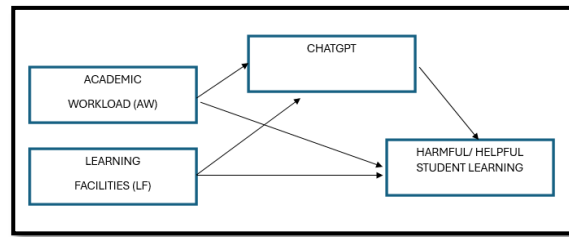
Similarly, a study by Limna et al. (2023), studied the institutions in Krabi found that ChatGPT reduced student's workload with providing answers to frequently asked queries that allowing students to concentrate on more difficult problems and other assessments. Students also said ChatGPT was an easy-to-use tool for helping with their academics. They valued it because it allowed them to get quick feedback and have support when they needed it to keep focused on their studies after regular class hours. A few students also mentioned that ChatGPT's trustworthy information and advice increased their sense of confidence in their ability to learn.

## **3 Methodology**

### **3.1 Conceptual framework**

This study employs a quantitative research design to assess the impact of ChatGPT on academic workload and learning facilities among higher education students (Alneyadi & Wardat, 2023). The independent variables in this study are academic workload and learning facilities, while the dependent variable is the perceived helpfulness or harmfulness of ChatGPT (Singh et al., 2023). ChatGPT itself is considered as a mediator. To further explain the purpose of this research, the research framework is set out below





**Fig. 1.** Research Framework

### 3.2 Sampling and data collection

The survey is open to students enrolled from various departments and courses at Polytechnique Sultan Idris Shah, actively using ChatGPT for academic purposes, and willing to participate. Data will be collected using a structured online questionnaire distributed with responses measured on a Likert scale. The sample of this study involved 119 respondents.

### 3.3 Research instrument

The authors modified past study structures to obtain primary data relevant to the current research objectives. In order to guarantee the content validity of the final research instrument and restore confidence, the authors implemented a pilot study with a sample size of 30. After that, the final study instrument was ready to gather primary data.

### 3.4 Reliability measures

Internal consistency is quantified using Cronbach's alpha, which must exceed 0.7 according to Nunnally (1978). The current study examines scores above 0.7 for all four components, as indicated in Table 1.

**Table 2:** Reliability Measurement Result

No	Construct	Cronbach's alpha
1	ChatGPT	0.973
2	Academic Workload	0.844
3	Learning facilities	0.875
4	Harmful/Helpful	0.723

### 3.5 Data analysis

Data analysis was conducted using the Statistical Package for Social Science (SPSS). Descriptive statistics were employed to analyze demographic and survey responses data. The relationship between the independent variable, mediator and dependent variables is investigated using simple mediation analysis using Process Model 4 in SPSS (Mike Crowson, 2023). According to Hayes (2022), mediation analysis is a sophisticated statistical approach used to examine hypotheses about the mechanisms by which the independent variable (X) can influence the dependent variable (Y). This method allows researchers to explore potential mediating processes to explain the relationship between X and Y. Specifically, the mediator (M) represents a hypothetical channel through which X can influence Y. It will provide a conceptual framework to understand the reasons underlying the path. Ethical considerations are carefully followed, where notification is given to respondents before they answer the survey questions where confidentiality of data and information is maintained.

## 4 Finding and Analysis

### 4.1 Research Objective One : The Level Of the perception of academic workload, learning facilities and ChatGPT for student learning activities.

This study's main objective is to evaluate the perception levels of academic workload, learning facilities, and ChatGPT for student learning activities. To achieve this, a quantitative analysis was conducted, using a questionnaire to gather responses from students. The responses were analyzed based on mean scores, which were then interpreted according to a predefined scale (Moidunny, 2009).

**Table 3 :** Mean score Interpretation table (Moidunny, 2009)

Mean Score	Interpretation
4.21 – 5.00	Very High
3.21 – 4.20	High
2.61 – 3.20	Medium
1.81 – 2.60	Low
1.00 – 1.80	Very Low

The descriptive statistics for the variables MEANAW (Mean Academic Workload), MEANLF (Mean Learning Facilities), MEANCG (Mean ChatGPT Use), and MEANHH (Mean Helpful/Harmful Perception) are summarized below:

**Table 4.** The Level of Perception of the academic workload, learning facilities, ChatGPT use and helpful/harmful in their learning activities

Mean	Mean	Std. Dev	Mean Value
AW	3.42	0.720	High
LF	3.54	0.668	High
CG	3.06	1.111	Medium
HH	3.66	0.680	High

The data indicates that students perceive the academic workload (MEANAW) and learning facilities (MEANLF) as high, with mean scores of 3.42 and 3.54 respectively. This suggests that students generally have a favorable view of both the academic workload and the learning facilities available to them.

In contrast, the perception of ChatGPT's use for student learning activities (MEANCG) is at a medium level, with a mean score of 3.06. This indicates a more moderate perception, suggesting that while some students may find ChatGPT beneficial, others might be ambivalent or less convinced about its utility.

Lastly, the overall perception of whether ChatGPT is helpful or harmful (MEANHH) also falls within the high range, with a mean score of 3.66. This indicates that, on average, students lean towards finding ChatGPT more helpful than harmful in their learning activities.

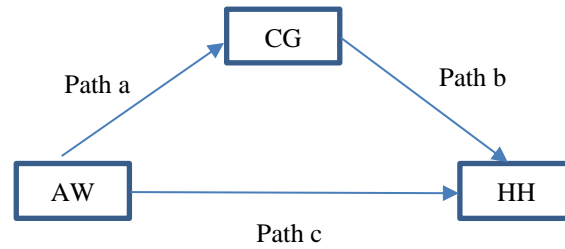
## 4.2 Research Objective Two: To examine the integration of ChatGPT as mediator is helpful or harmful for student learning activities.

### 4.2.1 Examine the mediator (Chat GPT) mediates the relationship between academic workload (AW) and ChatGPT Harmful or Helpful Student Learning Activities (HH).

#### a. Direct effects between Academic Workload (AW), ChatGPT Use (CG) and Helpful or Harmful Perception (HH)

**Table 5:** Direct effects between Academic Workload (AW), ChatGPT Use (CG) and Helpful or Harmful Perception (HH).

Predicted relationship	coefficient	Se-value	p-value
Path a AW → CG	0.471	0.138	0.007
Path b CG → HH	0.293	0.049	0.000
Path c AW → HH	0.168	0.076	0.031
Note(s): se-Standardized Effects, p-probability, p-value of 0.05 or lower is generally considered statistically significant.			



i. *Direct Effect of Academic Workload on ChatGPT Use.*

The analysis showed a substantial and positive relationship between Academic Workload (AW) and ChatGPT Use (CG), with an unstandardized path coefficient (b) of 0.471 and a standardized effects (s.e.) of 0.138. This outcome is statistically significant at the  $p < .005$  level. This implies that there is a correlation between an escalation in academic workload and a greater frequency of ChatGPT utilization among students. In other words, as academic workload increases, students tend to utilize ChatGPT more frequently (Lund et al., 2023).

ii. *Direct Effect of ChatGPT Use on Helpful or Harmful (HH)*

The study revealed a positive and statistically significant correlation between the use of ChatGPT (CG) and the rating of ChatGPT as either helpful or harmful (HH). The unstandardized path coefficient for this connection is 0.293, with a standardized effects of 0.049. This finding is statistically significant at the  $p < .05$  level. This shows that, greater use of ChatGPT has a positive effect on students' evaluations of its usefulness. Thus, students who use ChatGPT more often are more likely to see it as a more beneficial tool for handling their academic activities efficiently (Abbas et al., 2024).

iii. *Direct Effect of Academic Workload (AW) on Helpful/Harmful Perception (HH)*

The direct effect of Academic Workload (AW) on the perception of ChatGPT as Helpful or Harmful (HH) was positive but not statistically significant. The unstandardized path coefficient for this effect is 0.168 with a standardized effects of 0.076, and the p value is 0.031. Although the coefficient shows a positive relationship, indicating that a higher academic workload may slightly increase the perception of ChatGPT as helpful. The lack of statistical significance (given that the p-value threshold is usually  $< 0.05$  for significance) means that the increase in academic workload does influence or impact the perception of harmful or helpful for student learning activities. (Sallam, 2023), stated the mediating effect as an important factor in influencing the experience and perception of students in managing their academic workload with the use of technology such as ChatGPT.

b. *Indirect effects between Academic Workload (AW), ChatGPT Use (CG) and Helpful /Harmful Perception (HH).*

**Table 6:** Indirect effects between Academic Workload (AW), ChatGPT Use (CG) and Helpful /Harmful Perception (HH).

Predicted relationship	Effect	Boot LLCI	Boot ULCI
Path a.b AW → CG → HH	0.138	0.045	0.239
Note(s): BootLLCI- Bootstrap Lower Limit Confidence Interval BootULCI- Bootstrap Upper Limit Confidence Interval.			

The analysis demonstrates that each one-unit increase in Academic Workload (AW) corresponds to a 0.138-unit increase in helpful or harmful perception (HH), mediated by the use of ChatGPT. This unstandardized indirect effect is statistically significant, as evidenced by the bootstrap confidence interval ranging from 0.045 to 0.239, which notably does not include zero (Mike Crowson, 2023). This indicates that the mediation effect of ChatGPT is meaningful and not due to chance, suggesting a genuine influence of academic workload on perceptions through this mediator.

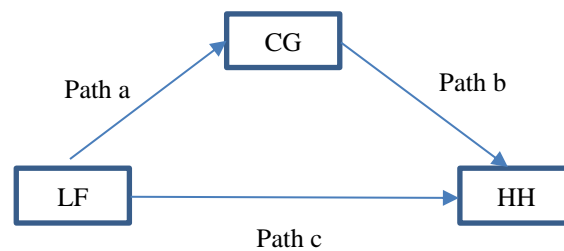
The positive indirect effect's significance implies that as academic workload increases, ChatGPT's role in shaping perceptions of helpfulness also intensifies depending on their personal experiences and the context of use, students interpret a higher workload as leading them to perceive ChatGPT as more helpful. The statistical analysis robustly supports this relationship, confirming that the impact of academic workload on perceptions of helpfulness is indeed mediated by the use of ChatGPT (Abbas et al., 2024)

4.2.2 Examine the mediator (Chat GPT) mediates the relationship between Learning Facilities (LF) and ChatGPT Harmful or Helpful Student Learning Activities (HH).

a. Direct effects between Learning Facilities (LF), ChatGPT Use (CG) and Helpful /Harmful Perception (HH)

**Table 7.** Direct effects between Learning Facilities (LF), ChatGPT Use (CG) and Helpful /Harmful Perception (HH).

Predicted relationship	coefficient	Se-value	p-value
Path a LF → CG	0.244	0.152	0.111
Path b CG → HH	0.301	0.046	0.000
Path c LF → HH	0.279	0.077	0.000
Note(s): se-Standardized Effects, p-probability, p-value of 0.05 or lower is generally considered statistically significant.			



i. Direct Effect of Learning Facilities on ChatGPT Use.

The research finding on the impact of Learning Facilities (LF) on ChatGPT indicates a positive but not statistically significant effect. Specifically, the path coefficient is 0.244, suggesting that an increase in learning facilities would lead to a slight increase in the dependent variable related with ChatGPT. However, the coefficient's standard error is 0.152, which introduces some uncertainty about the precision of this estimated effect. This coefficient's p-value is 0.111, which exceeds the commonly accepted significance threshold of 0.05. This suggests that the observed effect might not be statistically significant. (Kohnke et al., 2023).

This result means that the positive correlation between the learning facilities and the use of ChatGPT among students may be a coincidence rather than a definitive cause-and-effect relationship. This suggests that improvements in learning facilities may not be attributed to ChatGPT alone.

ii. Direct Effect of ChatGPT on Helpful/Harmful Perception (HH) Use.

The findings of the research indicate that there is a correlation that is statistically significant between the utilisation of ChatGPT and the perception of whether it is helpful or harmful, with a coefficient of 0.301, a standard error of 0.046, and a p-value of 0.000 (Rahman et al., 2023). This indicates a positive association, suggesting that as the use of ChatGPT increases, the perception of it being helpful also rises. The low standard error implies that the coefficient estimate is precise, while the p-value of 0.000 demonstrates that the relationship is highly significant. Therefore, the data supports the conclusion that ChatGPT is perceived as a beneficial tool by users, likely due to its capabilities in assisting with various academic tasks.

These findings are essential for understanding the impact of AI tools like ChatGPT on academic environments, particularly in managing academic workloads and accessing learning resources. The positive perception could be attributed to ChatGPT's efficiency in providing timely information, aiding in research, and offering a supplementary educational resource (Aljuaid, 2024).

iii. Direct Effect of Learning Facilities (LF) on Helpful/Harmful Perception (HH)

The analysis of the data reveals a significant and positive relationship between the quality of learning facilities and their perception as helpful or harmful, with a coefficient of 0.279, a standard error of 0.077, and a p-value of 0.000 (Jamshed et al., 2024). The positive coefficient indicates a correlation between improvements in learning facilities and students' more

favorable perception of their helpfulness. The relatively low standard error signifies that the estimate is precise, while the highly significant p-value confirms that this relationship is not due to random chance.

These findings underscore the critical importance of high-quality learning facilities in academic institutions. Superior learning facilities, such as well-equipped libraries, advanced technological resources, and conducive study environments, are instrumental in supporting students' academic endeavors and enhancing their learning experiences.

b. *Indirect effects between Learning Facilities (LF) (AW), ChatGPT Use (CG) and Helpful /Harmful Perception (HH).*

Predicted relationship	Effect	Boot LLCI	Boot ULCI
Path a.b LF → CG → HH	0.074	-0.032	0.172
Note(s): BootLLCI- Bootstrap Lower Limit Confidence Interval BootULCI- Bootstrap Upper Limit Confidence Interval.			

The data analysis indicates a predicted relationship between learning facilities (LF), ChatGPT (CG), and the helpful/harmful perception (HH), with an effect size of 0.074. The bootstrap lower limit confidence interval (BootLLCI) is -0.032, and the bootstrap upper limit confidence interval (BootULCI) is 0.172. This range includes zero, suggesting that the observed effect of learning facilities on the perception of helpfulness or harmfulness mediated by ChatGPT is not statistically significant at the 95% confidence level (Hwang & Oh, 2021).

These findings imply that while learning facilitation has a positive effect on perceived helpfulness through ChatGPT, this effect is not strong enough to be considered significant. A confidence interval indicates the uncertainty around the effect size, and the presence of zero in the interval highlights that the relationship is negligible. This shows that the ChatGPT mediator factor does not influence the effects of changes and improvements in learning facilities to help students' learning.

## Conclusion

The study at Polytechnique Sultan Idris Shah has revealed both promising benefits and notable challenges associated with the integration of ChatGPT within educational frameworks. The findings indicate that while students generally perceive their academic workload and learning facilities favorably, their views on ChatGPT's utility remain good. According to Montenegro et al. (2023), ChatGPT enhances the educational experience by offering personalized assistance and supporting academic tasks, which aligns with the positive perceptions of its utility among some students. However, the mediation analysis showed that the use of ChatGPT helped a lot with their academic workload. This suggests that its usefulness depends on the situation such as can improve students' academic content generation, idea brainstorming, and text rewriting, leading to increased satisfaction among students (Magalhães Araujo & Cruz-Correia, 2024).

The study underscores the importance of quality learning facilities in fostering student success. High-quality resources, well-equipped libraries, and conducive study environments significantly contribute to positive academic outcomes (Yap et al., 2022). However, the mediation analysis shows that any change in the quality of learning facilities can help improve students' academic activities without being affected by the full use of ChatGPT.

In conclusion, this implies that as students face higher academic demands, the support provided by ChatGPT becomes more valued. The insights gained from this study advocate for the thoughtful integration of AI in education, where the focus remains on complementing traditional learning methods and addressing the diverse needs of students while maintaining academic rigor and integrity. It also aims to improve teaching and learning experiences and prepare students for a dynamic world (Baskara, 2024).(Baskara, 2024).

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## References

1. Abdelhafiz, A. S., Ali, A., Maaly, A. M., Ziady, H. H., Sultan, E. A., & Mahgoub, M. A. (2024). Knowledge, Perceptions and Attitude of Researchers Towards Using ChatGPT in Research. *Journal of Medical Systems*, 48(1). <https://doi.org/10.1007/s10916-024-02044-4>
2. Abd Rahim, E. M., Abd Rahim, M. E., Razawi, N. A., & Mohamed, N. A. (2023). Students' perception on the use of ChatGPT as a language learning tool. *Ideology Journal*, 8(2), 70-78.
3. Abdullayeva, N. (2023). The Role of Libraries in Academic Achievement: Case Study of Azerbaijan University Libraries. *Library Management*, 45(1/2), 21–36. <https://doi.org/10.1108/lm-06-2023-0056>
4. Abbas, M., Jam, F. A., & Khan, T. I. (2024). Is it harmful or helpful? Examining the causes and consequences of generative AI usage among university students. *International Journal of Educational Technology in Higher Education*, 21(1), 10. <https://doi.org/10.1186/s41239024-00444-7>
5. Adıgüzel, T., Kaya, M. H., & Cansu, F. K. (2023). Revolutionizing Education With AI: Exploring the Transformative Potential of ChatGPT. *Contemporary Educational Technology*, 15(3), ep429. <https://doi.org/10.30935/cedtech/13152>
6. Aljuaid, H. (2024). The Impact of Artificial Intelligence Tools on Academic Writing Instruction in Higher Education: A Systematic Review. *Arab World English Journal*, 1(1), 26–55. <https://doi.org/10.24093/awej/chatgpt.2>
7. Allen, J., Smith, R., & Doe, M. (2017). Time Management Challenges among College Students. *Journal of Educational Psychology*, 112(3), 456-478.
8. Alneyadi, S. S., & Wardat, Y. (2023). ChatGPT: Revolutionizing Student Achievement in the Electronic Magnetism Unit for Eleventh-Grade Students in Emirates Schools. *Contemporary Educational Technology*, 15(4), ep448. <https://doi.org/10.30935/cedtech/13417>
9. Baskara, F. X. R. (2024). ChatGPT and Personalised Learning: Reshaping Pedagogical Approaches in the VUCA Age. *Journal Educative Journal of Educational Studies*, 8(2), 167. <https://doi.org/10.30983/educative.v8i2.7620>
10. Bernstein, I. A., Zhang, Y. (Victor), Govil, D., Majid, I., Chang, R. T., Sun, Y., Shue, A., Chou, J. C., Schehlein, E., Christopher, K. L., Groth, S. L., Ludwig, C., & Wang, S. Y. (2023). Comparison of Ophthalmologist and Large Language Model Chatbot Responses to Online Patient Eye Care Questions. *Jama Network Open*, 6(8), e2330320. <https://doi.org/10.1001/jamanetworkopen.2023.30320>
11. Brown, P., & Taylor, F. (2020). Academic Stress and Mental Health in University Students: The Role of Course Load. *International Journal of Higher Education*, 9(4), 89-102.
12. Cu, M. A., & Hochman, S. (2023, January 22). Scores of Stanford students used ChatGPT on final exams. *The Stanford Daily*. <https://stanforddaily.com/2023/01/22/scores-of-stanford-students-used-chatgpt-on-final-exams-survey-suggests/>
13. Dempere, J., Modugu, K., Hesham, A., & Ramasamy, L. K. (2023). The Impact of ChatGPT on Higher Education. *Frontiers in Education*, 8. <https://doi.org/10.3389/feduc.2023.1206936>
14. Doe, J., & Roe, M. (2018). Assignment Overload and Student Performance. *Educational Research Quarterly*, 41(2), 123-135.
15. Gilbert, C., Easterly, R. G., Bunch, J. C., Warner, L. A., & Dossett, J. (2023). Characteristics of Effective Instruction and Student Engagement: A Case Study of Two Exemplary Florida Agriculture Teachers. *Advancements in Agricultural Development*, 4(1), 5–16. <https://doi.org/10.37433/aad.v4i1.273>
16. Halaweh, M. (2023). ChatGPT in Education: Strategies for Responsible Implementation. *Contemporary Educational Technology*, 15(2), ep421. <https://doi.org/10.30935/cedtech/13036>
17. Hwang, Y. H., & Oh, J. (2021). The Relationship Between Self-Directed Learning and Problem-Solving Ability: The Mediating Role of Academic Self-Efficacy and Self-Regulated Learning Among Nursing Students. *International Journal of Environmental Research and Public Health*, 18(4), 1738. <https://doi.org/10.3390/ijerph18041738>
18. Jamshed, A., None, N., Khan, M. A., & None, N. (2024). *Exploring the Impact of University Type and Facilities on Students' Academic Achievement*. 3(1), 420–443. <https://doi.org/10.62681/sprypublishers.scep/3/1/23>
19. Javaid, M., Haleem, A., Singh, R. P., Khan, S., & Khan, I. H. (2023). Unlocking the opportunities through ChatGPT tool towards ameliorating the education system. *BenchCouncil Transactions on Benchmarks, Standards and Evaluations*, 3(2), 100115. <https://doi.org/10.1016/j.tbench.2023.100115>
20. Johnson, K., & Lee, H. (2020). Coordination of Assignment Deadlines: Faculty Perspectives and Student Outcomes. *Journal of Higher Education Policy and Management*, 42(1), 34-49.
21. Jones, A., Smith, B., & Brown, C. (2019). The Impact of High Academic Expectations on Student Well-being. *College Student Journal*, 53(1), 25-38.
22. Kang, S. H. K., & Recard, M. (2023). Investigating the Implementation of Gamification Approach to Enhance Students Learning Engagement. *Journey (Journal of English Language and Pedagogy)*, 6(2), 295–307. <https://doi.org/10.33503/journey.v6i2.2846>
23. Kohnke, L., Moorhouse, B. L., & Zou, D. (2023). ChatGPT for Language Teaching and Learning. *Relc Journal*, 54(2), 537–550. <https://doi.org/10.1177/00336882231162868>

24. Korkealehto, K., Lakkala, M., & Toom, A. (2021). Enrolled or Engaged? Students' Perceptions of Engagement and Oral Interaction in a Blended Learning Language Course. *The Jalt Call Journal*, 17(1), 1–22. <https://doi.org/10.29140/jaltcall.v17n1.268>
25. Limna, P., Kraiwatit, T., Jangjarat, K., Klayklung, P., & Chocksathaporn, P. (2023). The use of ChatGPT in the digital era: Perspectives on chatbot implementation. *Journal of Applied Learning and Teaching*, 6(1), 64–74.
26. Lund, B., Wang, T., Mannuru, N. R., Nie, B., Shimray, S. R., & Wang, Z. (2023). <scp>ChatGPT</Scp> and a New Academic Reality: <scp>Artificial Intelligence-written</Scp> Research Papers and the Ethics of the Large Language Models in Scholarly Publishing. *Journal of the Association for Information Science and Technology*, 74(5), 570–581. <https://doi.org/10.1002/asi.24750>
27. Magalhães Araujo, S., & Cruz-Correia, R. (2024). Incorporating ChatGPT in Medical Informatics Education: Mixed Methods Study on Student Perceptions and Experiential Integration Proposals. *Jmir Medical Education*, 10, e51151. <https://doi.org/10.2196/51151>
28. Montenegro-Rueda, M., Fernández-Cerero, J., Fernández-Batanero, J. M., & López-Meneses, E. (2023). Impact of the implementation of ChatGPT in education: A systematic review. *Computers*, 12(8), 153.
29. Nugraheni, M. M. Y., Suryaningrum, P., & Rudito, M. A. (2022). Analysis of the Students' Engagement in the Process of Learning Mathematics Using a Flipped-Classroom Approach to Trigonometry. *Journal of Mathematics and Mathematics Education*, 12(2). <https://doi.org/10.20961/jmme.v12i2.64420>
30. Osorio, J.A.C. Explorando el potencial de ChatGPT en la escritura científica: Ventajas, desafíos y precauciones. *Sci. Et Tech.* 2023, 28, 3–5
31. Prabowo, H., Yuniarty, Y., & Ikhsan, R. B. (2022). Student Engagement Mechanism of Online Learning: The Effect of Service Quality on Learning Management System. *Joiv International Journal on Informatics Visualization*, 6(3), 681. <https://doi.org/10.30630/joiv.6.3.1263>
32. Rahman, M. M., & Watanobe, Y. (2023). ChatGPT for education and research: Opportunities, threats, and strategies. *Applied Sciences*, 13(9), 5783.
33. Rafi, M., Zheng, J., & Ahmad, K. (2019). Technology Integration for Students' Information and Digital Literacy Education in Academic Libraries. *Information Discovery and Delivery*, 47(4), 203–217. <https://doi.org/10.1108/idd-07-2019-0049>
34. Rahman, M. S., Sabbir, M. M., Zhang, D. J., Moral, I. H., & Hossain, G. M. S. (2023). Examining Students' Intention to Use ChatGPT: Does Trust Matter? *Australasian Journal of Educational Technology*, 51–71. <https://doi.org/10.14742/ajet.8956>
35. Sallam, M. (2023). ChatGPT Utility in Healthcare Education, Research, and Practice: Systematic Review on the Promising Perspectives and Valid Concerns. *Healthcare*, 11(6), 887. <https://doi.org/10.3390/healthcare11060887>
36. Scoulas, J. M., & Groote, S. L. De. (2019). The Library's Impact on University Students' Academic Success and Learning. *Evidence Based Library and Information Practice*, 14(3), 2–27. <https://doi.org/10.18438/ebliip29547>
37. Singh, H., Tayarani-Najaran, M.-H., & Yaqoob, M. (2023). Exploring Computer Science Students' Perception of ChatGPT in Higher Education: A Descriptive and Correlation Study. *Education Sciences*, 13(9), 924. <https://doi.org/10.3390/educsci13090924>
38. Smith, B., & Brown, C. (2020). The Psychological Effects of Academic Workload on Students. *Journal of College Student Development*, 61(2), 150–167.
39. Smith, B., Taylor, R., & Jones, A. (2019). Maintaining Academic Performance under Stress. *Higher Education Review*, 51(4), 380–397.
40. Solihah, I., Astuti, B., & Abubakari, M. S. (2022). Students' Engagement Model in Online Learning Guided by School Counselor During Covid-19 Pandemic. *Jurnal Kajian Bimbingan Dan Konseling*, 7(3), 150–165. <https://doi.org/10.17977/um001v7i32022p150-165>
41. Taylor, R., & Francis, D. (2019). Time Management and Academic Success: The Student Perspective. *Studies in Higher Education*, 44(8), 1432–1445.
42. Wang, Y. (2024). Reviewing the Usage of ChatGPT on L2 Students' English Academic Writing Learning. *Journal of Education Humanities and Social Sciences*, 30, 173–178. <https://doi.org/10.54097/dvjkj706>
43. Williams, L., & Thompson, P. (2018). Procrastination and Academic Performance: An Analysis. *Journal of Educational Research*, 56(3), 267–284.
44. Winkler, R., & Söllner, M. (2018, July). Unleashing the potential of chatbots in education: A state-of-the-art analysis. In *Academy of Management Proceedings* (Vol. 2018, No. 1, p. 15903). Briarcliff Manor, NY 10510: Academy of Management.
45. Wu, Y. (2023). Integrating generative AI in education: how ChatGPT brings challenges for future learning and teaching. *Journal of Advanced Research in Education*, 2(4), 6–10. [https://www.phdfood2019.it/wpcontent/uploads/2019/05/APA\\_Guide\\_2017.pdf](https://www.phdfood2019.it/wpcontent/uploads/2019/05/APA_Guide_2017.pdf)
46. Yap, J. B. H., Hew, Q. L. T., & Skitmore, M. (2022). Student Learning Experiences in Higher Education: Investigating a Quantity Surveying Programme in Malaysia. *Construction Economics and Building*, 22(1). <https://doi.org/10.5130/ajceb.v22i1.7835>

# How Study Techniques Affect Student Outcomes: A Case of Politeknik Kuching Sarawak

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**Abstract.** This study investigates the methods students at Politeknik Kuching Sarawak use to study, emphasising how these methods change between departments and semesters. The study's sample size is 120 respondents, who are students from all semesters and represent the institution's major departments. The study aims to determine popular study techniques, evaluate their efficacy, and comprehend how students feel about different study approaches. A standardised questionnaire was used to gather the data. Time management, test strategies, motivation, note-taking, and information processing were among the questionnaire's topics. The results show a variety of study methods, with appreciable variations in preferences and efficacy according to the student's departmental affiliations and academic standing. The study shows a link between productive study habits and improved academic achievement, emphasising the value of customised study techniques to improve learning results. The study offers suggestions at the end for enhancing student's study skills, such as holding advanced study skills training sessions and seminars, encouraging group learning, and incorporating technology into the classroom. These programmes are designed to help students at Politeknik Kuching Sarawak meet their academic objectives and improve their overall educational experience.

**Keywords:** student study skills, study techniques, and Politeknik Kuching Sarawak

## 1 Introduction

Proficient study abilities are essential for achieving academic achievement, yet numerous students encounter difficulties in recognising and cultivating the strategies that most effectively facilitate their learning. The Study Skills Assessment Questionnaire is specifically created to assist students in assessing their academic abilities, offering a comprehensive comprehension of their areas of expertise and areas that require enhancement. Hattie et al. demonstrated that study skill improvement programmes are generally effective.

This comprehensive tool is structured into eight sections, each dedicated to a crucial aspect of study skills: time management and procrastination, concentration and memory, study aids and note-taking, test strategies and test anxiety, organising and processing information, motivation and attitude, and reading and selecting the main idea.

By participating in this questionnaire, students can acquire vital perceptions about their talents and pinpoint areas that may require improvement. Every part contains handouts and connections to valuable resources, providing practical guidance and tactics specifically designed for each skill domain. Completing the exams typically requires less than 10 minutes per component providing a handy and effective method for students to contemplate and enhance their study habits.

The Study Skills Assessment Questionnaire not only identifies existing study patterns but also offers practical measures to enhance academic achievement. The materials provided are designed to assist students in achieving their educational goals by helping them manage time more effectively, enhance concentration, utilise study aids, and overcome exam anxiety. Nevertheless, numerous university students have challenges when it comes to self-regulating their learning (Peverly, 2003). For example, students need to learn efficient learning techniques (Bjork, et.al., 2013) and help with time and study organisation (Steel, 2007). Consequently, there is a significant need for training programmes that promote self-regulated learning (SRL) among university students. Through a methodical examination of every component of study skills, students can cultivate a more organised and efficient method for their studies, resulting in enhanced academic achievements and a more gratifying educational journey.

## 2 Methodology

The technique employed in this study is founded around utilising the Study Skills Assessment Questionnaire, established by the Counselling and Mental Health Centre at the University of Houston- Clear Lake in 2023. The questionnaire is accessible online and can be obtained on their official website.



The study population comprises 120 respondents who are students enrolled at Politeknik Kuching Sarawak. The respondents are chosen from different departments and consist of students from all semesters, guaranteeing a broad and representative sample.

The sampling method used is stratified random sampling, ensuring that each department and semester is represented proportionally. This approach ensures that the findings may be applied to the entire student population of the institution. The primary tool utilised in this study is the Study Skills Assessment Questionnaire. This comprehensive tool is segmented into eight domains, each dedicated to certain facets of study skills:

Section 1: Time management and procrastination

Section 2: Concentration and memory

Section 3: Study aids and note-taking

Section 4: Test strategies and test anxiety

Section 5: Processing information

Section 6: Motivation and attitude

Section 7: Reading and selecting the main idea

Section 8: Writing

The questionnaire was given to the chosen respondents through social media platforms like WhatsApp group and Telegram group, which contained hyperlinks to the internet-based survey. The distribution mechanism guarantees equitable participation opportunities across all departments and semesters.

Respondents are allotted a specific duration (usually two weeks) to finish the questionnaire. Reminders are dispatched to guarantee a heightened rate of response.

Anonymity is ensured by having responders answer the questionnaire without revealing their identity. There is no collection of any personally identifiable information.

The statistical software Google Spreadsheet and XLMiner Analysis ToolPak is used to analyse the quantitative data obtained from the questionnaire responses. Descriptive statistics, such as the frequency, percentage, mean, standard deviation, sample variance and confidence level, summarise each segment's data.

Assessing the reliability of the questionnaire involves utilising Cronbach's alpha of 0.95 to confirm that the instrument has internal consistency. Content validity is determined by subjecting the questionnaire to expert assessment, ensuring it thoroughly encompasses the essential components of study skills. Construct validity is assessed by establishing a correlation between questionnaire results and markers of academic performance.

The data is securely saved and can only be viewed by the study team. Data is presented collectively to prevent the identification of individual responses from any participant. Self-reported statistics might be prone to response bias, since respondents may overestimate or underestimate their study ability. This study collects data at a particular moment, which may not accurately represent the changes in study skills across the semester or academic year.

This methodology presents a structured strategy for evaluating and analysing the student's study abilities at Politeknik Kuching Sarawak. The study offers practical insights into how students might improve their academic performance by analysing data using a verified questionnaire and robust data analysis tools.

### 3 Findings and discussions

#### 3.1 Demographic profile of respondents

The study encompassed a heterogeneous cohort of 120 respondents hailing from Politeknik Kuching Sarawak. The collected demographic and academic data offer a thorough picture of the participants, which is essential for comprehending the context of their study skills and habits. Presented below in Table 1 is a comprehensive analysis of the respondents categorised according to gender, department, semester, and academic achievement.

**Table 1** Demographic profile of respondents

	<i>n</i>	%
<b>Gender</b>		
Male	53	44.2
Female	67	55.8
<b>Department</b>		
Civil Engineering Department (JKA)	44	36.7
Electrical Engineering Department (JKE)	2	1.7
Mechanical Engineering Department (JKM)	6	5.0
Petrochemical Engineering Department (JKPK)	1	0.8
Commerce Department (JP)	62	51.7
Information Technology and Communication Department (JMSK)	5	4.2
<b>What semester are you in?</b>		
Semester 1	18	15.0
Semester 2	61	50.8
Semester 3	2	1.7
Semester 4	27	22.5
Semester 5	10	8.3
Semester 6 and extended semester	2	1.7
<b>What is your targeted CGPA range for this semester?</b>		
2.50 – 2.99	2	1.7
3.00 – 3.49	31	25.8
3.50 – 4.00	82	68.3
N/A	5	4.2
<b>What is your CGPA in the previous semester?</b>		
Below 3.00	29	24.2
3.00 and above	71	59.2
N/A	20	16.7

The sample exhibits in Table 1, a marginally greater proportion of female respondents (55.8%) in comparison to male respondents (44.2%), thereby ensuring a well-balanced gender representation. The Commerce Department (JP) has the largest proportion of respondents, accounting for 51.7% of the total, while the Civil Engineering Department (JKA) has a representation of 36.7%. The Electrical Engineering Department (JKE) and the Petrochemical Engineering Department (JKPK) have the lowest number of respondents compared to other departments.

Over half of the respondents, namely, 50.8% of them, are in Semester 2. This suggests that there is a notable focus on respondents who are in the early phases of their academic programmes. Most of the respondents strive for excellent academic achievement, with 68.3% specifically aiming for a CGPA range of 3.50 – 4.00. Merely a minuscule proportion (1.7%) strives to achieve a CGPA within the range of 2.50 – 2.99. The distribution of CGPA from the previous semester indicates that a significant proportion of students obtained a CGPA ranging from 3.00 to 4.00. Specifically, 59.2% of students earned a CGPA between 3.00 and 4.00, while 24.2% of students obtained a CGPA below 3.00. A minority of respondents selected the answer "not available" (N/A) since they are currently in their first semester.

The demographic and academic profile data reveals a varied sample with an equitable distribution of genders and a notable cluster of students in the initial semesters, specifically Semester 2. A significant proportion of respondents are striving for exceptional academic performance, with a substantial percentage having attained respectable Cumulative Grade Point Averages (CGPAs) in previous semesters. The full profile is essential for evaluating the study skills and habits evaluated in the questionnaire. It serves as a contextual basis for understanding the academic behaviours and aspirations of the students at Politeknik Kuching Sarawak.

### 3.2 Key statistical measurements for eight domains of study skills

The following data displays in Table 2, the average scores and standard deviations for various study skills areas among students from Politeknik Kuching Sarawak. This study offers a deeper understanding of the student's skill level and range of performance in each specific area.

The mean score indicates a moderate proficiency in time management and dealing with procrastination. The relatively high standard deviation suggests a wide variability in how students manage their time and procrastination, indicating that while some students excel, others struggle significantly in this area.

Students exhibit comparable levels of aptitude in focus and memory as they do in time management. The standard deviation is marginally reduced, suggesting a higher level of consistency in pupils' ability to sustain concentration and retain knowledge.

The level of skill in utilising study aids and taking efficient notes is comparable to other areas, although there is still a significant amount of variation. This indicates variations in proficiency and utilisation of educational resources and strategies for taking notes among students.

The higher average score in this domain indicates that students possess a comparatively superior ability to utilise test strategies and handle test anxiety. The lower standard deviation, in comparison to other areas, suggests a more consistent capacity to handle testing and the accompanying stress.

Students demonstrate a notable aptitude in the organisation and manipulation of information, which is comparable to their abilities in test-taking tactics. The standard deviation indicates the degree of consistency in the performance of pupils in this crucial skill domain.

The student's motivation and attitude towards studies are moderately levelled, with a standard deviation indicating some degree of variability. This suggests that although a significant number of students are driven and exhibit a favourable mindset, there are discernible variations in this regard.

Students demonstrate a high level of competency in their writing skills, which is on par with their capacity to comprehend information. The standard deviation indicates that although many students demonstrate proficiency, there exists a subset who encounter difficulties in writing.

The study skills assessment indicates that respondents from Politeknik Kuching Sarawak have strong performance in exam methods, information processing, and writing. Nevertheless, there is significant variation in the way individuals manage their time, utilise study aids, and stay motivated. This suggests that there are specific areas where focused assistance and more resources could be advantageous. The findings derived from this analysis can assist educators and counsellors in formulating interventions to target these requirements and enhance the overall academic achievement of students.

**Table 2.** Key statistical measurements for eight domains of study skills

		SD	Sample Variance	Confidence Level (95%)
TM	24.34	4.90	24.00	0.89
CM	24.67	4.75	22.59	0.86
SA	24.28	4.72	22.29	0.85
TS	25.42	4.30	18.53	0.79
PI	25.28	4.39	19.24	0.79
MA	24.27	4.40	19.34	0.79
RS	25.12	4.00	16.00	0.72
WE	25.29	4.37	19.08	0.79

The following Table 2 displays essential statistical measures for eight study skills domains: Time Management and Procrastination (TM), Concentration and Memory (CM), Study Aids and Note-Taking (SA), Test Strategies and Test Anxiety (TS), Processing Information (PI), Motivation and Attitude (MA), Reading and Selecting the Main Idea (RS), and Writing (WR).

The mean represents the arithmetic average of the scores within each domain. It serves as a central reference point for the distribution of individual scores. As an example, the average score for Time Management and Procrastination (TM) is 24.34, suggesting that respondents typically score close to this figure for TM.

Standard Deviation (SD) is a statistical measure that quantifies the amount of variability or dispersion in a set of data. The standard deviation quantifies the degree of variability or spread away from the average. A higher standard deviation signifies greater dispersion in results, whereas a lower standard deviation suggests that scores are more tightly clustered around the mean. As an illustration, the standard deviation (SD) of Time Management and Procrastination (TM) is 4.90, indicating a significant amount of variation in the TM scores among the individuals surveyed.

The sample variance is calculated as the squared value of the standard deviation and provides a measure of the magnitude of the divergence of each score from the mean. Greater variance indicates a larger spread of scores. As an illustration (Table 2), the variance for Time Management and Procrastination (TM) is 24.01, indicating a substantial spread in the scores.

The confidence level represents the interval in which we can have 95% certainty that the actual average of the population is located. A narrower confidence interval signifies a more accurate estimation of the population mean. The confidence level for Time Management and Procrastination (TM) is 0.89, indicating that we may have 95% confidence that the actual average TM score is within 0.89 points of the sample mean.

The average scores are rather consistent across several areas, ranging from 24.27 (Motivation and Attitude) to 25.42 (Test Strategies and Test Anxiety). This indicates that, on average, the respondents' proficiency in various study skills areas is quite similar.

The domain of Test Strategies and Test Anxiety (TS) exhibits the lowest standard deviation (4.30) and variance (18.53), suggesting that the scores in this domain are more consistent among the respondents. On the other hand, Time Management and Procrastination (TM) exhibits the highest standard deviation (4.90) and variance (24.01), suggesting a greater range of differences in respondents' skills in this area.

The confidence intervals for all domains are narrow, indicating that the sample mean is a dependable estimate of the population mean. The domain "Reading and Selecting the Main Idea (RS)" has the narrowest confidence interval of 0.72, which indicates a highly precise mean score estimation for this domain.

In conclusion, the statistical measurements offer a thorough assessment of the study skills domains among the respondents. The mean scores provide an overall measure of competency, while the standard deviations and variances indicate the extent of variation in the abilities of the respondents. The confidence intervals indicate that the sample means are trustworthy approximations of the actual population means, offering useful insights regarding the study abilities of the respondents.

### 3.3 Distribution of respondents' proficiency in different study skills domains

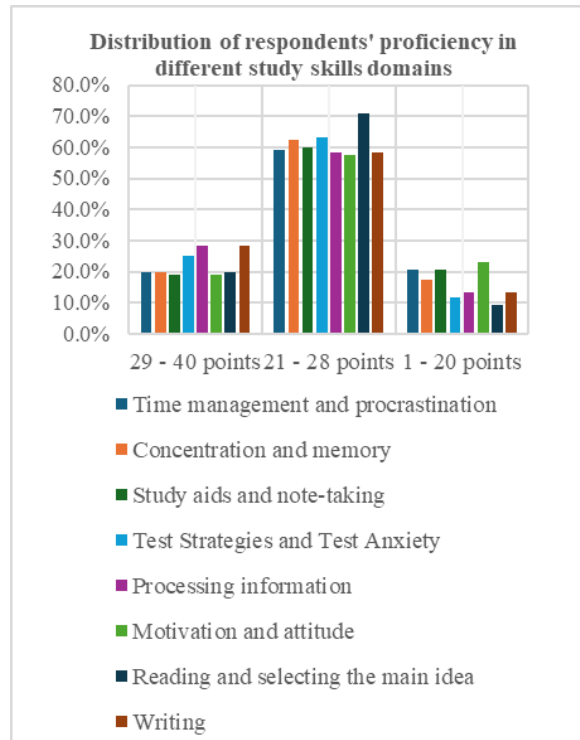
The following data (Figure 1) classifies students' competence in different study skills domains into three score intervals: "29-40 points," "21-28 points," and "1-20 points." Each category displays the proportion of students who fall between these score ranges for each skill.

#### 3.3.1 Time management and procrastination

From a range of 29 to 40 points, around 20.0% of respondents have exceptional skills in time management and controlling procrastination, suggesting a high level of proficiency in effectively managing their time. 21 - 28 points: A substantial majority, comprising 59.2% of respondents, are situated in the middle category, indicating an average level of proficiency. 1 - 20 points: 20.8% of respondents face difficulties in this domain, suggesting challenges with time management and a proclivity for procrastination.

#### 3.3.2 Concentration and Memory

For respondents who score between 29 and 40 points, around 20.0% demonstrate a high level of competency in concentration and memory recall. 21 - 28 points: 62.5% of respondents demonstrate moderate focus and memory abilities, indicating average performance in these areas. 1 - 20 points: 17.5% of students exhibit challenges in this domain, suggesting inadequate focus and retention abilities



**Fig. 1.** Distribution of respondents' proficiency in different study skills domains

### 3.3.3 Study aids and note-taking

19.2% of respondents achieve a high score, ranging from 29 to 40 points, indicating their proficient ability in utilising study aids and employing good note-taking strategies. 21 - 28 points: 60.0% of students fall within the mid-range, indicating a moderate level of skills. 1 - 20 points: 20.8% of respondents demonstrate inadequate proficiency, highlighting the necessity for enhancement in this domain.

### 3.3.4 Test strategies and the test anxiety

A significant proportion of respondents, specifically 63.3%, achieve scores within the mid-range of 21-28. This suggests that they possess a reasonable level of proficiency in test methods and the capacity to manage test anxiety. 25.0% of respondents demonstrate exceptional performance, achieving scores above 29, while only 11.7% obtain scores below 21, suggesting a lower prevalence of major difficulties related to test anxiety and methods among students.

### 3.3.5 Processing information

Of all the respondents, 28.3% demonstrate exceptional skills in processing information, scoring between 29 and 40 points. These students have a strong aptitude for comprehending and arranging information effectively. 21 - 28 points: 58.3% of respondents fall within the mid-range, suggesting that they possess average skills. For the range of 1 to 20 points, around 13.3% of respondents demonstrate inadequate proficiency in processing information.

### 3.3.6 Motivation and Attitude

Between 29 and 40 points, approximately 19.2% of respondents exhibit a high degree of enthusiasm and a good attitude towards their academics. 21 - 28 points: Approximately 57.5% of respondents demonstrate moderate levels of motivation and attitude since they fall within the mid-range. For scores ranging from 1 to 20 points, approximately 23.3% of respondents demonstrate low motivation and a negative attitude, highlighting the need for intervention in this area.

### 3.3.7 Reading and selecting the main idea

For the score range of 29 to 40 points, 20.0% of respondents demonstrate a high level of proficiency in reading and accurately identifying the major themes. For students who score between 21 and 28 points, approximately 70.8% fall within this range, suggesting that they possess strong, albeit not outstanding, skills. For the range of 1 to 20 points, only 9.2% of students face severe difficulties in this area, which is the smallest number compared to all other skills evaluated.

### 3.3.8 Writing

From a range of 29 to 40 points, around 28.3% of respondents exhibit a high level of proficiency in writing, which is the largest proportion compared to other skill categories. 21 - 28 points: Approximately 58.3% of respondents demonstrate ordinary writing skills, as they fall within the mid-range. From a sample of 1 - 20 points, it was shown that 13.3% of respondents face difficulties in writing, suggesting a requirement for enhancement.

**Summary Strengths:** The subjects "Processing Information" and "Writing" show the highest proportions of respondents achieving scores in the top range (29 - 40 points), suggesting that these areas are very strong. Most students demonstrate intermediate proficiency, with the majority scoring between 21 and 28 points in all skill categories.

**Areas of worry:** The category of "Motivation and Attitude" exhibits the highest proportion of respondents who scored within the lowest range of 1 to 20 points. This indicates a noteworthy area of concern that requires attention.

This comprehensive study identifies the specific areas in which respondents demonstrate exceptional proficiency and the areas in which they require additional assistance. It offers useful insights for educators and administrators at Politeknik Kuching Sarawak, enabling them to customise interventions and enhance overall student performance.

## 3.4 Relationships Correlations among the study skills domains

Table 3 below presents the correlation coefficients among eight study skills domains: Time Management and Procrastination (TM), Concentration and Memory (CM), Study Aids and Note-Taking (SA), Test Strategies and Test Anxiety (TS), Processing Information (PI), Motivation and Attitude (MA), Reading and Selecting the Main Idea (RS), and Writing (WR). These correlation coefficients range from -1 to 1, where values closer to 1 indicate a strong positive relationship, values closer to -1 indicate a strong negative relationship, and values around 0 indicate no relationship.

**Table 3.** Correlations among the study skills domains

	<i>TM</i>	<i>CM</i>	<i>SA</i>	<i>TS</i>	<i>PI</i>	<i>MA</i>	<i>RS</i>	<i>WR</i>
<b><i>TM</i></b>	1.00							
<b><i>CM</i></b>	0.66	1.00						
<b><i>SA</i></b>	0.69	<b>0.72</b>	1.00					
<b><i>TS</i></b>	0.51	0.59	0.58	1.00				
<b><i>PI</i></b>	0.59	0.62	0.65	<b>0.71</b>	1.00			
<b><i>MA</i></b>	0.56	0.58	0.63	0.63	<b>0.753</b>	1.00		
<b><i>RS</i></b>	0.56	0.56	0.65	0.61	<b>0.79</b>	0.67	1.00	
<b><i>WR</i></b>	0.59	0.62	0.65	<b>0.71</b>	<b>0.99</b>	<b>0.74</b>	<b>0.79</b>	1.00

#### 3.4.1 Time management and procrastination (*TM*)

Strong associations: Trait Mindfulness (*TM*) has robust positive associations with Study Aids and Note-Taking (*SA*) (0.69) and Concentration and Memory (*CM*) (0.66). These findings suggest that improved utilisation of study aids, note-taking, and memory and concentration skills are linked to effective time management and less procrastination

#### 3.4.2 Concentration and Memory (*CM*)

Strong connections: Cognitive Metacognition (*CM*) exhibits strong connections with Study Aids and Note-Taking (*SA*) (0.72) and Processing Information (*PI*) (0.62). Students with strong concentration and recall abilities are more likely to effectively use study aids and efficiently process information.

#### 3.4.3 Study Aids and Note-Taking (*SA*)

There are high correlations between *SA* and two other factors: Processing Information (*PI*) with a correlation coefficient of 0.65, and Test Strategies and Test Anxiety (*TS*) with a correlation coefficient of 0.58. This implies that students who have a high level of proficiency in using study tools and note-taking techniques also demonstrate exceptional skills in processing information and employing effective tactics during tests.

#### 3.4.4 Test Strategies and Test Anxiety (*TS*)

Significant correlations: Trait Sensitivity (*TS*) has a robust association with Processing Information (*PI*) (0.71) and a modest correlation with Motivation and Attitude (*MA*) (0.63). The effectiveness of exam strategies is strongly correlated with students' information processing abilities, as well as their motivation and attitude towards their academics.

#### 3.4.5 Processing Information (*PI*)

Significant Correlation: Pearson's correlation coefficient between Processing Information (*PI*) and Writing (*WR*) is 0.99, showing a strong positive relationship. This suggests that individuals who excel in information processing also tend to excel in writing. Furthermore, it has significant associations with Reading and Selecting the Main Idea (*RS*) (0.79) as well as Motivation and Attitude (*MA*) (0.75). Research conducted by Howard et.al (2016) has demonstrated that students' ability to process information is also impacted by their aptitude for integrating technology into their academic tasks.

#### 3.4.6 Motivation and Attitude (*MA*)

There are substantial correlations between the scores of *MA* and the scores of Writings (*WR*) (0.74) as well as Reading and Selecting the Main Idea (*RS*) (0.67). These findings indicate that students who are driven and have a favourable mindset also excel in their writing skills and the ability to discern important themes when reading.

#### 3.4.7 Reading and Selecting the Main Idea (*RS*)

Strong Correlations: The correlation coefficient (*RS*) indicates a strong positive relationship with Writing (*WR*) (0.79) and Processing Information (*PI*) (0.79). This suggests that kids who have proficiency in identifying key concepts while reading also demonstrate exceptional abilities in writing and comprehending material.

### 3.4.8 Writing (WR)

**High connection:** The substantial connection between WR (writing skills) and Processing Information (PI) (0.99) indicates that writing skills are closely related to information processing skills in this situation. Writing (WR) is highly correlated with Reading and Selecting the Main Idea (RS) with a correlation coefficient of 0.79, as well as with Motivation and Attitude (MA) with a correlation coefficient of 0.74.

**Interconnected Skills:** The robust connections between several domains indicate that these study skills are interdependent. Improving time management skills has the potential to enhance other areas of performance, such as note-taking and focus. The study conducted by Hosseini et al. supports the existing findings by highlighting the need for structured and continuous educational courses to improve study skills. The factors that influenced their academic endeavours were efficient time management, readiness for exams, concentrated focus, rigorous reading, and precise note-taking.

**Areas of focus for improvement:** Concentrating interventions on domains such as Processing Information and Writing could yield extensive advantages as they are strongly correlated with several other areas. Didarloo, & Khalkhali, (2014), imply that if students effectively allocate their time to studying and focus on comprehending science subjects, they will achieve success in obtaining knowledge and learning. Some investigations corroborate and substantiate this aspect of the study's conclusions. Nourian et al. found that the average score for time management was higher than the scores for other study skills. This finding aligns completely with the results of the current analysis.

**A comprehensive approach:** It is essential to adopt a comprehensive strategy when developing study skills, as mastery in one area typically enhances mastery in other areas. Gaining insight into these linkages can assist educators in developing more efficient programmes to enhance students' academic achievement by simultaneously addressing many interconnected skills.

## 4 Conclusion and recommendations

Recap on the problems faced by Geodesy 2 students on implementing instrument calibration An examination of study skills among students at Politeknik Kuching Sarawak provides significant revelations regarding the elements that impact academic achievement. The research reveals substantial disparities in study habits, skills, and attitudes across various domains, encompassing time management, concentration, utilisation of study aids, exam methods, information processing, motivation, reading, and writing. However, the effectiveness of learning is heavily influenced by the active learning attitude and self-study abilities of students. The robust relationships among these categories indicate that these talents are interconnected, and enhancements in one domain can have a positive influence on the others.

Significantly, most students have attained a Cumulative Grade Point Average (CGPA) of 3.00 or higher, indicating impressive academic accomplishments and successful study methodologies. Nevertheless, a significant proportion of students who have a CGPA below 3.00 demonstrates the necessity for focused academic assistance to enhance their academic performance.

The study also emphasises the significance of tackling exam anxiety, as it is strongly associated with other study skills such as information processing and motivation. Implementing efficient examination tactics can mitigate feelings of unease and result in enhanced scholastic achievements. Furthermore, the results emphasise the necessity of adopting a comprehensive strategy to enhance study skills, acknowledging the interdependent nature of these abilities. Hedin and Kann (2019) argue that students who possess a diverse range of study abilities are more likely to experience good effects on their learning. This is because they can adjust their learning strategies to varied scenarios.

According to the results of this study, the following recommendations are put forward:

### 1 Focused Academic Assistance:

**Tutoring Programmes:** Establish tutoring initiatives targeting students with a Cumulative Grade Point Average (CGPA) below 3.00, aiming to deliver individualised support and enhance their academic aptitude. Organise workshops and seminars focused on teaching students practical methods to improve their study habits, including effective time management, concentration techniques, and note-taking procedures.

### 2 Comprehensive Skill Development:

**Integrated Skill Training:** Create comprehensive training programmes that target many study skills concurrently, including time management, information processing, and exam strategies. This strategy utilises the robust relationships among these talents. Implement peer mentoring programmes that facilitate the transfer of successful study habits and tactics from high-achieving students to their classmates.

### 3 Managing Test Anxiety:

**Stress Management courses:** Provide courses focused on stress management and ways to reduce exam anxiety, such as mindfulness and relaxation exercises. **Counselling Services:** Facilitate students' access to counselling services to address severe test anxiety, ensuring they receive expert assistance.

#### *4 Improving Motivation and Attitude:*

**Goal-Setting Programmes:** Introduce programmes aimed at assisting students in establishing attainable academic objectives and cultivating favourable mindsets towards their studies. Implement incentive systems that acknowledge and promote academic accomplishments, hence cultivating a stimulating atmosphere.

#### *5 Resource utilisation:*

Ensure equitable access to essential study resources, such as libraries, online databases, and study aids, for all students. Encourage the utilisation of technical tools and applications that facilitate time management, note-taking, and information processing.

#### *6 Ongoing surveillance and evaluation:*

**Periodic Evaluations:** Perform periodic evaluations of pupils' study abilities and academic achievement to pinpoint areas requiring enhancement.

**Feedback Mechanisms:** Implement feedback mechanisms to provide students with helpful input regarding their study techniques and academic success.

### **5 Future Research**

Subsequent investigations should investigate the enduring effects of the adopted suggestions on student's academic achievement and study abilities. Furthermore, conducting an inquiry into the difficulties encountered by students who chose not to disclose their CGPA can offer additional understanding in terms of assisting this specific subgroup. Including a broader and more varied sample in the study can improve the potential to apply the findings to a wider population. Politeknik Kuching Sarawak can create a conducive environment for academic performance by addressing the identified demands and utilising the strong interconnections among study skills.

### **References**

- 1 Bjork, R. A., Dunlosky, J., & Kornell, N. (2013). Self-regulated learning: Beliefs, techniques, and illusions. *Annual Review of Psychology*, 64, 417–444.
- 2 Didarloo, A., & Khalkhali, H. R. (2014). Assessing study skills among university students: an Iranian survey. *Journal of educational evaluation for health professions*, 11, 8. <https://doi.org/10.3352/jeehp.2014.11.8>
- 3 Fereidouni Moghadam, M., & Cheraghian, B. (2009). Study habits and their relationship with academic performance among students of Abadan School of Nursing. *Strides in Development of Medical Education*, 6(1), 21–28.
- 5 Hattie, J., Biggs, J., & Purdie, N. (1996). Effects of learning skills interventions on student learning: A meta-analysis. *Review of Educational Research*, 66(2), 99–136. <https://doi.org/10.2307/1170605>
- 6 Hedin, B., & Kann, V. (2019). Improving Study Skills by Combining a Study Skill Module and Repeated Reflection Seminars. *Education Research International*. 2019. 1–8. 10.1155/2019/9739854.
- 7 Howard, S. K., Ma, J., & Yang, J. (2016). Student rules: Exploring patterns of students' computer-efficacy and engagement with digital technologies in learning. *Computers & Education*, 101, 29–42.
- 8 Nourian, A., Shah Mohammadi, F., Mousavi Nasab, S. N., & Nourian, A. (2011). Study Skills and Habits of the Students in Tehran Islamic Azad University of Medical Sciences in the Academic Year 2008–2009. *Strides in Development of Medical Education*, 7(2), 104–111.
- 9 Peverly, S. T., Brobst, K. E., Graham, M., & Shaw, R. (2003). College adults are not good at self-regulation: A study on the relationship of self-regulation, note taking, and test-taking. *Journal of Educational Psychology*, 95(2), 335–346. <https://doi.org/10.1037/0022-0663.95.2.335>
- 10 Steel, P. (2007). The nature of procrastination: A meta-analytic and theoretical review of quintessential self-regulatory failure. *Psychological Bulletin*, 133(1), 65–94. <https://doi.org/10.1037/0033-2909.133.1.65>
- 11 University of Houston-Clear Lake Counseling and Mental Health Center (2023). Study Skills Assessment Questionnaire. Available from: <https://www.uhcl.edu/cmhc/resources/docume>



# Mooting as a Simulation to Enhance Understanding of Business Law for Non-Law Students in Polytechnic Kuching Sarawak

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**Abstract.** Mooting is a simulated court process in a moot court whereby students must analyze a problem-based question based on real cases, research relevant law, prepare legal arguments, and present their case to a moot court (Fletcher, R. P., 2021). Mooting has long been connected with helping law students enhance their legal knowledge. However, mooting can be used as a teaching simulation for non-law students (Fletcher, 2021). This research investigates mooting as a simulation (Mahmood, A., Hashim, H. N. M., & Zakuan, Z. Z. A., 2024) for non-law students at Polytechnic Kuching Sarawak to improve their understanding of business law. Mooting allows students to understand the legal principles of business law, develop communication skills, and strengthen their critical thinking and analytical capabilities (Williams, 2020). The study applied a quantitative research approach, using surveys and informal interviews to gather data on the effectiveness of mooting in enhancing students' comprehension of legal principles, communication skills, and critical thinking. The findings indicate that mooting significantly improves non-law students' understanding of business law, enhances their communication skills, and boosts their confidence in legal reasoning.

**Keywords:** Mooting, Simulation, Business Law, Polytechnic, Legal Skills

## 1 Introduction

Business law is essential to any business studies level to understand the law in the corporate world. For non-law students, such as in this research context, the Diploma in Accountancy and Diploma in Business Studies might find law difficult as they require a lot of reading. Traditional teaching approaches are less engaging and make it hard for students to apply their legal understandings in the real world, which would therefore be hard on their future jobs (Willingham, D. T., 2021). Mooting, a simulated court process in which students argue a moot problem, is one innovative method for teaching business law to non-law students (Fletcher, R. P., 2021).

## 2 Literature review

Mooting provides various advantages to non-law students studying business law. For instance, it helps students develop important legal skills such as legal research, critical analysis, and oral advocacy (Fletcher, R. P., 2021). Students obtain a better understanding of legal ideas and how to apply them in real-world situations by examining case law and statutes to create arguments. It is undeniable that mooting helps to enhance students' communication skills, as they need to speak impromptu and rebut any arguments during a rebuttal session (Tsaoussi, 2020). Furthermore, mooting enables students to analyze legal principles and cases with the moot problem given, which leads the student to solve the moot problem and develop critical thinking skills (Fletcher, R. P., 2021). This mooting approach helps students gain a better knowledge of business law and prepares them for future business law issues (Davidson, D. V., Forsythe, L. M., & Holland, N. A., 2023).

## 3 Methodology

This study applied quantitative research to examine how mooting affects students' understanding of business law. Data was collected through surveys distributed to 51 students from Polytechnic Kuching Sarawak who participated in mooting activities, informal interviews with participants, and article research on the effectiveness of mooting for non-law students. The survey included questions rated on a Likert scale from 1 (strongly disagree) to 5 (strongly agree) to gauge students' perceptions of mooting's effectiveness. A statistical analysis was conducted to validate the findings and determine the significance of the results.

### 3.1 Implementation in Polytechnic settings

Several steps have been taken before implementing mooting at Polytechnic Kuching, Sarawak. First, lecturers must create a moot problem that is based on case law and legal principles. The moot problem should be intriguing and demanding, prompting students to conduct legal study and analysis (Strong, S. I., 2022). The students should then be divided into teams and assigned roles such as lawyers for the plaintiff and defendant (Fletcher, R. P., 2021). Each team is then given time to develop their arguments in their bundle of authorities and oral submission during the moot courts' hearing session (Onn, L. M., 2022). the rebuttal session, and students should receive comments to help them improve their legal reasoning and advocacy skills (Hill, J., 2021).

During a hearing session in a moot court, students are required to make an oral submission in front of the lecturer acting as a judge (Tsaoussi, 2020). Then, a rebuttal session is given to each team—the plaintiff and defendant—to rebut any arguments from the opposite team. The judge in the moot court then comes out with judgements after the rebuttal session, and students should receive comments to help them improve their legal reasoning and advocacy skills (Hill, J., 2021).

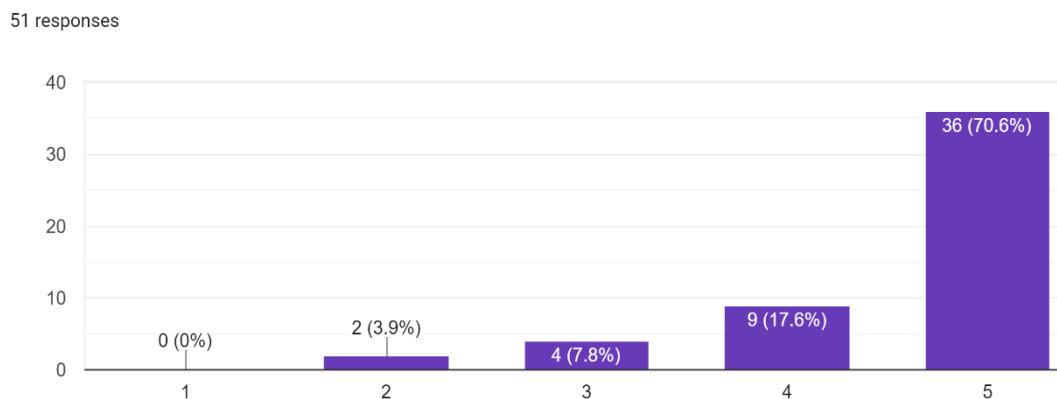
### 3.2 Impact on Student Comprehension

Mooting is undeniable and helps to improve students' understanding of business law (Fletcher, R. P., 2021). Survey results show that 86.3% of students can understand the legal principles and cases practically, which they were unable to see during the lecture (Finch, E., & Fafinski, S., 2023). They learn how to apply legal ideas to actual-life situations, preparing them for the obstacles that may arise in their future careers (Hägg, G., & Jones, C., 2021). Furthermore, mooting boosts 80.4% of student's confidence in their legal talents by giving them practice in presenting arguments and discussing legal topics in a moot court (Thomas, M., & Craddock, L., 2019). The confidence created within students implicitly helps them prepare for their career pathway in the corporate sector, where understanding of business law is crucial (Tsaoussi, 2020).

## 4 Results

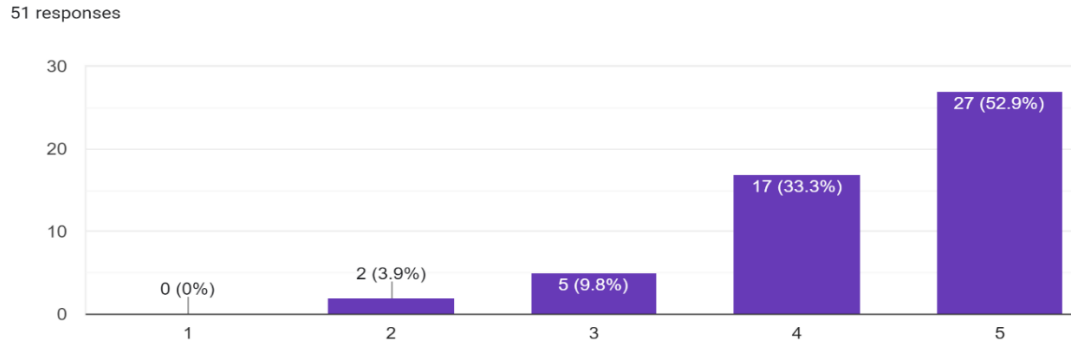
Based on the research, mooting helps improve student understanding significantly when studying business law at Polytechnic Kuching Sarawak. A survey of 51 students was given to determine the effectiveness of mooting as a simulation for non-law students at Polytechnic Kuching Sarawak to study business law. Scale 1 indicates disagreement, while scale 5 shows great agreement with the questions given in the survey. The research findings indicate that mooting significantly improves non-law students' understanding of business law. Key results from the survey include:

**a) Improved Understanding:** 86.3 % of students claimed that mooting helped them have a better understanding of business law principles and cases at Polytechnic Kuching Sarawak. Understanding business law is impliedly important to help them answer law questions in final exams and tests. Therefore, mooting helps to understand complicated legal topics from lectures in class (Finch, E., & Fafinski, S., 2023).



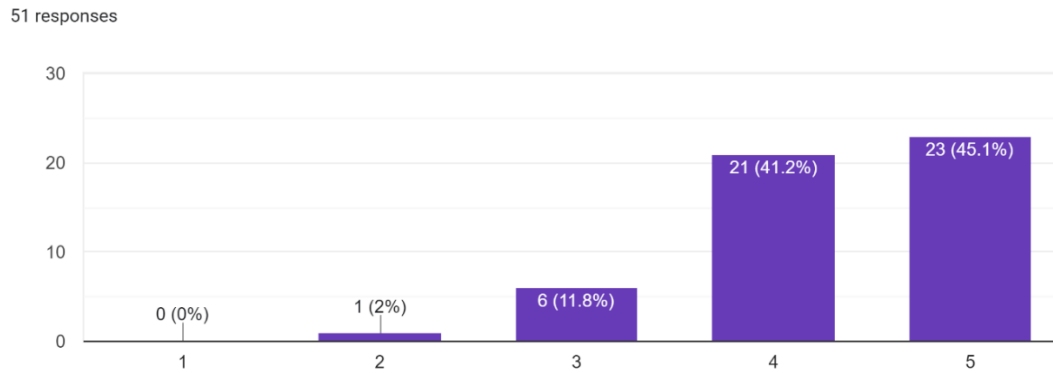
**Fig. 1. whether mooting is the first experience for the respondents**

The figure above is to determine whether mooting is the first experience for the respondents. Based on a survey given to students, 70.6% said that mooting was their first experience with a presentation at Polytechnic Kuching Sarawak.



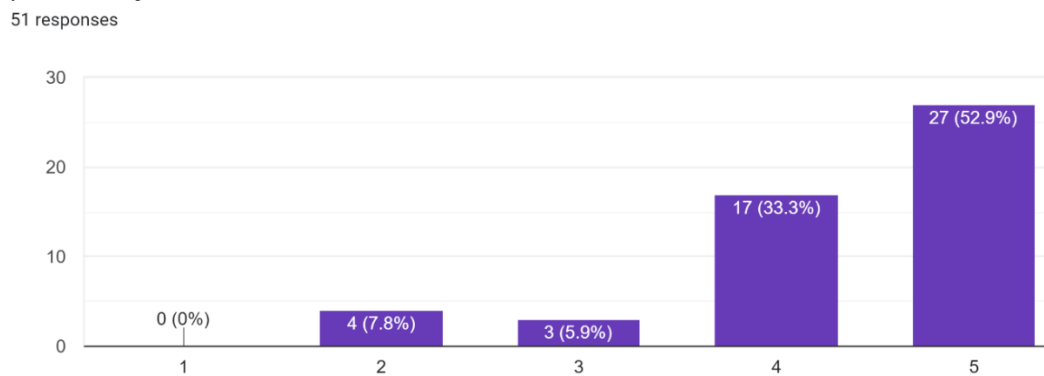
**Fig. 2. Mooting as a suitable simulation for non-law students**

Students agreed that mooting is suitable as a presentation tool for business law studies, as 52.9% agreed and 3.9% did not agree, which shows that mooting is a suitable simulation for non-law students.



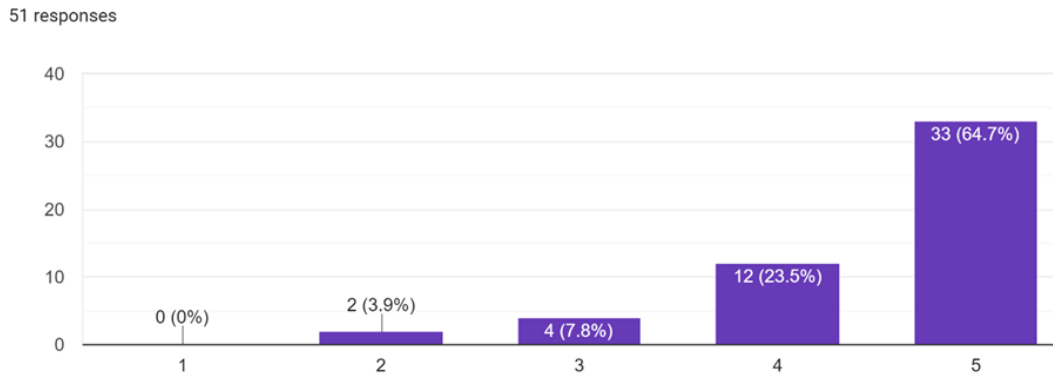
**Fig. 3. mooting helps them to have a better understanding of business law principles and cases**

The majority of the students with a combination of scales 4 and 5, 86.3%, agree that mooting helps them to have a better understanding of business law principles and cases.



**Fig. 4. mooting as a simulation for a better understanding of business law than using conventional presentation**

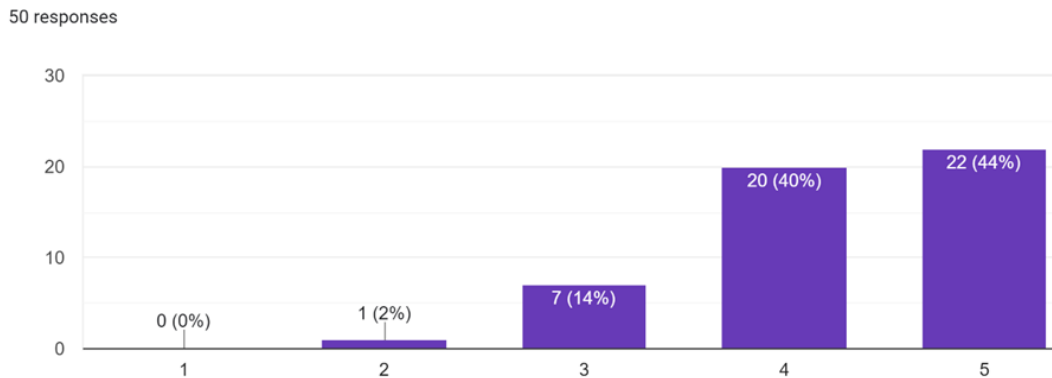
The figure above indicates that 52.9% of students agreed that they enjoyed using mooting as a simulation for a better understanding of business law than using conventional presentation.



**Fig. 5. mootng helps to enhance understanding of business law**

From the survey given, students agreed, with 64.7% choosing scale 5 and 23.5% choosing scale 4, that mootng helps to enhance understanding of business law.

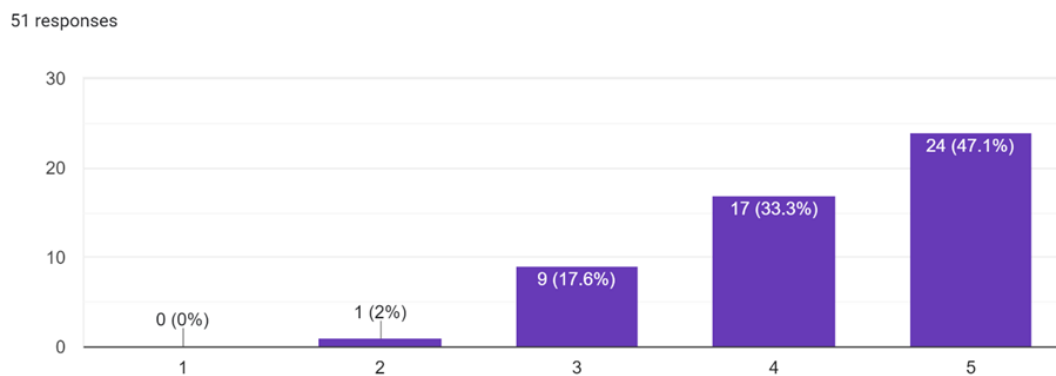
**b) Enhanced Skills:** Through mootng, 84% reported mootng helps students with legal research, critical thinking, and communication skills. Mootng enables students to analyze moot problems given from different perspectives and enhance their argumentation skills, which are useful in the corporate world (Fletcher, R. P., 2021).



**Fig. 6. Mooting is a simulation that helps to boost communication skills**

Mooting is a simulation that helps to boost communication skills as the students are required to speak individually and to answer questions in rebuttal sessions without script preparation during the oral mootng session. 84% of the students agreed that mootng helps boost their confidence and communication skills with others.

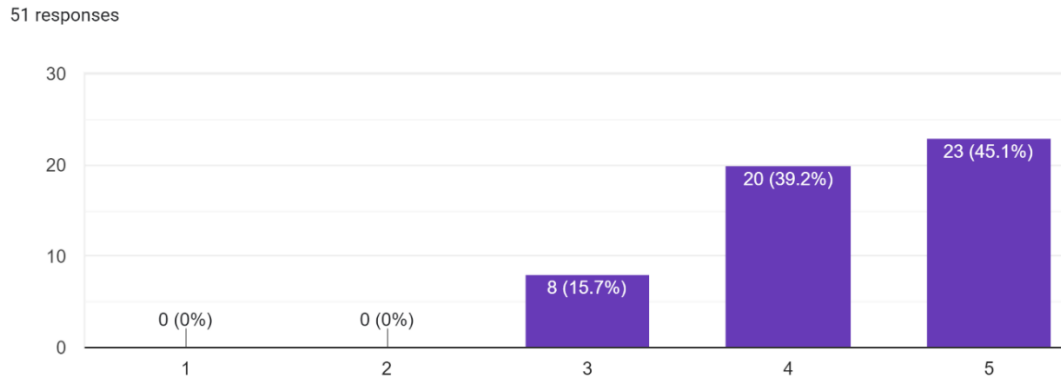
**c) Increased Confidence:** 80.4% felt better when participating in mootng increased students' confidence in their legal abilities. They felt more equipped to apply legal principles in real-world situations, which is critical for their future professions (Tsaoussi, 2020).



**Fig. 7. mootng helps them communicate better in English**

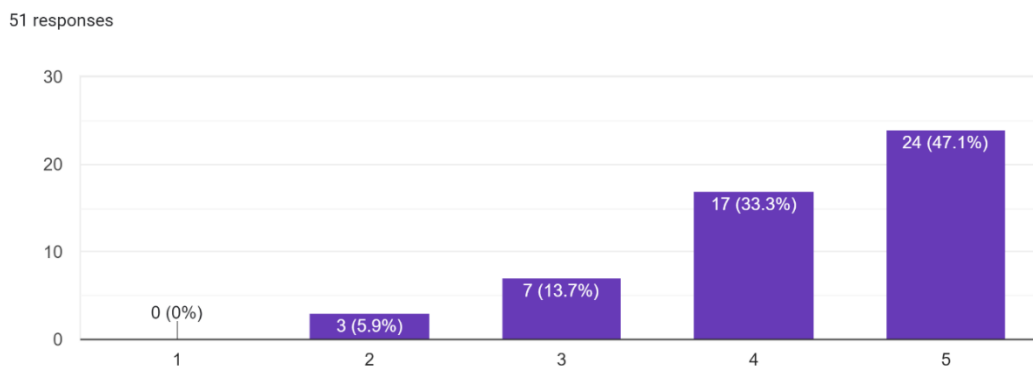
During the mootings session, students are required to speak in English. All cases and references in the bundle of authorities will also be prepared in English. 80.4% of students agreed that mootings helps them communicate better in English.

Apart from the three skills that were drawn up from the research above and the survey given, students agreed that mootings should continue as a simulation for business law during the presentation or end-of-chapter assessment.



**Fig. 8. mootings should continue as a simulation tool for business law**

Students were being asked if mootings should be continued as a simulation for business law. 84.3% of students agreed that mootings should continue as a simulation tool for business law.



**Fig. 9. a bundle of authorities was suitable for mootings as a projection to convey information**

In any usual presentation, a PowerPoint is the most common tool being used as a projection to convey information. However, in mootings, the bundle of authorities is required to be prepared by the students to answer all problem-based questions given. 80.4% of students agreed that a bundle of authorities was suitable for mootings.

## 5 Discussion

The results demonstrate that mootings is an effective method for teaching business law to non-law students. By engaging in simulated court processes, students can apply theoretical knowledge to practical scenarios, enhancing their comprehension and retention of legal concepts (Subrin, S. N., Minow, M. L., Brodin, M. S., Main, T. O., & Lahav, A. D., 2024). Additionally, mootings helps develop essential skills such as legal research, critical thinking, and oral advocacy, which are valuable in both academic and professional settings (Finch, E., & Fafinski, S., 2023).

Comparing these findings to previous studies, it is evident that mootings can bridge the gap between theoretical knowledge and practical application, providing a more holistic learning experience for students. While mootings has many advantages, its implementation in polytechnic settings might be difficult (Fletcher, R. P., 2021). Limited resources, such as access to legal information and competent legal practitioners, can reduce the effectiveness of mootings as a simulation method (Voskobitova, M. R., 2021).

To address these issues, lecturers can work with legal professionals to provide assistance and criticism to students (Tsaoussi, 2020). Online legal databases and resources can also assist students in conducting research and preparing their arguments more effectively (Heinrich, M., Denitsa, R., & Oltz, T. P. (2020). Furthermore, incorporating mootings into the curriculum regularly might help students steadily enhance their legal skills over time (Fletcher, R. P., 2021). The study highlights the importance of experiential learning in bridging the gap between theoretical knowledge and practical application.

## 6 Conclusion

The findings of this study show that mootting is a beneficial simulation tool for improving student grasp of business law at Polytechnic Kuching, Sarawak. Mooting helps students gain the information, skills, and confidence they need to succeed in their future employment by teaching them legal ideas practically and interestingly. Integrating mootting into the curriculum may benefit non-law students studying corporate law.

Mooting is an effective simulation method for improving non-legal students' understanding of business law at Polytechnic Kuching Sarawak. Mooting provides students with a hands-on learning experience that helps them acquire critical legal skills and prepares them for the difficulties of business. With careful organization and execution, mootting can be a very effective technique for teaching business law in polytechnic contexts. Future research could explore the long-term impacts of mootting on students' career readiness and expand the study to other polytechnic institutions.

## References

1. Davidson, D. V., Forsythe, L. M., & Holland, N. A. (2023). *Business Law: Principles and Cases in the Legal Environment [Connected EBook with Study Center]*. Aspen Publishing.
2. Finch, E., & Fafinski, S. (2023). *Legal skills*. Oxford University Press.
3. Fletcher, R. P. (2021). *How do students' experiences of, and approaches to, mootting, affect their learning of substantive law and understanding of the law?* University of Northumbria at Newcastle (United Kingdom).
4. Hägg, G., & Jones, C. (2021). Educating towards the prudent entrepreneurial self—an educational journey including agency and social awareness to handle the unknown. *International Journal of Entrepreneurial Behavior & Research*, 27(9), 82-103.
5. Heinrich, M., Denitsa, R., & Oltz, T. P. (2020). Legal Research Just in Time: A New Approach to Integrating Legal Research Into the Law School Curriculum. *Tenn. L. Rev.*, 88, 469.
6. Hill, J. (2021). *The Practical Guide to Mooting*. Bloomsbury Publishing.
7. Mahmood, A., Hashim, H. N. M., & Zakuan, Z. Z. A. (2024). Utilizing Experiential Learning Methods to Teach Substantive Law Courses to Undergraduate Students. *Asian Journal of Legal Education*, 11(1), 97-113.
8. Onn, L. M. (2022). Achieving Graduate Capabilities Through an Online Mooting Module
9. Scott, D. M., & Soirila, U. (2021). The politics of the moot court.
10. Strong, S. I. (2022). *How to write law essays & exams*. Oxford University Press.
11. Subrin, S. N., Minow, M. L., Brodin, M. S., Main, T. O., & Lahav, A. D. (2024). *Civil Procedure: Doctrine, Practice, and Context [Connected EBook with Study Center]*. Aspen Publishing.
12. Thomas, M., & Craddock, L. (2019). *The art of mootting: Theories, principles, and practice*. Edward Elgar Publishing.
13. Tsaoussi, A. I. (2020). Using soft skills courses to inspire law teachers: a new methodology for a more humanistic legal education. *The Law Teacher*, 54(1), 1-30.
14. Voskobitova, M. R. (2021). Online Simulations for Teaching Professional Legal Skills. *Kutafin Law Review*, 8(4), 519-545.
15. Willingham, D. T. (2021). *Why don't students like school?: A cognitive scientist answers questions about how the mind works and what it means for the classroom*. John Wiley & Sons.

# Preliminary Study on Intention Towards Sustainable Investment Among TVET Institutions

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**Abstract.** Sustainable investment is vital for economic and personal development. The global investment landscape is seeing a rise in the use of sustainable investing, which integrates environmental, social, and governance (ESG) considerations into financial analysis and decision-making. A sustainable investment should enhance a person's wealth and deliver positive societal and environmental outcomes. However, with the increasing attention towards this so-called Socially Responsible Investment (SRI) is still unknown. Many of that generation did not have much knowledge in making sustainable investments and required help to do financial planning that provides continuous returns. Thus, this study intends to examine the factors that will impact sustainable investment. This cross-sectional study utilizes an adapted questionnaire to measure the attitude, financial knowledge and religious value in measuring the sustainable investment among TVET students. This pilot study has exhibited a prominent level of reliability but there are much to explore and learn to better conduct rigorous findings.

**Keywords:** Sustainable Investment, TVET Students, Attitude, Financial Knowledge, Religious Value

## 1 Introduction

Socially responsible investments (SRI) are essentially the idea of investing that considers social, ethical, governance, and environmental issues. They are also referred to as *green investing*, *ethical investing*, *values-based investing*, *sustainable investing*, and, more recently, just *responsible investing* and *ESG investing*. The concept of sustainable investment in Malaysia is still in its early stage, due to lack of exposure of the sustainable investment concept among the population. Technical and Vocational Education and Training (TVET) institutions play a critical role in equipping young people with the skills and knowledge needed to participate in sustainable investment. Investment literacy is something that requires action and should be encouraged especially among youngsters (Abdul et al., 2021). Mooting, a simulated court process in which students argue a moot problem, is one innovative method for teaching business law to non-law students (Fletcher, R. P., 2021). As Malaysia is progressing and the world out there is challenging. With an increasing of living standard, most people are having two jobs to support their life (Zickar et al., 2004), (Chadi & Hetschko, 2021). Thus, financial literacy is deemed important to leverage their financial income.

A combination of financial information, awareness, skills, abilities, attitudes, and behaviors that are required to make wise and trustworthy financial decisions to promote financial health is known as financial literacy. Financial literacy would much give greater impact on an individual's financial income. Today, it not only financial literacy which has been captured the attention, but the green issue which is the people, planet and profit must be taken into consideration. In this growing era of this green or sustainable investment, all efforts should govern towards it. However the young generation is yet to embark on sustainable investment (Nur et al., 2022). Thus, this study aims at (i) investigating the level of financial knowledge, attitude and religious value towards sustainable investment and (ii) recognizing the factors to influence sustainable investment among TVET institutions. The preliminary study was conducted, and the data collection process gained some points to be taken into considerations.

## 2 Literature review

### 2.1 Financial knowledge

Understanding of common financial products is one of the key factors influencing people's financial knowledge. Financial knowledge can hone the skills and confidence to manage wealth effectively. Everyone should at least achieve a basic understanding of finance by knowing how finance can affect their lives. Inadequate financial knowledge can lead to financial

misunderstandings that lead to irrational financial decisions (Ying, L. T., & Jamal, A. a. A. 2023). It is not an exaggeration to state that the increase in cases of fraud and scams every year is caused by the lack of financial knowledge among Malaysians.

The survey findings by Agensi Kaunseling dan Pengurusan Kredit (AKPK) on Financial Behaviour and State of Financial Well-Being of Malaysian Working Adults 2018 (AFBES'18) and Securities Commission Malaysia's Assessment of Capital Markets through Malaysians Investors' Perspective 2018 (ACM 2018) found that financial education plays an important role in improving financial behavior. The National Strategy for Financial Literacy 2019-2023) has been developed by the Malaysian government to intensify financial education to elevate the financial literacy of Malaysians.

A study by Murugiah, L. (2016) shows that young men aged between 18 and 25 who are self-employed with low levels of education and income below RM1500 are found to be financially illiterate and this group should be highlighted as a target group in raising their level of financial knowledge. Therefore, an effective strategy needs to be structured to assist this target group. The level of understanding and strategies to enhance financial knowledge among Malaysian.

## 2.2 Attitude

An individual's character to react with a certain degree of favorableness or unfavorableness to an object, behavior, person, institution or event known as attitude (Ajzen, 1993). Frumkin N. (2020) mentioned that an attitude is enduring, general evaluation of people (including oneself), objects, advertisements, or issues. Moreover, Musa (2023) stated that attitudes are an assessment of psychological and fundamental concepts because they assist in explaining people's decisions and actions. It is a broad and comparatively enduring assessment of how generally good, desirable, or unattractive we believe the goal to be.

A study by Nur et al. (2022) shows that attitude is the most significant factor that influences the millennials' intention to participate in sustainable investment. In the aspect of finance, a study by Sorongan (2022) revealed that financial attitude has a prominent effect on student investment decisions. A person with a better financial attitude will have a better attitude in managing their finances, including investment decisions.

## 2.3 Religious Value

Religion plays a main role in a person's lives by creating their beliefs, knowledge and attitudes (Ateeq-ur-Rehman & Shabbir, 2010). Religion is one of the most universal and influential social institutions which has significant influence on people's attitudes, values and behaviors at both the individual and societal levels. A study by (Kenechi et al., 2017). Alam et al (2012) indicate that religiosity had significant influences on the intention of Islamic home financing among Muslims in Klang Valley.

Religious value is considered an important determinant influencing people's decisions. Findings of the study by Kenechi et al. (2017) have shown that religion has considered a significant position in determining people's behavior, preferences and dispositions. Religious leaders play critical roles even outside the spheres of religion in communities with larger religious populations.

Studies on the influence of religion on economic decision-making have been conducted in a variety of contexts. For example, religiosity has been shown to influence the decision to pursue entrepreneurial activities (Audretsch et al., 2013). Further study by Lestari et al. (2021) find that religiosity, as a Muslim's nature and value, is a strong predictor of their investment decision behaviors. Muslims who are considered moderate or highly religious have varying degrees of risk preferences. They will thus be able to tolerate risk and return differently, which gives them various levels of motivation, tendency, and intention to invest in Sharia compared to other alternative investment medium.

## 2.4 Sustainable Investment

Sustainable investment is an investment approach that considers environmental, social, and governance (Alphonse G., 2018). Sustainable investing involves the integration of some conventional strategies of investing with environment, social, and governance factors with the objective of outcompeting a particular benchmark over a particular period. The sustainable investment framework might be a strategy for investors to uphold the principles of sustainability and responsibility of companies through their ESG performance. Investors and academics rely on this framework as a key indicator of a company's commitment to sustainability and corporate social responsibility (CSR) as mentioned by Whitelock (2019).

Sustainable investment, also known as Socially Responsible Investment, has played a role in the economy since 1980. The fact that sustainable investment exists illustrates a pattern of values that started in religion, toward the end of recorded history, and then spread to modernity where societies face social justice, ecological, and governance problems (Townsend, 2020).

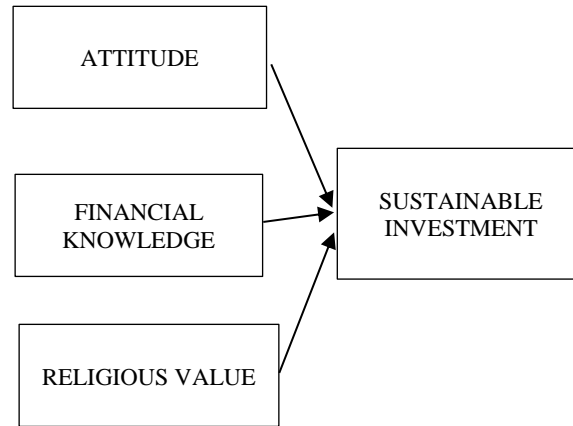
Meanwhile the Malaysia Securities Commission had recognized early on that the global trends towards investments that focus on climate change and social issues would become a major force in the financial landscape. The SC's Capital Market Masterplan 2 (CMP2), a 10-year strategy blueprint for the period 2011-2020, recognizes the role of the capital market in supporting the sustainability agenda (Securities Commissions, 2019). The importance of ESG in providing reputation establishment, rise in efficiency and competitive advantage have been noticed by companies. (Alsayegh et al., 2020).

Sustainable investment continues to be concerned by the young millennials. A study by Farah Nur Shahirah, Nur Ashikin & Wan Zailani (Nur et al., 2022) shows that the factors that influence Malaysian millennials to invest in sustainable investments, namely subjective norm, PCB, attitude, financial knowledge and religious values. Furthermore, the study indicates that millennials' intention to engage in sustainable investing was significantly influenced only by attitude.



### 3 Methodology

This cross-sectional study utilizes online questionnaire as an instrument. This quantitative research method employs the below conceptual framework. Sustainable investment is the dependent variable while attitude, financial knowledge and religious value are the dependent variable or the predictors.



**Fig. 1.** Research Conceptual Framework

This study employs three independent variables and sustainable investment as the dependent variable. The data collection utilized an instrument using an online questionnaire. For the first attempt on data collection, which is also called the feasibility study, an online questionnaire has been distributed in Politeknik Sultan Idris Shah, Politeknik Metro Betong Sarawak & Politeknik Sultan Azlan Shah. The questionnaires consist of six sections

- Section one: Screening Questions
- Section two: Attitude
- Section three: Financial Knowledge
- Section four: Religious Value
- Section five: Sustainable Investment
- Section six: Demographic detail

The instruments has been adapted from Nur et al. (2022) and researchers have been using five Likert scales in the questions with five scales namely 1: Strongly Disagree, 2: Disagree, 3: Almost agree, 4: Agree and 5: Strongly agree. Almost all questions use Likert Scale, and this study also employs ordinal and nominal scale questions. This study utilizes simple random sampling (Hair et al., 2007). The population are the TVET students studying at multiple institutions such as polytechnic, MTUN (Malaysia Technical Universities), Vocational Colleges and other Skills Institutions in Malaysia.

### 4 Finding and analysis

This preliminary study is aiming at pilot study findings and analysis. To further view the credibility and reliability of the instruments, a Cronbach Alpha Reliability Coefficient is being carried out. 35 samples have been collected as a pilot sample and their responses have been analyzed using SPSS version 27.

Table 1: The Cronbach Coefficient and Reliability Value

Variables	No of items	Cronbach Coefficient	Reliability Value
SUSTAINABLE INVESTMENT	5	0.880	Good
ATTITUDE	7	0.921	Excellent
FINACIAL KNOWLEDGE	5	0.884	Good
RELOGIOUS VALUE	6	0.783	Acceptable

From the above diagram, the construct of variables exhibited a good value of Cronbach coefficient value. Although the construct of religious value is an only acceptable value, all construct can measure what it is supposed to measure (Creswell, 2013).

Related findings to this feasibility study are:

- i) Item D1 must be changed to “I often do internet search about faith on religion”. This item exhibited low score. Researchers can predict that these young people are less likely to read. The original sentence is about doing some reading on religious.
- ii) Item demographic on semester level. The checkbox must be replaced to multiple choice. This is because the checkbox is for more than one answer can be chosen.
- iii) There are some typing errors in the questionnaire which should be corrected.

## 5 Conclusion

This smaller scale study is a tool used by researchers to decide whether the study could be proceeded, improve on certain area or strategies on data collection method. To obtain high quality response and outcomes, this cross-sectional study must be quick on collecting the data for the entire research could be accomplished on time.

Future action lies on the commitment of the researchers in planning and implementing the field work. A few actions must be taken in managing the data collection, especially which regards to management and policies in TVET institutions. Future data collection has been continued and on its way to 384 samples (Hair et al., 2007).

## Acknowledgement

We would like to express our deepest gratitude to all for their help, guidance and contributions which have made this study possible. Thank you, Department of Polytechnic and Community College, and also all MTON (Malaysia Technical Universities) as well all our superiors and colleagues and special thanks to all of our respondents.

## References

1. Abdul, Z., Nukman, M., Haiza, N., Zawawi, M., & Najit, M. (2021). Investment literacy, social influence and undergraduates' readiness to invest: dataset from Malaysia. Data in Brief, 34, 0–5. <https://doi.org/10.1016/j.dib.2020.106700>
2. Ajzen, I. (1993). Attitude theory and the attitude-behavior relation. In Krebs, D. and Schmidt, P. (Eds), New Directions in Attitude Measurement, January 1993, 41–57.
3. Alam, S. S., Janor, H., Zanariah, Wel, C. A. C., & Ahsan, M. N. (2012). Is Religiosity an important factor in influencing the intention to undertake Islamic home financing in Klang Valley? World Applied Sciences Journal, 19(7), 1030–1041. <https://doi.org/10.5829/idosi.wasj.2012.19.07.392>
4. Alphonse G., E. M., Rodrigue, -L. (2018). GSI Report 2012.
5. Alsayegh, M. F., Rahman, R. A., & Homayoun, S. (2020). Corporate economic, environmental, and social sustainability performance transformation through ESG disclosure. Sustainability (Switzerland), 12(9). <https://doi.org/10.3390/su12093910>
6. Ateeq-ur-Rehman, & Shabbir, M. S. (2010). The relationship between religiosity and new product adoption. Journal of Islamic Marketing, 1(1), 63–69. <https://doi.org/10.1108/17590831011026231>
7. Audretsch, D. B., Bönte, W., & Tamvada, J. P. (2013). Religion, social class, and entrepreneurial choice. Journal of Business Venturing, 28(6), 774–789. <https://doi.org/10.1016/j.jbusvent.2013.06.002>
8. Chadi, A., & Hetschko, C. (2021). How Job Changes Affect People's Lives — Evidence from Subjective Well-Being Data. British Journal of Industrial Relations, 59(2), 279–306. <https://doi.org/10.1111/bjir.12536>
9. Creswell, J. W. (2013). Qualitative Inquiry and Research Design. In Qualitative Inquiry and Research Design. <https://doi.org/10.4324/9780203807170>
10. Frumkin, N. (2020). Consumer Attitude Indexes. Guide to Economic Indicators, June 2012, 55–61. <https://doi.org/10.4324/9781315703916-15>
11. Hair, J. F., Arthur H, M., Philip Samouel, & Mike Page. (2007). Research Method for Business.
12. Kenechi, J., Nkechi, O., & Ojiagu, C. (2017). Religiosity and Financial Decisions of Young Adult Nigerians: Is the Financial Advice of religious leaders Sacrosanct? Journal of Economics and Sustainable Development Wwww.iiste.Org ISSN, 8(8). [www.iiste.org](http://www.iiste.org)
13. Lestari, I. P., Ginanjar, W., & Warokka, A. (2021). Multidimensional Risk and Religiosity Towards Indonesian Muslims' Sharia Investment Decision. Journal of Islamic Monetary Economics and Finance, 7(2), 369–400. <https://doi.org/10.21098/jimf.v7i2.1321>
14. Musa, A. J. (2023). The Impact of Employees' Attitudes on Job Satisfaction and Organisational Effectiveness. African Journal of Management and Business Research, 11(1), 134–143. [www.afropolitanjournals.com](http://www.afropolitanjournals.com)
15. Nur, F., Kolek, S., Jamaludin, N., & Abdullah, Z. W. A. N. (2022). FACTORS THAT ENCOURAGE MILLENNIALS TO INVEST IN SUSTAINABLE INVESTMENTS IN MALAYSIA. Journal of Business and Social Development, 10(1), 59–74.
16. Securities Commisisions. (2019). SUSTAINABLE AND RESPONSIBLE INVESTMENT ROADMAP FOR THE MALAYSIAN CAPITAL MARKET. Securities Commissions, 46.

17. Sorongan, F. A. (2022). The Influence of Behavior Financial and Financial Attitude on Investment Decisions With Financial Literature as Moderating Variable. *European Journal of Business and Management Research*, 7(1), 265–268. <https://doi.org/10.24018/ejbmr.2022.7.1.1291>
18. Townsend, B. (2020). From SRI to ESG: The Origins of Socially Responsible and Sustainable Investing . *The Journal of Impact and ESG Investing*, 1(1), 10–25. <https://doi.org/10.3905/jesg.2020.1.1.010>
19. Whitelock, V. G. (2019). Multidimensional environmental social governance sustainability framework: Integration, using a purchasing, operations, and supply chain management context. *Sustainable Development*, 27(5), 923–931. <https://doi.org/10.1002/sd.1951>
20. Ying, L. T., & Jamal, A. a. A. (2023). A study on financial product knowledge, attitudes and behaviours among Malaysian young working adults. *Malaysian Journal of Social Sciences and Humanities*, 8(1), e002079. <https://doi.org/10.47405/mjssh.v8i1.2079>
21. Zickar, M. J., Gibby, R. E., & Jenny, T. (2004). Job attitudes of workers with two jobs. *Journal of Vocational Behavior*, 64(1), 222–235. [https://doi.org/10.1016/S0001-8791\(03\)00047-2](https://doi.org/10.1016/S0001-8791(03)00047-2)

# Determinants of Students' Enrolment Decisions at Kolej Komuniti Sarikei and Kolej Komuniti Sarikei Cawangan Sibul

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**Abstract.** This paper examines the relationship between the influence of surrounding people, the college's promotional activities and the qualities of Kolej Komuniti Sarikei (KKSAR) and Kolej Komuniti Sarikei Cawangan Sibul (KKSARCS) itself with students' enrolment decisions KKSAR and its Sibul branch. It also explores the most dominant influencing determinant. Hence, it can help the KKSAR and KKSARCS in creating targeted enrolment and outreach plans. A total of 97 respondents participated in this study. It was conducted using an adapted questionnaire. The data collected from the questionnaire was analysed using SPSS software to obtain mean scores, frequencies, correlations, and regressions. The Cronbach's Alpha reliability coefficient obtained in the pilot study was 0.97, indicating that the adapted questionnaire is suitable for this study. The findings of this study show that all the determinants have a significant relationship with the students' enrolment decisions, and the qualities of KKSAR and KKSARCS itself is the dominant determinant that affects students' decisions to pursue their studies at KKSAR and KKSARCS.

**Keywords:** Determinants, Students' Decision, Enrolment, Kolej Komuniti Sarikei, Kolej Komuniti Sarikei Cawangan Sibul

## 1 Introduction

Tertiary education, also known as higher education, plays a vital role for students after secondary school. Through higher education, students acquire knowledge, develop skills, and qualifications for specific professions. It also brings great benefits to students for their future such as expanding their career opportunities, increasing their job security, earning higher incomes, and improving their quality of life. Therefore, students need to carefully consider and choose which higher education institution can provide academic programmes that align with their desired career path (Hair Awang et al., 2012).

Community Colleges (CCs) are considered one of the public higher education providers. Currently, there are 105 CCs in Malaysia. CCs provide a wide range of technical and vocational education training programmes that aim to equip students with hands-on skills and knowledge before they enter the labour market. CCs have student enrolment sessions twice a year.

To achieve the standard number of students intake, CCs always come up with all sorts of plans to promote CCs and attract prospective students. Most of the prospective students are the *Sijil Pelajaran Malaysia* (SPM) graduates.

KKSAR was established on 1 October 2013, and started offering its first programme, the Certificate in Culinary (SKU) in 2014. Then, the following year, KKSAR offers its second programme, the Certificate in Computer System and Support (SKS). Due to the changes in curriculum structure, the SKS programme was renamed twice. It was first renamed the Certificate in Computer System and Networking (SSK), and it is now known as the Certificate in Information Technology (STM). In 2019, KKSAR began managing a branch in Sibul that offers the Certificate in Travelling and Tourism (SPP). However, due to some changes in the curriculum structure, the programme has been renamed to the Certificate in Adventure Tourism (SPL).

### 1.1 Problem Statement

Currently, the student intake performance for the SKU programme is satisfactory. However, the student intake performance for the STM programme and the SPL programme is in a critical situation. Particularly, the second intake for each year both programmes are very difficult to reach half of the standard number of student intake, which is 30 students.

According to the past 3 sessions of student intake, the student enrolment rate at KKSAR and KKSARCS is considered low at only 44.9% which means a total of 101 students were enrolled. KKSAR and KKSARCS are critically lacking 124 students based on the standard number of student intake, 225 that allocated by *Bahagian Ambilan dan Pembangunan Pelajar* (BAPP).

By comparing the student enrolment rate of each programme, the SKU reached the highest rate, which is 88.9%, with 9 students enrolled in session II of 2023/2024, 20 in session I 2023/2024 and 11 in session of 2022/2023. By contrast, the student

enrolment rate of the STM and the SPL are low which are 50% and 17.8% respectively. The STM has 7 students enrolled in session II of 2023/2024, 30 in session I of 2023/2024, and 8 in session II of 2022/2023. While, the SPL has 5 students enrolled in session II of 2023/2024, 8 in session I of 2023/2024, and 3 in session II of 2022/2023.

In response to the current situation where the SKU enrolment fails to meet the standard intake of 15 students per session, and the critical enrolment problems faced by the STM and the SPL programmes, KKS and KKSRCs intend to identify the determinants that influence students' decisions in pursuing their studies in these three programmes. Moreover, no research has ever been conducted on this matter by KKS and KKSRCs. Many attempts have been made to attract students' attention and influence their decisions to enrol at KKS and KKSRCs. Nonetheless, these initiatives are seen as ineffective without an appropriate plan based on some studies of this problem. Thus, by the identifying the influence of these determinants, KKS and KKSRCs can develop targeted enrolment and outreach plans to attract more prospective students (Por et al., 2024).

## 1.2 Objectives

The purpose of this study is to uncover the determinants that affect students' decisions to enrol at KKS and KKSRCs. Besides, it is also to discover the dominant determinants that influence students' enrolment decisions.

## 1.3 Research questions

RQ1. Does the influence of surrounding people affect students' enrolment decisions at KKS and KKSRCs?

RQ2. Do the college's promotional activities influence students' enrolment decisions at KKS and KKSRCs?

RQ3. Do the qualities of KKS and KKSRCs influence students' enrolment decisions at KKS and KKSRCs?

RQ4. What are the dominant determinants influencing students' enrolment decisions at KKS and KKSRCs?

## 1.4 Research Framework

This study is based on the below research model where, the 3 determinants - Influence of Surrounding People, College's Promotional Activities and Qualities of KKS and KKSRCs - are the independent variables, while the dependent variable is Students' Enrolment Decisions at KKS and its Sibu Branch. The Theory of Planned Behavior (TPB), upon which this framework is based, offers a helpful conceptual framework for addressing the complexities of social behavior in humans (Ajzen, 1991).

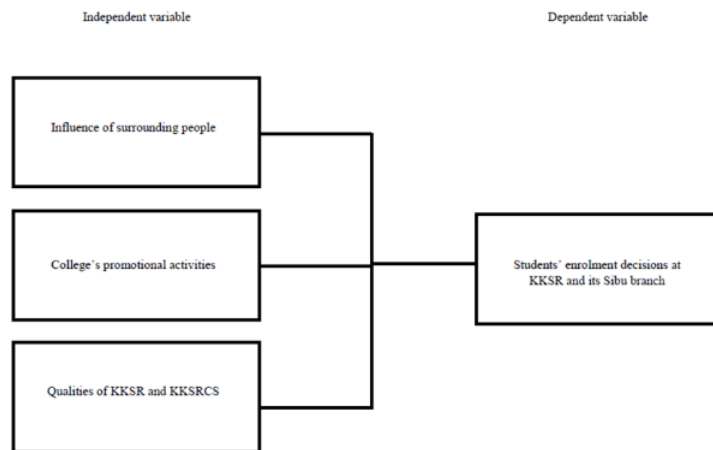


Fig. 1. Conceptual Framework

## 2 Literature review

### Influence of surrounding people

People around students, such as family, peers, and teachers, play an important role in their enrolment decisions. They often give opinions and advice about educational choices. They have great influence on students' choice in pursuing their and studies at institutions of higher learning (Abdul-Aziz et al., 2020).

Family, especially parents, have the most influence on students. Parents are closest to the students, who are their children. Most parents are concerned about their children's education and their future career. They usually give guidance to their children when making educational choices. As a result, the parents' influence significantly affects the choice of students in choosing the right higher education institution that is closely related to their children's career paths (Buntat & Hassan, 2010).

Friends and alumni also have an impact on students' decisions to pursue their studies. Friends and alumni that have positive influences on students will inspire the students to further their studies. Their academic experiences can encourage the students to know the value of higher education and the benefits of continuing their studies in higher education. Besides, the information about higher education that is given by friends and alumni will motivate the students to seek opportunities to enhance their skills and knowledge (Sia, 2013).

The guidance and career counselling unit of schools also affects students in choosing their career paths. Normally, school counselling teachers, also known as school counsellors, organize education fairs at school by inviting Public Higher Education Institutions (IPTA) and Private Higher Education Institutions (IPTS) to provide information and guidance to students. This helps the students in determining their respective study destinations. In fact, when the SPM results are announced, the counselling teachers will suggest the appropriate IPTA/IPTS based on the students' SPM results. Thus, it is undeniable that counselling teachers also affect students' decisions in continuing their studies to higher levels (Sukri & Nachiappan, 2021).

### **College's promotional activities**

Promotional activities of a higher education institution are one of the important aspects that can influence students' choice in choosing an institution to further their studies. Through effective promotional activities, students will gain knowledge from the information that is provided by the higher education institution. This will attract and motivate students to enrol at it. College's promotional activities can be carried out in many ways including advertising on mass media, at education fairs, and college visits. Due to the advancement of technology, promotional activities not only can be carried out face-to-face, they also can be done online, especially via the internet and social media. With the internet and social media, colleges can deliver information rapidly and broadly to the public as well as to prospective students (Fernandez, 2010).

Online promotional activities, especially on official websites and social media websites, are cost-effective ways to advertise or market a higher education institution, especially for those institutions with limited budgets. The official website and social media websites of a higher education institution enable users, particularly students, to access programmes information anytime and from any location. This extremely helps students who cannot attend physical promotional activities due to distance or time constraints. Apart from that, social media is a platform where individuals can share their academic experiences and success stories with their peers. This can increase the publicity of an institution and raise students' interest in furthering their studies. On the other hand, face-to-face promotions are also effective in encouraging students to continue their studies because they enable direct interaction with individuals. This allows better and more efficient communication, where queries can be responded to immediately, and explanations given in more detail (Syakur & Panuju, 2020).

Additionally, promoting admissions to Technical and Vocational Education and Training (TVET) programmes through social media is highly effective due to its widespread usage and meets the students' expectations (Matlin et al., 2023). This highlights the importance of promoting colleges through social media to attract students to further their education at higher educational institutions. Effective promotion can deliver clear and compelling information about the advantages to prospective students, encouraging them to choose the college as their educational destination. Hence, the ability to highlight the advantages and unique features of the college during promotions is considered one of the important aspects that affect students' enrolment decision. This includes the facilities provided, the academic programmes offered, excellence in specific fields, the college's reputation, as well as the support and assistance given to students. All these features can strongly affect students' preference for the institution (Mazzarol, 1998).

### **Qualities of KKSRR and KKSRRCS**

Educational institutions play a major role in highlighting their own qualities by providing all relevant information about the programmes offered. This includes the course content, the required qualifications, the location of the institution, the cost of education, and the career opportunities after graduation (Naemat et al., 2017). Since the programmes offered are one of the most important qualities of an institution, they significantly contribute to students' decision to pursue further studies (Baliyan & Mokoena, 2024). Furthermore, the programmes offered should be tailored to the local community (Sia, 2013). The quality of an institution's programmes is closely related to academic excellence, which includes programmes quality, educator experience and professionalism, and curriculum relevance (Nor, 2018). One critical aspect of academic excellence is educator experience and professionalism. To accomplish this, educators must enhance their ability in using effective teaching and learning strategies. Merely having qualifications in the field is not sufficient. Educators must be highly knowledgeable to produce excellent students while also implementing effective learning activities (Poh Choo & Michael, 2014).

Additionally, the financial assistance provided, and tuition fees are the qualities that can influence students' decision to further their studies. The flexibility in fee payment options, the accessibility of financial assistance, and the affordability of accommodation expenses greatly impact students' decision-making when selecting a higher education institution (Foskett et al., 2005).

### **Students' enrolment decisions**

Decision-making can be defined as a process that begins with a point and comes up with a conclusion. Decision making involves

following a procedure that includes numerous steps and precise techniques for completing each step successfully. This approach helps decision-makers understand what they need to do at each phase and the cause (Nutt, 2008). Despite this, decisions in the process might be made through either individual or as a group (Taherdoost & Madanchian, 2024).

Students tend to continue their studies at the tertiary level since acquiring higher education has a significant impact on their social standing and career prospects in the future. According to Baker, (2011), rapid expansion of higher education and economic growth has increased the capability of post-secondary students to enrol in and complete their higher education. This will be beneficial to students in their social status and expand their opportunities in terms of employment, higher earnings, and social mobility (Baker, 2011). Hence, students' enrolment decisions are affected by their understanding of the importance of higher education in defining their standing and career prospects.

Students' choice of a higher education institution has a direct impact on the enrolment rate of an institution. If the intake of students is too low, it has negative impacts on the institution. Insufficient student numbers can affect academic programmes and extracurricular activities. This can be seen at KKKSR & KKSRCs, where student intake in each session is inconsistent, often failing to meet the intake norms allocated by BAPP.

Students' enrolment decisions have an impact on the enrolment rate of an institution. If the intake of students is too low, it can adversely affect the institution. Insufficient student numbers can disrupt academic programs and extracurricular activities. This issue is evident at KKKSR & KKSRCs, where student enrolment in each session is inconsistent, often failing to meet the intake norms allocated by BAPP. Before choosing to attend an IPTA, there are several factors to consider (Ibnu Ruslan et al., 2014).

### 3 Methodology

There are two categories of variables in this study: independent and dependent. In this study, where there is a substantial association between all the determinants on students' enrolment decisions at KKSr and its Sibu Branch, a quantitative technique is more appropriate for the study. The instrument of this study is a questionnaire adapted and adopted from (Songan et al., 2010) and 22 questions (items) on a five-point Likert scale, from strongly disagree to strongly agree, made up the questionnaire. Using SPSS, the Cronbach's Alpha coefficient was used to assess the instrument's reliability. The 22 items' Cronbach's Alpha was found to be 0.972, demonstrating its high degree of consistency and dependability as a measuring instrument.

**Table 1.** Reliability Statistics

Cronbach's Alpha	N of Item
.972	22

#### 3.1 Research participants

Primary data from respondents who are students at KKSr and KKSRCs from semester 1 until 4 for session II of 2023/2024 was gathered for this study using a questionnaire. The researcher had easy access to 97 students to gather data.

#### 3.2 Research population and sampling

Only 97 students from the 130 students enrolled in session II 2023/2024 at KKSr and KKSRC were selected as the sample from this group in accordance with the advice of Morgan and Krejcie, (1970).

**Table 2.** Sample size based on Morgan and Krejcie, (1970)

Population (N)	Sample (S)
120	92
130	97
140	103
150	108
160	113
170	118
180	123
190	127
200	132

#### 3.3 Data analysis

Using SPSS software, the data will be analyzed to determine the relationship and the most dominant determinants influencing the students' decisions to enroll at KKSr and its Sibu Branch. Two SPSS data analysis tools were used in this study: inferential statistics and descriptive statistics. Regression analysis is a component of inferential statistics, whereas mean, frequency and correlation analysis are methods used in descriptive statistics.

## 4 Finding and analysis

The demographics of the respondents, including their program, gender, and college, will be covered in this study. A descriptive analysis of mean scores, a Pearson correlation analysis, and regression analysis are also shown in the study's findings. The table below displays the acquired data.

**Table 3.** Respondents' College

Demographic	Item	Frequency	Percent
College	KKSR	83	85.6
	KKSRCS	14	14.4
Gender	Male	48	49.5
	Female	49	50.5
Program	SKU	39	40.2
	STM	44	45.4
	SPL	14	14.4

Table 3 displays the respondents' college distribution for the study, with KKSR accounting for 85.6% of the students and KKSRCS for 14.4%. Based on the data, it was found that most of the study participants were from the SKU and STM that offered in KKSR rather than SPL in KKSRCS. Upon closer inspection of the Table, 49 respondents, or 50.5% of the total, were found to be female and 49.5% to be male. The information demonstrates that there is a gender balance among the students at KKSR and KKSRCS. Lastly, the study found that a total of 44 STM students or 45.4% participated in this study, while 39 SKU students, equivalent to 40.2%, and only 14 SPL students, representing 14.4%, participated in this study.

**Table 4.** Descriptive Statistics

	N	Mean	Std. Deviation
Surrounding	97	2.8995	1.15465
Promotional	97	3.1340	1.18094
Qualities	97	3.5037	1.00363
Valid N (listwise)	97		

Mean Score Scale: 1.00 – 2.33 = Low; 2.34 – 3.66 = Moderate; 3.67 – 5.00 = High  
(Scale adapted from Bahaman and Turiman (1993))

Table 4 shows that, with means of 3.5037 and 3.1340, respectively, the qualities of KKSR and KKSRCS and college's promotional activities both have a moderate effect on students' enrolment decisions at KKSR and KKSRCS. With a mean of 2.8995, the influence of surrounding shows a low effect among all the determinants.

**Table 5.** Correlations

		SUR	PRO	QUA	STD
<b>SUR</b>	Pearson Correlation	1	.652**	.580**	.765**
	Sig. (2-tailed)		.000	.000	.000
	N	97	97	97	97
<b>PRO</b>	Pearson Correlation	.652**	1	.793**	.808**
	Sig. (2-tailed)	.000		.000	.000
	N	97	97	97	97
<b>QUA</b>	Pearson Correlation	.580**	.793**	1	.836**
	Sig. (2-tailed)	.000	.000		.000
	N	97	97	97	97
<b>STD</b>	Pearson Correlation	.765**	.808**	.836**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	97	97	97	97

\*\* . Correlation is significant at the 0.01 level (2-tailed).

Pearson Correlations Analysis: 0.00 – 0.30 = Low; 0.40 – 0.69 = Moderate; 0.70 – 0.89 = High; 0.90 – 0.99 = Very High (Source from Collis et al, (2009))



The findings of the correlation analysis are displayed in Table 5, where the dependent variable of students' enrolment decisions related to each of the three determinants. According to the study's objectives, the exam was designed to find a relationship between determinants and students' decisions to enrol at KKSRR and KKSRRCS. The results of the correlation analysis demonstrated that determinants such as the influence of surrounding, college's promotional activities, and the qualities of KKSRR and KKSRRCS significantly correlated with students' decisions to enrol at KKSRR and KKSRRCS. The qualities of KKSRR and KKSRRCS have been determined to have the greatest relationship on students' enrolment decisions ( $r=.836$ ,  $P=.000$ ), with college's promotional activities coming in second ( $r=.808$ ,  $P=.000$ ). For the influence of the surroundings, there still exists a relationship with students' decisions, but it is the lowest among the three independent variables ( $r=.765$ ,  $P=.000$ ).

**Table 6.** Coefficients

Model	Std.Error	Beta	t	Sig
Surrounding	.050	.363	6.366	.000
Promotional	.065	.203	2.6633	.009
Qualities	.071	.465	6.566	.000

a Dependent Variable: Student's Decisions

The regression output shown at table 6 above shows that the influence of surrounding, college's promotional activities and the qualities of KKSRR and KKSRRCS variables are statistically significant because their p-values equal 0.00 less than significance level of 0.05. It means that students' enrolment decision affected by all these 3 determinants.

**Table 7.** Model Summary<sup>b</sup>

Model	R	R Square	Adjusted R	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	Df1	Df2	Sig. F Change
1	.911 <sup>a</sup>	.830	.824	.42241	.830	151.231	3	93	.000

a. Predictors: (Constant), Qualities, Surrounding, Promotional

b. Dependent Variable: Students' Decisions

Table 7 above indicates that there is a strong positive correlation between the influence of surrounding, college's promotional activities and the qualities of KKSRR and KKSRRCS with students' decisions to enrol at KKSRR and KKSRRCS. [ $p=.000$ ,  $r=.911$ ]. This indicates that 83% of the variation in students' enrolment decisions at KKSRR and KKSRRCS is due to the influence of surroundings, college promotional activities, and the qualities of KKSRR and KKSRRCS.

The purpose of this study is to uncover the determinants that affect students' decisions to enrol at KKSRR and KKSRRCS. Besides, it is also to discover the dominant determinants that influence students' enrolment decisions. The results of this study have shown that three determinants have a major influence on students' decisions to enrol at KKSRR and KKSRRCS and the dominant determinants that influence students' enrolment decisions is the qualities of KKSRR and KKSRRCS.

### Does the influence of surrounding people affect students' enrolment decisions at KKSRR and KKSRRCS?

The analysis's findings demonstrated that the people in surrounding have an impact on students' decisions to enrol at KKSRR and KKSRRCS. The results showed a substantial correlation between students' enrolment decisions and the influence of parents, current community college (CC) students, siblings, friends, alumni, high school teachers, counsellors and relatives. Many individuals indicated that they agreed or strongly agreed, indicating that parental influence was the most significant contributing element to the surrounding determinant. According to the study's findings, 18.9% of respondents strongly disputed that their parents encouraged them to pursue their education at KKSRR and KKSRRCS, while 44.3% of respondents acknowledged that their parents had an impact on them (Mohd Ariffin, 2012). Almost half of the respondents chose to study at KKSRR and KKSRRCS due to the influence of current CC students, as evidenced by 40.5% of respondents agreeing that they chose KKSRR and KKSRRCS after discussing it with current students. Another factor influencing students' choices is friends, with 38.7% of respondents agreeing that their friends encouraged them to enrol at KKSRR and KKSRRCS. Additionally, 35.9% agreed that they were influenced by CC alumni, 34.9% by siblings, 33% by high school teachers, 28.3% by relatives, and the lowest influence was from counsellors at 27.6%. Therefore, the influence of surrounding people can significantly impact an individual's decision, according to Abu & A. Aziz, (2010). However, this element has the least impact on decision-making out of the three

determinants.

### **Do the college's promotional activities influence students' enrolment decisions at KKS and KKSRCs?**

There are four criteria under college promotional activities that contribute to the second most significant determinant related to students' enrolment decisions. The study findings show that promotional announcements about KKS and KKSRCs on websites and social media platforms like Facebook, Instagram, and TikTok are the most influential factors, with 51% of respondents agreeing. This is followed by educational exhibitions, with 40.6% of respondents agreeing. For the items regarding brochures and mass media promotions such as radio and television, 38.7% and 38.6% of respondents agreed, respectively. Respondents acknowledged that they were motivated to pursue further education through marketing activities by the institution, such as open days, family and friends' recommendations, and mass media advertising. This indicates positive feedback for the institution to enhance its marketing strategies, according to (Naemat et al., 2017).

### **Do qualities of KKS and KKSRCs Cawangan Sib influence students' enrolment decisions at KKS and KKSRCs?**

The third determinant is the qualities of KKS and KKSRCs itself. The quality of a college is very important in ensuring that students continue their studies at an institution. Although studies at KKS and KKSRCs are only at the certificate level, modern students have realized that job opportunities in the TVET field are increasing and gaining much attention because there is a high demand by the TVET employers. Thus, the data shows that 61.3% of students agree that a CC certificate can guarantee future job opportunities. TVET employers generally show a greater preference for the employability skills of graduates. As the employer's job position within the organization rises, so do the expectations placed on graduates (Esa & Rahman, 2014). Findings from this study indicate that the quality of the certificate KKS and KKSRCs is the most impactful factor in students' decisions to further their studies at KKS and KKSRCs. All students want a better job after they graduate. Therefore, students will focus more on the job market to identify which industries most need manpower. Additionally, the location of an institution is the second criterion under the qualities determinant that affects students' decisions to continue their studies at KKS and KKSRCs, with 54.7% agreeing. In Sarawak, there are 7 CCs located in the districts of Kuching, Mas Gading, Santubong, Sib, Sarikei, Betong, and Miri. Students and their families may prioritize the location of these CCs in Sarawak over other factors when deciding where to further their studies. This factor has a positive impact because it relates to the ability of students and their families. Students from low-income families consider location an important factor in choosing a place to study. Low income and minority communities utilize active transportation methods to commute to school significantly more than higher income students (McDonald, 2008). CCs under the Ministry of Higher Education (MOHE) also offer financial assistance to students who meet the eligibility criteria, amounting to RM7200 for three semesters of study (excluding the final industrial training semester), without requiring repayment. This helps certificate-level students who do not have other educational loans such as *Perbadanan Tabung Pendidikan Tinggi Nasional (PTPTN)*. This assistance indirectly influences students' decisions to further their studies at KKS and KKSRCs, with 50.9% agreeing. Moreover, 49% of the respondents agree that the tuition fee of RM200 at KKS and KKSRCs is a factor in their decision to study here. Apart from that, to ensure the qualities of an institution, the programs offered need to be strong and aligned with industry demands so that students who graduate can pursue careers in their field of study. KKS and KKSRCs offer three programs: SKU, STM, and SPL. A total of 51.9% of students agreed to continue their studies here due to the programs offered. To enrol in KKS and KKSRCs for programs such as SKU, STM, and SPL, the admission requirements are minimal. Each student must have passed the Sijil Pelajaran Malaysia (SPM) exams, specifically in Bahasa Melayu, History, and Mathematics, and have at least one credit in any other SPM subject. Therefore, there is a great opportunity for all SPM graduates, regardless of age, to continue their studies. The final criterion is the reputation of the college. (Nor, 2018) reviews that institutional image and reputation is an important factor considered by students during the institutional choice process. Therefore, the party responsible which is Polytechnique and Community College (PolyCC) department needs to review the syllabus regularly to maintain the quality of our education, so that we will not be left behind academically, and the graduates meet the industrial expectation.

### **What are the dominant determinants influencing students' enrolment decisions at KKS and KKSRCs?**

The most dominant determinants influencing students' enrolment decisions at KKS and KKSRCs are the qualities of KKS and KKSRCs followed by the college's promotional activities and the influence of the surroundings. Among the alternatives that can be implemented by KKS and KKSRCs is to ensure that the skills of the teaching staff are honed and trained to maintain the quality of the skills certificates offered here. It is essential that educators possess not just technical abilities but also knowledge of curriculum development that satisfies industry standards. This will enable the current curriculum to be improved. Students who graduate from KKS and KKSRCs will have high employability due to the quality education provided by qualified educators when their teaching skills are at an encouraging level. This is expected to attract high school graduates to KKS and KKSRCs to further their studies.

## 5 Conclusion

The findings of this research are to aid *Unit Ambilan Pelajar* (UAP) KKS and KKSRCs along with all parties involved including higher education to review and develop appropriate strategies to promote KKS and KKSRCs through better knowledge by focusing on the key factors that could significantly affect students' enrolment decisions. The results of this study indicate that 83% of the variability in students' enrollment decisions may be attributed to differences in the qualities of KKS and KKSRCs, the influence of the surrounding environment, and the college's promotional activities. Still undetermined, however, are 17% more elements that affect students' decisions to continue their education at KKS and KKSRCs.

The limitation of this study is its narrow focus on determinants outlined in existing literature. The analysis overlooked several determinants such as socioeconomic status, individual values, college facilities including provided dormitories and health care services provided. Universities or any institutions should equip themselves not only in teaching and learning areas, but also other aspects associated with it such as facilities, learning environment, and health care services (Nor, 2018).

This research offers insight into the fundamental mechanisms by which these determinants impact decision-making. Several recommendations can be suggested: The KKS and KKSRCs's administration should persist in efforts to enhance the quality of teaching and learning methods at KKS and KKSRCs, and consistently enhance the academic skills of its programs through diverse professional development initiatives, thereby enriching their effectiveness as educators to sustain and improve its existing qualities of college.

Furthermore, it is recommended that the management of KKS and KKSRCs put more emphasis on improving the quality of KKS and KKSRCs website design and the information within it. The high-quality data dissemination about the programs advertised at KKS and KKSRCs, specifically SKU, STM, and SPL, be uploaded more efficiently so that it can attract more people to browse it especially SPM graduates to proceed their studies at KKS and KKSRCs.

In expansion other than offering low educational cost expenses, the Malaysian government can consider arranging facilities for public colleges in Malaysia, particularly CCs, by providing dormitory buildings or student accommodations at all CCs in Malaysia to improve the quality of facilities and amenities at Malaysian CCs. Many students studying at KKS and KKSRCs are from out of town, where they ought to rent rooms while continuing their studies. A few students refuse to pursue their education at KKS and KKSRCs due to financial factors, as they cannot afford the high room rental expenses that must be paid per month instead of per semester when KKS and KKSRCs do not provide student accommodation facilities.

Lastly, it is suggested that additional research be conducted to confirm the results of this study by examining the relationship between surrounding influence and students' decisions. This should involve parents, siblings, high school teachers, and friends too as a respondent. Furthermore, as a follow-up to the current study, the researchers suggest doing a study on the favored course too.

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## References

1. Abu, B., & A. Aziz, N. F. (2010). *Faktor-Faktor Yang Mendorong Guru Pelatih Fakulti Pendidikan Memilih Bidang Perguruan*.
2. Ajzen, I. (1991). *The Theory of Planned Behavior*.
3. Baker, D. P. (2011). Forward and backward, horizontal and vertical: Transformation of occupational credentialing in the schooled society. *Research in Social Stratification and Mobility*, 29(1), 5–29. <https://doi.org/10.1016/j.rssm.2011.01.001>
4. Baliyan, S. P., & Mokoena, S. (2024). Students' Choice Management: Recipe for Improving Enrollment in Private Higher Education Institutions. *Asian Journal of University Education*, 20(1), 206–220. <https://doi.org/10.24191/AJUE.V20I1.26030>
5. Buntat, Y., & Hassan, K. B. (2010). Faktor-faktor yang mempengaruhi pemilihan kerjaya perguruan di kalangan Pelajar Tahun Dua Sarjana Muda Teknologi Serta Pendidikan, Fakulti Pendidikan, UTM. *International Conference on Innovation and Technology for Sustainable Built Environment*. <https://core.ac.uk/download/pdf/11786731.pdf>
6. Esa, A., & Rahman, J. A. (2014). TVET And Strategies Helping Student Providers Into Market. In *Online) Journal of Education and Human Development* (Vol. 3, Issue 2).
7. Foskett, N., Roberts, D., & Maringe, F. (2005). *Changing Fee Regimes and Their Impact on Student Attitudes to Higher Education*.

8. Ibnu Ruslan, R., Halim, K., Hamid, K., & Ariffin, K. (2014). Determinants Students' Selection of Higher Education Institutions in Malaysia. In *Article in Advances in Environmental Biology*. <https://www.researchgate.net/publication/263807482>
9. Matlin, M., Ahmad Hudin, A. S., & Gumbayan, M. (2023). Kecenderungan Medium Promosi Bagi Pelajar Kolej Komuniti Kota Marudu Sabah. *Jurnal of Applied Accounting And Business*, 5(2), 107–112. <http://ojs.politeknikjambi.ac.id/jaab>
10. Mazzarol, T. (1998). Critical Success Factors for International Education Marketing The Economic Importance Of International Education. In *International Journal of Educational Management* (Vol. 12, Issue 4).
11. McDonald, N. C. (2008). Critical Factors for Active Transportation to School Among Low-Income and Minority Students. Evidence from the 2001 National Household Travel Survey. *American Journal of Preventive Medicine*, 34(4), 341–344. <https://doi.org/10.1016/j.amepre.2008.01.004>
12. Mohd Ariffin, A. A. (2012). *Faktor-Faktor Yang Menentukan Pemilihan Pelajar Mengikuti Kursus di Kolej Komuniti di Sekitar Negeri Johor*.
13. Naemat, M. R., Khairil, M. N., Harun, M. R., Ahmad, A., & Osman, L. H. (2017). Faktor Pendorong yang Mempengaruhi Keputusan Melanjutkan Pengajian ke Institusi Pengajian Tinggi di kalangan Staf Kerajaan dan Swasta. *Jurnal Personalia Pelajar*, 20(1), 59–65.
14. Nor, A. I. (2018). Factors Contributing to the Students' Choice of University: A Case Study of Somali National University. *Imperial Journal of Interdisciplinary Research (IJIR) Peer Reviewed-International Journal*, 4.
15. Nutt, P. C. (2008). *Investigating the Success of Decision Making Processes*.
16. Poh Choo, C. L., & Michael, B. (2014). *Persepsi Pelajar Terhadap Program Sijil Aplikasi Perisian Komputer Di Kolej Komuniti Mas Gading*.
17. Sia, J. K. M. (2013). University Choice: Implications for Marketing and Positioning. *Education*, 3(1), 7–14. <https://doi.org/10.5923/j.edu.20130301.02>
18. Songan, P., Tonga, G., Abdul Rahman, M., Hong, K. S., & Law, L. (2010). *Factors Influencing Students' Selection of Universiti Malaysia Sarawak*. Universiti Malaysia Sarawak.
19. Taherdoost, H., & Madanchian, M. (2024). Decision Making: Models, Processes, Techniques. *Cloud Computing and Data Science*, 5(1). <https://doi.org/10.37256/ccds.5120243284>

# Board Characteristics and Financing Risks of Indonesian Islamic Banks: Do Women's Contributions Matter

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**Abstract.** Since the global financial crisis of 2007-2008, researchers and practitioners have increasingly focused on Islamic banks because they are considered more resilient than conventional banks in the face of the crisis. However, Islamic banks in Indonesia, like conventional banks, face a high level of financing risk often referred to as Non-Performing Financing (NPF). The increase in NPF indicates a decrease in the quality of Islamic banks' financing portfolio, a decrease in the ability to channel funding, and a decrease in bank capital. Therefore, minimizing NPF is an important issue for academic researchers, practitioners, and other stakeholders. This conceptual paper examines the role of the Board of Commissioners (BOC) and Sharia Supervisory Board (SSB) in controlling the NPF of Islamic banks in Indonesia from 2010 to 2022. The characteristics of the BOC are represented by independent BOC and female BOC. Meanwhile, SSB characteristics are represented by female SSBs. The data in this study were analyzed with Random effect model (REM) robustness. The findings suggest that women's BOC plays a role in lowering NPF. Meanwhile, independent BOC and female SSBs are not involved in NPF control of Islamic banks in Indonesia. This research expands on the existing literature on the relationship of board characteristics to bank performance, particularly the NPFs of Islamic banks. In addition, it adds insight for banking practitioners, such as regulators, investors, and management.

**Keywords:** - Characteristics of the board of commissioners and sharia supervisors, Non-performing financing, Indonesian Islamic banks.

## 1 Introduction

In recent decades, Islamic banking has experienced significant growth in various countries, including Indonesia. As a country with the largest Muslim population in the world, Indonesia has great potential to develop the Islamic banking industry. However, along with this growth, challenges arise in managing financing risks that can affect the stability and performance of Islamic banks. Islamic banks in Indonesia face a high level of financing risk, often referred to as Non-Performing Financing (NPF), which is a ratio that indicates the level of problematic financing in Islamic banks (Sihotang, Hasanah, & Hayati, 2022). High NPF can indicate poor financing quality and potentially pose more significant risks for Islamic banks (Yokoyama & Mahardika, 2019).

The increase in NPF indicates a decline in the quality of the Islamic bank financing portfolio, a decline in the ability to channel funds, and a decline in bank capital. Therefore, minimizing NPF is essential for academic researchers, practitioners, and other stakeholders. In this regard, corporate governance is vital in managing problem loans in the banking sector. Studies have shown that excellent or effective corporate governance can reduce non-performing loans (NPL) or non-performing financing (NPF), essential indicators of banks' credit risk and financial health. Research conducted in Pakistan shows corporate governance's negative and significant effect on NPL, indicating that compliance with corporate governance can help control bank credit risk (Khan, Ilyas, & Khan, 2019). Thus, poor corporate governance can increase problematic lending due to poor lending decisions and lack of bank accountability (Kamruzzaman & Ullah, 2022).

The role of the Board of Commissioners (BOC) and the Sharia Supervisory Board (SSB) in controlling financing risk or NPF in Islamic banks is significant in maintaining financial stability and encouraging effective governance. The literature shows that the board's composition, which reflects corporate governance, can affect the financial performance of Islamic banks (Darwanto & Chariri, 2019). In this case, the existence of the Sharia Board of Commissioners and Supervisors is associated with better financial performance and lower NPF (Darwanto & Chariri, 2019). The presence of women in corporate governance can reduce agency conflicts and provide a new perspective that leads to better decisions regarding problem-solving and improving company performance (Amin, Ali, Rehman, Naseem, & Ahmad, 2022).

Several studies have shown that the presence of women on BOC can bring different perspectives and improve the quality of decision-making, which can impact financial performance (Awwad, Binsaddig, Kanan, & Al Shirawi, 2023; Baklouti, 2022; Jabari & Muhamad, 2020; Leyva-Townsend, Rodriguez, Idrovo, & Pulga, 2021). However, research examining the specific impact of women's contribution to financing risk in Islamic banks still needs to be completed, especially in the Indonesian context.

This research aims to fill the knowledge gap by examining the impact between board characteristics and financing risk of Indonesian Islamic Commercial Banks (IB), specifically focusing on board independence, the role of women in the Board of Commissioners (BOC), and the Sharia Supervisory Board (SSB). Additionally, this study provides insights for banking practitioners, including regulators, management, and investors. The underlying rationale for this research is to shed light on the potential benefits of gender diversity and women's contributions in mitigating financing risk for Islamic Commercial Banks in Indonesia.

## 2 Literature review

The impact of the Board of Commissioners' independence on non-performing loans is an exciting subject in the literature. Board independence is generally associated with lower bankruptcy risk (Maier & Yurtoglu, 2022). The board's independence is generally considered to enhance oversight and reduce agency problems, leading to better credit decisions and lower non-performing loan values. Research by Rehman, Zhang, and Ahmad (2016) states that board independence has a negative relationship with NPL, indicating that higher BOC independence can lead to lower levels of credit risk. Budotela, Mmari, and Towo (2023) also report a significant negative impact of BOC independence on NPL. However, the study by Lu and Boateng (2018) asserts that board independence positively affects bank credit risk in the UK (Lu & Boateng, 2018). On the contrary, Balagobei (2019) presents a contrasting view, finding no significant influence of board independence on bank credit risk in Sri Lanka.

### **H1: The Independent Board of Commissioners negatively affects the financing risk of Islamic commercial banks in Indonesia.**

Pradana and Rani (2020) found that gender diversity in the BOC positively and significantly impacts lower risk-taking in Islamic banks. This lower risk-taking may reflect more cautious financial management, resulting in lower NPF (Pradana & Rani, 2020). Budotela, Mmari, and Towo (2023) demonstrate that the presence of female directors on the board of directors of commercial banks significantly negatively affects NPLs, indicating that female directors help reduce problematic loans. Lu and Boateng (2018) research also found that women on boards hurt credit risk in the UK (Lu & Boateng, 2018). These findings align with agency theory, which states that effective governance can reduce agency problems and improve performance, as evidenced by decreased problematic loans (Budotela et al., 2023).

### **H2: The Women's Board of Commissioners negatively affects the financing risk of Indonesian Islamic Commercial Banks.**

The impact of female Sharia Supervisory Board (SSB) members on credit risk in Islamic banks is complex. A study by Mai, Kristianingsih, and Dahtiah (2024) revealed that the presence of women in SSBs has a negative effect on NPF. This indicates that the representation of women in SSBs can reduce credit risk or problematic financing in Islamic banks (Mai et al., 2024). Research by Ramly, Datuk, and Nordin (2018) found that SSBs with female members, especially those with expertise in banking and Sharia, can mitigate credit risk. Apriliana and Hartomo (2020) discovered that a higher proportion of female members in SSB could reduce operational risk. However, a study by Ghazali, Basiruddin, and Zamil (2021) found that smaller SSBs with fewer female representatives are associated with lower credit risk.

### **H3: The Women's Sharia Supervisory Board negatively affects the financing risk of Islamic Commercial Banks in Indonesia.**

## 3 Methodology

This research is a quantitative study. That is, one of the research methods for conducting research on a certain population/sample, the content of which is in the form of numbers, and aims to test the research hypothesis (Sugiyono, 2017).

The population of this study consists of all Islamic Commercial Banks (IB) registered with the Financial Services Authority (OJK) during the research period from 2010-2022. The research sample was taken using a non-probability sampling technique, which involves selecting the entire research population as the sample due to its relatively small size. Based on this, the research sample consists of 16 Islamic Commercial Banks registered with the OJK during 2010-2022, and forms unbalance panel data with a total of 148 observations.

The type of data used in this study is secondary data. The data sources for this study were obtained from financial reports, annual reports, and good corporate governance reports of each IB that have been published on the official website of each IB.

In this study, there are 3 types of research variables that will be used, namely dependent, independent, and control variables. The dependent variable in this study is the risk of bank financing, measured by Non-Performing Financing (NPF). NPF is the ratio of problematic financing to total financing. The independent variables considered in this study consist of Independent Board of Commissioners (BOC\_IN), which is the proportion of independent board members to total board members; Women Board of Commissioners (BOC\_WMN), which is the number of women on the board of Commissioners; and Women Sharia Supervisory Board (SSB\_WMN), which is the number of women on the sharia supervisory board. The control variables consist of Operational Efficiency Ratio (BOPO), which is the ratio of operational expenses to operational income; Capital Adequacy Ratio (CAR), obtained by dividing total capital by risk-weighted assets; Economic growth measured by Gross Domestic Product growth (RGDPG); Inflation (INFLA), and Interest (INTRST). The presence of this control variable is not explicitly hypothesized; its existence is considered relevant to ensure that the impact between Board characteristics and financing risks of Indonesian Islamic banks can be analyzed carefully, taking into account other potential factors that may influence the research outcomes. Control variables are used to manage factors that affect the relationship between the independent and dependent variables, making the research results more valid and reliable.

The data analysis technique used in this research is panel data regression with Random Effect Model (REM) robustness. The statistical tool used to analyze the data is Stata. The equation model applied in this study can be explained as follows.

$$NPF_{it} = \epsilon_0 + \epsilon_1 BOC\_IN_{it-1} + \epsilon_2 BOC\_WMN_{it} + \epsilon_3 SSB\_WMN_{it} + \epsilon_4 BOPO_{it} + \epsilon_5 CAR_{it} + \epsilon_6 RGDPG_{it} + \epsilon_7 INFLA_{it} + \epsilon_8 INTRST_{it} + \epsilon_{1it}$$

Information:

$\epsilon_0$  = constant,  $\epsilon_1 - \epsilon_8$  = coefficient,  
 $i$  = research sample,  $t$  = research period,  
 $\epsilon_{1it}$  = error term.

To see how the influence between independent variables partially impacts the independent variables, this study uses the following model. Figure 1 shows the impact between the variables.

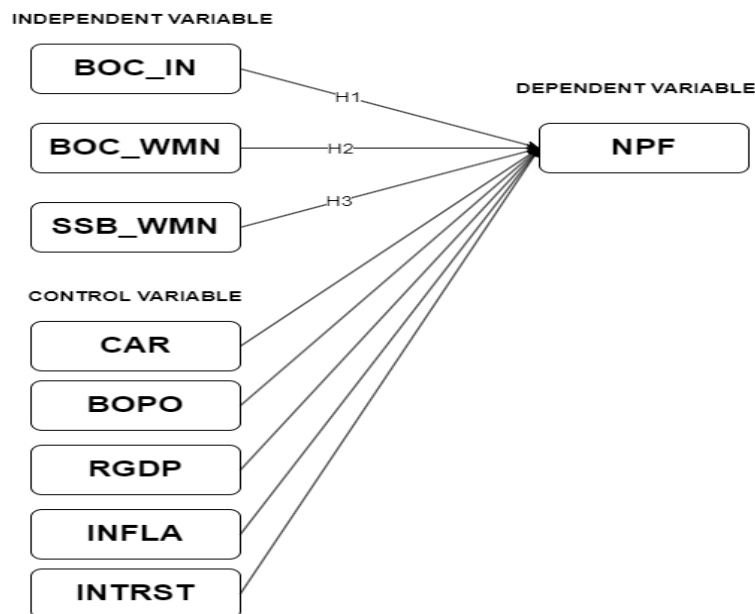


Fig. 1. Research Model

## 4 Finding and Analysis

### Descriptive Statistical Analysis

Descriptive statistics have been calculated to provide a general overview of the variables used in this research. These include the mean, standard deviation, minimum value, and maximum value for each variable. A summary of descriptive statistics is presented in Table 1.

Table 1. Descriptive Statistics

Variable	Mean	Std. Dev	Min	Max
NPF	1.746	1.505	0	4.97
BOC_IN	0.614	0.166	0	1
BOC_WMN	0.399	0.647	0	3

<b>SSB_WMN</b>	0.095	0.294	0	1
<b>CAR</b>	0.341	0.507	0.106	3.905
<b>BOPO</b>	4.246	16.264	0.347	95.41
<b>RGDPG</b>	4.540	2.228	-2.07	6.22
<b>INFLA</b>	4.194	2.137	1.68	8.38
<b>INTRST</b>	5.590	1.344	3.5	7,75

Source: Data processed by the author (2024)

Based on Table 1, it can be seen that the NPF variable has a mean value of 1.74%, indicating that the average NPF in the bank is still within reasonable limits; however, the maximum NPF value reaches 4.97%, which needs to be monitored as it is close to 5%. According to OJK Regulation No 15 of 2017, banks with NPF values exceeding 5% are considered to have potential difficulties that could endanger their business continuity. The average value or mean of the BOC\_IN variable is 0.61, with a maximum value of 1. In this case, several Islamic commercial banks have independent boards of commissioners. BOC\_WMN has an average value of 0.399 and a maximum value of 3, indicating that the number of women commissioners in Islamic commercial banks is at most 3. SSB\_WMN has a mean of 0.095 and a maximum value of 1, showing that the number of women on the SSB is at most 1.

### Correlation Matrix Analysis

The following is the correlation matrix located in Table 2.

**Table 2.** Correlation Matriks

Variable	NPF	BOC_IN	BOC_WMN	SSB_WMN	CAR	BOPO	RGDPG	INFLA	INTRST
<b>NPF</b>	1.0000								
<b>BOC_IN</b>	-0.0763	1.0000							
<b>BOC_WMN</b>	-0.3957	-0.0483	1.0000						
<b>SSB_WMN</b>	0.1955	-0.0298	-0.0566	1.0000					
<b>CAR</b>	-0.3397	0.0059	0.3261	-0.0828	1.0000				
<b>BOPO</b>	-0.0476	-0.2219	-0.0201	-0.0650	-0.0357	1.0000			
<b>RGDPG</b>	0.0213	-0.0743	-0.1491	-0.1340	-0.1161	-0.1113	1.0000		
<b>INFLA</b>	0.0534	0.0113	-0.0998	-0.0742	-0.1185	-0.0650	0.4783	1.0000	
<b>INTRST</b>	0.1772	-0.0679	-0.1920	-0.0431	-0.1923	-0.1716	0.5365	0.7612	1.0000

Source: Financial statements of Indonesian Islamic banks processed

Table 2 shows that the correlation relationship among the research variables is not greater than 0.8. Thus, this research model does not exhibit a multicollinearity symptom.

### Regression Results

The results of the robustness REM model regression are located in Table 3.

**Table 3.** REM Regression Results

Variable	Coeff.	Std. err.	z	P> z
BOC_IN	-0.5168	0.5210	-0.99	0.321
BOC_WMN	-0.3226	0.1630	-1.98	0.048
SSB_WMN	-0.3922	0.5462	-0.72	0.473
CAR	-0.4736	0.2047	-2.31	0.021
BOPO	-0.0085	0.0028	-3.04	0.002
RGDPG	-0.0738	0.0448	-1.65	0.100
INFLA	-0.0804	0.0437	-1.84	0.066
INTRST	0.1677	0.1287	1.30	0.193
_cons	2.0395	0.8118	2.51	0.012
Observation				148
IslamicBank				16
R-squared				0.2412
Wald chi2(8)				36.35
Prob > chi2				0.000

Source: Output Stata (2024)



The REM model robustness used in this study has shown suitable suitability. Based on Table 3, the research results obtained a Prob > chi2 value of  $0.000 < 0.05$ , indicating that the independent variables consisting of BOC\_IN, BOC\_WMN, and SSB\_WMN collectively have a significant impact on NPF. Below are the discussion results regarding the influence of each independent variable on the NPF of Islamic Commercial Bank.

**First**, The findings of the research reveal that the coefficient for BOC\_IN is -0.5168, which means that BOC\_IN has a negative impact on the NPF level, but it is not significant. This is indicated by a probability value  $p > |z|$  of  $0.321 > 0.05$ . This means that increases and decreases in BOC\_IN does not affect the risk of financing in Islamic banks in Indonesia. These research findings are consistent with Suwandi (2020), Balagobei (2019), Darwanto and Chariri (2019) who state that the independence of the board does not have a significant impact on credit risk for banks. The lack of significant influence from independent commissioners is due to BOC\_IN's limitations in authority and direct influence on day-to-day operational decisions, including financing decisions. They play a more significant role in supervision and providing strategic advice rather than being directly involved in the management of financing risk. In addition, the factors that influence the NPF are very complex and may not be fully controlled by the presence of an independent commissioner. There are other factors such as macroeconomic conditions, the quality of risk management, and market conditions which can also play a big role in influencing the level of financing risk in Islamic banks.

**Secondly**, the research results indicate a coefficient value of BOC\_WMN of -0.3226 with a probability value  $p > |z|$  of  $0.048 < 0.05$ . This means that BOC\_WMN has a negative and significant impact on financing risk. In this case, an increase in the proportion of women on the board of directors can reduce financing risk. These findings align with Budotela et al. (2023), Khoirotunnisa (2021), and Lu & Boateng (2018) which show that women on the board of commissioner have a negative effect on credit risk. This can mitigate agency problems and improve performance, as evidenced by a decrease in credit or problematic financing risk. The presence of women in BOC can enrich perspectives and enhance decision-making quality. This research demonstrates that a more diverse board is generally more effective in overseeing management and reducing risks faced by the company, including financing risk measured by NPF. In this case, women tend to be more cautious and conservative in decision making, which can help reduce the credit risk taken by banks (Khoirotunnisa, 2021). According to research conducted by Liao et al. (2015) there are significant differences between women and men in several aspects, such as personality, communication style, educational background, career experience, and expertise. These differences, when present on the board of commissioners, can provide valuable contributions to decision-making.

In terms of personality, women tend to be more collaborative and empathetic, while men may be more competitive and direct. This diversity in personality can help the board of commissioners to consider various perspectives and approaches in decision making. In addition, the expertise possessed by women and men is also often different. Women may have stronger expertise in soft skills such as negotiation and conflict management, while men may excel in hard skills such as data analysis and business strategy. The combination of these various expertise can improve the quality of decisions taken by the board of commissioners.

**Thirdly**, the research results indicate a coefficient value of SSB\_WMN -0.3922, with a probability value  $p > |z|$  of  $0.473 > 0.05$ . This means that SSB\_WMN has a negative but insignificant impact on financing risk. In this context, the increase or decrease in the proportion of women in SSB does not affect financing risk. This insignificant influence is due to the main task of the SSB which is more focused on supervising sharia principles rather than on financial risk management or daily operations which can directly affect the NPF. These findings align with Budiarsih and Mulyati (2023), Isa and Lee (2020), who revealed that women in SSB do not significantly influence financing risk in Islamic banks.

SSB\_WMN plays a more significant role in supervision and strategic advice than directly participating in financing. SSB has the responsibility to ensure that all Islamic banking products and procedures are in accordance with Islamic principles. Therefore, changes in gender composition in SSB do not directly affect the NPF level. Although SSB\_WMN can bring new perspectives to SSB, it does not directly affect technical aspects such as NPF which is more influenced by other factors such as macroeconomic and bank-specific.

## 5 Implications

These findings contribute to the existing literature on the impact between board characteristics and bank financing risk, particularly in the context of Islamic banks. Additionally, the study provides valuable insights for banking practitioners, such as regulators, investors, and management, as it highlights the importance of gender diversity on the board of commissioners in maintaining financing risk.

Banking regulators can use these findings to formulate policies that encourage gender diversity on bank boards of commissioners. There is evidence that the presence of women on the board of commissioners can reduce financing risk as measured by the NPF. Based on this, bank regulators can consider establishing rules or guidelines that encourage increased representation of women in leadership positions in Islamic banks, especially on the board of commissioners.

Islamic bank management can also take steps to increase gender diversity at the leadership level. By understanding that gender diversity can contribute to better financing risk management, management can design more inclusive recruitment and career development strategies for women.

## 6 Conclusion

This research examines the influence of board characteristics on financing risk by studying the roles of the BOC and the SSB

in controlling non-performing financing (NPF) in Indonesian Islamic banks from 2010 to 2022. Independent and female commissioners represent the characteristics of the Board of Commissioners in this study. Meanwhile, the characteristics of the Sharia Supervisory Board are represented by female members. The research findings indicate that female commissioners hurt financing risk (NPF) in Indonesian Islamic banks. This means that the presence of women on BOC can provide different perspectives and reduce financing risk. However, independent commissioners and female members of the Sharia Supervisory Board do not significantly impact the NPF levels in Indonesian Islamic banks.

This study has limitations on the sample studied, which only consists of Islamic Banks in Indonesia with a period of 12 years. In addition, the variables used in this study only focus on the board characteristics variables consisting of independent commissioners, female commissioners, and female sharia supervisory boards. And for the measurement of financing risk, it is only measured by NPF. Based on this, future research could explore the impact between diversity in other areas, such as ethnicity, age, educational background, skills or expertise. And considering other factors such as bank size, capital structure, and regulatory policies in analyzing more deeply the impact between board characteristics and financing risk in Islamic banks.

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## References

1. Amin, A., Ali, R., Rehman, R. ur, Naseem, M. A., & Ahmad, M. I. (2022). Female presence in corporate governance, firm performance, and the moderating role of family ownership. *Economic Research-Ekonomska Istrazivanja*, 35(1), 929–948. <https://doi.org/10.1080/1331677X.2021.1952086>
2. Apriliana, A. I., & Hartomo, D. D. (2020). Dewan Pengawas Syariah dan Risiko Bank Syariah. *Jurnal Bisnis & Manajemen*, 20(1), 45–54. Retrieved from <https://jurnal.uns.ac.id/jbm/article/view/54489>
3. Awwad, B. S., Binsaddig, R., Kanan, M., & Al Shirawi, T. (2023). Women on boards: an empirical study on the effects on financial performance and corporate social responsibility. *Competitiveness Review*, 33(1), 147–160. <https://doi.org/10.1108/CR-06-2022-0084>
4. Baklouti, I. (2022). Is the Sharia supervisory board a friend or an enemy of Islamic banks? *Journal of Islamic Marketing*, 13(2), 526–541. <https://doi.org/10.1108/JIMA-04-2020-0118>
5. Balagobei, S. (2019). Corporate governance and non - performing loans : evidence from listed banks in Sri Lanka. *International Journal of Accounting & Business Finance*, 5(1), 72–85.
6. Budiarsih, N. L., & Mulyati, S. (2023). Pengaruh Keragaman pada Dewan Direksi dan Dewan Pengawas Syariah terhadap Risiko Kredit di Bank Syariah. *Selektia Manajemen: Jurnal Mahasiswa ...*, 02(03), 130–147. Retrieved from <https://journal.uin.ac.id/selma/article/view/29653%0Ahttps://journal.uin.ac.id/selma/article/download/29653/15482>
7. Budotela, G., Mmari, G., & Towo, N. (2023). Board Composition and Non-Performing Loans among Commercial Banks in Tanzania. *Journal of Accounting Research, Organization and Economics*, 6(1), 1–18.
8. Darwanto, D., & Chariri, A. (2019). Corporate governance and financial performance in Islamic banks: the role of the sharia supervisory board in multiple-layer management. *Banks and Bank Systems*, 14(4). [https://doi.org/10.21511/bbs.14\(4\).2019.17](https://doi.org/10.21511/bbs.14(4).2019.17)
9. Ghazali, S. S., Basiruddin, R., & Zamil, N. A. M. (2021). Effects of Shariah Supervisory Board Characteristics on Credit Risk of Islamic Banks. *International Journal of Academic Research in Accounting Finance and Management Sciences*, 11(2), 202–221. <https://doi.org/10.6007/IJARAFMS>
10. Isa, M., & Lee, S. P. (2020). Does the Shariah committee influence risk-taking and performance of Islamic banks in Malaysia? *Journal of Islamic Accounting and Business Research*, 11(9), 1739–1755. <https://doi.org/10.1108/JIABR-12-2018-0207>
11. Jabari, H. N., & Muhamad, R. (2020). Gender diversity and financial performance of Islamic banks. *Journal of Financial Reporting and Accounting*, 19(3), 412–433. <https://doi.org/10.1108/JFRA-03-2020-0061>
12. Kamruzzaman, M., & Ullah, A. K. M. M. (2022). Corporate Governance Practices and Non-performing Loans in Banking Sector of Bangladesh : A comparative Study. *Journal of Business Studies Pabna University of Science and Technology*, 3(1), 1–25. <https://doi.org/10.58753/jbspust.3.1.2022.1>
13. Khan, I., Ilyas, M., & Khan, S. (2019). Assessing the Impact of Corporate Governance on Non-Performing Loans : Empirical Analysis of the Listed Commercial Banks of Pakistan. *Global Social Sciences Review (GSSR)*, IV(III), 188–196.
14. Khoirotnunisa, F. (2021). Board Gender Diversity Dan Board Education Diversity terhadap Bank-Risk Taking. *BALANCE: Economic, Business, Management and Accounting Journal*, 18(2), 1. <https://doi.org/10.30651/blc.v18i2.5375>

15. Leyva-Townsend, P., Rodriguez, W., Idrovo, S., & Pulga, F. (2021). Female board participation and firm's financial performance: a panel study from a Latin American economy. *Corporate Governance (Bingley)*, 21(5), 920–938. <https://doi.org/10.1108/CG-07-2019-0235>
16. Liao, L., Luo, L., & Tang, Q. (2015). Gender diversity, board independence, environmental committee and greenhouse gas disclosure. *British Accounting Review*, 47(4), 409–424. <https://doi.org/10.1016/j.bar.2014.01.002>
17. Lu, J., & Boateng, A. (2018). Board composition, monitoring and credit risk: evidence from the UK banking industry. *Review of Quantitative Finance and Accounting*, 51(4), 1107–1128. <https://doi.org/10.1007/s11156-017-0698-x>
18. Mai, M. U., Kristianingsih, K., & Dahtiah, N. (2024). Sharia Board Characteristics, Macroeconomic Factors, and Non-performing Financing of Indonesian Islamic banks. *Muqtasid: Jurnal Ekonomi Dan Perbankan Syariah*, 14(2), 148–164. <https://doi.org/10.18326/muqtasid.v14i2.148-164>
19. Maier, F., & Yurtoglu, B. B. (2022). Board Characteristics and the Insolvency Risk of Non-Financial Firms. *Journal of Risk and Financial Management*, 15(7), 303. <https://doi.org/https://doi.org/10.3390/jrfm15070303>
20. Pradana, P. K., & Rani, L. N. (2020). Gender Diversity, Independensi, Keahlian Keuangan Dan Risk-Taking Behaviour Pada Bank Umum Syariah. *Jurnal Ekonomi Syariah Teori Dan Terapan*, 7(10), 1869. <https://doi.org/10.20473/vol7iss202010pp1869-1886>
21. Ramly, Z., Datuk, N., & Nordin, H. M. (2018). Sharia Supervision Board, Board Independence, Risk Committee and Risk-taking of Islamic Banks in Malaysia. *International Journal of Economics and Financial Issues*, 8(4), 290–300. Retrieved from <http://www.econjournals.com>
22. Rehman, R. U., Zhang, J., & Ahmad, M. I. (2016). Political system of a country and its non-performing loans : A case of emerging markets Political system of a country and its non-performing loans : a case of emerging markets Ramiz Ur Rehman \* and Junrui Zhang Muhammad Ishfaq Ahmad. *International Journal of Business Performance Management*, (January). <https://doi.org/10.1504/IJBPM.2016.077243>
23. Sihotang, M. K., Hasanah, U., & Hayati, I. (2022). Model of Sharia Bank Profitability Determination Factors by Measuring Internal and Externals Variables. *Indonesian Interdisciplinary Journal of Sharia Economics (IIJSE)*, 5(1), 235–251. <https://doi.org/10.31538/iijs.v5i1.1949>
24. Sugiyono. (2017). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta.
25. Suwandi, E. D. (2020). Analisis Perkembangan Bursa Efek Indonesia dan Saham Syariah di Indonesia Periode 2013-2018. *Jurnal Ilmiah Akuntansi Dan Keuangan*, 9(2), 160–169. <https://doi.org/10.32639/jiak.v9i2.626>
26. Yokoyama, E. P., & Mahardika, D. P. K. (2019). Pengaruh Non Performing Financing (NPF), Return On Asset (ROA), dan Financing to Deposit Ratio (FDR) terhadap Capital Adequacy Ratio (CAR) (Studi Kasus pada Bank Umum Syariah di Indonesia yang Terdaftar di Otoritas Jasa Keuangan). *Jimea*, 3(2), 28–44. <https://doi.org/10.31955/mea.vol3.iss2.pp>

# Audit Committee Composition and Bank Profitability Growth: Evidence from Indonesia

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**Abstract.** Banks have a tremendous impact on a country's economic growth. High bank performance indicates a good economy, and vice versa. Numerous studies have investigated the most important aspects that shaping bank performance. However, majority of these studies focus more on examining the influence of corporate governance represented by the board of commissioners and the board of directors on several measures of banking performance, including financial performance, credit risk and corporate social responsibility. Meanwhile, the connection between audit committees along with bank profitability growth has received less attention from previous researchers. The objective of this studies is to examine the influence of audit committee composition on the growth of banking financial gains in Indonesia for 2010-2022 period. The makeup of the audit committee is depicted by audit committee size, age of the audit committee chairman, female audit committee, audit committee assembly and female audit committee meetings. Profitability growth is quantified by the annual growth of return of assets as well as return of equity. Data is estimated using the Feasible Generalized Least Square (FGLS) model. The outcome exhibit that the size of the audit committee and the age of the audit committee chairman raise profitability growth, while women in audit committee meetings decrease profitability growth. This research bridges the gap in prevailing literature regarding the relationship between corporate governance along with bank performance. Apart from that, it opens insight for banking practicing individuals, such as policy makers, regulators, investors as well as management.

**Keywords:** audit committee composition, profitability growth, banking sector

## 1 Introduction

Although banks are one of the most risk-vulnerable institutions, the existing academic literature documents that banking institutions make an important contribution to the country economic growth (Gani and Bahari, 2021; Elnahass et al., 2021; Anwar et al., 2020). In this case, the high performance of banking institutions suggests that the country's economy is thriving, and vice versa. The onset of the global financial crisis in 2007 to 2008 in European countries and the United States was more caused by the poor performance of banking institutions in these countries (Adegboye, Ojeka, and Adegboye, 2020). Meanwhile, it proved that the main cause of the weak performance of banking institutions in European countries and the United States in 2007-2008 was the poor quality of corporate governance implemented by banking institutions in these countries (Yahaya, Mahat, and Yahya, 2021). Thus, it is not surprising that the examination of the connection between corporate oversight and the performance of banking institutions has received more and more attention from practitioners and academic researchers, resulting in a large increase in the number and variety of literature on the relationship between these two variables (Merin, 2016; Haryono, Ariffin, and Hamat, 2016; (Zarrouk, Ghak, and Haija, 2017; Ben Zeineb and Mensi, 2018; Khatun and Ghosh, 2019; Bezawada and Adavelli 2020; Molla, Islam, and Rahaman, 2021; (Masrizal et al., 2022; Brogi and Lagasio, 2022; (Athar, Chughtai, and Rashid, 2023) Several studies that have been conducted focus more on exploring the influence of corporate governance, represented by the board and the top management team, on several measures of banking institution's performance, such as financial performance, credit risk, dividend policy, capital composition, and corporate social responsibility. Meanwhile, the connection between the audit committee and the growth of bank institutional profitability has received less attention from previous researchers. In addition, evaluating and controlling the growth of a banking institution's profitability seems to be more important when compared to just paying attention to the institution's profitability level. Therefore, examining the relationship between the composition of the audit committee and the growth of banking institutions is important and interesting to do.

This study intends to explore the effect of audit committee composition on the growth of bank profitability in Indonesia for the period 2010-2022. Literature on the relationship between the composition of the audit committee and the growth of the profitability of companies, particularly banks, is rare. Thus, this research has great potential to address the gap in existing literature concerning the relationship of corporate governance betwixt the performance of banking institutions. In addition, it opens insights for banking practitioners, such as policymakers, regulators, investors, management, and depositors.

## 2 Literature Review

### 1.1 Study area

As has been pointed out, the body of research on the connection between audit committee composition and the growth of the profitability of companies, including banks, is difficult to find because it has never been studied before. Furthermore, for the purposes of theoretical reference and empirical evidence, this study adopts the existing literature regarding the relationship between the composition of the audit committee and some measures of the performance of companies, especially banking institutions.

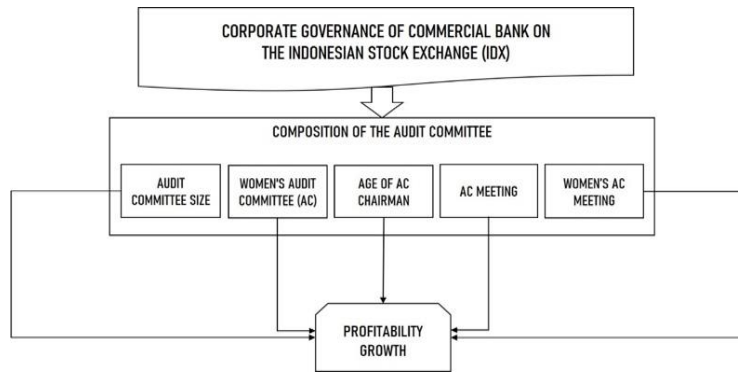
The importance of the position of the audit committee in corporate governance has prompted researchers, academics, and practitioners to inspect the characteristic role of the audit committee in improving various measures of corporate performance, namely the company's financial performance, the quality of the company's financial statements and corporate social responsibility. For example, non-bank financial institutions in Ghana with larger audit committee sizes and more prevalent audit committee frequency are linked to increased profitability (Ofoeda, 2017). Similarly in Palestine, The scale and regularity of audit committee meetings contribute positively to company performance (Musallam, 2020). These results align with resource dependency theory which advocate that more extensive audit committee sizes dedicate greater resources and expertise to more efficient task performance (Jan, Lai, and Tahir, 2021). Consequently, an increasing number of audit committee members are projected to possess a variety of perspectives, expertise, experience, and skills to ensure more effective oversight (Altin, 2024). In addition, resource dependency theory posits that frequent meetings make the audit committee more informed and alert to audit and accounting issues when conflicts occur in the company. Therefore, more frequent audit committee meetings reduce the likelihood of financial fraud (Al Farooque, Buachoom, and Sun, 2020).

Resource dependency theory argues that audit committee chairs, including audit committee members, with higher expertise, experience and skills will ensure more effective monitoring and control (Erin, Adegbeye, and Bamigboye 2022). Another study proves that the chairman of the audit committee with financial and accounting expertise is able to ameliorate the performance of the banking sector in India (Gupta and Mahakud, 2021). That finding is consistent with Musallam (2020) which reports that the expertise of the chairman of the audit committee enhance the performance of companies listed in the Palestinian capital market. Meanwhile, a research in Russia concludes that earnings management of public companies can be reduced by the existence of an audit committee with accounting and financial expertise (Nikulin et al. 2022).

Agency theory argues that the length of the term of office of the chairman of the audit committee endangers the independence of the audit committee (Altin, 2024). The chairman of the audit committee with a long term of office has deep-rooted power, so he tends not to respond to questions about the quality of the company's financial statements. Furthermore, the chairman of this audit committee builds a good relationship with its members to influence the objectivity of the audit committee's decisions, lower the audit committee's monitoring, and in turn lower the company's performance. Referring to stewardship theory, the audit committee chairman's term of office is longer as an arrangement that provides continuity to the committee. This is because the company has been served by the chairman of the audit committee for many years, culminating in a deep understanding of the company's culture and operations, which makes his actions more responsible and instills a sense of ownership in the company (Baatwah, Salleh, and Stewart, 2019). The study Al-Absy, Ku Ismail, and Chandren (2019) proved that the tenure of the chairman of the audit committee plays a prominent role in lowering the company's profit management in Malaysia, which aligns with stewardship theory. Meanwhile, Gupta and Mahakud (2021) reported that the tenure of the chairman of the audit committee has no relationship with the performance of banks in India. Study by Junior (2022) proved that the age of a chairman of the board, including the audit committee, decreases the performance of the company because the older the chairman, the lower the cognitive ability. In addition, the longer experience of a chairman is associated with lower motivation. However, Priyadi et al. (2021) argue that high-level management abilities are acquired with age. Furthermore, Ouma and Webi (2017) proved that an older board chairman results in gaining experience and a willingness to embrace new ideas. In the context of earnings management, Xiong (2016) found that the age of the board chairman was significantly negatively correlated with earnings management, meaning that the older board chairman is able to overcome the practice of earnings management in the company. Lastly, Al-Absy et al. (2019) proved that the age of the chairman of the audit committee has no relationship with earnings management in Malaysian companies.

A better management of building relationships among individuals through collaborative and inclusive methods that can influence the behavior of other audit committee members are facilitated by the presence of women on audit committees (Green and Homroy, 2018). Therefore, ethical decision-making and the fostering of trust among stakeholders are expected outcomes of increased female representation, which in turn enhances the company's performance (Alqatamin 2018). Research by Ararat and Yurtoglu (2021) proved that the purpose of presenting women members in the audit committee is for

real benefits in maintaining the effectiveness of the audit committee's performance and shows that women's representation has a positive impact. However, Gupta and Mahakud (2021) reported that women serving on the audit committee do not show any significant role in improving the financial outcomes of the banking industry in India. The composition of the audit committee is represented by five variables consisting of the size of the audit committee, the proportion of female audit committee members, the age of the audit committee chair, the frequency of audit committee meetings and the proportion of female audit committee meeting attendance. Meanwhile, the growth of bank profitability is assessed by the growth of return on assets as well as return on equity. Furthermore, to provide a clearer picture of the relationship between the variables representing the composition of the audit committee and the growth of the bank profitability tested in this research developed the following pictograph model.



**Fig.1.** Research pictograph model  
Source: Developed for this study

## 3 Methodology

### 3.1 Sample

The sample for this research consists of commercial banks which are listed on the Indonesia Stock Exchange (IDX) from 2010 - 2022. Data was obtained from bank financial statements downloaded from the IDX website and the pages of each bank as well as from the banks' annual reports downloaded from each bank's website which resulted in 47.47 banks summing up to 476 bank-year scrutiny.

### 3.2 Variables

The variables in this study consist of dependent variables, independent variables and control variables. As a dependent variable, profitability growth is assessed through the growth of return on assets (ROA\_GROWTH) and return on equity (ROE\_GROWTH). The independent variable is represented by the composition of the audit committee, which is proxied by five variables. First, the size of the audit committee (AC\_SIZE) is defined as the total number of members on the audit committee, as suggested by Fariha, Hossain and Ghosh (2022). Second, the proportion of female audit committee members (PWM\_AC) whose value is determined by the ratio of the number of female audit committee members to the total audit committee members, as used by Ararat and Yurtoglu (2021). Third, the age of the chairman of the audit committee (ACC\_AGE) which is calculated as the age (years) of the chairman of the audit committee at the time of data collection, as suggested by Info (2023). Fourth, the frequency of audit committee meetings (AC\_MTF) whose value is calculated as the number of audit committee meetings within a year, as used by Altin (2024). Fifth, the fraction of women audit committee meetings (WAC\_MTF) whose value is determined by the ratio of the number of women audit committee meetings to the number of audit committee meetings in one year (Uribe-Bohorquez, Martínez-Ferrero, and García-Sánchez, 2019).

The control variables are Capital Adequacy Ratio (CAR), Non-Performing Loans (NPL), Operational Efficiency Ratio (OER), Size (SIZE), asset growth (TA\_GROWTH), and Leverage (LEV). CAR is the ratio of total capital to weighted assets according to risk (Priyadi et al., 2021). NPLs are the ratio of non-performing loans to total loans (Kjosevski and Petkovski 2020). OER is the total operating expenses divided by operating income (Mai, Nansuri, and Setiawan, 2024). SIZE is the logarithm of total assets (Priyadi et al., 2021). TA\_GROWTH is defined as the ratio of annual asset growth (Hoque and Liu, 2021; Budagaga, 2020). LEV is defined as the ratio of total debt to total assets (Danso et al., 2020).

### 3.3 Analysis Model

The data in this study underwent analysis using the Generalized Least Squares (GLS) model (Haddad, El Ammari, and Bouri, 2021; Khatun and Ghosh, 2019; Al-Nasser Mohammed and Muhammed, 2017). The researchers argue that the variables that represent corporate governance, including the audit committee, are endogenous. GLS is considered one of the most reliable

models for overcoming endogeneity. The following GLS model is used:

$$ROA\_GROWTH_{it} = \beta_0 + \beta_1 AC\_SIZE_{it} + \beta_2 PWM\_AC_{it} + \beta_3 ACC\_AGE_{it} + \beta_4 AC\_MTF_{it} + \beta_5 WAC\_MTF_{it} + \beta_6 CAR_{it} + \beta_7 NPL_{it} + \beta_8 OER_{it} + \beta_9 SIZE_{it} + \beta_{10} GROW_{it} + \beta_{11} LEV_{it} + \epsilon_{1it} \quad (1)$$

$$ROE\_GROWTH_{it} = \beta_0 + \beta_1 AC\_SIZE_{it} + \beta_2 PWM\_AC_{it} + \beta_3 ACC\_AGE_{it} + \beta_4 AC\_MTF_{it} + \beta_5 WAC\_MTF_{it} + \beta_6 CAR_{it} + \beta_7 NPL_{it} + \beta_8 OER_{it} + \beta_9 SIZE_{it} + \beta_{10} GROW_{it} + \beta_{11} LEV_{it} + \epsilon_{2it} \quad (2)$$

Note: Those above represents the selected banks as sample,  $t$  is showing the period in years from 2010 to 2022,  $\beta_0$  is the value konstanta,  $\beta_1$  to  $\beta_{11}$  are the value of the regression coefficient,  $\epsilon$  is used to accommodate the error estimates of the two equation models developed.

## 4 Finding and Analysis

The findings as the analysis of the GLS model results, which is the regression coefficient of the influence of independent variables on dependent variables. The regression coefficient has positive or negative signs and is significant or insignificant. Briefly, the findings are shown in Table 1.

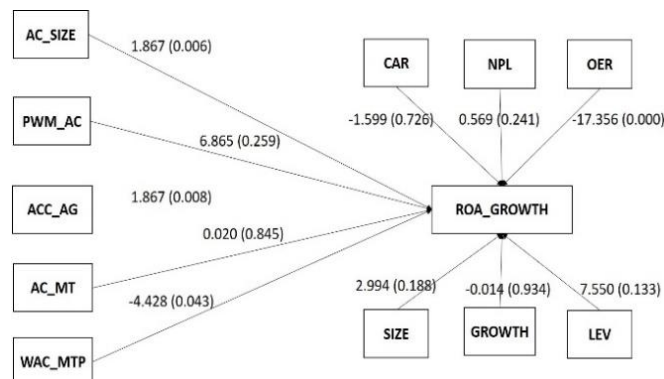
**Table 1.** GLS ROA\_GROWTH - ROE\_GROWTH results

Variables	ROA_GRWTH		ROE_GRWTH	
	Coefficient	z	Coefficient	z
AC_SIZE	1.868***	2.73	1.730***	2.16
PWM_AC	6.865	1.13	8.591	1.20
ACC_AGE	0.188***	2.66	0.174**	2.11
AC_MT	0.020	0.20	0.076	0.63
WAC_MTP	-4.428**	-2.02	-5.680**	-2.21
CAR	-1.599	-0.35	0.654	0.12
NPL	0.569	1.17	1.151**	2.02
OER	-17.356***	-4.19	-18.908***	-3.89
SIZE	2.994	1.32	0.934	0.35
GROWTH	-.0139	-0.08	-0.477	-0.24
LEV	7.550	1.50	3.154	0.53
Constant	-30.947*	-1.74	-13.452	-0.65
Wald chi2	236.35		162.96	
Prob > chi2	0.0000		0.0000	
Coefficients	GLS		GLS	
Panels	homoskedastic		homoskedastic	
Correlation	no autocorrelation		no autocorrelation	

Notes: \*, \*\* and \*\*\* significant at the level of 10%, 5% and 1%

According to Table 1, it is evident that the GLS estimation results meet the goodness of fit model qualifications, both for Model 1 and Model 2. This is shown by the value of Wald chi2 of 236.35 and Prob > chi2 of 0.000 from Model 1, and the value of Wald chi2 of 162.96 and Prob > chi2 of 0.000 from Model 2. Furthermore, by taking into account several bank-specific factors such as CAR, NPL, OER, SIZE, TA\_GROWTH, and LEV, the analysis of the findings of this research is as follows.

To provide clearer results, Figure 2 presents the outcomes of the analysis ROA\_GROWTH.



**Fig.2.** Fictograph model of ROA\_GROWTH results

To provide clearer results, Figure 3 shows the analysis results of ROE\_GROWT.

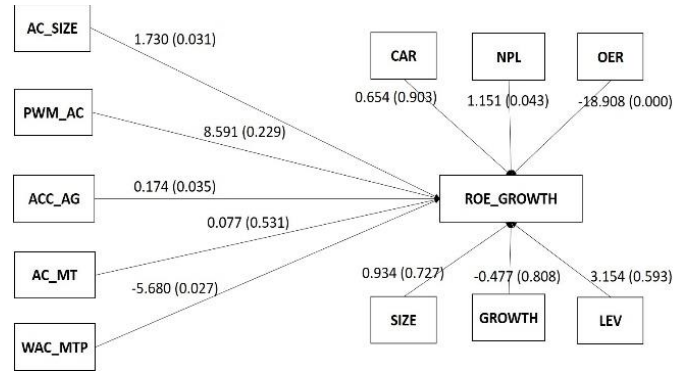


Fig. 3. Fictograph model of ROE\_GROWT results

The results of the research in the form of successive narrative are presented as follows:

**First**, the findings show that the size of the audit committee (AC\_SIZE) has a significant positive effect on the growth of bank profitability in Indonesia, both measured by ROA\_GROWTH and ROE\_GROWTH. This discovery suggests that greater audit committee size correlates with increased profitability growth, as measured by both ROA as well as ROE. This finding reflects the resource dependency theory's assertion that a larger audit committee size correlates with improved firm performance including higher bank profitability growth (Al Farooque, Buachoom, and Sun, 2020). This theory views that each member of the audit committee functions as a strategic asset that grants access to external resources essential for the company's success. As a result, large audit committee sizes are better than smaller audit committee sizes (Musallam, 2020; Ofoeda, 2017).

**Second**, the findings show that the proportion of female audit committee members (PWMN\_AC) has no influence on the growth of bank profitability in Indonesia, both measured by ROA\_GROWTH and ROE\_GROWTH. This findings tend to be consistent with Gupta and Mahakud (2021) which proved that the representation of women in the audit committee does not have a significant relationship with the profitability of banks in India. However, these findings are incongruous with Ararat and Yurtoglu (2021) which proved that a higher proportion of female audit committee members are able to boost a company's financial performance.

**Third**, the findings of this study show that the age of the chairman of the audit committee (ACC\_AGE) has a positive and significant impact on the growth of bank profitability in Indonesia, both measured by ROA\_GROWTH and ROE\_GROWTH. These findings appear to be consistent with (Muhammad, Suluki, and Nugraheni 2020) which states that higher managerial abilities are acquired with age. Older board chairs, including audit committee chairs, show greater experience and insight as well as openness to new ideas (Ouma and Webi 2017).

**Fourth**, the findings revealed that the frequency of audit committee meetings (AC\_MTF) has no impact on the growth of bank profitability in Indonesia, both as assessed by ROA\_GROWTH and ROE\_GROWTH. These results tend to be consistent with Altin (2024) which concludes that the frequency of audit meetings has no effect on firm performance in many countries. However, this study results do not align with the agency theory which holds that more frequent meetings reduce the company's performance because it increases agency costs and shows important problems in the company (Hsieh et al., 2020; Morck, Shleifer, and Vishny, 1988). This gave contradictory finding about the resource dependency theory (Ofoeda 2017) which argues that frequent meetings improve company performance because they show diligence, concern, and capability of audit committee members.

**Fifth**, the findings of this study show that the proportion of female audit committee (WAC\_MTP) attendance exerts a detrimental and noteworthy impact on the growth of bank profitability in Indonesia, both assessed by ROA\_GROWTH and ROE\_GROWTH. This finding is consistent with agency theory (Jensen and Meckling (1976) which predicts a negative relationship between the frequency of meetings and company performance because frequent meetings require large costs and imply problems in the company (Alsartawi. 2019; Bezawada and Adavelli, 2020). In the context of women's representation in corporate governance, including in audit committees, Herrera-Cano and Gonzalez-Perez (2019) argued that women are often considered to lack the qualities necessary to succeed in audit committees such as toughness and firmness that are often possessed by male audit committee members.

Regarding the control variables, it can be stated briefly that high NPLs reduce the growth of bank profitability as measured by ROE\_GROWTH. Furthermore, high OER reduces the growth of bank profitability, both measured by ROA\_GROWTH and ROE\_GROWTH. Finally, this research has no influence of CAR, SIZE, TA\_GROWTH, and LEV on the growth of bank profitability in Indonesia, both measured by ROA\_GROWTH and ROE\_GROWTH.

## 5 Conclusion

Based on the findings of this study, the general conclusion is that the composition of the audit committee notably impacts the growth of bank profitability in Indonesia. In particular, it appears that the size of the audit committee and the age of the audit committee chairperson increase the growth of banks, while the proportion of women in audit committee meetings decreases the



growth of bank profitability in Indonesia. Unfortunately, this research does not find any significant impact of the proportion of women on the audit committee and the frequency of audit committee meetings on the growth of bank profitability in Indonesia. This research bridges the gap in prevailing literature regarding the relationship between corporate governance, especially the composition of the audit committee, and bank performance as measured by profitability growth. In addition, increasing understanding opens up insights for banking practitioners, such as policymakers, regulators, investors, and management. The results of this study suggest banking practitioners increase the size of members of the audit committee because the larger the size of the audit committee, the more strength, diversity of experience, thinking, and skills which in turn improves the bank's performance. In addition, banking directors should consider the chairman of the audit committee who is older because managerial abilities increase as they gain more experience, insight, and wisdom. The presence of women's meetings does reduce the growth of banks' profitability because efforts to increase profitability call for higher risks, meanwhile, the characteristics of women tend to avoid higher risks. As such, banking practitioners should consider more objectively the presence of women in audit committee meetings.

While this study offers unique and current insights, it is constrained by two specific limitations. Firstly, it focuses solely on a sample drawn from the banking sector listed on the Indonesia Stock Exchange (IDX). Secondly, the analysis of audit committees is restricted to variables such as committee size, proportion of female members, age of the chairperson, meeting frequency, and attendance rates of female members. Therefore, the upcoming research agenda should prioritize two key considerations. First, expanding the sample to encompass both conventional and Islamic commercial banks in Indonesia and potentially other countries. Second, expanding the scope of audit committee analysis to include factors such as tenure, diversity of membership, compensation, and the professional commitments or concurrent roles of committee members.

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## References

1. Adegboye, Alex, Stephen Ojeka, and Kofo Adegboye. 2020. "Corporate Governance Structure, Bank Externalities and Sensitivity of Non-Performing Loans in Nigeria." *Cogent Economics and Finance* 8(1). <https://doi.org/10.1080/23322039.2020.1816611>.
2. Al-Absy, Mujeeb Saif Mohsen, Ku Nor Izah Ku Ismail, and Sitraselvi Chandren. 2019. 11 Asia-Pacific Journal of Business Administration *Audit Committee Chairman Characteristics and Earnings Management: The Influence of Family Chairman*.
3. Al-Nasser Mohammed, Sulaiman Abdullah Saif, and Datin Jariah Muhammed. 2017. "Financial Crisis, Legal Origin, Economic Status and Multi-Bank Performance Indicators Evidence from Islamic Banks in Developing Countries." *Journal of Applied Accounting Research* 18(2): 208–22.
4. Alsartawi, Abdalmuttaleb Musleh. 2019. "Board Independence, Frequency of Meetings and Performance." *Journal of Islamic Marketing* 10(1): 290–303.
5. Altin, Meltem. 2024. "Audit Committee Characteristics and Firm Performance: A Cross-Country Meta-Analysis." *Management Decision* (January).
6. Ararat, Melsa, and B. Burcin Yurtoglu. 2021. "Female Directors, Board Committees, and Firm Performance: Time-Series Evidence from Turkey." *Emerging Markets Review* 48: 100768. <https://doi.org/10.1016/j.ememar.2020.100768>.
7. Athar, Muhammad, Sumayya Chughtai, and Abdul Rashid. 2023. "Corporate Governance and Bank Performance: Evidence from Banking Sector of Pakistan." *Corporate Governance* 23(6): 1339–60. <https://doi.org/10.1108/CG-06-2022-0261>.
8. Baatwah, Saeed Rabea, Zalailah Salleh, and Jenny Stewart. 2019. "Audit Committee Chair Accounting Expertise and Audit Report Timeliness: The Moderating Effect of Chair Characteristics." *Asian Review of Accounting* 27(2): 273–306.
9. Bezawada, Brahmaiah, and Sager Reddy Adavelli. 2020. "Corporate Governance, Board Characteristics and Performance of Indian Banks: An Empirical Study." *International Journal of Economics and Financial Issues* 10(3): 83–87. [www.econjournals.com](http://www.econjournals.com).
10. Brogi, Marina, and Valentina Lagasio. 2022. "Better Safe than Sorry. Bank Corporate Governance, Risk-Taking, and Performance." *Finance Research Letters* 44(March): 102039. <https://doi.org/10.1016/j.frl.2021.102039>.
11. Budagaga, Akram Ramadan. 2020. "Determinants of Banks' Dividend Payment Decisions: Evidence from MENA Countries." *International Journal of Islamic and Middle Eastern Finance and Management*.
12. Danso, Albert, Theophilus A. Lartey, Daniel Gyimah, and Emmanuel Adu-Ameyaw. 2020. "Leverage and Performance: Do Size and Crisis Matter?" *Managerial Finance*.
13. Erin, Olayinka, Alex Adegboye, and Omololu Adex Bamigboye. 2022. "Corporate Governance and Sustainability Reporting Quality: Evidence from Nigeria." *Sustainability Accounting, Management and Policy Journal* 13(3): 680–707.
14. Fariha, Rifat, Md Mukarrom Hossain, and Ratan Ghosh. 2022. "Board Characteristics, Audit Committee Attributes and Firm Performance: Empirical Evidence from Emerging Economy." *Asian Journal of Accounting Research* 7(1): 84–96.
15. Al Farooque, Omar, Wonlop Buachoom, and Lan Sun. 2020. "Board, Audit Committee, Ownership and Financial Performance – Emerging Trends from Thailand." *Pacific Accounting Review* 32(1): 54–81.
16. Gupta, Neeraj, and Jitendra Mahakud. 2021. "Audit Committee Characteristics and Bank Performance: Evidence from

- India." *Managerial Auditing Journal* 36(6): 813–55.
17. Haddad, Achraf, Anis El Ammari, and Abdelfattah Bouri. 2021. "The Effect of Audit Committee Quality on the Conventional and Islamic Banks' Financial Performance between Subprime and Corona Crises." *Asian Journal of Accounting Research*.
18. Haryono, Yono, Noraini Mohd. Ariffin, and Mustapha Hamat. 2016. "Factors Affecting Credit Risk in Indonesian Islamic Banks." *Journal of Islamic Finance* 5(1): 12–25.
19. Herrera-Cano, Carolina, and Maria Alejandra Gonzalez-Perez. 2019. "Representation of Women on Corporate Boards of Directors and Firm Financial Performance." *Advanced Series in Management* 22: 37–60.
20. Hoque, Hafiz, and Heng Liu. 2021. "Capital Structure of Islamic Banks: How Different Are They from Conventional Banks?" *Global Finance Journal* (May 2020): 100634. <https://doi.org/10.1016/j.gfj.2021.100634>.
21. Hsieh, Chin Hsien, Irene Wei Kiong Ting, Jawad Asif, and Hanh Thi My Le. 2020. "The Role of Controlling Shareholders in Determining Investments of Intellectual Capital among Taiwanese Semiconductor Companies." *Journal of Intellectual Capital* 21(1): 62–86.
22. Info, Article. 2023. "Influence Board of Directors and Audit Committee on Performance Finance Company." 12(04): 1349–58.
23. Jan, Ahmad Ali, Fong Woon Lai, and Muhammad Tahir. 2021. "Developing an Islamic Corporate Governance Framework to Examine Sustainability Performance in Islamic Banks and Financial Institutions." *Journal of Cleaner Production* 315(March): 128099. <https://doi.org/10.1016/j.jclepro.2021.128099>.
24. Jensen, Michael C., and William H. Meckling. 1976. "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure." *Journal of Financial Economics* 3(4): 305–60.
25. Junior, Dermeval Martins Borges. 2022. "Corporate Governance and Capital Structure in Latin America: Empirical Evidence." *Journal of Capital Markets Studies* 6(2): 148–65.
26. Khatun, Asia, and Ratan Ghosh. 2019. "Corporate Governance Practices and Non-Performing Loans of Banking Sector of Bangladesh: A Panel Data Analysis." *International Journal of Accounting and Financial Reporting* 9(2): 12.
27. Kjosovski, Jordan, and Mihail Petkovski. 2020. "Macroeconomic and Bank-Specific Determinants of Non-Performing Loans: The Case of Baltic States." *Empirica* (0123456789). <https://doi.org/10.1007/s10663-020-09491-5>.
28. Mai, Muhamad Umar, Ruhadi Nansuri, and Setiawan Setiawan. 2024. "Ownership Structure, Board Characteristics, and Performance of Indonesian Islamic Rural Banks." *International Journal of Islamic and Middle Eastern Finance and Management* 17(2): 292–309. <https://doi.org/10.1108/IMEFM-12-2022-0465%0A>.
29. Masrizal, Raditya Sukmana, Bayu Arie Fianto, and Rifyal Zuhdi Gultom. 2022. "Does Economic Freedom Fosters Islamic Rural Banks Efficiency? Evidence from Indonesia." *International Journal of Productivity and Performance Management* ahead-of-p(ahead-of-print).
30. Merin, Melaku Aweke. 2016. "Determinants of Bank Profitability in Ethiopia : A Case Study of Private Commercial Banks." *Research Journal of Finance and Accounting* 7(7): 28–43.
31. Molla, Md. Ibrahim, Md. Saiful Islam, and Md. Kayes Bin Rahaman. 2021. "Corporate Governance Structure and Bank Performance: Evidence from an Emerging Economy." *Journal of Economic and Administrative Sciences*.
32. Morck, Randall, Andrei Shleifer, and Robert W. Vishny. 1988. "Management Ownership and Market Valuation. An Empirical Analysis." *Journal of Financial Economics* 20: 293–315.
33. Muhammad, Rifqi, Ahsin Suluki, and Peni Nugraheni. 2020. "Internal Factors and Non-Performing Financing in Indonesian Islamic Rural Banks." *Cogent Business and Management* 7(1). <https://doi.org/10.1080/23311975.2020.1823583>.
34. Musallam, Sami R.M. 2020. "Effects of Board Characteristics, Audit Committee and Risk Management on Corporate Performance: Evidence from Palestinian Listed Companies." *International Journal of Islamic and Middle Eastern Finance and Management* 13(4): 691–706.
35. Nikulin, Egor D., Marat V. Smirnov, Andrei A. Sviridov, and Olesya V. Bandalyuk. 2022. "Audit Committee Composition and Earnings Management in a Specific Institutional Environment: The Case of Russia." *Corporate Governance (Bingley)* 22(7): 1491–1522.
36. Ofoeda, Isaac. 2017. "Corporate Governance and Non-Bank Financial Institutions Profitability." *International Journal of Law and Management* 59(6): 854–75.
37. Ouma, Caren, and Recadina Y Webi. 2017. "Effect of Age Diversity of Board Members on Performance of Non-Governmental Organizations in Kenya." *International Journal of Novel Research in Marketing Management and Economics* 4(2): 101–23. [www.noveltyjournals.com](http://www.noveltyjournals.com).
38. Priyadi, Unggul, Kurnia Dwi Sari Utami, Rifqi Muhammad, and Peni Nugraheni. 2021. "Determinants of Credit Risk of Indonesian Shari'ah Rural Banks." *ISRA International Journal of Islamic Finance* 13(3): 284–301.
39. Uribe-Bohorquez, María Victoria, Jennifer Martínez-Ferrero, and Isabel María García-Sánchez. 2019. "Women on Boards and Efficiency in a Business-Orientated Environment." *Corporate Social Responsibility and Environmental Management* 26(1): 82–96.
40. Xiong, Jiakai. 2016. "Chairman Characteristics and Earnings Management: Evidence from Chinese Listed Firms." *Open Journal of Accounting* 05(04): 82–94.
41. Yahaya, Adamu, Fauziah Mahat, and M. H. Yahya. 2021. "Effect of Liquidity and Credit Risk on Banking Performance: Evidence from Sub Saharan Africa." *Journal of Economic Cooperation and Development* 42(2): 69–102.
42. Zarrouk, Hajer, Teheni El Ghak, and Elias Abu Al Haija. 2017. "Financial Development, Islamic Finance and Economic Growth: Evidence of the UAE." *Journal of Islamic Accounting and Business Research* 8(1): 2–2.
43. Ben Zeineb, Ghada, and Sami Mensi. 2018. "Corporate Governance, Risk and Efficiency: Evidence from GCC Islamic Banks." *Managerial Finance* 44(5): 551–69.

# Awareness of the Importance of Fiber Optic Installation Course Among Students of Computer System and Network Certificate Program at Melaka Community College

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**Abstract.** This research paper is a study on the awareness level of students participating in the Fiber Optic Installation Course among students of the Computer System and network Certificate Program (SSK) at Melaka Community Colleges. Fiber optics is a network cable technology that uses glass threads to transmit data in the form of light waves. As SSK students who are potential participants in the field of fiber optic installation, they should have knowledge, skills and experience that would enable them to meet industry requirements in the future. The objectives of the study are to identify the level of student awareness about the importance of fiber optic installation, to determine the level of skill proficiency in fiber optic installation, and to assess the level of understanding of fiber optic installation learning. This study was conducted using a quantitative approach with a questionnaire as the instrument. The instrument was distributed to SSK students at Kolej Komuniti Jasin (KKJS), Kolej Komuniti Masjid Tanah (KKMT) dan Kolej Komuniti Selandar (KKSL) who are taking the Fiber Optic Installation Course. Data were analyzed using IBM SPSS version 27. The findings of the study indicate that the level of awareness about the importance of fiber optic installation is high, the level of skill proficiency in fiber optic installation is high, and the level of understanding of fiber optic installation learning is also high. This shows that students have mastered the skills of fiber optic installation as a result of participating in the course.

**Keywords:** Fiber Optic Installation, Computer System and Network Certificate Program

## 1 Introduction

Fiber optic technology is a commonly used method of cable technology that uses glass threads to transmit data in the form of light waves. The rapid advancement of technology, especially in the field of telecommunications, has led industry players to focus on the latest development in fiber optic cables to provide communication lines that are in line with the needs of the Industry Revolution 4.0. Technological advancements in education have made the technology sector a cornerstone for the future development of the education system in Malaysia. According to the Ministry of Education's report (2013), the Malaysian Education Development Plan (PPPM) 2013-2025 emphasizes that information and communication technology must be enhanced through quality curriculum plans at higher education institutions in Malaysia to produce a competitive generation ready to face the challenges of the industrial revolution 4.0.

The Computer Systems and Networking Certificate Program (SSK) is offered at 19 Community Colleges in Malaysia, including three in Melaka, namely Kolej Komuniti Jasin (KKJS), Kolej Komuniti Masjid Tanah (KKMT), and Kolej Komuniti Selandar (KKSL). This SSK program is designed to produce semi-professional graduates in computer networking, in line with the latest technological developments. In this program, students are exposed to skills in network system wiring, network system configuration, and network management. The syllabus related to network systems includes the Network Technology SSK20353 course offered to second-semester students, which encompasses ten assignments in continuous assessment and a practical final exam to evaluate student achievement.

The syllabus content for the Network Technology course includes four topics: network cable technology, network cable termination, network wings, and the installation of wired and wireless network equipment. Based on the syllabus requirements, students will learn to use coaxial cables and fiber optic cables to carry out evaluations. Adequate coaxial cable equipment ensures a smooth teaching and learning process, but this is not the case with fiber optic cables. This constraint has led course lecturers to seek alternative ways to optimize student knowledge by conducting fiber optic installation courses, supported by the industry, particularly in terms of providing equipment related to fiber optic installation.

According to Nur Ishah (2020), exposure to skills courses can accelerate knowledge acquisition and foster creative thinking among students. The study's findings can demonstrate the importance of the course, the level of skill proficiency, and student understanding related to fiber optic installation, thus contributing to improvements in the teaching and learning process.

## 2 Objective

The objective of this study is:

- i. To identify the level of student awareness about the importance of fiber optic installation.
- ii. To identify the level of skill proficiency in fiber optic installation.
- iii. To identify the level of student understanding of the learning process in fiber optic installation.

## 3 Literature Review

According to Abdullah et al. (2001), the diverse processes of teaching and learning influence how students understand the approaches emphasized by lecturers in lectures. It is not merely about the delivery of knowledge but also about ensuring that students can master other self-skills such as communication skills and critical thinking skills. Polyxeni (2017) states that good lecture management strategies help lecturers assess the teaching and learning process. Meanwhile, Rathaneswary et al. (2022) state that the role of higher education institutions, such as community colleges, is to emphasize skills among students in line with industry needs, making skill-based learning processes particularly necessary for technical courses. Students are exposed to knowledge and understanding to adapt theoretical and practical learning as preparation for entering the real working world (Nelson, 2007).

Based on Kolb, D.A. (2015), practical learning provides students with the experience of handling activities by interacting with objects and understanding the concepts of processes, including learning technical skills. Technical skills among higher education students are crucial to ensure they can meet industry job requirements. Emphasis on technical skills for SSK students in community colleges involves the Fiber Optic Installation Course. The widespread use of fiber optic cable technology necessitates that students possess the requisite knowledge and technical skills. Sarikaya Erdem et al. (2019) conclude that students with technical skills have an advantage and greater confidence in preparing themselves for the real working world.

Several factors influence lecturers' readiness to implement skills courses as opportunities for students to acquire technical skills through the courses offered. According to Sharifah Hamidah et al. (2022), these factors include students' ability to adapt to the latest technological changes, ensuring that students have skills that match the courses to meet industry needs, and providing feedback on curriculum planning directed toward technical courses in line with the needs of the Industry 4.0 revolution.

## 4 Methodology

Descriptive and inferential method of a sample survey was used as a research design, which is to survey the level of awareness in the importance of improving the skills of students in the Computer Systems and Networking programme. The scope of research is within the state of Melaka. According to Sabitha Marican (2005), the questionnaire instrument used for analysis is a tool that is specifically formed to answer research questions. Even Sherri L. Jackson (2006) also stated that it is also an in-depth study of one or more individuals in the hope of revealing the truth. The study respondents consisted of students in the second semester of the Computer and Network Systems programme from Kolej Komuniti Jasin, Kolej Komuniti Masjid Tanah and Kolej Komuniti Selandar with a total of 45 students. The selection of the sample is because students of the second semester of the Computer Systems and Networking Program have followed the Fibre Optic Installation course. The teaching and learning technique used by the lecturer to teach this course is in the form of demonstration and suitable for this study.

Since this study is in the form of a social study, the type of research instrument chosen is a questionnaire method constructed by the researcher himself. The questionnaire has four (4) parts, namely Part A contains demographic information, Part B contains information on program evaluation, Part C contains information on the evaluation of the effectiveness of the program on participants and Part D contains information on comments and suggestions for improvement purposes. A Likert Scale is used to conduct this survey because the researcher will be able to control the feedback from the respondents without bias. This scale will express Strongly Disagree, Disagree, Slightly Disagree, Agree and Strongly Agree. The scale will be given starting from the number 1 to 5 as in the Likert Scale Table.

**Table 1.** Likert Scale

Scale	Interpretation
1	Strongly Disagree
2	Disagree
3	Slightly Disagree
4	Agree
5	Strongly Agree

All the respondents involved have filled out the questionnaire online using Google Form after all the students has followed the Fibre Optic Installation Course completely and successfully. Respondents' answers were analysed statistically and descriptively for the researcher to obtain the mean by using SPSS software. In this study, the researcher used the interpretation of the mean score to answer the questions in Part B and C. Questionnaire was used as an instrument for all the questions. The interpretation

of the findings from the questionnaire is analysed as in the Mean Score Interpretation Table.

**Table 2.** Mean Score Interpretation Table

Group	Range	Level of Inclination
1	1.00 – 2.33	Low
2	2.34 – 3.67	Average
3	3.68 – 5.00	High

(Source: Adaptation from Jamil Ahmad, 2002)

## 5 Analysis and Discussion

The researcher analyses and discusses the findings of this study through two aspects: the evaluation of program implementation and the assessment of program effectiveness among students of the Computer Systems and Networking Certificate Program (SSK) at the Community College in Melaka. The researcher found that both study variables are at a very high level. Information collected from respondents is analysed and presented in descriptive statistical form to elucidate findings based on the study's objectives.

### 5.1 Comprehensive Information on Respondent Demographics

Based on Table 3, the demographic analysis of program participants reveals several key findings that can be summarized with a critical academic approach. Regarding gender, most participants are male, numbering 28 individuals (62.2%), compared to 17 females (37.8%). Regarding ethnicity, the program participants are predominantly Malay, with 39 individuals (86.7%), followed by Indian participants with 5 individuals (11.1%), while Chinese and other ethnicities are represented by 0 and 1 individual(s) (2.2%), respectively.

Within the context of study programs, all participants are from the SSK program (100%), with no participants from the STM program. The distribution of participants according to their study semester shows that the majority are in the second semester, with 25 individuals (55.6%), followed by the third and fourth semesters, each with 10 individuals (22.2%). There are no participants from the first semester.

Most participants are students from the Kolej Komuniti Jasin, numbering 27 individuals (60.0%), followed by 13 individuals (28.9%) from the Kolej Komuniti Selandar, and 5 individuals (11.1%) from the Kolej Komuniti Masjid Tanah. Regarding the program's novelty as an activity, most participants view it as a new activity, with 40 individuals (88.9%) perceiving it as such, while only 5 individuals (11.1%) do not share this view. Lastly, in terms of attendance, all participants attended the program voluntarily (100%) without any compulsion.

Overall, this analysis indicates that the program has attracted the interest and participation of a diverse group of participants, particularly regarding gender and ethnicity. However, there is an imbalance in gender and ethnic distribution that may have implications for the program's diversity and inclusivity. Additionally, the high involvement from the second semester may reflect a more suitable scheduling or greater interest among students at this stage. This suggests that program coordinators may need to consider more effective strategies to attract better balanced participation across various semesters, ethnic backgrounds, and genders. This is crucial to ensure the effectiveness and accessibility of the program to all students.

**Table 3.** Demographic Analysis of Students in the Computer Systems and Networking Certificate Program (SSK) at the Melaka Community College

CATEGORY		QUANTITY, N	PERCENTAGE, %
Gender	Male	28	62.2
	Female	17	37.8
Ethnicity	Malay	39	86.7
	Chinese	0	0
	Indian	5	11.1
	Others	1	2.2
Study Program	STM	0	0
	SSK	45	100
Study Semester	1	0	0
	2	25	55.6
	3	10	22.2
	4	10	22.2
Community College	Kolej Komuniti Jasin	27	60.0
	Selandar Community College	13	28.9
	Masjid Tanah Community College	5	11.1
Program as a New Activity	Yes	40	88.9
	No	5	11.1
Attendance	Voluntary	45	100
	Compulsory	0	0

## 5.2 Respondents' Evaluation of the Implementation of the Fiber Optic Installation Course Among Students of the Computer Systems and Networking Certificate Program at the Melaka Community College

Descriptive analysis of the data obtained from item B in Table 4 can be summarized as indicating that the program has shown high effectiveness in various aspects of evaluation by participants. The overall mean value for item B is 4.74, with a standard deviation of 0.49, indicating positive and consistent perceptions from participants towards this program.

Each item in Category B shows a high mean value. The overall evaluation of the program content (B1) received a mean value of 4.69 and a standard deviation (SD) of 0.51, indicating that the program content was well-received by participants. The achievement of program objectives (B2) has a mean value of 4.62 and an SD of 0.71, reflecting the program's success in achieving its set goals despite greater variation in participants' perceptions. The program's structure (B3) and the suitability of the program duration (B4) each recorded mean values of 4.71 and 4.73 with SDs of 0.45 and 0.49, respectively, indicating that the program's structure and duration are appropriate and effective.

The program location (B5) shows a mean value of 4.76 and an SD of 0.56, indicating the suitability of the location with the needs of the participants. The delivery of information by facilitators (B6) and the use of teaching aids (B7) each recorded mean values of 4.73 and 4.78 with SDs of 0.56, showing that the facilitators and teaching aids played an effective role. The planning and implementation of the program (B8) with a mean value of 4.76 and an SD of 0.46 indicate that the program was executed smoothly. The time allocated for each session (B9) is appropriate with a mean value of 4.82 and an SD of 0.38, suggesting that the time provided was sufficient for each session. The provision of meals (B10) and the collaboration of the organizers (B11) each recorded mean values of 4.71 and 4.78 with SDs of 0.45 and 0.42, indicating participants' satisfaction with logistical aspects and the organizers' cooperation.

Overall, this descriptive analysis shows that the program has successfully met the needs and expectations of participants in various aspects, from content and objectives to implementation and facility provision. The low standard deviation (SD) in most items indicates consistency in participants' evaluations, reinforcing the credibility of these survey results. The program can be concluded as highly effective and satisfactory, demonstrating high awareness among students about the importance of fiber optic installation and good preparation in meeting industry requirements.

**Table 4.** Distribution of Respondents' Evaluation of the Implementation of the Fiber Optic Installation Course

ITEM NUMBER	ITEM	MIN	SD	LEVEL
B1	Overall evaluation of the program content.	4.69	0.51	High
B2	Achievement of program objectives.	4.62	0.71	High
B3	The program content is very appropriate.	4.71	0.45	High
B4	Appropriateness of the program duration.	4.73	0.49	High
B5	The location of the program is appropriate.	4.73	0.49	High
B6	The delivery of information and instructions by the facilitator is good and effective.	4.76	0.56	High
B7	The use of teaching aids is effective.	4.78	0.42	High
B8	The planning and execution of the program were smooth.	4.76	0.48	High
B9	The allocated time for each session is appropriate.	4.82	0.38	High
B10	The provision of food throughout the program is satisfactory.	4.71	0.45	High
B11	The cooperation of the organizing committee is very satisfactory.	4.78	0.42	High
	Overall Min Value	4.74	0.49	High

## 5.3 Evaluation of the Effectiveness of the Fiber Optic Installation Course Among Students of the Computer Systems and Networking Certificate Program at the Melaka Community College

Based on the data obtained from item C in Table 5, it can be summarized that the fiber optic installation program has successfully enhanced the participants' skill mastery and understanding to a high degree. Each measured item shows consistently high mean values with an overall mean value of 4.69, and the standard deviation falls within an acceptable range (0.40 to 0.67), indicating uniform and positive perceptions from participants regarding the effectiveness of this program.

Specifically, item C1 with a mean value of 4.80 and an SD of 0.40 shows that participants have a strong understanding of the basics of fiber optic installation (fusion splicing). Practical training (C2) with a mean value of 4.78 and an SD of 0.42 also indicates that the training provided was sufficient to aid participants' understanding. The effectiveness of the tools used in the program (C3) received a mean value of 4.60 and an SD of 0.65, indicating that the provided tools functioned well. Participants' confidence in performing fiber optic installation (C4) also increased, with a mean value of 4.71 and an SD of 0.50. The skills learned were deemed useful for future careers (C5) with a mean value of 4.64 and an SD of 0.67, indicating the program's relevance to industry needs. Participants' recommendation for the program (C6) received a mean value of 4.60

and an SD of 0.65, signifying that they are willing to recommend the program to others. The overall program evaluation (C7) with a mean value of 4.71 and an SD of 0.50 indicates that the program was successful and beneficial to the participants.

Overall, this descriptive analysis shows that the fiber optic installation program has effectively achieved its objectives, and enhanced participants' skill mastery and understanding, while also providing high levels of confidence and satisfaction. The low standard deviation in several items indicates that participants' evaluations are consistent, adding credibility to the survey results.

**Table 5.** Distribution of the Evaluation of the Effectiveness of the Implementation of the Fiber Optic Installation Course

ITEM NUMBER	ITEM	MIN	SD	LEVEL
C1	This program helps me understand the basics of fiber optic installation (fusion splicing).	4.80	0.40	High
C2	The practical training during this program is sufficient to aid my understanding.	4.78	0.42	High
C3	The equipment provided in this program is adequate and functions well.	4.60	0.65	High
C4	This program can enhance my confidence in performing fiber optic installation.	4.71	0.50	High
C5	The skills learned in this program are useful for my future career.	4.64	0.67	High
C6	I will recommend this program to my colleagues.	4.60	0.65	High
C7	Overall, this program is successful and beneficial to me.	4.71	0.50	High
Overall Min Value		4.69	0.54	

## 6 Conclusion and recommendations

In conclusion, the descriptive analysis of the implementation and effectiveness of the fiber optic installation course among students of the Computer Systems and Networking Certificate Program (SSK) at the Melaka Community College indicates that this program is highly effective, with high levels of satisfaction and skill mastery. With overall high mean values and low standard deviations, participants reported significant improvements in their understanding and confidence regarding fiber optic installation. Despite the imbalance in participation concerning gender and ethnicity, the program successfully attracted students from diverse backgrounds and was attended voluntarily. For the future, it is recommended that program coordinators strive to achieve more balanced participation to ensure greater effectiveness and inclusivity.

## References

1. B. C Nelson (2007). Exploring the use of individualized reflective guidance in and educational multiuser virtual environment. *J. Sci. Educ. Technol.*, vol16, no 1, pp 83-97.
2. D. Rathaneswaary & Y. M. Ruhizan (2022). Tahap Pengetahuan, Penerimaan, Kesiediaan dan Amalan Pengajaran Guru Pemulihan Khas Terhadap Pengajaan Terbeza. *Malaysian Journal of Social Sciences and humanities (MJSSH)*, 7(4), e001445.
3. H. Abdullah, M. Ainol (2001). Kursus Berfikir untuk Kolej dan Universiti. Kuala Lumpur. PTS Publications and Distributors Sdn Bhd.
4. I. Nur Ishah (2020). Kesedaran Penggunaan Teknologi Fiber Di Kalangan Pelatih ILKBS. *Skills Malaysian Journal*, Vol.6 No 1, p. 7-12
5. Jamil Ahmad. (2002). Pemupukan Budaya Penyelidikan di Kalangan Guru di Sekolah: Satu Penilaian.
6. Tesis Ijazah Kedoktoran, Fakulti Pendidikan: Universiti Kebangsaan Malaysia.
7. Kolb, D. A. (2015). *Experiential Learning: Experience as the Source of Learning and Development*.
8. Kementerian Pendidikan Malaysia. (2013). *Pelan Pembangunan Pendidikan Malaysia 2013-2025*
9. Polyxeni, M. (2017). Practical implementation of differentiated teaching during school age. *British Journal of Education, Society & Behavioural Science*, 19(3), 1-8.
10. S.H. Sharifah Hamidah, H. Hasrizam, Z. A. Hasnidah (2022). Tahap Kesiediaan Pensyarah Dalam Bidang Sains dan Teknologi di Kolej Komuniti Bersasar Sebagai Pemudahcara: Program Techno-preneur (Robotik) In *Borneo National Conference*
11. Sherri L. Jackson. (2006). *Research Methods and Statistics: A critical thinking approach*. United States: Thomson Wadsworth.
12. Sabitha Marican (2005). *Kaedah Penyelidikan Sains Social*. Petaling Jaya, Selangor. Pearson Prentice Hall.
13. Sarıkaya Erdem, Y., & Yıldırım, A. (2019). Effective Teaching and Learning at Vocational Education at Tertiary Level: A Qualitative Study of Teachers', Students' and Administrators' Perceptions. *Trends in Vocational Education and Training Research*, Vol. II. Proceedings of the European Conference on Educational Research (ECER), Vocational Education and Training Network (VETNET), II, 366–375.



# Exploring Teachers' Perception of the Implementation of Employability Skills Among Students with Disabilities in Vocational Settings

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**Abstract.** Employability skills are an important aspect of graduate preparation, especially for students with disabilities. However, employers state that the employability skills of students with disabilities, particularly communication skills, are only at a moderate level. This study aims to explore teachers' perception of the implementation of employability skills for students with disabilities in the vocational setting. The study was conducted qualitatively by interviewing three vocational special education teachers with over 10 years of experience in the field. Thematic analysis was used to identify key themes. The themes that emerged in the implementation of employability skills for students with disabilities, based on the teachers' perspectives, include career transition programs, entrepreneurship programs, and visits to the industrial sector. Through these three steps, students with disabilities have the opportunity to learn about the environment and equipment used in the industrial sector. Additionally, students can become independent in managing their lives and generating their own income through the prescribed training. In conclusion, there is a need for schools and special education teachers to place greater emphasis on enhancing the self-sufficiency and self-reliance of students with disabilities before they graduate.

**Keywords:** perception, employability skills, students with disabilities, vocational

## 1 Introduction

Technical and Vocational Education and Training (TVET) is an educational system that generally emphasises the industrial sphere and has promising job prospects (Kwami, 2024; Nor Zulia Samiran, Kama Shaffeei, et al., 2024). As an effort to increase the potential of students with disabilities, TVET can train these students as a preparatory measure prior to them entering the workforce and it could also expose students with disabilities to the working environment while they are still in school (Rusli, 2024). Generally, there are four Special Needs Secondary Schools that offer a Vocational stream for students with disabilities that are Sekolah Menengah Pendidikan Khas Vokasional (SMPKV) Shah Alam, SMPKV Indahpura, SMPKV Merbok dan SMPKV Kuantan. Therefore, students with disabilities who have various functionalities stand a chance to venture into the vocational field and increase their personal development and potential.

One of the criteria that employers want in an employee is employability skills. Similar to technical skills, employability skills are one of the important aspects of an individual's work skills but it is regarded as a non-technical ability (Yusof et al., 2017). Employers might consider an individual without employability skills to be lacking in quality even though the individual possesses good technical skills. As an effort to increase the job opportunities for students with disabilities, the former and fifth Prime Minister of Malaysia urged employers to open up more job opportunities for these students in order for them to gain independence and take part in economic development.

Although there have been efforts to assist students with disabilities, studies by (Khaizer Omar et al., 2022; Nasrul et al., 2022; Noor Fazlina Abd Kadir, 2018) found that some disabled or Orang Kurang Upaya (OKU) graduates were forced to be self-employed as there is a low acceptance for them to work from the industry. This is caused by society's negative stigma that looks down on those who are disabled. This lasting stigma has resulted in certain employers being unprepared to give job opportunities to those who are disabled.

In another study by Adulyasas et al., (2024); Bhawra and Sharma, (2024) stated that the skill level possessed by students is still low and furthermore, employability skills such as communication skills among individuals with special needs relating to intellectual disabilities are at an average level and they also lack confidence (Jalil et al., 2021). In the same study, it was revealed that from the employers' perspective, they emphasised the need for students to be given career training prior to the students entering the workforce as a way to prepare them and hone their employability skills (Scheef, 2023).



Meanwhile, findings from studies conducted by Gupta et al., (2023); Saad et al., 2023; Schriemer et al., (2022) also showed that from the perspective of employers, the employability skills of individuals with hearing problems are at an average level whereby they give commitment and attain good achievements while working but their 3M skills (Reading, Writing,

Counting) along with their thinking skills were found to be poor (Syazwan Zainal et al., 2020). Employability skills are now regarded as an important aspect and there are high demands for it in the job market. Currently, the paradigm shift in the nation's economy requires a change in education that is directed towards the needs of a particular individual. Therefore, the attitude and readiness that graduates possess to attain employability skills required by the industry must be emphasised before they enter the job market.

Thus, there is a need to explore the implementation of employability skills among students with disabilities from the perspective of teachers. Through this study, strategies could be suggested to increase the implementation of employability skills among students with disabilities. Thus, this study is conducted to answer the following research question:

- (i) What is the teacher's perception of the implementation of employability skills for students with special needs in the vocational stream?

## 2 Literature Review

### 2.1 The concept of employability skills

Employability is defined as a skill or ability possessed by an employee that could attract the attention of future employers to offer a job opportunity to them. Employability skills are important because it is one of the causes of unemployment (Maharam Mamat et al., 2019). Graduates' lack of preparation in honing their employability skills could cause them to experience difficulty in securing employment. In previous research, employability is defined as a set of skills and personality traits that are crucially needed by employers and at the same time, needed by graduates to obtain a job (Behle, 2020; Römgers et al., 2020). According to the SCANS model (1991), there are a few main characteristics of employability skills that are important and needed by employers and these characteristics are generic skills, personal qualities, and work competence. The research has identified seven main competencies and 40 items relating to employability skills required during the early stages of employment. The seven main competencies are (1) basic skills, (2) thinking skills, (3) resource management skills, (4) informational skills, (5) interpersonal skills, (6) system and technology skills, and (7) personal qualities (Abelha et al., 2020; Fajaryati et al., 2020; Halik Bassah & Mohd Noor, 2023; Sattar et al., 2009). In short, this model consists of three main parts for skills and personal qualities that are needed for solid job performance.

Individuals who possess high employability skills have an advantage and a chance to gain employment (Cheng et al., 2022; Jackson & Bridgstock, 2021). Therefore, graduates need to prepare themselves with the aforementioned skills in order to have the chance to successfully overcome the challenging competition of participating in the job market nowadays. Schools and training institutions play a role in applying the aspects of employability skills through the learning curriculum (Bhatti et al., 2023; Cheng et al., 2022). Teachers and educators should also fulfill their role in delivering knowledge of employability skills through the learning activities that they implement for their students (Sarkar et al., 2020). This is to enable the students to immerse themselves in and appreciate that knowledge before they leave school to participate in the workforce. Thereby, schools will be able to produce students who have excellent and high-quality personalities before they head into their respective careers.

In the context of those who have disabilities, this model could be a reference as needed in providing specific training and support based on their ability to develop their employability skills. Meanwhile, in the context of special education, students with disabilities should also learn and possess employability skills since it is one of the requirements in the industry (Verulava & Bedianashvili, 2021). Possessing certain aspects of employability skills could assist them in going through life and interacting with their community well. Additionally, employers in the industrial sector are of the opinion that the aspect of employability skills is important and must be possessed by their employees to ensure any particular employee is skilled in their work.

### 2.2 TVET for special education

The aim of the Special Education Curriculum is to provide knowledge and skills through a flexible teaching and learning process that could fulfill the needs of individuals with various levels of abilities to lead a meaningful life (Francisco et al., 2020). As a way to fulfill the Malaysian Education Blueprint (MEB), the Malaysian Ministry of Education (MOE) has introduced vocational programs for students with disabilities since these students are also capable of contributing to the nation's economic growth (Adams, 2022; Ramlee Mustapha & Mohd Azlan Mohammad Hussain, 2022). Technical and Vocational Education for students with disabilities is more flexible, focused, interesting, and suited to the students' abilities. Through vocational education, individuals with disabilities stand a chance to undergo job-related skills training that could assist them to become more independent in supporting their own livelihood similar to other typical individuals.

Curriculum development for specific vocational skills subjects (SVS) is based on the National Occupational Skills Standards (NOSS) released by the Department of Skills Development. An initiative of the Special Education Department in MOE to empower the marketability of students with disabilities is the Career Transition Program (CTP) that was introduced in 2019 (Meng et al., 2023; Syazwan Zainal et al., 2021). CTP is intended to increase the readiness of students with disabilities from the aspect of their soft skills or employability skills in order for them to be able to voice their intentions or advocate for

their rights (Mohd Yusoff & Khairuddin, 2024; Syazwan Zainal, 2023). There are six components applied in this module that are life skills, self-advocate and communication skills, cultivating adult-life skills, career skills, career readiness, and support development in the workplace. Concisely, it could be seen that this module is designed specifically to encourage elements of employability skills in students with disabilities. This effort is in accordance with MOE's hope to obtain recognition for students with disabilities from external agencies and increase these students' marketability.

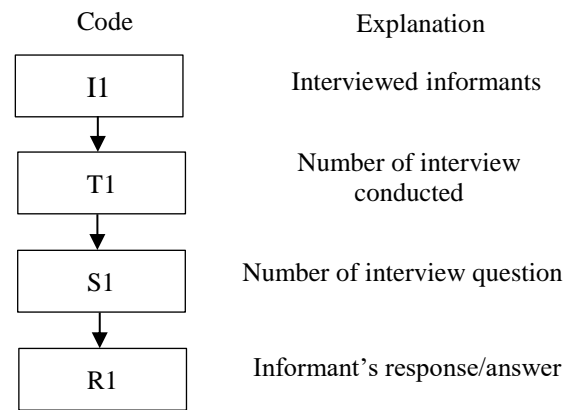
### 3 Methodology

The research design for this study is a qualitative study. This study involved observations, interviews with the respondents, and document analysis to support the findings of the study. In the context of this study, the interviews conducted were aimed to explore the perspective of special education teachers concerning the implementation of employability skills for students with disabilities in the vocational stream.

The research sample consisted of three special education teachers who possess more than 10 years of experience in the special education field. These teachers also have experience in teaching specific vocational skills subjects (SVS) for students with disabilities. This study was conducted in a Special Needs Secondary School and a vocational-stream Integrated Special Education Program (ISEP) National Secondary School in Selangor and Perak. The interview sessions were conducted online by contacting the informants individually. Each interview was conducted separately due to the informants' differing schedules and lasted about one hour. Before concluding, the informants were given a consent form.

All the data that were found along with the interview data from the questionnaire were analysed through thematic analysis (Peel, 2020). As such, the analysis was done by categorising the data and developing suitable themes to answer the research question in this study (Braun & Clarke, 2022; Kiger & Varpio, 2020).

For analysing data, a coding system was utilised to facilitate the process of identifying data types and research questions.. Researchers have adapted the coding system method used in Fathiyah et al. (2023). An example of the code system used by the researcher is shown in Figure 1.



**Fig.1.**Code system

Based on Figure 1, an example of the code system used in this study is I1T1-S1R1. Here, I1 represents the first informant interviewed, T1 indicates the number of interview sessions conducted, S1 refers to the question number, and R1 denotes the response to the question asked during the interview. Five informants, coded I1 to I5, were interviewed to explore attributes relevant to the 4IR generic skill constructs. Subsequently, a matrix analysis was conducted to facilitate comparison and extract themes of the 4IR generic skill attributes. This method aligns with the researcher's perspective, as supported by Meriam & Tisdell (2016), where the analysis relies on the researcher's creativity.

### 4 Finding and Discussions

From the data analysis process, there were five themes that were identified based on the feedback received from the research respondents who were interviewed.

The aim of the study is to explore teachers' perspectives on students' employability skills and their form of implementation. Based on the interviews that were conducted, the research respondents were not very familiar with the term 'employability skills'. However, after an explanation was given by the researcher, it was found that the teachers used other terms that have the same meaning as the definition of employability skills. From the aspect of the form of the curriculum being used, all the respondents were of the opinion that the curriculum specifications that were used for specific vocational skills are under the Department of Skills Development.

From the aspect of the training of employability skills, there are numerous programs that were implemented to encourage students' employability skills. All the research respondents stated that the implementation method used to encourage employability skills among students with disabilities is through the career transition program. The career transition program

is an educational program that was created to be a catalyst for the actualisation of workers who have potential in line with the education philosophy (Yusof et al., 2017). Additionally, I1 also claimed that there are three forms of training that were prepared for students with disabilities that is through the Core Abilities Program set by the Department of Skills Development for vocational schools in Malaysia. The Core Abilities Program was introduced by the Department of Skills Development in 2006 and consists of four levels for the application of employability skills elements. Apart from that, there are also internal programs provided by schools such as the entrepreneurship program. Lastly, there is also an initiative carried out by the panel and teachers of vocational skills that involves taking students with disabilities in the vocational stream on study tours to government-owned or private industrial companies. Aside from that, I2 and I3 stated that, usually, they would also implement elements of employability skills in their teaching and learning sessions through the core subjects such as Bahasa Melayu, English, and etcetera.

Moving on to the effects of the implementation of employability skills on the students' future, based on the teachers' perspective, I1 believed that it is now possible for students with disabilities to know the environment and tools used in the industrial sector. Furthermore, students could also be independent in managing their lives and they are capable of generating their own income through the training provided by the teachers such as the entrepreneurship program and other similar initiatives. This statement was supported by I3 who claimed that students could now stand on their own two feet and experience life without the need to be dependent on others.

As for the aspect of assessment of employability skills, it was found that in this aspect, the respondents have differing opinions. I1 stated that employability skills could not be assessed and there is no performance record of that particular skill kept by the school. I1 also claimed that teachers in their particular school focus more on providing the skills training that is necessary for students to pass and obtain the Malaysian Skills Certificate (SKM) and thus, they focus less on employability skills. From the perspective of I2 and I3, both respondents stated that employability skills are also assessed through core subjects and moreover, the performance of students with disabilities in these assessments is recorded in the Individual Education Plan (RPI).

**Table 1.** Summary of themes & sub-themes of teachers' perspectives

Themes and sub-themes	I1	I2	I3
Employability Skills Development Activities			
Career Transition Program	/	/	/
Entrepreneurship Program	/		
Study tours to the industrial sector	/	/	/

## 5 Conclusion

In this study, the researchers have explored the perception of special education teachers concerning the employability skills of students with disabilities in the vocational stream. This study examined how employability skills are encouraged and implemented by schools and teachers towards students with disabilities. The findings of the study show that the implementation of employability skills is carried out in the schooling stage. This is due to the early exposure received by students with disabilities in the vocational stream through their schooling by following the curriculum measures set by the Department of Skills Development (JPK).

From the aspect of implications for the educational field, the findings of this study could provide insight for the authorities regarding the importance of the implementation of employability skills for students with disabilities. Therefore, the related parties could take the initiative to create a module or any special education program for students with disabilities that is intended to encourage employability skills among students with disabilities in schools. Readyng these students with skills could be one of the initiatives taken to produce students who are proficient and capable of contributing towards the growth of the nation.

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## References

1. Abelha, M., Fernandes, S., Mesquita, D., Seabra, F., & Ferreira-Oliveira, A. T. (2020). Graduate employability and competence development in higher education-A systematic literature review using PRISMA. *Sustainability (Switzerland)*, 12(15). <https://doi.org/10.3390/SU12155900>
2. Adams, D. , & T. K. L. (2022). *Malaysian Education System: Progress, Standards and Aspirations In Education in Malaysia* . Routledge.

3. Adulyasas, L., Puripanyanan, P., & Tanomlikhitwong, J. (2024). Enhancing number and algebra skills of primary students with learning disabilities or low mathematics achievement through a smartphone application. *Eurasia Journal of Mathematics, Science and Technology Education*, 20(5). <https://doi.org/10.29333/ejmste/14482>
4. Behle, H. (2020). Students' and graduates' employability. A framework to classify and measure employability gain. *Policy Reviews in Higher Education*, 4(1), 105–130. <https://doi.org/10.1080/23322969.2020.1712662>
5. Bhatti, M., Alyahya, M., Alshiha, A. A., Qureshi, M. G., Juhari, A. S., & Aldossary, M. (2023). Exploring business graduates employability skills and teaching/learning techniques. *Innovations in Education and Teaching International*, 60(2), 207–217. <https://doi.org/10.1080/14703297.2022.2049851>
6. Bhawra, S., & Sharma, S. K. (2024). Anatomizing the Mathematical Disabilities in Students-Biological Factors, Gender Factors, Environmental Factors. *AIP Conference Proceedings*, 3087(1). <https://doi.org/10.1063/5.0199491>
7. Braun, V., & Clarke, V. (2022). Conceptual and design thinking for thematic analysis. *Qualitative Psychology*, 9(1), 3–26. <https://doi.org/10.1037/qup0000196>
8. Cheng, M., Adekola, O., Albia, J., & Cai, S. (2022). Employability in higher education: a review of key stakeholders' perspectives. *Higher Education Evaluation and Development*, 16(1), 16–31. <https://doi.org/10.1108/heed-03-2021-0025>
9. Fajaryati, N., Budiyo, B., Akhyar, M., & Wiranto, W. (2020). The employability skills needed to face the demands of work in the future: Systematic literature reviews. *Open Engineering*, 10(1), 595–603. <https://doi.org/10.1515/eng-2020-0072>
10. Francisco, M. P. B., Hartman, M., & Wang, Y. (2020). Inclusion and special education. *Education Sciences*, 10(9), 1–17. <https://doi.org/10.3390/educsci10090238>
11. Fathiyah, M. K., Roszilah, H., Azrul, A. A., Rasul, M. S., Omar, M. & Mohd Fakhrul Azizie, M. Z. (2023). Exploration and Verification of 4IR Generic Skills Attributes for Entry-Level Civil Engineers. *International Journal of Evaluation and Research in Education*, 12(1), 121-130.
12. Gupta, S., Jaiswal, A., Sukhai, M., & Wittich, W. (2023). Hearing disability and employment: a population-based analysis using the 2017 Canadian survey on disability. *Disability and Rehabilitation*, 45(11), 1836–1846. <https://doi.org/10.1080/09638288.2022.2076938>
13. Halik Bassah, N. S., & Mohd Noor, M. A. (2023). Employability Skills Needed for TVET Graduates in Malaysia: Perspective of Industry Expert. *Online Journal for TVET Practitioners*, 8(1). <https://doi.org/10.30880/ojtp.2023.08.01.005>
14. Jackson, D., & Bridgstock, R. (2021). What actually works to enhance graduate employability? The relative value of curricular, co-curricular, and extra-curricular learning and paid work. *Higher Education*, 81(4), 723–739. <https://doi.org/10.1007/s10734-020-00570-x>
15. Jalil, A., Tohara, T., Shuhidan, S. M., Diana, F., Bahry, S., & Norazmi Bin Nordin, M. (2021). Exploring Digital Literacy Strategies for Students with Special Educational Needs in the Digital Age. In *Turkish Journal of Computer and Mathematics Education* (Vol. 12, Issue 9).
16. Khaizer Omar, M., Che Mat, H., Hazwan Mohd Puad, M., & Yaakub, M. (2022). Can we get a job? Employability skills acquisition during educational experience of student with disability. *International Journal of Social Science Research (IJSSR)*, 4(1), 115–123. <http://myjms.mohe.gov.my/index.php/ijssrJournalwebsite:http://myjms.mohe.gov.my/index.php/ijssr>
17. Kiger, M. E., & Varpio, L. (2020). Thematic analysis of qualitative data: AMEE Guide No. 131. *Medical Teacher*, 42(8), 846–854. <https://doi.org/10.1080/0142159X.2020.1755030>
18. Kwami, A. (2024). Repositioning technical vocational education and training (TVET) for youth empowerment and entrepreneurship: An agenda for renewed hope in Nigeria. In *Advanced Journal of Research in Education* (Vol. 9, Issue 2).
19. Maharam Mamat, Dayana Daiman, Rahani Mohd Musa, Nur Athirah Irmah, Wong Kok Mun, & Yong Voon Yau. (2019). Kebolehpekerjaan Graduan Institut Latihan Perindustrian Kuala Langat, Selangor. *Jurnal Pengajian Umum Asia Tenggara*, 20, 46–63. <https://doi.org/10.17576/malim-2019-2001-05>
20. Meng, T. Y., Hanafi, M., & Yasin, M. (2023). *Implementation of Career Transition Program for Students with Learning Disabilities in Sabah*.
21. Mohd Yusoff, N. L., & Khairuddin, K. F. (2024). Readiness of Special Education Teachers in the Implementation of a Career Transition Programme for Students with Special Educational Needs in Malaysian Island Schools. *International Journal of Academic Research in Progressive Education and Development*, 13(2). <https://doi.org/10.6007/ijarped/v13-i2/21164>
22. Nasrul, M., Noor, M., Binti Madzen, U., Marzuqi, A., & Azzahari, M. (2022). A study on impacts of unemployment among person with disabilities during covid-19 pandemic. *International Journal for Studies on Children, Women, Elderly and Disabled*, 17.
23. Noor Fazlina Abd Kadir. (2018). *A study of employment opportunities for persons with disabilities in the public sector in Kedah*. Universiti Utara Malaysia.
24. Nor Zulia Samiran, Kama Shaffeei, & Abdul Rahim Razalli. (2024). Kesediaan guru dalam pelaksanaan Sijil Kemahiran Malaysia di Program Pendidikan Khas Integrasi bagi murid berkeperluan pendidikan khas. *Jurnal Pendidikan Bitara UPSI*, 17(1), 30–36. <https://doi.org/10.37134/bitara.vol17.1.3.2024>
25. Peel, K. L. (2020). beginner's guide to applied educational research using thematic analysis. *Practical Assessment, Research and Evaluation*, 25(1), 1–16. <https://doi.org/10.7275/rvr5-k983>
26. Ramlee Mustapha, & Mohd Azlan Mohammad Hussain. (2022). *Vocational education and training in Malaysia*. Springer Nature Singapore.

27. Römogens, I., Scoupe, R., & Beausaert, S. (2020). Unraveling the concept of employability, bringing together research on employability in higher education and the workplace. *Studies in Higher Education*, 45(12), 2588–2603. <https://doi.org/10.1080/03075079.2019.1623770>
28. Rusli, N. A. (2024). *OJ-TP A Comparative Analysis of Technical and Vocational Education and Training (TVET) for Special Needs Students in Malaysia and Hungary*. 9(1), 14–23. <https://doi.org/10.30880/ojtp.2024.09.01.002>
29. Saad, S., Jambari, H., Jamal, A. H. M. amal, Saud, S., Osman, S., & Hamzah, F. (2023). Factors Affecting the Level of Achieving Employability 4.0 of Hearing-Impaired Special Education Students. *Journal of Technical Education and Training*, 15(1), 215–233. <https://doi.org/10.30880/jtet.2023.15.01.019>
30. Sarkar, M., Overton, T., Thompson, C. D., & Rayner, G. (2020). Academics' perspectives of the teaching and development of generic employability skills in science curricula. *Higher Education Research & Development*, 39(2), 346–361. <https://doi.org/10.1080/07294360.2019.1664998>
31. Sattar, M., Md, R., Napsiah, Y. I., Rashid, I., Roseamnah, R., & Rauf Abstrak, A. (2009). Aspek Kemahiran “Employability” yang Dikehendaki Majikan Industri Pembuatan Masa Kini (Aspects of Employability Skills Needed by the Manufacturing Industries Employers). In *Jurnal Pendidikan Malaysia* (Vol. 34, Issue 2).
32. Scheef, A. R. (2023). School-Based Transition Programming to Improve Employment Outcomes for Youth with Disabilities. In *The Routledge Handbook of Inclusive Education for Teacher Educators* (pp. 593–607). Routledge India. <https://doi.org/10.4324/9781003266068-43>
33. Syazwan Zainal, M. (2023). *A Conceptual Paper: Career Self-Efficacy as The Role of Career Transition Programme for Students on the Autism Spectrum in Malaysia*. <https://doi.org/10.6007/IJARPED/v12-i3/18114>
34. Syazwan Zainal, M., Munsif, W. A., Pa, W., & Sofwan Mahmud, M. (2021). Internship Program For Students With Disabilities: Are Malaysian Family Ready? *Journal of Contemporary Issues in Business and Government*, 27(1), 2021. <https://cibg.org.au/2754>
35. Syazwan Zainal, M., Sofwan Mahmud, M., Munsif, W. A., & Pa, W. (2020). Job Marketable for Student with Disability: What We Should Know for Career Transition Programme. *Journal of University of Shanghai for Science and Technology*. <https://doi.org/10.51201/12507>
36. Verulava, T., & Bedianashvili, G. (2021). *Work Inclusion of Persons with Disabilities: Employers' Perspectives*. <https://www.researchgate.net/publication/351547400>
37. Yusof, M. M., Hanafi, M., Ohd Yasin, M., & Itam, A. (2017). *Kemahiran kebolehkerjaan individu masalah pendengaran dan implikasinya terhadap program pendidikan*.

# A Review of the Written Instructional Material on Malaysia Skills Certification System: Adaptation Technology Emerging in TVET Teaching and Learning

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**Abstract.** This review paper examines the improvements to the Written Instructional Materials (WIM) that have been developed by the Skills Development Department (DSD) as a guide for the implementation of skills training at accredited centers that conduct TVET Training in Malaysia. Written Instructional Materials developed based on the National Occupational Skills Standard (NOSS) consist of Theory Teaching Plans, Practical Teaching Plans, Information Papers, Assignment Papers and Work Papers to ensure that the implementation of skills training is carried out well and meets the competencies that have been set. There are many technological advances in today's technical and vocational education landscape. Despite the focus on specific skills, the existing TVET education framework needs to be improved to reflect the growing importance of emerging technologies such as Augmented Reality, Virtual Reality and Artificial Intelligence. TVET institutions face multiple challenges in effectively incorporating emerging technologies into the curriculum. A quantitative methods approach will be employed to comprehensively assess the factors affecting the effectiveness of emerging technologies in TVET education. Data will be collected through surveys given to TVET Training Centre administrator, instructors, students and graduates across various institutions and programs to evaluate the current level of technology integration and potential integration of emerging technologies. Moreover, the effectiveness of both current and emerging technologies integration in the TVET education will be evaluated. Dependent variables include technological factors, teacher competencies and training, student factors, institutional factors, curriculum design and content, pedagogical approaches, teacher-student interaction and classroom environment. The target variable is the effectiveness of emerging technologies integration into the TVET education landscape. Statistical analysis such as T-test, ANOVA and regression analysis will be utilized to identify correlation and relationships between the variables. Improvement the standard framework will be proposed to improve the quality of TVET education through the integration of technology emerging in the Written Instructional Materials.

**Keywords:** TVET Education, Written Instructional Material (WIM), Emerging Technologies & Training Effectiveness

## 1 Introduction

The integration of emerging technologies into Technical and Vocational Education and Training (TVET) in Malaysia has the potential to revolutionize the educational landscape, particularly in urban areas. As the Skills Development Department (DSD) continues to develop and refine Written Instructional Materials (WIM) based on the National Occupational Skills Standard (NOSS), there is a growing need to incorporate advanced technologies such as Augmented Reality (AR), Virtual Reality (VR), and Artificial Intelligence (AI) into these materials. These technologies can significantly enhance the learning experience, making it more interactive, engaging, and effective. Emerging technologies offer numerous advantages for TVET education. AR and VR, for instance, provide immersive learning experiences that can help students understand complex technical concepts and practice skills in a safe, controlled environment. AI can be used to personalize learning, providing tailored content and feedback to students based on their individual needs and progress. These technologies can bridge the gap between theoretical knowledge and practical application, which is crucial in vocational training.

Despite the clear benefits, the implementation of these technologies in TVET education faces several challenges. Urban areas, with their better access to infrastructure and technological resources, are ideal for piloting the integration of these technologies into WIM. However, even in these areas, there are obstacles such as the need for significant investment in technology, training for instructors, and the development of appropriate digital content. Additionally, there is a need for a robust framework to guide the integration process, ensuring that the use of technology enhances rather than detracts from the educational goals.

The study aims to improve current framework that can be used to systematically improve the quality of TVET education through the effective integration of advanced technologies. This framework will address the challenges and provide strategies

for successful implementation, ensuring that TVET institutions can fully leverage the benefits of emerging technologies to enhance learning and teaching.

## 2 Literature Review

Technical and Vocational Education and Training (TVET) in Malaysia plays a crucial role in preparing students for the workforce, particularly in the context of Industry 4.0. The integration of emerging technologies into TVET is essential to enhance educational practices and outcomes. This literature review examines the current integration of emerging technologies in Written Instructional Materials (WIM), their impact on student learning outcomes, and the effects on teaching methodologies in Malaysian TVET education.

The Department of Skills Development (DSD) in Malaysia, under the Ministry of Human Resources, plays a pivotal role in the advancement of Technical and Vocational Education and Training (TVET). DSD is responsible for developing the National Occupational Skills Standards (NOSS), which serve as benchmarks for industry-required competencies, guiding curriculum development and assessment in TVET programs (Department of Skills Development Malaysia, n.d.). Additionally, DSD certifies individuals through the Malaysian Skills Certification (MSC) system, ensuring graduates meet the required competency levels. The department accredits TVET training providers to maintain high standards of education and training quality. DSD also promotes TVET as a viable career path, collaborates with industries to align training with market needs, and implements skills upgrading programs to keep the workforce updated with emerging technologies (Department of Skills Development Malaysia, n.d.). These efforts by DSD are crucial in integrating emerging technologies into TVET education, thereby enhancing the quality of written instructional materials (WIM), improving student learning outcomes, and modernizing teaching methodologies.

The Malaysian Skills Certification (MSC) system, overseen by the Department of Skills Development (DSD), is a framework designed to certify the competencies of individuals in various vocational fields. The MSC system aligns with the National Occupational Skills Standards (NOSS), which delineate the skills and knowledge required for specific job roles within different industries (Department of Skills Development Malaysia, n.d.). This certification system ensures that TVET graduates possess the competencies demanded by employers, thereby enhancing their employability and career prospects. The MSC system encompasses multiple levels of certification, from basic skills to advanced professional qualifications, promoting lifelong learning and continuous skill enhancement (Cheong, 2010). By standardizing skill assessment and certification, the MSC system supports the integration of emerging technologies in TVET, ensuring that both instructional materials and teaching methodologies remain relevant and effective.

To apply for the Malaysian Skills Certification (MSC) system, training centers must meet several specific requirements set by the Department of Skills Development (DSD). Firstly, the training center must be registered and recognized by the DSD. This involves adhering to the standards and guidelines outlined in the National Occupational Skills Standards (NOSS), which ensure the quality and relevance of the training programs offered (Department of Skills Development Malaysia, n.d.). The center must employ qualified trainers who possess the necessary certifications and experience in their respective fields. Additionally, the training center must provide adequate facilities and resources, including well-equipped workshops, laboratories, and Written Instructional Material (WIM), to support the delivery of the curriculum (Cheong, 2010). The center must also implement a robust quality management system to monitor and continuously improve the training processes. Finally, the center must undergo regular audits and assessments by the DSD to ensure ongoing compliance with the MSC requirements and maintain accreditation.

Written Instructional Material (WIM) includes textbooks, manuals, guides, and digital documents that provide structured educational content for TVET students. These materials are fundamental in standardizing instruction, providing a consistent framework for both students and educators (Reid & Garson, 2016). The integration of emerging technologies into WIM can transform traditional learning resources into interactive and engaging tools, enhancing the learning experience and making the materials more relevant to current industry practices (Mayer, 2009).

The integration of Information and Communication Technology (ICT) in TVET has been a key focus in Malaysia. Yaakob et al. (2020) discuss the evolution of TVET in Malaysia and highlight the significant role of ICT in shaping its future. The study emphasizes that the Malaysian government has been proactive in enacting policies to ensure that TVET institutions keep pace with industrial demands. ICT is integrated into various instructional materials to enhance the learning experience and prepare students for the demands of Industry 4.0. The use of interactive multimedia e-Learning systems is another notable development. Noor et al. (2022) describe the implementation of an e-Learning system called SpmiILP, designed to facilitate online interactions and cognitive development among TVET students. This system has shown positive influences on student learning processes, especially during the COVID-19 pandemic when traditional face-to-face teaching was disrupted.

Emerging technologies have been found to significantly enhance student engagement and motivation. For instance, mobile learning (m-Learning) offers flexibility and accessibility, allowing students to engage in learning anytime and anywhere. Azmi, Noor, and Mohamed (2017) propose a model for m-Learning in TVET, which aims to improve teaching and learning quality by making education more accessible and interactive. The use of data analytics to understand learning styles also contributes to improved learning outcomes. Bujang et al. (2019) utilized data analytics to visualize learning styles among TVET students, providing insights that can help tailor instructional methods to better suit student needs. This personalized approach enhances student performance and engagement.

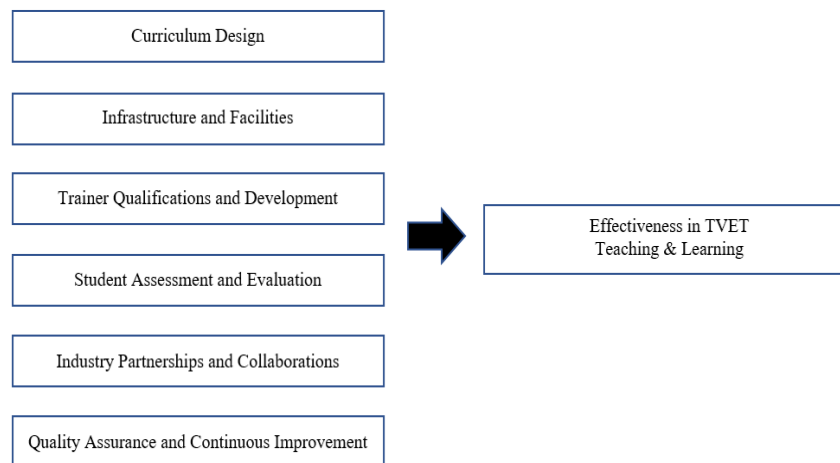
The adoption of emerging technologies has led to significant changes in teaching methodologies within TVET education. Chua and Jamil (2014) analyze the impact of field specialization on Technological Pedagogical Content Knowledge (TPACK) among Malaysian TVET instructors. Their study suggests that effective integration of technology in teaching requires comprehensive professional development for educators to enhance their technological skills. The implementation of Building

Information Modelling (BIM) in TVET institutions is another example of how technology is transforming teaching practices. Ismail and Kamal (2023) highlight the challenges and strategies for implementing BIM, emphasizing the need for collaboration with industry and adequate training for educators to effectively utilize this technology in their teaching.

The TPACK framework, introduced by Mishra and Koehler (2006), emphasizes the intersection of technological knowledge, pedagogical knowledge, and content knowledge. TPACK highlights the importance of integrating these three domains to effectively use technology in teaching. In TVET education, TPACK is crucial as it helps educators design instructional materials that are technologically sound, pedagogically effective, and content-rich.

The integration of emerging technologies in Malaysian TVET education has shown significant potential in enhancing instructional quality, student engagement, and teaching methodologies. However, challenges such as infrastructure constraints, lack of skilled personnel, and resistance to change need to be addressed to fully realize the benefits of these technologies. Ongoing research and development, along with strategic investments in training and infrastructure, are essential to ensure that TVET education in Malaysia can meet the demands of the modern workforce and contribute to national development.

#### *Department of Skills Development Training Framework*



**Fig. 1. Conceptual Framework**

### **3 Discussion**

The training framework for applying as a training center under the Department of Skills Development is designed to ensure high standards of vocational education and training. This framework requires the training center to meet specific accreditation and compliance standards set by the Department, ensuring adherence to local and national regulations. The curriculum must be industry-aligned, incorporating emerging technologies such as augmented reality (AR), virtual reality (VR), artificial intelligence (AI), and interactive multimedia to provide dynamic and engaging learning experiences. The training center must be equipped with state-of-the-art infrastructure and facilities, including modern tools, devices, and reliable internet connectivity, to support both practical and theoretical training. Qualified trainers with relevant industry experience are essential, and continuous professional development opportunities must be provided to keep them updated with the latest technologies and teaching methodologies.

The framework emphasizes technology-enhanced assessments and competency-based evaluations to measure student performance effectively. Establishing strong industry partnerships is crucial, offering work-based learning opportunities such as internships and apprenticeships to ensure the training remains relevant to current job market demands. Continuous monitoring and evaluation, along with feedback mechanisms from students, trainers, and industry partners, are vital for quality assurance and continuous improvement. The application process involves submitting a detailed proposal outlining the training programs, curriculum, facilities, trainer qualifications, and industry partnerships, followed by a site inspection by the Department to verify compliance. Upon approval and accreditation, the training center is authorized to operate, providing quality vocational education that prepares students for the modern workforce.

### **4 Research design & methodology**

This study employs a quantitative methods research design to provide a comprehensive assessment of the factors influencing the effectiveness of emerging technologies in Technical and Vocational Education and Training (TVET) in Malaysia to enhance the validity and reliability of the findings.



1. *Population and Sample:*

- The population for this study includes TVET educators, students, and administrators from various TVET institutions across Malaysia.
- A stratified random sampling method will be used to ensure representation from different regions and types of TVET institutions (e.g., public, private, rural, urban).
- The target sample size is approximately 500 participants, including 200 educators, 250 students, and 50 administrators.

2. *Data Collection Instrument:*

- Structured questionnaires will be developed based on the research objectives and hypotheses.
- The questionnaire for educators will assess their perceptions of the integration of emerging technologies in Written Instructional Materials (WIM), the impact on teaching methodologies, and the challenges faced.
- The student questionnaire will focus on the impact of emerging technologies on their engagement, motivation, and learning outcomes.
- The administrator questionnaire will evaluate the institutional policies and support for integrating emerging technologies.

3. *Data Analysis:*

- Descriptive statistics (mean, standard deviation, frequency) will be used to summarize the data.
- Inferential statistics, such as t-tests, ANOVA, and regression analysis, will be employed to test the hypotheses and examine relationships between variables.

4. *Validity and Reliability :*

- Pilot testing of the survey instruments will be conducted to ensure clarity and reliability.
- Cronbach's alpha will be used to assess the internal consistency of the survey instruments.

## 5 Finding analysis

The analysis of research findings provides crucial insights into the current integration, impact, and methodological effects of emerging technologies in Technical and Vocational Education and Training (TVET) in Malaysia. The findings from this study will be organized according to the research objectives : integration of emerging technologies in Written Instructional Materials (WIM), impact on student learning outcomes, and effects on teaching methodologies.

1. *Extent of Integration :*

- The survey data revealed that a significant proportion of TVET institutions in Malaysia have incorporated emerging technologies such as e-learning platforms, augmented reality (AR), and virtual reality (VR) into their WIM. Approximately 70% of educators reported using these technologies to enhance instructional materials.
- Analysis of institutional documents showed varying levels of integration, with urban institutions displaying higher integration rates compared to rural institutions (Yaakob et al., 2020).

2. *Quality and Effectiveness :*

- Qualitative feedback from educators indicated that the integration of these technologies has improved the clarity and engagement level of WIM. For instance, VR simulations in technical subjects have made complex concepts more accessible to students.
- Students reported higher satisfaction with courses that utilized interactive and multimedia elements, suggesting that these technologies contribute positively to the learning experience (Noor et al., 2022).

3. *Student Engagement and Motivation :*

- Quantitative data from student surveys showed a significant increase in engagement and motivation among students using emerging technologies. Approximately 80% of students reported feeling more engaged in their studies when using AR and VR tools.
- Focus group discussions revealed that gamified learning platforms and interactive simulations were particularly effective in maintaining student interest and participation (Azmi, Noor, & Mohamed, 2017).

4. *Academic Performance :*

- Comparative analysis of academic performance data indicated that students using emerging technologies scored, on average, 15% higher in practical assessments and exams compared to those using traditional learning methods.
- Data analytics tools used to visualize learning styles helped tailor instructional methods to individual student needs, further enhancing academic performance (Bujang et al., 2019).

5. *Skill Acquisition and Workforce Readiness :*

- Interviews with employers and graduates indicated that students trained with emerging technologies demonstrated superior practical skills and were better prepared for the workforce. Employers noted that these students adapted more quickly to technological tools used in the industry (Bakar & Mahmud, 2020).

6. *Transformation of Teaching Practices :*

- The adoption of emerging technologies has led to significant changes in teaching methodologies. Educators reported a shift towards more student-centered and interactive teaching practices, such as flipped classrooms and blended learning models (Chua & Jamil, 2014).

- Case studies of successful technology integration highlighted best practices, including continuous professional development for educators and collaborative planning sessions to design tech-enhanced curricula.
7. *Challenges Faced by Educators :*
    - Despite the benefits, educators faced several challenges in integrating emerging technologies. These included a lack of technical support, insufficient training, and resistance to change among some staff members (Hamid et al., 2023).
    - The survey data indicated that 60% of educators felt inadequately prepared to use advanced technologies effectively, pointing to a need for comprehensive training programs.
  8. *Institutional Support and Policy :*
    - Institutional policies and support systems played a crucial role in the successful adoption of emerging technologies. Institutions with robust support systems, including dedicated IT support and ongoing professional development, reported higher levels of technology integration and effectiveness (Ismail & Kamal, 2023).

## 6 Interpretation

The findings suggest a substantial adoption of emerging technologies in WIM, particularly in urban TVET institutions. The qualitative improvements in instructional quality highlight the potential of these technologies to make learning more interactive and effective. However, the disparity between urban and rural institutions indicates a need for targeted interventions to ensure equitable access to technological resources across all regions.

Findings also demonstrate a clear positive impact of emerging technologies on student engagement, motivation, and academic performance. The use of data analytics to personalize learning and the application of AR and VR for practical skills training significantly enhance students' preparedness for the workforce. These outcomes underscore the value of integrating emerging technologies into TVET education to produce job-ready graduates.

The findings highlight the transformative potential of emerging technologies in teaching methodologies, promoting more interactive and student-centered approaches. However, the challenges faced by educators underline the importance of institutional support and comprehensive training programs. Addressing these challenges is essential to fully leverage the benefits of emerging technologies in TVET education.

## 7 Conclusion

The correlation between the recommendations on the utilization of emerging technologies and the proposed research framework is robust and integral to the successful enhancement of TVET education in Malaysia. The framework's emphasis on technological integration in Written Instructional Materials (WIM), impact on student learning outcomes, and transformation of teaching methodologies is directly aligned with the recommendations advocating for the incorporation of technologies like AR, VR, and AI. These technologies promise to make learning more interactive and immersive, improving student engagement and knowledge retention.

The framework's focus on evaluating and developing best practices for teaching methodologies reflects the recommendations' emphasis on interactive, student-centered learning approaches. By addressing the need for professional development and training for educators, the framework ensures that teachers are prepared to effectively utilize these technologies. Additionally, the inclusion of institutional support and infrastructure within the framework aligns with recommendations highlighting the importance of adequate resources and technical support for sustainable technology integration. This comprehensive approach ensures that the recommendations are not only considered but systematically implemented, leading to improved instructional quality, student outcomes, and teaching practices in TVET education.

## 8 Recommendations

Based on the findings, the following recommendations are proposed to enhance the effectiveness of emerging technologies utilization in TVET education in Malaysia:

1. *Strengthening Infrastructure and Resources:*
  - **Recommendation:** Increase investment in technological infrastructure, especially in rural TVET institutions, to ensure equitable access to emerging technologies.
  - **Rationale:** The disparity between urban and rural institutions in technology integration needs to be addressed to provide all students with high-quality educational experiences (Yaakob et al., 2020).
2. *Comprehensive Training for Educators:*
  - **Recommendation:** Implement continuous professional development programs for educators focused on the effective use of emerging technologies.
  - **Rationale:** Adequate training is essential for educators to fully leverage the benefits of technologies like AR and VR in their teaching practices (Chua & Jamil, 2014).
3. *Developing Supportive Institutional Policies:*
  - **Recommendation:** Formulate and enforce institutional policies that support the integration of emerging technologies, including providing technical support and incentives for educators.

- **Rationale:** Supportive policies and adequate resources are crucial for overcoming resistance and fostering a culture of innovation within TVET institutions (Hamid et al., 2023).
4. *Encouraging Industry Collaboration:*
- **Recommendation:** Strengthen partnerships between TVET institutions and industries to ensure that the technologies used are aligned with industry requirements and enhance employability skills.
  - **Rationale:** Collaborations with industry can provide practical insights and resources that are essential for developing relevant and effective instructional materials (Bakar & Mahmud, 2020).
5. *Expanding Research and Development:*
- **Recommendation:** Promote research and development initiatives focused on exploring new and emerging technologies that can be integrated into TVET education.
  - **Rationale:** Continuous research is necessary to stay abreast of technological advancements and their potential applications in education (Ismail & Kamal, 2023).

## References

1. Azmi, S., Noor, S., & Mohamed, H., *A Proposed Model of M-Learning for Technical and Vocational Education Training (TVET) Students*. Journal of Theoretical and Applied Information Technology, **95** (2017)
2. Bakar, A., & Mahmud, M. I., *Profiling of Aspiration and Interest towards STEM and TVET Careers among Lower Secondary Students: A Malaysian Case Study*, Journal for the Education of Gifted Young Scientists, **8**, (2020).
3. Chua, J., & Jamil, H., *The Effect of Field Specialization Variation on Technological Pedagogical Content Knowledge (TPACK) among Malaysian TVET Instructors*, Malaysian Online Journal of Educational Technology, **2**, (2014)
4. Hamid, H. A., Piahat, M. T., Haris, N. A. A., & Hassan, M. F. *Shades of Gray TVET in Malaysia: Issues and Challenges*. International Journal of Academic Research in Business and Social Sciences, (2023)
5. Ismail, N. H., & Kamal, E. M. *The Awareness of Implementing Building Information Modelling (BIM) For Educators In Malaysia TVET Institutions: A Systematic Literature Review*. Current Integrative Engineering, (2023)
6. Noor, S., Mohamed, H., Zaini, N. A., & Daiman, D. *Use of Interactive Multimedia e-Learning in TVET Education*. International Journal of Advanced Computer Science and Applications, (2022)
7. Yaakob, M., Awang, H., Ismail, M. Z., Zain, F., Kasim, M., & Adnan, A. A. Z. *Backward and Forward Reviews on Technical and Vocational Education and Training (TVET) in Malaysia: The Evolution and ICT-Driven Future Prospect*. Universal Journal of Educational Research (2020)
8. Mishra, P., & Koehler, M. J. *Technological Pedagogical Content Knowledge: A Framework for Integrating Technology in Teacher Knowledge*. Teachers College Record, **108(6)**, (2006)
9. Cheong, K. C. *The Malaysian Skills Certification System: Can it be a model for ASEAN countries?* Journal of Education and Work, 23(2), 117-136, (2010)
10. Department of Skills Development Malaysia. (n.d.). *National Occupational Skills Standard*. Retrieved from DSD Official Website.
11. Dede, C. *The Role of Digital Technologies in Deeper Learning*. Students at the Center: Deeper Learning Research Series. Jobs for the Future, (2014).
12. Johnson, L., Becker, S. A., Estrada, V., & Freeman, A.. NMC Horizon Report: 2016 Higher Education Edition. The New Media Consortium, (2016)
13. Mayer, R. E.. *Multimedia Learning*. Cambridge University Press, (2009)
14. Reid, A., & Garson, K. *Teaching and Learning in Higher Education: Perspectives from UDL*. Higher Education Press, (2016).
15. Sampaio, A. Z., & Almeida, J. P. *The Use of Virtual Reality Technology in Engineering Education*. In Handbook of Research on Applied E-Learning in Engineering and Architecture Education (pp. 135-156). IGI Global, (2016)

# Reading Habits and Attitudes of Students Towards Reading: A Study on Students at Ledang Community College Johor

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**Abstract.** Reading is important for intellectual and emotional growth of an individual and has a significant impact on life beyond academic fields. This study identifies the main issues faced in fostering reading habits within the community, especially among students at Ledang Community College. The objectives of the study are to identify students' reading habits, examine their attitudes towards reading, and determine how these attitudes influence their reading habits. A quantitative approach was used, with a questionnaire as the main instrument, involving 102 students from various fields as the study sample. The questionnaire contained 23 items divided into three sections: demographic information, reading habits, and attitudes towards reading. Descriptive analysis was used to obtain a comprehensive overview of students' reading habits and attitudes using SPSS Statistics version 29.0. The results showed that although students understand the benefits of reading, emotional disturbances affect their continuous reading habits. The majority of students prefer digital reading materials over printed texts, and most of them prefer to read in Malay. Positive attitudes towards reading are evident, but challenges remain in maintaining interest in reading. The study recommends that lecturers and institutions actively promote interest in reading by incorporating diverse reading materials into the curriculum and creating a conducive reading environment. Additionally, leveraging technology and providing access to various digital resources can attract students' interest. In conclusion, addressing emotional and cognitive barriers and providing positive reinforcement can foster a proactive reading culture, ultimately improving students' reading habits and attitudes.

**Keywords:** reading attitudes, reading habits, student attitudes, Ledang Community

## 1 Introduction

Reading habits and attitudes towards reading are important for academic success and personal development. These factors influence not only students' academic success but also cognitive growth and critical thinking skills. Reading plays a crucial role in language learning and language skills. Early exposure to reading is essential for children's language development and future academic achievement (Mol & Bus, 2011). Continuous reading for adults is associated with lifelong learning and cognitive resilience (Stanovich, 2000). Therefore, fostering a reading culture is vital for individual and societal development. Furthermore, reading can expand one's knowledge, stimulate imagination, and foster empathy by exposing people to different ideas and cultures (Snow, 2002). The ability to read is fundamental to academic success and personal development.

According to Mol and Bus (2011), students' reading habits, including the frequency they read, the time they spend reading, and the types of materials they choose, can significantly impact their academic performance and cognitive development. Positive reading habits have been linked to several benefits, including increased vocabulary, improved thinking skills, and higher academic achievement (Whitten et al., 2016). These habits can vary greatly, driven by factors such as the availability of books, digital media usage, and academic workload. Meanwhile, attitudes towards reading refer to students' sentiments and views about reading, which can significantly affect their desire and willingness to engage with texts (Gambrell, 2015). Livingston, Siegel, and Ribary (2018) found that emotional support and enjoyable reading experiences can enhance children's motivation to read and literacy rates. Ajzen (2014) discussed the relationship between attitude and behavior, suggesting that intentions often predict actual reading behavior.

This research discusses the reading habits and attitudes of students at Ledang Community College. Previous studies have shown a positive relationship between reading habits and students' academic performance. Students who frequently read demonstrate better academic achievement. However, many students still have low reading frequency, especially in academic reading and reading for pleasure (Frontiers, 2023).

This study identifies students' reading habits and attitudes and attempts to establish a relationship between reading habits and attitudes, offering solutions to improve reading habits aligned with their preferences. Students who do not receive

adequate emotional support tend to show negative attitudes towards reading, resulting in decreased interest and reading frequency. Moreover, inconsistent reading habits can adversely affect students' academic performance and cognitive function, while negative affective attitudes, such as viewing reading as a boring activity, can hinder the development of good reading habits. The likelihood that students' reading habits may be influenced by the frequency of reading academic or non-academic materials, the types of academic and non-academic reading they prefer, their preference for printed texts versus digital materials, and their preferred language for reading.

The objectives of this paper are aligned with the following research questions:

1. What are the reading habits of students at Ledang Community College?
2. What are students' attitudes towards reading?
3. How do these attitudes influence their reading habits?

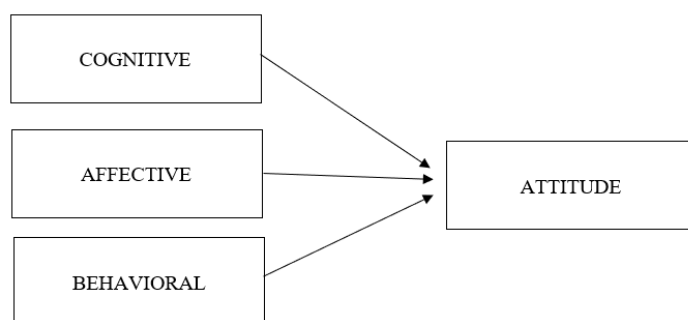
## Reading habits

Smith and Robinson (1980) defined reading as an active effort to understand the author's message through analysis, reasoning, thinking, imagining, and consideration. The goal is not only to gain knowledge but also to develop maturity and increase awareness of current situations (Kim & Anderson, 2011). According to Mohd Noor (2011), good reading habits promote intellectual growth by fostering aspirations and enhancing the ability to understand rather than criticize. Various factors influence reading habits, including technological advancements, educational methods, and sociocultural influences. Huang et al. (2014) investigated the reading habits of college students in the United States and found a significant reduction in recreational reading associated with increased use of digital media and the internet for academic purposes. This shift towards digital use has changed the way students interact with texts, with many preferring shorter reading types over long, in-depth reading practices. Davidovitch et al. (2016) explored changes in students' reading habits, revealing a preference for digital over printed media.

This impacts educational practices as educators must integrate digital literacy while maintaining quality reading comprehension and critical thinking skills. Wang et al. (2016) found that students' reading habits have shifted to accept more digital information, particularly electronic magazines. However, they found that printed materials produce better engagement and comprehension levels. Educational approaches have a significant impact on students' reading habits. Digital literacy, or the ability to browse and understand digital texts properly, is becoming increasingly important in the digital age. This includes critically evaluating online content, understanding digital forms, and using digital reading tools (Leu et al., 2013). Gallagher (2023) argued that contemporary classroom procedures, often focused on standardized testing and inflexible curricula, can hinder students' natural enthusiasm for reading. Renandya and Jacobs (2016) called for comprehensive reading programs in classrooms, encouraging students to read a large number of self-chosen books.

## Attitudes towards reading

According to the APA Dictionary of Psychology (2015), attitude means "a relatively enduring and general evaluation of an object, person, group, issue, or concept on a dimension that ranges from negative to positive. Attitudes provide a summary evaluation of a target object and are often assumed to derive from beliefs, emotions, and past behaviors related to the object." Attitudes are crucial in many aspects of human life. An individual's attitude is a learned psychological state that influences their choice of behavior. An article by Masarogulları and Kocakgöl (2011) states that there are three parts to the definition of attitude: behavioral, cognitive, and affective. The first is affective, consisting of feelings in response to the attitude. The second part is the cognitive component, consisting of one's thoughts and perspectives toward the attitude object. The third component is behavior, encompassing actions related to the attitude. Figure 1 is an attitude model by Haddock & Maio (2004).



**Fig.1.** Attitude Model

An individual's attitude has an evaluative component and affects students' disposition and tendency to respond well or poorly to something. Students' attitudes are an important element in determining their learning achievements (Sánchez & Gavilánez,

2017). Kpolovie et al. (2014) investigated the influence of cognitive attitudes on academic achievement and found that students who understand the value of reading for learning interact more deeply with texts. This cognitive recognition generally leads to

improved academic performance. According to Wei, Saab, and Admiraal (2021), cognitive attitudes towards reading are often influenced by early experiences and the perception of reading materials relevant to students' academic and personal objectives. Davidovitch, Yavich, and Druckman (2016) emphasized the importance of emotional engagement in reading, claiming that students who enjoy reading are more likely to develop long-term reading habits. Intrinsically engaging reading practices and metacognitive strategies used in digital reading can build strong academic resilience among students. Reading motivation and metacognitive strategies work in tandem to build resilient and strong readers and are important mechanisms that link digital reading practices with better reading achievement (Jang, Seo, & Brutt-Griffler, 2023).

During the COVID-19 pandemic, Sinaga and Pustika (2021) examined students' emotional responses to online reading exercises to highlight the affective dimension. Their study's findings indicate that students' enjoyment and interest in reading are essential for maintaining engagement in online learning environments. McGeown et al. (2015) found that students with higher intrinsic motivation driven by personal interest engage in more consistent reading behaviors. Yamashita (2013) found that students with positive cognitive and affective attitudes toward reading are more likely to engage in regular reading activities. Ben-Eliyahu, Moore, and Dorph (2018) agreed that intellectually stimulating activities that engage emotions and behaviors are most effective in fostering positive reading attitudes and habits. Students with positive reading attitudes are more likely to read frequently and engage in diverse reading activities (Tveit, 2014). Blazar and Kraft (2017) evaluated the impact of teacher behavior on students' attitudes and found that teachers who provide emotional support and encourage a positive classroom atmosphere significantly influence students' cognitive and affective attitudes towards reading.

## 2 Research methodology

This study uses a quantitative survey study. The study population consists of students at Ledang Community College. The sampling method used is Stratified Random Sampling, where students from semesters 1 to 3 at Ledang Community College are sampled. However, with only 102 students responding out of 240 students selected, the response rate is 72%. The study uses a questionnaire as the main instrument. Descriptive analysis was used to obtain a comprehensive overview of students' reading habits and attitudes using SPSS Statistics version 29.0. The questionnaire was constructed based on the three-party model of Mathewson (Matherson, 1994). The questionnaire was distributed via Google Form, allowing researchers greater flexibility in the data collection process. To ensure the validity of the questionnaire, it was reviewed by experts in the related research topic.

The questionnaire is divided into three sections. Section A contains questions about respondents' demographic information. Section B focuses on reading habits, including reading frequency, types of reading materials, online activities, and preferred reading language. Section C contains questions about reading attitudes. Responses are based on a four-point Likert Scale (i.e., 4=Strongly Agree, 3=Agree, 2=Disagree, 1=Strongly Disagree). The survey questionnaire consists of 23 questions items (8 items on cognitive attitudes, 7 items on affective attitudes, and 8 items on behavioral attitudes) to measure students' attitudes towards reading. In addition, to ensure the validity of the questionnaire, it was reviewed by experts in the study topic.

## 3 Findings and discussion

From the 102 respondents, 63 (61.8%) were male and the remaining 39 (38.2%) were female. Table 1 shows the demographic profile of the respondents. Table 1 shows respondents from Pastry 49 (48%), Automotive 22 (21.6%), Refrigeration and Air Conditioning 16 (15.7%), and Business 15 (14.7%).

**Table 1.** Respondents' Demographics

Variable	Category	Frequency	Percentage
Gender	Male	63	61.8%
	Female	39	38.2%
Field	Pastry	49	48%
	Automotive	22	21.6%
	Refrigeration and Air Conditioning	16	15.7%
	Business	15	14.7%

### Reading habits

Respondents' reading habits were analysed through reading frequency, whether academic or leisure, the types of academic and non-academic reading they preferred, their preference for printed texts versus digital materials, and respondents' preferred reading language.

**Table 2.** Frequency of Reading Academic and Non-Academic Materials

Item	Frequency	Percentage
Academic Reading		
Daily	5	4.9%
Several times/week	51	50.0%
Weekly	31	30.4%
Rarely	15	14.7%
Never	0	0%
Non-Academic Reading		
Daily	15	14.7%
Several times/week	43	42.2%
Weekly	26	25.5%
Rarely	18	17.6%
Never	0	0%

Table 2 shows the frequency of reading. 5 (4.9%) respondents do their academic reading daily, 51 (50%) say several times a week, 31 (30.4%) answer weekly, and 15 (14.7%) admit to rarely reading for academic purposes. Interestingly, 15 (14.7%) respondents engage in leisure reading daily, 43 (42.2%) say several times a week, 26 (25.5%) answer weekly, and 26 (25.5%) admit to rarely reading for leisure. The study findings show that respondents' frequency of academic reading is high, with most reading academic materials several times a week and weekly. Similarly, for leisure reading, most respondents acknowledge that they read for leisure several times a week and weekly.

**Table 3.** Types of Reading Materials

Item	Frequency	Percentage
Printed Books	11	10.8%
e-Books	33	32.4%
Online Articles/Blogs	50	49.01%
Newspapers/Magazines	3	2.9%
Others	5	4.9%

Table 3 shows the distribution of the types of reading materials used by respondents. The study findings show that students use various types of reading materials for reading purposes. 49.01% of students read online articles/blogs. This is followed by e-books (32.4%), printed books (10.8%), others (4.9%), and newspapers or magazines (2.9%). The results show that most students prefer using online materials for reading.

**Table 4.** Preference between Printed Texts and Digital Materials

Item	Frequency	Percentage
Printed Books	20	19.6%
Digital Materials	82	80.4%

Respondents were also asked to evaluate their preference for reading materials between digital materials and printed texts. 82 (80.4%) respondents chose digital materials, while the remaining 20 (19.6%) chose printed books.

**Table 5.** Preferred Reading Language

Item	Frequency	Percentage
Malay	85	83.3%
English	10	9.8%
Mandarin	3	2.9%
Tamil	3	2.9%
Others	1	0.9%

Table 5 shows the distribution of the respondents' preferred reading language used daily. The study shows that the majority of students (83.3%) prefer reading in Malay compared to other languages. This fact can be understood as the majority of respondents use Malay as their official language. 9.8% use English, while Mandarin and Tamil are used by 2.9% of respondents while using various reading materials. Other languages account for 0.9%.

## Reading attitudes

The reading attitude section consists of 23 items based on Mathewson's (1994) three-party model. The section is categorized into three variables (i) Cognitive (eight questions), (ii) Affective (seven questions), and (iii) Behavioral (eight questions). Reliability analysis of the variables used in the study was conducted. The Cronbach alpha value is 0.794, indicating a good level of internal consistency for the questionnaire items.

**Table 6.** Cognitive Attitude Variables

QUESTION	Strongly Agree 4	Agree 3	Disagree 2	Strongly Disagree 1
Reading is for learning but not for pleasure.	65 63.7%	17 16.6%	14 13.7%	6 5.8%
Money spent on books is well spent.	46 45.1%	52 51.0%	2 2.0%	2 2.0%
Nothing can be gained from reading books.	4 3.9%	11 10.85	31 30.4%	56 54.9%
Reading is a good way to spend leisure time.	53 51.9%	42 41.2%	6 5.8%	1 0.9%
Sharing books with friends is a waste of time.	5 4.9%	4 3.9%	42 41.2%	51 50%
I will spend more time reading during semester break.	47 46.1%	44 43.1%	9 8.8%	2 2.0%
Reading is something I cannot miss during leisure time.	50 49%	42 41.2%	9 8.8%	1 0.9%
I get bored easily when reading.	4 3.9%	13 12.7%	36 35.3%	49 48.0%

In Table 6, 63.7% of students strongly agree and 16.6% agree, indicating that the majority view reading primarily as an academic activity rather than for pleasure. 45.1% of respondents strongly agree and 51.0% agree, indicating belief in the value of investing in buying a book. 54.9% of students strongly disagree and 30.4% disagree, reflecting that reading has intrinsic value. 51.9% strongly agree and 41.2% agree, indicating that students recognize the benefits gained while reading during leisure time. 50% strongly disagree and 41.2% disagree, indicating respondents' positive attitude towards sharing books. 46.1% strongly agree and 43.1% agree, indicating that students recognize the benefits of leisure reading. 49% strongly agree and 41.2% agree, indicating that many students believe reading should be part of their leisure activities. 48% strongly agree and 35.3% agree, highlighting the significant challenge of maintaining students' interest in reading.

Respondents recognize the value of reading and consider money spent on buying books well invested; however, they also report a lack of enjoyment and a tendency to get bored. This shows cognitive recognition of the importance of reading, but emotional barriers can affect continuous reading habits.

**Table 7.** Affective Attitude Variables

QUESTION	Strongly Agree 4	Agree 3	Disagree 2	Strongly Disagree 1
I get bored easily when reading.	4 3.9%	5 4.9%	46 45.1%	47 46.1%
Reading excite me.	51 50%	45 44.1%	6 5.8%	0 0%
I feel tired when presented with long texts.	49 48%	43 42.2%	9 8.8%	1 0.9%
Reading rewards me.	51 50%	45 44.1%	2 2%	4 3.9%
I feel anxious when I have to read a book.	7 6.9%	6 5.9%	42 41.0%	47 46.0%
Reading during leisure time has no meaning.	6 5.9%	5 4.9%	41 40.2%	50 49%
Reading many books broadens our views.	55 54%	46 45.1%	1 0.9%	0 0%



In Table 7, 46.1% strongly disagree and 45.1% disagree, indicating that students generally do not find reading books boring. 50% strongly agree and 44.1% agree, indicating positive emotional responses to reading by students. 48% strongly agree and 42.2% agree, indicating that many students do not have the stamina for prolonged reading sessions. 50% strongly agree and 44.1% agree, indicating that students find reading rewarding. 46.1% strongly disagree and 41.0% disagree, indicating that most students do not feel anxious about reading. 49% strongly disagree and 40.2% disagree, indicating that students recognize the benefits of reading during leisure time. 54% strongly agree and 45.1% agree, a very positive response about the impact of reading on broadening views. Overall, the affective value reveals respondents' positive feelings towards reading, such as enjoyment and recognition of its educational value.

**Table 8.** Behavioral Attitude Variables

QUESTION	Strongly Agree 4	Agree 3	Disagree 2	Strongly Disagree 1
I make a point to finish the book I read.	46 25.1%	43 42.2%	8 7.8%	0 0%
There are many books I wish to read.	51 50%	46 45.1%	5 4.9%	0 0%
I will not read a book unless for class needs.	5 4.9%	15 14.7%	35 34.3%	47 46.1%
Reading is something I can do without being directed.	55 53.9%	42 41.2%	4 3.9%	1 0.9%
I will spend more time reading during semester break.	55 53.9%	36 35.3%	11 10.8%	0 0%
I will buy books as gifts for others.	56 54.9%	33 32.4%	12 12%	1 0.9%
Reading is a good activity.	61 59.8%	40 39.2%	0 0%	1 0.9%
I think reading is a good hobby.	59 57.8%	39 38.2%	3 2.94%	1 0.9%

In Table 8, 25.1% strongly agree and 42.2% agree, indicating a high commitment to finishing reading a book. 50% strongly agree and 45.1% agree, indicating a strong interest in reading in the future. 46.1% strongly disagree and 34.3% disagree, indicating that many students read outside of academic time. 53.9% strongly agree and 41.2% agree, indicating that some students see reading as a choice. 53.9% strongly agree and 35.3% agree, indicating commitment and importance to reading. 54.9% strongly agree and 32.4% agree, indicating that students value books as gifts. 59.8% strongly agree and 39.2% agree, indicating agreement that reading activities are useful. 57.8% strongly agree and 38.2% agree that reading is a useful activity even if they do not practice it frequently. The behavioral dimension shows respondents' high commitment to reading academic materials but significant lack of interest and motivation for reading outside of academic needs.

**Table 9.** Overall Percentage of Reading Attitudes

Variable	Strongly Agree 4	Agree 3	Disagree 2	Strongly Disagree 1
Cognitive Attitude Variables	34 33.6%	28 27.6%	19 18.2%	21 20.7%
Affective Attitude Variables	25 31.2%	28 27.3%	21 20.7%	21 20.7%
Behavioral Attitude Variables	49 45%	37 36%	10 9.6%	6 6.2%

Table 9 provides an overview of respondents' attitudes towards reading in terms of cognitive, affective, and behavioral dimensions. Cognitive attitudes indicate that a large portion of students view reading positively. A combined 61.2% of respondents either strongly agree or agree that reading is a good practice for learning and self-improvement. However, the presence of 38.9% of respondents who disagree or strongly disagree with this sentiment indicates a significant minority who may not fully recognize or appreciate the cognitive benefits of reading. Affective attitudes show that about 58.5% of students have positive emotional responses to reading, as shown in Table 9.

This indicates that many students find reading enjoyable and rewarding. However, the fact that 41.4% of students either disagree or strongly disagree indicates a significant number who may find reading emotionally unsatisfying. Behavioral attitudes are the most positive among the three dimensions, with 81% of students indicating that they agree with positive reading behaviors. This high level of agreement indicates that many students are aware of incorporating reading into their routines, such

as finishing reading books they start and considering reading a useful activity. The lower disagreement percentage (15.8%) indicates that only a small portion of students exhibit less proactive reading behaviors.

### Impact of reading attitudes on reading habits

Students' attitudes towards reading influence their reading habits. Positive cognitive attitudes foster belief in the value and benefits of reading, leading to active engagement with various reading materials. Positive affective attitudes make reading an enjoyable activity that provides emotional pleasure and encourages consistent reading behavior. Positive behavioral attitudes encourage proactive and voluntary reading habits, making reading practices part of daily life. Conversely, negative attitudes can hinder the development of reading habits, limiting students' engagement with reading materials.

To create enjoyment and positive emotions among students through reading practices, several strategies can be suggested, such as selecting appropriate and relevant reading materials that align with students' interests, using engaging and interactive texts, and providing diverse reading materials in terms of genre and format. Support activities such as book clubs, shared reading sessions, and book-related projects can encourage social interaction and enhance interest in reading. Creating a conducive reading environment with comfortable spaces and easy access to reading materials is also important. Additionally, recognizing reading achievements and using technology such as interactive reading apps can enhance students' motivation. With these strategies, the reading experience becomes more enjoyable, and positive emotions towards reading can be cultivated.

## 4 Conclusion and recommendations

This study was conducted in an effort to enhance our understanding of reading habits and attitudes of students at Ledang Community College. The majority of students engage in academic reading several times a week, indicating strong reading habits for learning purposes. Reading is considered a supplementary activity during leisure time. There is a preference for digital reading materials over printed texts, reflecting the current trend towards e-books and online articles for students at Ledang Community College. Students prefer reading in their mother tongue (Malay) and also in English, showing a bilingual reading culture that can be leveraged to provide a broader range of reading materials.

The study's findings on reading attitudes reveal that Ledang Community College students generally recognize the cognitive benefits of reading, such as gaining knowledge and improving academic performance. However, a significant minority do not view reading as beneficial, indicating a need to further raise awareness of reading benefits. 94% find reading enjoyable, but some experience negative emotions, especially with long texts. Students may choose lighter and more entertaining reading materials for leisure reading sessions. Fiction books, short stories, or comics can help reduce stress. Positive behavioral attitudes towards reading are evident, but there is room for improvement in fostering a proactive reading culture. Among the suggestions are integrating interesting reading materials into every subject, such as articles, short stories, or books relevant to the topics taught.

Several limitations can be found in conducting this study. Among them is the small sample size, which includes only students at Ledang Community College, and the limited number of variables studied. Larger-scale studies need to be conducted to obtain more reliable results and by testing more variables, such as socioeconomic status, availability of reading materials, or the effects of digital distractions.

This study provides recommendations based on the findings. Among them are providing a variety of reading materials that meet different academic levels and interests of students to demonstrate the practical and cognitive benefits of reading. Lecturers and institutions also play an important role in helping students improve their reading habits and attitudes, such as creating activities to encourage reading interest and adding diverse reading materials to the curriculum. Lecturers can encourage students and emphasize the benefits of reading. Creating a friendly environment with a well-equipped library and comfortable reading areas, as well as organizing book clubs, can make reading more enjoyable and socially engaging. Interactive reading apps with gamification features such as collecting points, badges, and reading challenges can also increase students' motivation in fostering a proactive reading culture. Integration of technology such as offering access to digital materials and digital literacy training, as well as promoting multilingual reading, can help students become more active. To foster a proactive reading culture in Polytechnics and Community Colleges in general, and at Ledang Community College specifically, several strategies can be implemented, such as creating a Digital Resource Center equipped with computers, tablets, and access to digital libraries. This center can be a hub for digital literacy-related activities and access to electronic reading materials. Regular training sessions should be conducted by the library or faculty to ensure students are always updated with the latest digital literacy skills.

This study provides suggestions for further research, such as observing behavior and using digital tools to record reading habits. The use of technology to record reading time and patterns can provide more accurate and detailed data on students' reading behavior. Another suggestion is to design and test interventions aimed at improving students' reading attitudes and habits. Among them are programs such as reading clubs, interactive reading sessions, and aligning reading with other interesting activities.

## References

1. Ajzen, I. Attitude structure and behavior. In *Attitude structure and function* (pp. 230-255). Taylor & Francis. (2014).
2. Ben-Eliyahu, A., Moore, D., & Dorph, R. Investigating the multidimensionality of engagement: Affective, behavioral, and cognitive engagement across science activities and contexts. *Contemporary Educational Psychology*, 53, 87-105. (2018).

3. Blazar, D., & Kraft, M. A. (2017). Teacher and teaching effects on students' attitudes and behaviors. *Educational Evaluation and Policy Analysis*, 39(1), 146-170. (2017).
4. Davidovitch, N., Yavich, R., & Druckman, E. Don't throw out paper and pens yet: On the reading habits of students. *Journal of International Education Research*, 12(3), 111-123. (2016).
5. Frontiers in Psychology. *Relationships among students' reading habits, study skills, and academic achievement in English at the secondary level*. Retrieved from <https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1020269/full>. (2023).
6. Gallagher, K. *Readicide: How schools are killing reading and what you can do about it*. New York: Stenhouse Publishers. (2023). <https://www.taylorfrancis.com/books/mono/10.4324/9781032682198/readicide-kelly-gallagher>
7. Gambrell, L. B. Getting students hooked on the reading habit. *The Reading Teacher*, 69(3), 259-263. (2015).
8. Huang, S. H., Capps, M., Blacklock, J., & Garza, M. Reading habits of college students in the United States. *Reading Psychology*, 35(5), 437-467. (2014).
9. Jang, E., Seo, Y. S., & Brutt-Griffler, J. Building Academic Resilience in Literacy: Digital Reading Practices and Motivational and Cognitive Engagement. *Reading Research Quarterly*, 58(1), 160-176. (2023).
10. Kim, J. Y., & Anderson, T. Reading across the curriculum: A framework for improving the reading abilities and habits of college students. *Journal of College Literacy and Learning*, 37, 29-40. (2011).
11. Kpolovie, P. J., Joe, A. I., & Okoto, T. Academic achievement prediction: Role of interest in learning and attitude towards school. *International Journal of Humanities Social Sciences and Education*, 1(11), 73-100. (2014).
12. Leu, D. J., Kinzer, C. K., Coiro, J., Castek, J., & Henry, L. A. New literacies: A dual-level theory of the changing nature of literacy, instruction, and assessment. In D. E. Alvermann, N. J. Unrau, & R. B. Ruddell (Eds.), *Theoretical models and processes of reading*, 6, 1150-1181. International Reading Association. (2013).
13. Livingston, E. M., Siegel, L. S., & Ribary, U. Developmental dyslexia: Emotional impact and consequences. *Australian Journal of Learning Difficulties*, 23(2), 83-96. (2018).
14. Masarogulları, G. & Kocakgöl, M. Psikoloji Sözlüğü. Ankara: Nobel Yayıncılık. (2011).
15. McGeown, S. P., Duncan, L. G., Griffiths, Y. M., & Stothard, S. E. Exploring the relationship between adolescents' reading skills, reading motivation and reading habits. *Reading and Writing*, 28(3), 545-569. (2015).
16. Mohd Noor, Noorizah. Reading habits and preferences of EFL post graduates: A case study. *Indonesian Journal of Applied Linguistics*. 1. (2011).
17. Mol, S. E., & Bus, A. G. To read or not to read: A meta-analysis of print exposure from infancy to early adulthood. *Psychological Bulletin*, 137(2), 267-296. (2011).
18. Renandya, W. A., & Jacobs, G. M. Extensive reading and listening in the L2 classroom. In W. A. Renandya & H. P. Widodo (Eds.), *English Language Teaching Today* (pp. 97-110). Springer. (2016).
19. Sánchez, X. A. C., & Gavilánez, L. F. P. Learners' attitudes toward extensive reading in EFL (English as a Foreign Language) contexts. *Revista Publicando*, 4(12), 259-268. (2017).
20. Sinaga, R. R. F., & Pustika, R. Exploring students' attitude towards English online learning using Moodle during COVID-19 pandemic at SMK Yadika Bandarlampung. *Journal of English Language Teaching*, 5(2), 56-65. (2021).
21. Smith, N. & Robinson, H. *Reading Instruction for Today's Children*, Prentice-Hall Inc., Englewood Cliffs, NJ. (1980).
22. Snow, C. E. *Reading for understanding: Toward an R&D program in reading comprehension*. RAND Corporation. (2002).
23. Stanovich, K. E. *Progress in understanding reading: Scientific foundations and new frontiers*. Guilford Press. (2000).
24. Tveit, A. K. Reading habits and attitudes towards reading among adolescents. *Scandinavian Journal of Educational Research*, 58(3), 268-281. (2014).
25. VandenBos, G. R. (Ed.). *APA dictionary of psychology* (2nd ed.). Washington, DC: American Psychological Association. (2015).
26. Wang, P., Chiu, D. K. W., Ho, K. K. W., & Lo, P. Why read it on your mobile device? Change in reading habit of electronic magazines for university students. *The Journal of Academic Librarianship*, 42(6), 687-696. (2016).
27. Wei, X., Saab, N., & Admiraal, W. Assessment of cognitive, behavioral, and affective learning outcomes in massive open online courses: A systematic literature review. *Computers & Education*, 163, 104097. (2021).
28. Whitten, C., Labby, S., & Sullivan, S. L. The impact of pleasure reading on academic success. *The Journal of Multidisciplinary Graduate Research*, 2(4), 48-64. (2016).
29. Yamashita, J. Effects of extensive reading on reading attitudes in a foreign language. *Reading in a Foreign Language*, 25(2), 248-263. (2013).

# Learning Facilities: A Pilot Investigation on The Perceived Academic Achievement in TVET Institutions

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**Abstract.** Facilities in learning institutions are supposedly designed to facilitate learning capabilities. However, an ill-defined system and a lack of facilities would jeopardize academic performance. This study aims to investigate the relationships and impact of facilities, ICT, and electronic materials, as well as CIDOS (an online center of learning and teaching), on perceived academic performance in Politeknik Sultan Idris Shah. This cross-sectional study utilizes an online survey instrument to measure the variables. This preliminary finding aims to measure the credibility of the instruments that have been conducted on the students of Politeknik Sultan Idris Shah. This pilot survey gives an essential stages to this study to be further examined and executed.

**Keywords:** perceived academic achievement, learning facilities, TVET

## 1 Introduction

Academic achievement normally explains the learning abilities of a student in their learning efforts. Academic achievement brings broad meaning in education and has broad definitions. It can be related to different grades, syllabus, skills, and abilities. Not to mention it can be defined from various perspectives and situations. Academic achievement defines as students' performance and outcomes in structured academic environments such as class, exam result, assignments and curricular activities (Zhao et al., 2023). Wikipedia defines academic achievement as the extent of a students, teachers, and institutions in attaining their goals. In TVET institutions whereby skills play a vital role in their academic achievement, the academic achievement would be carried out and measured by various means and assessments. In TVET institutions in Malaysia such as Politeknik Malaysia, an assessment process which includes continuous assessment and final examination determine the academic achievement. At some point academic achievement would also portray institutional performance and may retain the academic staff. While academic achievement in higher education influenced by several factors like self-efficacy and individual differences (Cassidy, 2012) other factors would be modern classroom, equipped with technology space and research laboratories (Issn et al., 2024) would enhance the academic achievement especially in higher education institutions. Facilities which can be the entire plant of the institution is paramount to students achievement (Asiyai, 2012).

However, lack of attention towards facilities and infrastructure may jeopardize the whole outcomes and learning process (Harapan & Puspita, 2020). Thus, this study aims at (i) investigating the learning facilities and the impact it may bring to the perceived academic achievement of students in TVET institution, (ii) to examine the level of electronic and ICT contribution towards perceived academic achievement among TVET students and (iii) to test the CIDOS and its relationship in determining the perceived academic achievement among TVET students. In implementing that, this paper is aiming at analyzing the pilot study which has been conducted at Politeknik Sultan Idris Shah to examine the matter.

## 2 Literature review

Facilities are not the only solo factors in academic achievement. Other support systems being investigated in this paper are electronic and ICT as well as CIDOS. CIDOS is an integrative and responsive platform used by Politeknik Sultan Idris Shah in their e-learning efforts. This online learning and teaching tool has been used widely and a KPI is always set up to ensure all staff will use this platform. Other factors which is ICT and electronic devices is also being measured other than mortar and bricks facilities.

### 2.1 Learning facilities

Facilities have a massive influence on academic performance (Farooq, 2019). Learning facilities in TVET institutions range from

physical facilities like classrooms, laboratories, sports facilities, cafeteria as well other services facilities like library and hostels. Online facilities like Wi-Fi coverage and online learning platforms. As the major elements in an educational system, it is learnt that parents as a stakeholders prefer and chose educational institutions based on facilities too (Ibrahim et al., 2016). Facilities is also associated with suspension and absenteeism and a good facilities is not also support achievement but also attendance in class (Hameen et al., 2020).

Although social facilities like spatial environment, people and communities, but built environments plats an important role in escalating student performance (Maria Cammila Coronado, 2021). Other study also emphasized that physical facilities is strongly associated with institutional readiness to serve the clients (Shaari & Ahmad, 2020). Thus, this study is crucial especially for the stakeholders view their commitment to TVET education.

## 2.2 CIDOS, Electronic and ICT

CIDOS is an online learning platform introduced by the Department of Polytechnic and Community College. This online learning platform is widely encouraged and used in teaching and learning. This digital learning platform provides flexibility, accessibility and fosters lifelong learning. Currently it is found that pedagogically, an instructional designed support self-regulated learning and develop teachers role in this digital challenges environment (Ferrer & Moral, 2022).

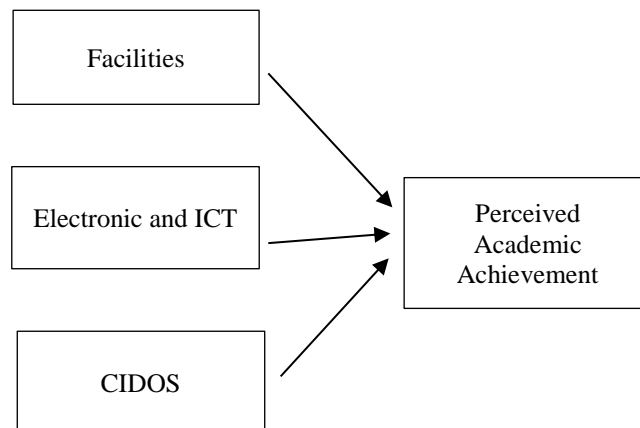
## 2.3 Academic Achievement

The ultimate aim of an educational system is the cognitive and behavior of the students in which the facilities, ICT and even any an online learning platform is all about (Afework, 2014). Academic achievement typically refers to the performance of students in their academic endeavors, this measurement in this study depends on individual achievement and expectations. This is important to an individual's life due to a few reasons namely personal growth, opportunities, development, social and economic pathway etc. This perceived achievement. As this academic achievement is measured by several means and methods and frequently seen from their grades, their achievement can be also measured by their thinking and creative thinking skills. These can be seen in their assignment and behavior (Uğur Akpur, 2020).

Thus, learning facilities, electronic & ICT and online learning platform might be an effort towards enhancing academic achievement. Online learning platforms and other blended learning is equivalent to conventional learning and can support educational objectives (Müller & Mildemberger, 2021).

## 3 Methodology

This cross-sectional study was conducted in Politeknik Sultan Idris Shah. The method used is a quantitative research method. Variables in this quantitative consist of facilities (FAC), electronic and ICT (I) and CIDOS as well as the dependent variable; perceived academic achievement (PER). The population in this study is 3,000 students. In this case the sample use will be 384 (Krejcie & Morgan, 1970). This is based on RBV Theory (Resource Based View Theory). This study adopted the mentioned theory to examine the performance of the students who utilized the resources. This study employs the following framework.



**Fig. 1.** Research Conceptual Framework

The data collection is carried out online and this paper is based on the pilot study which has been collected on 50 respondents. The questionnaires are adapted from Abd-elmotaleb & Saha, (2013) and also has been developed according to local practice and environment. The online questionnaire has been categorized into 6 sections. The first section is the screening section which screened the respondents. Only respondents from the students of Politeknik Sultan Idris Shah would be accepted. Other responses from will be eliminated. The second is 12 items in the construct which will measure the independent variable: facilities. The third and fourth section are the six and four items respectively. The fifth construct is the section

which examines the dependent variable; perceived academic achievement. The last section requires details on demographics and also an open-ended questionnaire about the overall questionnaires. The total number of questionnaires is 35 questions in scale, nominal dan ordinal.

## 4 Finding and Analysis

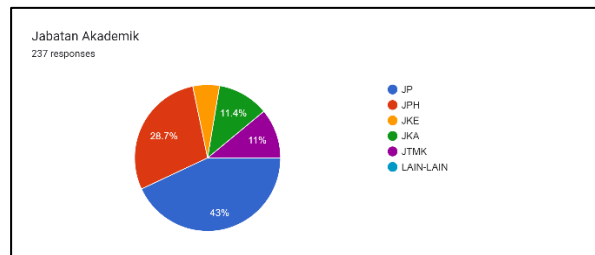
This preliminary study is aiming at pilot study findings and analysis. To further view the credibility and reliability of the instruments, a Cronbach Coefficient is being carried out.

**Table 1.** Cronbach Coefficient Value

No.	Variables	No of items	Cronbach Coefficient	Reliability Value
1.	Facilities	12	0.952	Excellent
2.	Electronic and ICT	6	0.914	Excellent
3.	CIDOS	4	0.981	Excellent
4.	Perceived Academic Achievement	6	0.940	Excellent

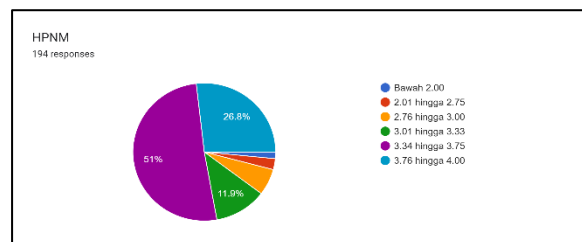
From the above diagram, all of construct of variables exhibited an excellent value of Cronbach coefficient value and shows that all construct can measure what it is supposed to measure (Creswell, 2014).

The instrument used is the online questionnaire. The questionnaire is divided into six sections. Section A is the screening questions whereby researcher has to ensure that all respondents are an actual selected participant. Section B is the independent variable; facilities, electronic and ICT and CIDOS. The dependent variable is the perceived academic achievement.



**Fig. 2.** Faculty/ Academic Department

The above diagram shows the dominant size of a department. It shows that Commerce Department students have above 40%, while other departments have less than 15% each. The label also shows other departments comprise some percentage in which it does not represent any other department.



**Fig. 3.** Academic result; CGPA

Fortunately, more than half of the respondents in this study are performed students based on their cumulative grade point average (CGPA). However, this study is not focusing on the performance based on CGPA achievement.

Based on this pilot data collection, there will be much more which can be learned and improved. For instance, the distribution of data collection method should be quicker and more extensive. This is due to the reasons that this study is conducted in this period and involves specific students which consume the facilities and ICT. In this feasibility study, there are a few issues and logistics which can be learned to collect better information on this matter.

As to infer to the population, the sampling method used is thru simple random sampling where everybody in the sample has the same probability to be selected (Hair et al., 2007). The sampling frame would be all the name list in Students Affair

in each institution. The population size is around 250,000 students and the sample size would be 384 students (Krejcie & Morgan, 1970).

## 2 Conclusion

This pilot study has provided necessary information to ensure this study is rigorously accomplished. It seems that some possible action should be taken into consideration in before executing to the actual data collection phase: Data protocols such as internal research procedures should be followed,

- i) Data collection via online questionnaires has come in handy recently but there are challenges when respondents might be reluctant to click the link since most illegal fraud use the same method.
- ii) The respondents are expected to respond efficiently under the influence of an academic advisor, thus the questionnaires have to go thru the academic advisors.

This valuable information may escalate the research process so that the result can be infer to the population.

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## References

1. Abd-elmotaleb, M., & Saha, S. K. (2013). *The Role of Academic Self-Efficacy as a Mediator Variable between Perceived Academic Climate and Academic Performance*. 2(3), 117–129. <https://doi.org/10.5539/jel.v2n3p117>
2. Afework, T. H. (2014). The Availability of School Facilities and Their Effects on the Quality of Education in Government Primary Schools of Harari Regional State and East Hararghe Zone , Ethiopia. *Middle Eastem and African Journal of Educational Research*, 11, 79.
3. Asiyai, R. (2012). Assessing School Facilities in Public Secondary Schools in Delta State, Nigeria. *African Research Review*, 6(2), 192–205. <https://doi.org/10.4314/afrrrev.v6i2.17>
4. Cassidy, S. (2012). Studies in Higher Education Exploring individual differences as determining factors in student academic achievement in higher education. *Studies in Higher Education*, December 2014, 37–41. <https://doi.org/10.1080/03075079.2010.545948>
5. Creswell, J. W. (2014). *Research Design, Qualitative, Quantitative and Mixed Method Approach*. SAGE Publication.
6. Farooq, M. (2019). Pakistan Journal of Social Research Vol. 1, 2019, pp. 25-34 [www.pjsr.com.pk](http://www.pjsr.com.pk). *Pakiistan Journal of Social Research*, 1, 25–34.
7. Ferrer, T., & Moral, V. (2022). *Flexible Learning Itineraries in Digital Environments for Personalised Learning in Teacher Training*. 25.
8. Hair, J. F., Arthur H. M., Philip Samouel, & Mike Page. (2007). *Research Method for Business*.
9. Hameen, E. C., Ken-opurum, B., Priyadarshini, S., Lartigue, B., & Anath-pisipati, S. (2020). Effects of School Facilities ' Mechanical and Plumbing Characteristics and Conditions on Student Attendance , Academic Performance and Health. *International of Civil and Enviromental Engineering*, 14 (7)(September), 193–201.
10. Harapan, E., & Puspita, Y. (2020). The Influence of Learning Facilities and Motivation On Student's Achievement. *International Journal of Progressive Sciences and Technologies (IJPSAT)*, 20(2), 284–290. <http://ijpsat.ijsh-journals.org>
11. Ibrahim, N. M., Osman, M. M., Bachok, S., & Zin, M. (2016). Assessment on the Condition of School Facilities : Case study of the selected public schools in Gombak district. *Procedia - Social and Behavioral Sciences*, 222, 228–234. <https://doi.org/10.1016/j.sbspro.2016.05.151>
12. Issn, P., Bella, K. M. J. E. S., & Vijayashree, P. (2024). A Study on Institutional Infrastructure and Facilities for Faculty. *Research Explorer*, XII(39), 80–84.
13. Krejcie, R. V., & Morgan, D. W. (1970). Determining Sample Size for Research Activties. *Educational and Psychological Measurement*, 607–610. <https://doi.org/10.1891/9780826138446.0006>
14. Maria Cammila Coronado. (2021). *THE IMPACT OF SCHOOL FACILITIES ON STUDENT LEARNING Net*.
15. Müller, C., & Mildemberger, T. (2021). Facilitating flexible learning by replacing classroom time with an online learning environment : A systematic review of blended learning in higher education. *Educational Research Review*, 34(June), 100394. <https://doi.org/10.1016/j.edurev.2021.100394>
16. Shaari, M. F., & Ahmad, S. S. (2020). Physical Learning Environment : Impact on Children School Readiness in Malaysian Preschools. *Procedia - Social and Behavioral Sciences*, 222, 9–18. <https://doi.org/10.1016/j.sbspro.2016.05.164>
17. Ugur Akpur. (2020). Critical, Reflective, Creative Thinking and Their Reflections on Academic Achievement c. *Thnking Skills and Creativity*, 37(May). <https://doi.org/10.1016/j.tsc.2020.100683>
18. Zhao, Z., Ren, P., & Yang, Q. (2023). Student self-management, academic achievement: Exploring the mediating role of self- efficacy and the moderating influence of gender—insights from a survey conducted in 3 universities in America. *Journal of Integrated Science and Humanities*, 1–12.

# Moderating Roles of Technology Readiness in Generalized Audit Software (GAS) Adaption: Evidence from Malaysia TVET Institution

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**Abstract.** In the current digital era, technology has become an essential component of auditing since it may make auditors' work more precise, efficient, and productive. Various professional parties, including industry, have urged the education sector, particularly higher education institutions (HEIs), to reform their academic accounting programs by integrating audit-related technology. The aim of this study is to examine the adoption of generalized audit software among academic staff using a technology acceptance model (TAM) with technology readiness (TR) as a moderator. A survey was conducted in which online questionnaires was distributed to a Malaysian Technical and Vocational Education and Training (TVET) institution. The collected data underwent preliminary screening using IBM SPSS Statistics 22 and analyzed using SmartPLS 4. The results agreed with TAM literature as intention to use GAS significantly influence by perceived usefulness and perceived ease use. TR however have no impact on TAM as moderator variable. This empirical evidence may serve as critical source to Malaysian Ministry of Higher Education (MOHE) regarding the current status of their staff competency before strategically restructure any plan to empower HEIs. Especially, TVET institution. Understanding user behavior before adopting new technology is crucial for optimizing utilization of new technology and preventing any financial losses due to technological investment failure.

**Keywords:** technology acceptance model, technology readiness, generalized audit

## 1 Introduction

Due to digital era, business sector gradually switches from paper-based to electronic techniques. In light of this, audit needs to start shifting its emphasis from human detection to technology-based detection and prevention. As a result, a new kind of auditor is required due to the changing audit scenario. They are expected to have crucial auditing skillset like data analytic, critical thinking, cybersecurity and communication (FasterCapital, 2024). Hence, higher education institution (HEIs) is called to reform their accounting curricula by including digital technology skills to respond to the new challenging environment (American Institute of Certified Public Accountants [AICPA], 2019; Tan & Laswad, 2018). However, the issue is whether the academic staff ready and willing to integrate audit-related technology such as generalized audit software (GAS) into their classroom? This motivates research into the factors that influence academic staff's acceptance of GAS, especially in Malaysian TVET institutions.

GAS is most popular computer assisted auditing tools and techniques (CAATs) equip with data analytic ability. Example of GAS is IDEA and ACL, a professional audit software package (INTOSAI, 2022). Since GAS allow automated the manual audit processes, the auditors could gain more understanding of financial data, increase accuracy, and expedite analysis which subsequently led to financial reporting becomes more reliable, risks are better managed, and audit quality increases (Atta et al., 2024). As a result, GAS become essential tools for auditors in current digital era. Moreover, COVID-19 has increased the popularity of GAS due its convenience for remote auditing (KPMG, 2020). In particular, accounting professional bodies have encourage auditors to adopt new technology including GAS to cope with movement restriction (International Federation of Accountant [IFAC], 2020). However, the usage of such technology and auditor with requisite skill is still limited in the industry (Saad et al, 2020; Deloitte, 2021). Due to that, audit quality become inconsistent, difficult to contact customers and auditors having an interruption in reporting an audit (Association of Chartered Certified Accountant [ACCA], 2020). This scenario has reshaped the industry expectation for future auditor with new skillset including digital data analytic skills, judgement and critical thinking and financial skills (Deloitte, 2021).

Accounting professional bodies agreed with industry and urged HEIs to revise their accounting curricula by providing the students with relevant digital technology skills as per industry demand (AICPA, 2019; PricewaterhouseCoopers [PWC], 2015). Unfortunately, HEIs delay in respond to those called. Malaysian TVET particularly yet to integrate GAS into their curricula or offering program related to audit-related technology. As a results, the skill gaps exist due to mismatch between the competency of accounting graduates with skills expected by employers. This contrary with National TVET Policy 2030 to develop future available talent to meet dynamic needs of the industry and directly reduce dependence on foreign labour (Wartawan BH, 2024).



Moreover, Malaysian professional bodies also mandated HEIs, particularly academic staff to nourish their accounting graduate with competency such as audit and accounting software skills to leverage the global digital economy (Malaysian Qualification Agency [MQA], 2014; MIA, 2018). Nevertheless, academic staff are found lacking in term of industry experience and are unable to successfully integrate ICT into educational activities (Yeap et al., 2021). As a result, the readiness and willingness of academic staff to incorporate GAS into accounting programs is being questioned. Hence, this study employed technology acceptance model to comprehend the driver of GAS adoption with technology readiness as moderator.

In GAS literature, the past studies mostly focus on the accounting practitioner perspective including audit partners, audit managers, or supervisors using various models like technology organizational environment (TOE) framework and Unified of Acceptance and Use of Technology (UTAUT) and Technology Acceptance Model (TAM). Hence, by examining the GAS adoption among academic staff with focusing on TR as moderator in TAM, this study fills the existing gap. The findings of this study could narrow these gaps in the relevant literature and providing empirical evidence for HEIs governing bodies as well as academic staff in creating opportunity to enhance their competency and remain competitive in producing skillful talent.

## 2 Literature review and hypotheses development

In literature, TAM is the most popular model to examine and forecast people's adoption of technology. As system-specific paradigm, TAM which developed by Davis (1989) is focused on how the features of technology impact the opinion of its users. This opinion subsequently determines whether the user will adopt the technology or not. In TAM, such opinion known as perceived ease of use and perceived usefulness, two significant but distinct concepts that affect a technology adoption decision (Davis, 1989). The previous studies by Kim et al. (2016) and Widuri et al. (2017) have focus on GAS adoption among accounting practitioners like internal and external auditors by employing TAM. Despite TR as another technology adoption model, there are limited number of studies that employ both TR and TAM simultaneously to comprehend GAS adoption. Unlike TAM, TR emphasizes on personality characteristic to clarify the application and embracing novel technologies. Essentially, an individual's character affects their likelihood of accepting technology (Godoe, P., & Johansen, 2012). Since users' inclinations to accept new technologies vary depending on their TR characteristics, TR should be incorporate to TAM studies due to its indisputable contribution to the prediction of technology adoption (Vatnani & Sanjeev, 2014). Thus, this study employs both model from system and user personality perspective to predict the behavioural intention to use GAS.

### 2.1 Perceived ease of use (PEASE)

PEASE refers as when individual believe that technology has user-friendly features. Individual will adopt technology when they believe that technology can be employ easily with less effort (Davis, 1989). The more user-friendly technology the higher possibility individual will adopt it (Raman and Aashish, 2022). In this study, academic staff willing to employ GAS in the class when they know that it easy to use.

Literature agreed that PEASE and intention to GAS has significant positive relationship (Atta et al., 2024; Kim et al., 2016). According to Atta et al. (2024, employing technology normally involved training which time consuming and raise learning curve issues. Nonetheless, entry barriers are falling due to user-friendly feature. Certain studies however denied PEASE will influence intention to use GAS (Purnamasari et al., 2022; Mahzan & Lymer, 2014). Auditor are considered expert in their field of work; thus, effort and time does not substantially hinder their use of audit technology (Mahzan & Lymer, 2014). Thus, the following hypothesis is developed:

*H1 PEASE has a positive significant relationship with the intention to use GAS.*

### 3 Perceived usefulness (PUSE)

PUSE is when individual believe that certain technology will lead to positive outcome. Literature reveals that the willingness of individual will increase once they belief the benefit and usefulness of certain technology (Raman and Aashish, 2022). In this study, academic staff may not hesitate to adopt GAS when they realized the important of GAS in auditors' profession.

GAS is said to improve performance of auditors when conducting an audit, including GAS will minimize time and money but increase the quality of audit (Mahzan and Lymer, 2014). As a result, prior studies mostly found that PUSE and intention to use CAATs, for example GAS, has positive significant relationship (Daoud, 2023; Purnamasari et al., 2022; Almagrashi et al., 2023). The auditor wiling to adopt CAATs once they realize that technology will enable them to complete jobs swifter, expedite analysis, increase accuracy and gain more understanding of financial data (Purnamasari et al., 2022; Atta et al., 2024). In contrary, the study by Kim et al. (2016) rejects the relationship between PUSE and intention to use CAATs. They argued that GAS only useful to auditor when it recommends by management, corporations, or peers. Thus, the following hypothesis is developed:

*H2 PUSE has a positive significant relationship with intention to use to use GAS*

## 4 Technology readiness (TR)

Literature show that individual variations are not taken into account by the TAM. Personality trait differences should be given more consideration than psychological or demographics variables since they are essential to the development of both individual attitudes and behavioural intentions (Chang et al. 2020). As a result, prior studies employed TR as moderator to TAM (Chang et al., 2020; Tsourela & Roumeliotis, 2015; Vatnani & Verma, 2014; Yousafzai & Yani-de-Soriano ,2012; Lin & Chang, 2011). An individual with high technological readiness is expected to care less about benefit and user-friendly features of new technology since they excited to employ it. Most of studies agree that TR moderate the relationship between PUSE and intention to use GAS (Vatnani & Verma, 2014; Yousafzai & Yani-de-Soriano ,2012; Chang et al., 2020; Tsourela & Roumeliotis, 2015). The intention of high TR individual to use new technology increases when they have a positive mindset regarding its benefits. However, Lin & Chang (2011) denied this finding and claimed that low TR individuals still interested in the features, benefits, and value of new technology to adopt it. In addition, TR are found attenuate the linkage between PEASE and intention to use GAS (Vatnani & Verma, 2014; Yousafzai & Yani-de-Soriano ,2012) but not in the studies by Chang et al. (2020) and Tsourela and Roumeliotis (2015). The reason behind this finding might be due to the lower technical expertise and the simplicity of the system. Thus, the following hypothesis is developed:

*H3 TR moderate the relationship between PUSE and intention to use GAS*

*H4 TR moderate the relationship between PEASE and intention to use GAS*

## 5 Methodology

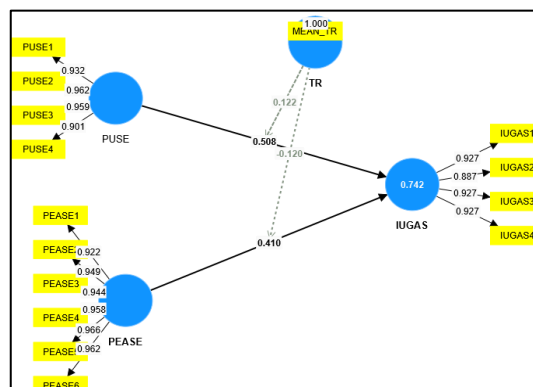
Online questionnaires of google form were distribute to all 16 branches of a Malaysian TVET institution. Unlike previous studies focusing on accounting practitioners, this study centered on academic staff with accounting background since they will integrate GAS into their auditing class activities. From total population of 270, only 119 responds to the questionnaire. Due to small number of academic staff, the sample size is equivalent to population. This may prevent bias in the sample which allowing generic findings and avoiding drawing incorrect conclusions. Thus, the response rate is 44%, without any outliers. This response rate is considered satisfactory since it over than 30% as suggested by Sekaran and Bougie (2016). The questionnaire was adapted from past studies by Parasuraman & Colby (2015), Davis (1989), Md Noh & Amron (2021), Damerji & Salimi (2021), and Chiu & Cho (2020) with two parts; background information and measurement of constructs. All the data were being screen using IBM SPSS Statistic 2 and analyses using a structural equation model via application of SmartPLS 4.

**Table 1.** Summary of background information

Background Information		Percentage
Gender	Female	80%
	Male	20%
Age	30-39	30%
	40-49	61%
	≥ 50	9%
Experience in industry sector	≤ 2	82%
	3-6	14%
	≥7	4%

## 6 Findings

Since it can attain high levels of statistical power with small sample numbers and perform well with complex models, the partial least squares structural equation modelling (PLS-SEM) is utilized in this study (Hair et al., 2021).



**Fig. 1.** Measurement model

From the measurement model above, there are no removed items since the outer value for all item constructs are above 0.40 value (Hair et al., 2022). This indicates all items in this study have common characteristic.

**Table 2.** Composite reliability (CR) and Average variance extracted (AVE)

First Order Construct	CR	AVE
IUGAS	0.955	0.842
PEASE	0.982	0.903
PUSE	0.967	0.881

*Note: IUGAS-intention to use GAS; PEASE-perceived ease of use; PUSE-perceived usefulness*

In addition, convergent and internal consistency reliability are found sufficient as the AVE score is above 0.50 and CR score is higher than 0.70. Outer loading is used to measure discriminant validity which shows cross loading is lesser than outer loading indicating that discriminant validity of the construct has been established. In summary, the instrument in this study is reliable and valid. Plus, there are no multicollinearity issues since the variance inflation factor (VIF) is lower than 5 and the tolerance value is higher than 0.20 for PEASE, PUSE and TR.

**Table 3.** Result of structural model analysis

Hypo	Relation	t-value	p-value	Decision
H1	PEASE-IUGAS	4.746	0.000	Supported
H2	PUSE-IUGAS	14.469	0.000	Supported
H3	PEASE*TR-IUGAS	1.486	0.137	Not supported
H4	PUSE*TR-IUGAS	1.44	0.15	Not supported

After conducting structural model analysis via bootstrapping, the results show H1 and H2 were supported while H3 and H3 were not supported. The threshold is based on Hair et al. (2022) with t-value must be lower than 5% significant level and p-value must be higher than critical value of 1.65. To forecast the predictive relevance, this study used PLSpredict to determine  $Q^2$ .  $Q^2$  score is IUGAS is large in term of predictive relevance with 0.596 (Hair et al., 2022). Furthermore,  $F^2$  is use to determine the effect size of model which evaluate the impact of predictor variables towards endogenous variables. The results indicate  $F^2$  for PEASE is moderate (0.277) and PUSE is strong (0.422) in accordance of Chin (1988). The goodness of fit index (GoF) score also been calculated which derived from AVE and  $R^2$  score, GoF score is 0.751 which consider large score indicating that the validity of PLS model is sufficient.

## 5 Discussion

This study focusing on how TR influence TAM in GAS adoption. The result shows that TR as moderator do not contribute in intention to adopt GAS among academic staff. In other words, TR do not have significant impact on the both linkage either between PEASE and IUGAS or PUSE and IUGAS. The finding in line with past studies by Chang et al. (2020) and Lin and Chang (2011). Despite being low TR, the academic staff still concern about the benefit and user-friendly feature of GAS which will increase the probability to adopt GAS. Since the majority of academic staff lacks industry experience, they might not be familiar with audit software like IDEA or ACL, which contributes to their low technological readiness for GAS. Furthermore, they may have limited technological expertise compared with the younger generation, who live in a technological environment. However, the low TR academic staff willing to adopt GAS because they may understand their adoption and integration GAS into the classroom will improve employability of their students.

Meanwhile, as expected, both TAM variables; PEASE and PUSE have positive significant linkage with intention to use GAS. This result validates the literature assertion about the ability of TAM in prediction behavior intention for any technology. When academic staff realize the benefit of GAS for their student as future auditor and how it can be master with minimum cost or time, this perception will influence them to adopt GAS. The findings are consistent with the studies by Atta et al. (2024) and Kim et al. (2016) in which any entry barrier can be reduce when the technology being perceived as user-friendly. It also supports the past research by Daoud (2023), Purnamasari et al. (2022) and Almagrashi et al. (2023) in regards of PUSE relationship with IUGAS. The willingness to adopt GAS will increase since GAS is essential tools that will empower auditor while conducting an auditing.

## 6 Conclusion

The accounting and auditing professions are projected to face both new opportunities and challenges as a result of growing digital

technologies. HEIs should carefully consider their next step to gain those opportunities and make sure future challenge is under control. Hence, the study's findings will offer empirical evidence as basis in strategically materialize their objective to produce high quality talent. The findings shows that academic staff have low TR, thus they depend on the simplicity and advantageous of audit software in deciding to adopt it. Therefore, HEIs should educate their academic staff about GAS and take into account about their technology competency level when structuring the training. HEIs may appoint industry trainers to equip academic staff with audit software skills and may also organize sharing sessions with the Malaysian National Audit Department, which has been adopting ACL since 2017. It also important to consider the user-friendly feature when choosing GAS to be embed into accounting curricula. These actions should be done to ensure not only the National TVET Policy 2023 being successfully achieved but may also prevent the loss in technology investment.

In addition, TR rarely being study in the past in GAS literature either as external variable of TAM or moderator in any models. Thus, the findings will expand the literature with new insight related to personality trait impact in technology adoption. Generally, this study verified the important to consider TR in TAM since the later solely focus on user perception about the technology.

This study has several limitations which suggest for future research. First, it only focuses on system-specific paradigm and personality traits. External variable like peer influence, facility condition and organization support should be consider being investigate by next researchers which might have bigger impact that led to rejection adoption by users. Second, this quantitative study only answers the question of "what" that may unable to explain certain variance in technology adoption. Thus, next study should employ qualitative research to explore more deeply about user behavioral intention which cannot being capture via quantitative study. Third, the findings of this study might not reflect the whole Malaysian HEIs since the subject is academic staff from Malaysian TVET institution. Therefore, future researcher might look into GAS adoption among lecturers in university.

## References

1. Almagrashi, A., Mujalli, A., Khan, T., & Attia, O. (2023). Factors determining internal auditors' behavioral intention to use computer-assisted auditing techniques: An extension of the UTAUT model and an empirical study. *Future Business Journal*, 9(1). <https://doi.org/10.1186/s43093-023-00231-2>
2. American Institute of Certified Public Accountants [AICPA].(2019). Summary of revisions to the Uniform CPA Examination\_ Blueprints Retrieved from <https://www.aicpa.org/content/dam/>
3. Association of Chartered Certified Accountants [ACCA]. (2020). ACCA Member Survey, Business challenges and considerations for the Covid-19 outbreak, Retrieved from [https://www.accaglobal.com/content/dam/ACCA\\_Global/Assets/campaigns/ACCA-member-survey-Business-challenges-Covid-19.pdf](https://www.accaglobal.com/content/dam/ACCA_Global/Assets/campaigns/ACCA-member-survey-Business-challenges-Covid-19.pdf)
4. Atta, A. A., Baniata, H. M., Othman, O. H., Ali, B. J., Abughaush, S. W., Aljundi, N. A., & Ahmad, A. Y. (2024). The impact of computer assisted auditing techniques in the Audit Process: An Assessment of performance and effort expectancy. *International Journal of Data and Network Science*, 8(2), 977–988. <https://doi.org/10.5267/j.ijdns.2023.12.009>
5. Chang, Y.-Z., Yu, C.-W., Chao, C.-M., & Lin, F.-C. (2020). Influences on medical app adoption by patients: The unified theory of acceptance and use of technology model and the moderating effects of technology readiness. *The Social Science Journal*, 1–14. <https://doi.org/10.1080/03623319.2020.1848338>
6. Chin, W. W. (1998). The partial least squares approach to structural equation modeling. *Modern Methods for Business Research*, 295(2), 295-336.
7. Daoud, L. (2023). Predictors of auditors' usage of caats: The role of Top Management Support and Trust. *Information Sciences Letters*, 12(5), 1841–1850. <https://doi.org/10.18576/isl/120528>
8. Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of Information Technology. *MIS Quarterly*, 13(3), 319. <https://doi.org/10.2307/249008>
9. Deloitte. (2021). The future of audit: An evolving financial reporting ecosystem in Singapore, Retrieved from <https://www2.deloitte.com/content/dam/Deloitte/sg/Documents/cxo-programs/sg-cxo-future-of-audit.pdf>
10. FasterCapital LLC-FZ. (2024, April 14). *Auditing skills: Auditing in the Digital Age: Leveraging Technology for Efficiency*. FasterCapital. <https://fastercapital.com/content/Auditing-skills--Auditing-in-the-Digital-Age--Leveraging-Technology-for-Efficiency.html>
11. Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). A primer on partial least squares structural equation modeling (*PLS-SEM*) (3rd ed.). Thousand Oaks:Sage
12. International Federation of Accountants [IFAC]. (2020), Summary of Covid-19 Audit Consideration, Retrieved from <https://www.ifac.org/knowledge-gateway/supporting-international-standards/discussion/summary-covid-19-financial-reporting-considerations>
13. INTOSAI Working Group on Big Data. (2022, September). Research paper on innovative audit technology. China.
14. Kim, H.-J., Kotb, A., & Eldaly, M. K. (2016). The use of generalized audit software by Egyptian external auditors. *Journal of Applied Accounting Research*, 17(4), 456–478. <https://doi.org/10.1108/jaar-10-2015-0079>
15. KPMG. (2020). Remote Audit for Internal Auditor, Retrieved from <https://assets.kpmg/content/dam/kpmg/be/pdf/2020/05/KPMGRemoteAuditingInternalAuditors.pdf>
16. Lin, J. C., & Chang, H. (2011). The role of technology readiness in self-service technology acceptance. *Managing Service Quality: An International Journal*, 21(4), 424–444. <https://doi.org/10.1108/09604521111146289>

17. Mahzan, N. and Lymer, A. (2014), "Examining the adoption of computerassisted audit tools and techniques: Cases of generalized audit software use by internal auditors", *Managerial Auditing Journal*, Vol. 29 No. 4, pp 327–349.
18. Malaysian Institute of Accountants [MIA]. (2018). Digital technological blueprint. Retrieve from <https://www.mia.org.my/v2/ppt/digital/technology.aspx>
19. Malaysian Qualifications Agency [MQA]. (2014). Program Standard: Accounting. Retrieved from [https://www2.mqa.gov.my/qad/v2/garispanduan/2019/PS%20Accounting/7.%20PS%20-%20Accounting\\_BI%20-%200%5BFB%5D.pdf](https://www2.mqa.gov.my/qad/v2/garispanduan/2019/PS%20Accounting/7.%20PS%20-%20Accounting_BI%20-%200%5BFB%5D.pdf)
20. PricewaterhouseCoopers [PwC]. (2015). Data driven: What students need to succeed in a rapidly changing business world (White paper). Retrieved from <https://www.pwc.com/us/en/faculty-resource/assets/PwC-Data-driven-paper-Feb2015.pdf>
21. Purnamasari, P., Amran, N. A., & Hartanto, R. (2022). Modelling Computer Assisted Audit Techniques (CAATS) in enhancing the Indonesian Public Sector. *F1000Research*, 11, 559. <https://doi.org/10.12688/f1000research.121674.1>
22. Raman, P., & Aashish, K. (2022). Gym users: An enabler in creating an acceptance of sports and fitness wearable devices in India. *International Journal of Sports Marketing and Sponsorship*, 23(4), 707–726. <https://doi.org/10.1108/ijsms-08-2021-0168>
23. Sekaran, U., & Bougie, R. (2016). *Research methods for business: A skill building approach* (7th ed.). West Sussex: UK: John Wiley & Sons.
24. Tan, L. M., & Laswad, F. (2018). Professional skills required of accountants: what do job advertisements tell us? *Accounting Education*, 27(4), 403–432. doi:10.1080/09639284.2018.1490189
25. Tsourela, M., & Roumeliotis, M. (2015). The moderating role of Technology Readiness, gender, and sex in consumer acceptance and actual use of technology-based services. *The Journal of High Technology Management Research*, 26(2), 124–136. <https://doi.org/10.1016/j.hitech.2015.09.003>
26. Vatnani, R., & Verma, S. (2014). Comprehensive framework for internet banking adoption: An empirical analysis in the Indian context. *International Journal of Business Information Systems*, 15(3), 307. <https://doi.org/10.1504/ijbis.2014.059753>
27. Wartawan BH. (2024, June 8). Dasar tvet negara 2030: 5 teras mendepani landskap semasa, cabaran teknologi baharu. *Berita Harian*.
28. Yeap, C. F., Suhaimi, N., & Nasir, M. K. M. (2021). Issues, Challenges, and Suggestions for Empowering Technical Vocational Education and Training Education during the COVID-19 Pandemic in Malaysia. *Creative Education*, 12, 1818–1839. <https://doi.org/10.4236/ce.2021.128138>
29. Yousafzai, S., & Yani-de-Soriano, M. (2012). Understanding customer-specific factors underpinning internet banking adoption. *International Journal of Bank Marketing*, 30(1), 60–81. <https://doi.org/10.1108/02652321211195703>

# A Preliminary Insights of Human Resource Sustainability Among Young Talents in TVET Institutions

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**Abstract.** Sustainable human resources are a performance factor in successful talent management. Various studies regarding this have been discovered including the leadership, relationship among human resource management, and the tensions and paradoxes of human resource management as well as the social dimension of this term. However, the term reportedly on ill-defined youngsters who are becoming future talents. Thus, this paper aims to describe and measure the actual scenario from a young perspective. This paper elaborates on the attendance management system and sustainability of human resource management in their knowledge of OSHA and employee benefits. This cross-sectional study utilizes a questionnaire survey to investigate the matter. Some challenges have been learned from a pilot study. Thus, this pilot study could be conducted until it reaches the population size.

**Keywords:** sustainable human resource management, OSHA, employee benefits

## 1 Introduction

Technical and Vocational Education and Training (TVET) institutions play a critical role in equipping young people with the skills and knowledge needed to succeed in the workforce. Ensuring human resource sustainability within these institutions, particularly among young talents, is crucial for their ongoing success and relevance. This report provides preliminary insights into the sustainability of human resources among young talents in TVET institutions.

Human resource sustainability in TVET institutions involves the development and retention of skilled and motivated staff and students. It ensures that institutions can continually provide high-quality education and training, adapt to changing industry needs, and foster innovation.

In this process, knowledge and cognitive skills are important to human resources, especially in personality, and factors to human resources apart from the company can successful performance in the marketplace would be the main sustainability factor (Hitka et al., 2019). Empirical evidence shows that age would be a moderating affect to sustainability either inside or outside the organization (Muñoz-Pascual et al., 2020). In previous years, a study about the sustainability process and encouragement has been done to cultivate sustainability among employees (Arnott et al., 2009). It is an initiative to equip and reshape the talents of organization into the journey toward sustainability of the organization.

At present, organization have been bombarded with several changes including monumental challenges like poverty, climate change, and population changes which can impact the environment, society, and business operations. Business leaders view this scenario as a new change that they should adhere to, and education institutions are the most spotted places to have an early view of the future sustainability of human resources. Youngsters have been seen to be involved in accidents in labs for instance although they exhibited a high level of awareness towards Occupational Safety and Health Administration (OSHA) (Ramli et al., 2020).

As such this study is crucial as most students will undergo their internship and embark on their career soon. This is vital to investigate the level of knowledge among students about the matter since companies are moving towards sustainability programs. Almost vicennial or two decades ago, companies invested in Environmental Management System (EMS) which were concerned with greener products demands by consumers and sustainable efficiencies of operations as well as the factors of human resource been investigated (Bonnie F Daily & Su Chun Huang, 2001). Studies have shown that green and sustainable human resource lead to environmental and financial performance of an organization (Amrutha & Geetha, 2020).

Besides initiatives from the government and concerns from business organizations especially on their performance leverage, the academic sector has started to focus on sustainability. Numerous studies have been conducted on sustainability including on social sustainability (Macke & Genari, 2019). Studies on sustainability in human resources come in different dimensions. Starting from the sustainability idea from the Triple Bottom Line Model of Elkington in 1987, the dimension varies from human resource management to corporate sustainability.

Thus, this study aims to (i) to investigate the level of awareness of OSHA in human resource management sustainability, (ii) to examine the level of awareness of work-life balance in human resource management, and (3) examine the level of the dependent variables, sustainable human resource management. As for this paper, this pilot study is aiming at learning the protocols, the process of data collection, sampling strategies, and other research potential problems that the research might adhere to.

## 2 Literature review

### 2.1 OSHA (Occupational Safety and Health Act)

Occupational Safety and Health have a positive impact on competitiveness and productivity (Okechukwu et al., 2021) and business success also depend on the business strategy on how they take care of their stakeholders and mankind (Suhaila Abdul Hamid, 2022). OSHA or workplace safety is also considered vital both by employers and employees (Hassam et al., 2023).

### 2.2 Work life benefits

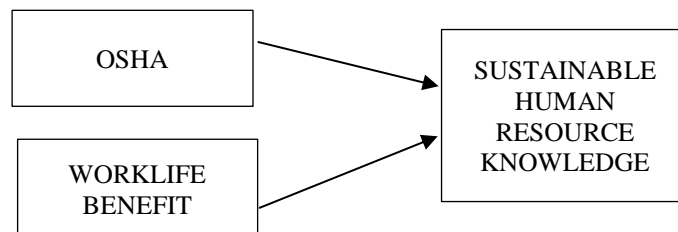
Work life benefits always associated with work life balance which emphasize on the extent to which employers allow for more benefits to employees benefits (Irawanto et al., 2021). Previously work life benefits would be an attraction in the recruiting process (Casper & Buffardi, 2004). Recently increasing awareness has been identified of the work life benefit and quality of life as one of the required elements in human resources (Aruldoss, 2020).

### 2.3 Sustainable human resource

Redesigned, regeneration and renewal and long-term development of human resources should be called sustainable (Davidescu et al., 2020). At present, sustainable human resources become vital and important. It is the basic principles that should be acquired along the way to industrial revolution 4.0 (Piwowar-sulej, 2021). Thus, it is important to measure the awareness of the sustainability of human resources among TVET youngsters.

## 3 Methodology

This pilot paper is based on the below conceptual framework which is based on Green Human Resource Management (GHRM). Green Human Resource Management is a set of policies, practices, and systems that can stimulate green behavior. In this study, researchers are examining the sustainability of human resource knowledge.



**Fig. 1.** Research Conceptual Framework

This study tests whether two systems in green human resources; OSHA (work life safety) and work life benefit could influence green knowledge among students. This table summarizes the content and meaning of the items in the construct bringing in measuring the objectives.

**Table 1.** Items in the Constructs

BIL	CONSTRUCT	ITEM
1.	OSHA (Work life Safety)	Zero accidents Safety workplace Human rights Work health Job security
2.	Work life benefit	Employee happiness Support for sport activities Pension

		Social events
3	Sustainability of human resource	Green human resource management Social project Flexible working environment Human rights, health and safety practices Diversity management Work life balance

These items in three constructs have been utilized to measure the knowledge students possess before they go for their internship. This preliminary study has been conducted in TVET education and 132 respondents have been measured as the pilot respondents. The questionnaire is divided into 5 sections:

*Section A:* Screening Section

*Section B:* Independent Variable 1, OSHA

*Section C:* Independent Variable 2: Work life benefits

*Section D:* Dependent Variable: Sustainable Human Resource

*Section E:* Demographic Detail

Based on the pilot test, below are the reliability coefficients that has been tested.

**Table 2.** Cronbach Reliability Coefficients

Variables	No of items	Cronbach Coefficient	Reliability Value
Worklife Safety	5	0.933	Excellent
Worklife Benefit	4	0.914	Excellent
Sustainable Hr	5	0.954	Excellent

From the above diagram, all of the construct of variables exhibited an excellent value of Cronbach coefficient value and shows that all constructs can measure what it is supposed to measure (Creswell, 2014). This preliminary study is aiming at pilot study findings and analysis. To further view the credibility and reliability of the instruments, a Cronbach coefficient is being carried out.

All the constructs exhibited an excellent coefficient which shows that all constructs are perfectly fit to measure what it supposed to measure (Hair et al., 2007). The TVET students' population is 256, 801 (Ministry of Higher Education, 2023) which lead the sample to be 384 (Krejcie & Morgan, 1970). The sample would be the students of TVET students from polytechnic, community college, and MTUN (Malaysian Technical University). The population will be divided into four regions of different institutions as shown in the below table. Using simple random sampling from the selected sample TVET institutions, personally administered online questionnaires would be distributed.

**Table 3.** Sampling Table

Bil	Region	Selected institutions	Sample Size
1.	Central	Politeknik Sultan Salehuddin Abdul Aziz Shah	25
		Politeknik Sultan Idris Shah	25
		Kolej Komuniti Selayang	24
		Politeknik Metro KL	28
2.	North	Politeknik Tuanku Syed Sirajuddin	22
		Universiti Malaysia Perlis	22
		Kolej Komuniti Bandar Baharu	22
		Politeknik Seberang Prai	22
3.	West	Politeknik Mukah	22
		Universiti Malaysia Sabah	22
		Politeknik Kuching	22
4	South	Politeknik Tun Syed Nasir	22
		Kolej Komuniti Selandar	22
		Politeknik Nilai	22
		Universiti Tun Husein Onn	22
		Politeknik Ibrahim Sultan	22
5.	East	Politeknik Kota Bharu	22
		Universiti Malaysia Pahang Sultan Abdullah	22
		Politeknik Hulu Terengganu	22
Total			384



## 4 Finding and Analysis

According to the analysis, several findings may be summarised and listed properly.

1. Reliability Analysis to measure the reliability of the construct.
2. Mean Score to determine research questions.
3. Descriptive Analysis to learn the pilot strategy.

The reliability analysis has been discussed in the methodology section and it shows how well the reliability of the instruments is to measure the variables.

**Table 4.** Mean Score of variables

	N	Mean	Std. Deviation
OSHAMAN	132	4.1533	0.84801
WORKBENEFIT	132	4.1417	0.83996
SUSTAINHR	132	4.1267	0.85578
Valid N (listwise)	132		

Based on the above table, this preliminary study can predict the level of variables. Referring to the mean score interpretation, a study (Hassan et al., 2018) used a similar table to interpret the mean score according to Jim Nunnally and Ira Bernstein (1994). However, this study utilized and referenced Moidunny (2009).

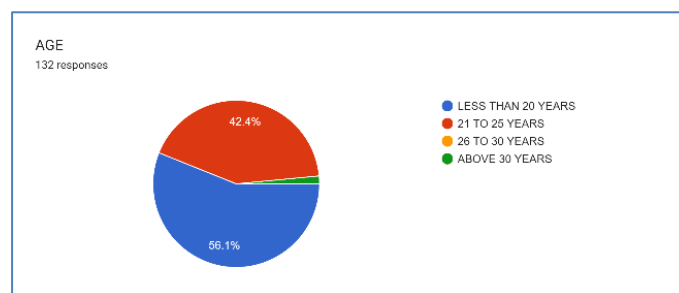
**Table 5.** Moidunny Mean Coefficient

4.21 – 5.00	Very High
3.21 – 4.20	High
2.61 – 3.20	Moderate
1.81 – 2.60	Low
1.00 – 1.80	Very Low

**Table 6.** Questionnaire items

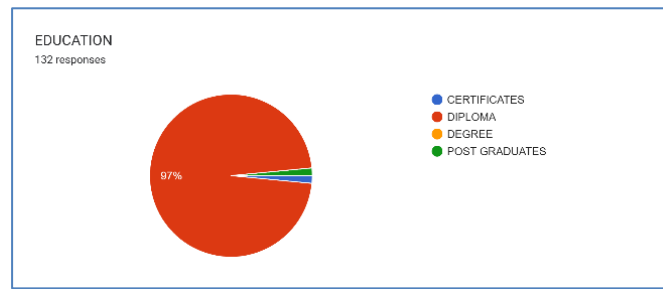
Variables	Mean Score	Level of Variables
OSHA	4.1533	High
Work Life Balance	4.1417	High
Sustainable Human Resources Management	4.1267	High

Based on this preliminary finding, all levels of variables exhibited high value.



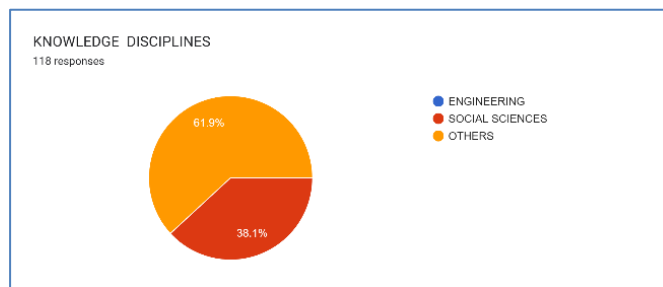
**Fig. 2.** Age of Respondents

This pilot study shows that most respondents were less than 25 years old. This confirms that this study is all about young talents.



**Fig. 3.** Educational Level

However, the pilot shows that most respondents study at a diploma level. This pilot study shows that in the actual data collection, the sampling should also consider some similarity to the level of education.



**Fig. 4.** Knowledge disciplines of the respondents

All the respondents are from social science disciplines and no respondents are from engineering disciplines. This pilot study also does not include any writing comments which is unable to learn other errors in collecting the data other than a few errors such as duplicate questionnaires and some typing errors.

## 5 Conclusion

This feasible study can be conducted and serves its purpose. However, some amendments must be made before starting the actual data collection process. Some notable points from the preliminary study should be followed. Future action should be continuously on data collection and reaching the sample size to infer the population.

## Acknowledgment

We would like to express our sincere gratitude to all those who have contributed to the development of this preliminary report on human resource sustainability among young talents in TVET institutions. Special thanks go to our research teams and academic research advisors for their dedication, hard work, and commitment to excellence. Your rigorous analysis and thoughtful input have been instrumental in producing this report. We hope that the insights provided in this report will pave the way for further research and improvements in human resource sustainability among young talents in TVET institutions.

## References

1. Amrutha, V. N., & Geetha, S. N. (2020). A systematic review on green human resource management: Implications for social sustainability. *Journal of Cleaner Production*, 247, 119131.
2. Arnott, J., Lacy, P., & Lowitt, E. (2009). The challenge of integrating sustainability into talent and organization strategies: Investing in the knowledge, skills and attitudes to achieve high performance. *Corporate Governance*, 9(4), 484–494.
3. Aruldoss, A. (2020). The relationship between quality of work life and work-life-balance mediating role of job stress , job satisfaction and job commitment : evidence from India. *Journal in Advanced of Management Research*, 18(1), 36–62.
4. Bonnie F Daily, & Su Chun Huang. (2001). Achieving Sustainability Through Attention to Human Resource Factor in Enviromental Management. *International Journal of Operation and Production Management*, 21(12), 1539–1552.
5. Casper, W. J., & Buffardi, L. C. (2004). Work-life benefits and job pursuit intentions : The role of anticipated organizational support. *Journal of Vocational Behavior*, 65, 391–410.
6. Creswell, J. W. (2014). *Research Design, Qualitative, Quantitative and Mixed Method Approach*. SAGE Publication.
7. Davidescu, A. A., Apostu, S., & Paul, A. (2020). Work Flexibility , Job Satisfaction , and Job Performance among Romanian Employees — Implications for Sustainable Human Resource Management. *Sustainability*, 1–53.

8. Hair, J. F., Arthur H, M., Philip Samouel, & Mike Page. (2007). *Research Method for Business*.
9. Hassam, S. F., Esa, M. M., Akbar, J., & Hassan, N. D. (2023). Building a Resilient and Sustainable Workplace: A Post-Pandemic Hazard Control and Preparedness Plan in Malaysia. *GATR Journal of Management and Marketing Review*, 8(1), 09–16.
10. Hassan, R., Ahmad, J., & Boon, Y. (2018). Instructional leadership practice among headmasters in the southern region of Malaysia. *Journal of Social Sciences Research*, 2018(Special Issue 2), 76–90.
11. Hitka, M., Alžbeta Kucharčíková, Peter Štarcho ě, Žaneta Balážová, Michal Lukáč, & Zdenko Stacho. (2019). Knowledge and Human Capital as Sustainable Competitive Advantage in Human Resource Management. *Sustainability*.
12. Irawanto, D. W., Novianti, K. R., & Roz, K. (2021). Work from Home : Measuring Satisfaction between Work – Life Balance and Work Stress during the COVID-19 Pandemic in Indonesia. *Economics* 9, 96.
13. Krejcie, R. V, & Morgan, D. W. (1970). Determining Sample Size for Research Activities. *Educational and Psychological Measurement*, 607–610.
14. Macke, J., & Genari, D. (2019). Systematic literature review on sustainable human resource management. *Journal of Cleaner Production*, 208, 806–815.
15. Muñoz-Pascual, L., Galende, J., & Curado, C. (2020). Human Resource Management Contributions to Knowledge Sharing for a Sustainability-Oriented Performance: A Mixed Methods Approach. *Sustainability (Switzerland)*, 12(1), 1–24.
16. Okechukwu, K. O., Eteng, M. J., Anochiwa, L. I., Njemanze, V., Agbanike, T. F., Eyisi, E., Agha, E., Chukwu, J., & Igu, N. C. N. (2021). Organizational Health/Safety And Employees' Performance For Sustainable Development. *Webology*, 18(1), 1011–1017.
17. Piowar-sulej, K. (2021). Human resources development as an element of sustainable HRM e with the focus on production engineers. *Journal of Cleaner Production*, 278, 124008.
18. Ramli, F. B., Nabila, S., Mokhtar, B., Haizal, M., Jamaluddin, B., Noor, M., Harun, B., Aizi, M., Mat, B., Nizam, M., Lokman, B., Rashid, A., Zailan, B., Yunus, N. B., Hidayah, N., & Mohd, B. (2020). Awareness Among Students and Staff on Occupational Safety and Health ( OSH ) in Universiti Teknologi Malaysia. *Advanced in Social Sciences Humanities Research*, 470(ICoSD 2019).
19. Suhaila Abdul Hamid. (2022). *Development of OSH Performance Management Framework in Malaysia* (Issue March).
20. Amrutha, V. N., & Geetha, S. N. (2020). A systematic review on green human resource management: Implications for social sustainability. *Journal of Cleaner Production*, 247, 119131.
21. Arnott, J., Lacy, P., & Lowitt, E. (2009). The challenge of integrating sustainability into talent and organization strategies: Investing in the knowledge, skills and attitudes to achieve high performance. *Corporate Governance*, 9(4), 484–494.
22. Aruldoss, A. (2020). The relationship between quality of work life and work-life-balance mediating role of job stress , job satisfaction and job commitment : evidence from India. *Journal in Advanced of Management Research*, 18(1), 36–62.
23. Bonnie F Daily, & Su Chun Huang. (2001). Achieving Sustainability Through Attention to Human Resource Factor in Enviromental Management. *International Journal of Operation and Production Management*, 21(12), 1539–1552.
24. Casper, W. J., & Buffardi, L. C. (2004). Work-life benefits and job pursuit intentions : The role of anticipated organizational support. *Journal of Vocational Behavior*, 65, 391–410.
25. Creswell, J. W. (2014). *Research Design, Qualitative, Quantitative and Mixed Method Approach*. SAGE Publication.
26. Davidescu, A. A., Apostu, S., & Paul, A. (2020). Work Flexibility , Job Satisfaction , and Job Performance among Romanian Employees — Implications for Sustainable Human Resource Management. *Sustainability*, 1–53.
27. Hair, J. F., Arthur H, M., Philip Samouel, & Mike Page. (2007). *Research Method for Business*.
28. Hassam, S. F., Esa, M. M., Akbar, J., & Hassan, N. D. (2023). Building a Resilient and Sustainable Workplace: A Post-Pandemic Hazard Control and Preparedness Plan in Malaysia. *GATR Journal of Management and Marketing Review*, 8(1), 09–16.
29. Hassan, R., Ahmad, J., & Boon, Y. (2018). Instructional leadership practice among headmasters in the southern region of Malaysia. *Journal of Social Sciences Research*, 2018(Special Issue 2), 76–90.
30. Hitka, M., Alžbeta Kucharčíková, Peter Štarcho ě, Žaneta Balážová, Michal Lukáč, & Zdenko Stacho. (2019). Knowledge and Human Capital as Sustainable Competitive Advantage in Human Resource Management. *Sustainability*.
31. Irawanto, D. W., Novianti, K. R., & Roz, K. (2021). Work from Home : Measuring Satisfaction between Work – Life Balance and Work Stress during the COVID-19 Pandemic in Indonesia. *Economics* 9, 96.
32. Krejcie, R. V, & Morgan, D. W. (1970). Determining Sample Size for Research Activities. *Educational and Psychological Measurement*, 607–610.
33. Macke, J., & Genari, D. (2019). Systematic literature review on sustainable human resource management. *Journal of Cleaner Production*, 208, 806–815.
34. Muñoz-Pascual, L., Galende, J., & Curado, C. (2020). Human Resource Management Contributions to Knowledge Sharing for a Sustainability-Oriented Performance: A Mixed Methods Approach. *Sustainability (Switzerland)*, 12(1), 1–24.
35. Okechukwu, K. O., Eteng, M. J., Anochiwa, L. I., Njemanze, V., Agbanike, T. F., Eyisi, E., Agha, E., Chukwu, J., & Igu, N. C. N. (2021). Organizational Health/Safety And Employees' Performance For Sustainable Development. *Webology*, 18(1), 1011–1017.
36. Piowar-sulej, K. (2021). Human resources development as an element of sustainable HRM e with the focus on production engineers. *Journal of Cleaner Production*, 278, 124008.
37. Ramli, F. B., Nabila, S., Mokhtar, B., Haizal, M., Jamaluddin, B., Noor, M., Harun, B., Aizi, M., Mat, B., Nizam, M., Lokman, B., Rashid, A., Zailan, B., Yunus, N. B., Hidayah, N., & Mohd, B. (2020). Awareness Among Students and Staff on Occupational Safety and Health ( OSH ) in Universiti Teknologi Malaysia. *Advanced in Social Sciences Humanities Research*, 470(ICoSD 2019).
38. Suhaila Abdul Hamid. (2022). *Development of OSH Performance Management Framework in Malaysia* (Issue March).

# Enhancing Utilization of Online Teaching Platforms: Factors Influencing Lecturers' Adoption and Usage Patterns in Politeknik Kuching Sarawak (PKS)

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**Abstract.** CIDOS, the Curriculum Information Document Online System used by Malaysian Polytechnics and Community Colleges (POLYCC), simplifies the management and sharing of curriculum-related documents and information. It aligns with the Concerns-Based Adoption Model (CBAM) by addressing educators' concerns and usage levels, providing resources for informed decision-making and collaboration, while its user-friendly interface and practical resources enhance its acceptance among educators fits in the Technology Acceptance Model (TAM), and collectively offer insights into CIDOS's effective adoption and utilization in educational contexts. Hence, the aim of this research paper is to identify the influencing adoption and usage patterns in Politeknik Kuching Sarawak (PKS) focusing on CIDOS facilitating conditions and infrastructure access. A descriptive survey method was used to gather data from 224 samples across eight academic departments at PKS. The questionnaire, including 10 demographic questions and 11 variables focused on CIDOS Facilitating Conditions (CFC) and Infrastructure Access (IA) to analyze CIDOS' use in education. Common statistical tools, including SPSS Version 27, were used for data analysis. The reliability tests showed Cronbach's Alpha values at 0.939 indicating excellent and reliable results. The findings provided highlights the CIDOS Facilitating Conditions, with a mean score of 3.57, which indicates extensive use of CIDOS due to its effective system support and shows high mean at 3.57 in Infrastructure Access (IA) where lecturers feel reluctant to use the platform due to poor internet connection. In conclusion, the research findings support SDG Goal 4 (Quality Education) by emphasizing the importance of preparing lecturers with the necessary knowledge and skills to effectively manage and utilize CIDOS, thereby enhancing teaching and learning outcomes. Ensuring reliable internet access and positive attitudes towards online learning also promotes inclusive and equitable quality education.

**Keywords:** CIDOS, Facilitating Conditions, Infrastructure Access, online learning

## 1 Introduction

CIDOS, the Curriculum Information Document Online System used by the Malaysian Polytechnics and Community Colleges (POLYCC), simplifies the management and sharing of curriculum-related documents and information. It offers educators and administrators easy access to essential resources like curriculum structures, teaching plans, and assessment materials, supporting effective teaching and learning processes. By streamlining administrative tasks, CIDOS ensures all stakeholders stay updated and maintains consistency and quality in education, particularly at institutions like Politeknik Kuching Sarawak. It aligns with the Concerns-Based Adoption Model (CBAM) by addressing educators' concerns and usage levels, providing resources for informed decision-making and collaboration. Gene E. Hall and Shirley M. Hord's work "Implementing Change: Patterns, Principles, and Potholes" (2014) explains CBAM's role in facilitating educational technology adoption, emphasizing the importance of support, professional development, and data-driven decision-making. Additionally, CIDOS fits into the Technology Acceptance Model (TAM), where its user-friendly interface and practical resources enhance its acceptance among educators. These frameworks collectively offer insights into CIDOS's effective adoption and utilization in educational contexts.

Many studies related to online learning, like CIDOS, are being carried out nowadays. Some studies support the idea that online learning using platforms like this is immensely helpful, while there is the other way around. Therefore, this survey is also being conducted to find out more about the CIDOS platform among lecturers. Moreover, such a study has never been conducted among lecturers at Politeknik Kuching Sarawak (PKS). The aim of this research paper is to identify factors influencing Lecturers' Adoption and Usage Patterns among lecturers of Politeknik Kuching Sarawak (PKS) on CIDOS Facilitating Conditions (CFC) and Infrastructure Access (IA). Through the analysis of various variables such as CIDOS facilitating conditions, infrastructure access, and user experience, the study seeks to understand the effectiveness of these platforms in supporting online teaching and learning. The study relates to sustainable technology as proposed in the United Nations' Sustainable Development Goals (SDGs), particularly Goal 4 (Quality Education) and Goal 9 (Industry, Innovation, and Infrastructure), by emphasizing the need for

reliable internet access and effective e-learning systems like CIDOS. By ensuring that technological infrastructure is in place and that educators are well-prepared to use these systems, the study supports the advancement of inclusive and equitable quality education, promoting lifelong learning opportunities for all.

Moreover, addressing infrastructure challenges aligns with the goal of building resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation.

## 2 Literature review

### 2.1 Online learning

Online learning is increasingly important in education today. Students prefer it for its convenience and flexibility, with positive views on both online and traditional methods, according to Mather and Sarkans (2018). Abdul Rahim, Md Noor, and Mohd Din (2021) on the other hand found that students and teachers have widely accepted official e-learning systems supporting blended learning, with acceptance linked to interaction, benefits, and ease of use. However, teachers show less acceptance, likely due to differences in technological infrastructure and planning components. Omani and Celcima (2022) reported that university students in Kosovo perceive online learning as more effective than conventional methods, while Wang (2019) identified factors such as student motivation, teacher support, and course design as crucial for successful e-learning outcomes. Kulal and Nayak (2020) examined attitudes towards online classrooms in Dakshina Kannada and Udupi Districts, revealing mixed perspectives among teachers who emphasized the need for training and best practices, while students generally held positive views. Overall, the literature indicates favorable perceptions of online learning among both students and lecturers, but challenges such as technical skills, learner motivation, media use, and interaction need addressing to ensure its success.

### 2.2 CIDOS

The Department of Polytechnic and Community College (JPPKK) introduced the CIDOS Platform, an e-learning system designed to enhance teaching and learning through technological advancements. Coordinated at the departmental level, CIDOS consolidates teaching resources for lecturers and students, enabling easy access to curriculum-related materials and supplementary resources. Lecturers utilize CIDOS to deliver course content and additional materials, fostering a seamless learning experience. As a document organization system, CIDOS simplifies the publication of curriculum-related information online, streamlining learning activities and curriculum management for both lecturers and polytechnic students.

According to Saharudin, Hamzah, & Rahman (2017), students find CIDOS beneficial for interacting with lecturers and accessing course structures and important dates conveniently. This aligns with Moore & Kearsley's (2013) who emphasis on the clarity of instructions and assessment dates in online learning platforms, as supported by Subramaniam et al. (2013). Azhani Hashim, Zainora Kamal Ludin & Noor Azizah Mat Isa (2012) highlight the significance of proficiency in using CIDOS, emphasizing its role in improving user ratings. Management's role in ensuring CIDOS's smooth operation, particularly during high user traffic, is crucial, necessitating improvements in internet accessibility and computer ease-of-use for students.

Despite CIDOS's benefits, challenges persist, particularly for polytechnics which are new to its implementation which was made essential especially during the pandemic COVID-19 where online learning becomes necessity. Lecturers must adapt teaching methods to create suitable online learning environments, as noted by Gilbert, John, & College (2015). Additionally, internet accessibility issues faced by students in remote areas, as highlighted by Zulkifli, Hamzah, & Razak (2020), pose significant obstacles. These challenges are echoed in previous studies (Appana, 2008; Azhari & Ming, 2015; Shear & Lasseter, 2012), emphasizing the need for proactive solutions to enhance CIDOS utilization like the designation of a team of 'master CIDOS' in POLYCC departments who receives training and become trainers at their own institutions.

Zulkifli, Hamzah, & Abdul Razak (2020) identify technology constraints as major barriers to effective Massive Open Online Course (MOOC) utilization, impacting student performance. Similarly, Hazwani Mohd Najib., Noor Raudhiah Abu Bakar., & Norziah Othman (2016) stress the importance of infrastructure in e-learning effectiveness, including internet access and study aids availability. To address these issues, this study aims to explore materials and teaching aids for future CIDOS sessions, providing valuable insights for lecturers to enhance learning material preparation. The findings will offer practical guidance for CIDOS usage scenarios, benefiting polytechnic education

### 2.3 CIDOS facilitating conditions (CFC)

Though not explicitly defined in the research, the concept of facilitating conditions in CIDOS can be understood through a general lens of online learning. It likely pertains to the availability of technical resources and organizational support required for users to effectively utilize the CIDOS platform. These resources encompass accessibility to tools, technical infrastructure, and support systems facilitating users' navigation and utilization of CIDOS for online learning. While a precise definition of facilitating conditions in CIDOS is absent, the concept resonates with the broader understanding of facilitating conditions in online learning contexts.

According to Mohanim and Mahaida (2021), enhancing the educators' teaching style and self-efficacy in using the system to teach digital literacy skills is necessary to help them handle the lesson with confidence and facilitate active contact between the lecturers and students.

Irfan and Iman (2020) argue against the efficacy of online learning, citing issues such as insufficient internet access, teachers' struggles with online teaching methods, and parents' lack of involvement. Conversely, Hasnan & Mohin (2021) acknowledge online learning's effectiveness in response to the pandemic but highlight challenges like high internet costs hindering learning objectives. Muhammad and Kainat (2020) further identify internet connectivity issues, limited student-teacher engagement, and a shortage of technological resources as barriers to effective online learning.

According to Wildana et al. (2020), institutional leadership plays a vital role in shaping online learning practices, emphasizing the importance of students' exposure to modern technologies for adapting to current learning environments. Additionally, Hamimi (2018) underscores the benefits of digital technology for students when utilized wisely, stressing the importance of tech familiarity even for those not directly using online platforms like CIDOS.

Despite its advantages, online learning faces drawbacks such as reduced student-teacher interaction, technical challenges, and budget constraints, as noted by Adnan (2020) and Hazwani et al. (2020). This lack of social interaction may dampen motivation, necessitating pedagogical enhancements and curriculum adjustments by lecturers to optimize online learning, as discussed by Verawardina et al. (2020). Moreover, Abu Seman, Hashim, Roslin, and Ishar's (2019) study highlights the pivotal role of lecturers in engaging students in online lessons through their pedagogical and technical skills, emphasizing the importance of content development and interaction technologies within platforms like CIDOS, as outlined by Kebritchi (2016).

## 2.4 Infrastructure access (IA)

The literature review examines infrastructure access in e-learning, with a focus on CIDOS, aiming to uncover barriers, challenges, and strategies affecting students' learning outcomes. Infrastructure access involves the availability and reliability of technological resources necessary for effective participation in CIDOS, including internet connectivity, devices, and software. Despite limited research specifically on CIDOS, we aim to discuss its relevance to online learning platforms. E-learning, as highlighted by Hussain & Mohamad Ros (2021), utilizes electronic networks to deliver content and foster interaction. According to Sankaran & Norazlinda (2021), educators require high commitment to transition to e-learning successfully, but incomplete facilities can hinder effectiveness. The Commonwealth of Learning (2020) stresses the need for current technology in learning, emphasizing comprehensive facilities. Inadequate infrastructure, as noted by Basar, Mansor, Jamaludin, & Alias (2021), can hinder internet access for students, reducing the effectiveness of online learning.

E-Learning refers to the use of technology in learning, encompassing digital equipment, virtual classes, web-based learning, and computer use (Hodgins & Corner, 2000 in Khairul Hamimah, 2007). It incorporates various electronic media such as the internet, intranet, satellite, audio-video tapes, interactive TV, and CD-ROMs to facilitate learning. According to Rosenberg (2001), e-learning utilizes internet technology to deliver information, enhance knowledge, and develop skills based on three criteria: it must use network access to receive, store, share, and update information; it must be delivered through computers using current internet technology; and it should focus on solutions guided by traditional teaching and learning processes.

Zainal Abidin (2014) identifies five key aspects crucial for the success of blended learning in polytechnic: pedagogic, lecturer, student, institutional (infrastructure and institutional), and organizational. This study focuses specifically on the lecturer aspect, aiming to investigate the necessary preparations, including knowledge and skills, required for lecturers to effectively manage and lead CIDOS to achieve learning outcomes. Inadequate internet access and negative attitudes towards online learning can impede its effectiveness, highlighting the importance of infrastructure access to ensure students have reliable, high-speed internet and maintain positive perceptions of online learning. Additionally, the application of intelligent services in distance education can enhance the learning experience, but optimal infrastructure access is essential for their effective utilization. Addressing infrastructure access in online learning requires attention to technical, logistical, and support-related considerations to optimize students' learning experiences.

## 3 Research design and methodology

The method used in this research is a descriptive survey method with questionnaire. The population targets lecturers from Politeknik Kuching Sarawak (PKS). The sample was taken based on Krejcie and Morgan's (1970) sample size determination table where a sample of 214 lecturers from a population of 464 was needed, but we managed to garner 224 samples from all eight academic departments at PKS. These departments include Mechanical Engineering, Civil Engineering, Petrochemical Engineering, Electrical Engineering, Information Technology and Communication, Commerce, Mathematics, Science and Computer, and General Studies department. Questionnaires were distributed via Google Forms over a period of two months from February till March 2023. The questionnaire adapted based on the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh, Morris, & Davis (2000), employed a 5-point Likert scale from fully agree to fully disagree. It includes 10 demographic questions and 11 variables focused on CIDOS Facilitating Conditions (CFC) and Infrastructure Access (IA) to analyze CIDOS' use in education and its effectiveness. Common statistical tools, SPSS Version 27, were used for data analysis. The reliability tests showed Cronbach's Alpha values above 0.60, indicating excellent and reliable results. A pilot test with 32 samples yielded a Cronbach Alpha of 0.939 for all 30 survey items before expanding to the larger sample.

## 4 Finding and analysis

### 4.1 Respondents' demographic profiles

**Table 1.** Respondents' demographic profiles

Characteristics		N	(%)
Age	21-25	0	0
	26-30	7	3.1
	31-35	18	8.0
	35-40	65	29.0
	>40	134	59.8
Gender	Male	101	45.1
	Female	123	54.9
Marital Status	Married	186	83.0
	Single	38	17.0
Department	Civil Engineering (JKA)	62	27.7
	Electrical Engineering (JKE)	21	9.4
	Mechanical Engineering (JKM)	44	19.6
	Petrochemical Engineering (JKPK)	33	14.7
	Information Technology & Communication (JTMK)	5	2.2
	Commerce (JP)	39	17.4
	Mathematics, Science & Computer (JMSK)	12	5.4
	General Studies (JPA)	8	3.6
Grade	DH41	58	25.9
	DH42	0	0
	DH44	105	46.9
	DH48	53	23.7
	DH52	8	3.6
	DH54	0	0
Education Level	Diploma	0	0
	Degree	138	61.6
	Master Degree	86	38.4
	PhD.	0	0
Years of teaching	1-6 years	14	6.3
	7-9 years	11	4.9
	10-12 years	45	20.1
	>12 years	154	68.8
ICT Knowledge	Poor	0	0
	Moderate	64	28.6
	Good	130	58.0
	Very Good	30	13.4
Internet Subscription	Yes	224	100.0
	No	0	0
Mobile Internet Access	Yes	224	100.0
	No	0	0

A total of 224 respondents participated in the survey, resulting in a 48% response rate. Table 1 details the demographic profiles of the respondents. The majority were female (54.9%), with male respondents making up another 45.1%. About 59.8% of the respondents were aged over 40 years, and 68.8% reported having more than 12 years of teaching experience. Feedback was obtained from various departments: Mechanical Engineering (19.6%), Commerce (17.4%), Electrical Engineering (9.4%), Information Technology and Communication (2.2%), Mathematics, Sciences and Computer (5.4%), General Studies (3.6%), and Civil Engineering (27.7%). Regarding educational qualifications, 61.6% of the respondents had a first degree, while 38.4% had a master's degree. In terms of ICT knowledge, 28.6% rated their skills as moderate, 58% as good, and 13.4% as very good. All the respondents had internet subscriptions and mobile internet access.

#### 4.2 CIDOS facilitating condition and infrastructure access

In this study, we aimed to examine CIDOS facilitating condition and infrastructure access. Table 2 below provides the means and standard deviation values for the eleven variables identified in this study, which include CIDOS Facilitating Conditions and Infrastructure Access.

**Table 2.** Mean and Standard Deviation (SD) for CIDOS Facilitating Conditions and Infrastructure Access

Item	Mean	SD
<b>CIDOS Facilitating Conditions</b>		
Because CIDOS master trainer is always there to help me, hence I use CIDOS extensively.	3.45	1.103
Because there is effective systems support, hence I use CIDOS extensively.	<b>3.57</b>	0.772
Because CIDOS E- Manual is easy to understand, hence I use CIDOS extensively.	3.49	0.863
Because CIDOS Master Trainer gave the course at the beginning of the semester, hence I use CIDOS extensively.	3.44	0.871
Because of the frequent training given, hence I use CIDOS extensively.	3.37	0.919
<b>Infrastructure Access (IA)</b>		
I am reluctant to use CIDOS due to poor Internet connection.	<b>3.57</b>	0.730
I can access CIDOS anywhere because the infrastructure is everywhere.	3.46	0.835
I can access CIDOS anytime because it is easily accessible.	3.50	0.883
My satisfaction with infrastructure access (such as the internet) leads me to use CIDOS extensively.	3.40	0.965
Because I have good internet access at home, I can use CIDOS effectively.	3.42	0.895
Because I have good internet access at the office, I can use CIDOS effectively.	3.34	0.999

As shown in Table 2, the highest value for CIDOS Facilitating Conditions, with a mean score of 3.57, indicates the extensive use of CIDOS due to its effective system support. Lecturers also favored CIDOS because of its user-friendly e-manual, which scored a mean of 3.49 during the survey. An effective e-manual is crucial for lecturers using an online teaching platform as it provides clear, concise, and accessible instructions on utilizing the platform's features efficiently. This reduces the learning curve, minimizes technical difficulties, and boosts confidence in using the platform. By offering step-by-step guidance, troubleshooting tips, and best practices, an e-manual ensures that lecturers can fully leverage the platform's capabilities to create engaging, interactive, and seamless online learning experiences. Consequently, this leads to more effective teaching, better student engagement, and overall satisfaction with the online learning environment. However, the least mean score of 3.37 indicates that the training provided to lecturers is still lacking. With institutional support in terms of training and continuous assistance, high ICT knowledge is not essential for utilizing the platform effectively. Organizational support for training and professional development of lecturers should be ongoing and updated in line with technological advancements (Alenezi, 2018). This opinion is further reinforced by a few other studies on the implementation of online learning, which call on the institution to host additional training sessions to increase the lecturers' expertise and improve their ability to present online course materials (Chung et al., 2020). Educational institutions cannot trust that lecturers can adapt to new ideas and abdicate their responsibilities to conduct research to provide high-quality instruction. System quality and support have an indirect impact on perceived usefulness but a direct impact on CIDOS users' satisfaction and intention to use.

The result also shows high mean at 3.57 in Infrastructure Access (IA) where lecturers feel reluctant to use the platform due to poor internet connection. Pre and post-pandemic, people often feel reluctant to use online learning platforms if the internet connection is poor due to the frustration and inefficiency caused by frequent interruptions, buffering, and disconnections. These issues hinder the flow of teaching and learning, reduce engagement, and increase stress for both students and educators. Poor connectivity can negatively impact academic performance by causing missed lessons and deadlines, making online learning seem ineffective compared to traditional methods. Additionally, constant technical difficulties and the high cost of data in some areas further discourage the adoption of online platforms, leading to a preference for more reliable, face-to-face interactions. This is in line with the finding from some research done by Hussain & Mohamad Ros (2021), Rosenberg (2001), Hasnan & Mohin (2021), Muhammad and Kainat (2020) who further identify internet connectivity issues, limited student-teacher engagement, and a shortage of technological resources as barriers to effective online learning. Similarly, Hazwani Mohd Najib., Noor



Raudhiah Abu Bakar., & Norziah Othman (2016) stress the importance of infrastructure in e-learning effectiveness, including internet access and study aids availability.

The lecturers also favor using CIDOS due to its easy accessibility, as indicated by the mean score of 3.50. However, in PKS, the preference for CIDOS remains unaffected by poor internet connections, as shown by the mean score of only 3.40. This resilience stems from the platform's ability to facilitate access to notes, lecture materials, and live online class streaming, even when relying on mobile internet access, thereby mitigating the impact of unreliable campus internet connections. This finding is supported by Irfan and Iman (2020) argue against the efficacy of online learning, citing issues such as insufficient internet access, teachers' struggles with online teaching methods, and parents' lack of involvement.

## 5 Conclusion and recommendations

The findings provided highlights the significant role of effective system support and user-friendly e-manuals in promoting the extensive use of CIDOS among lecturers for online teaching and learning process. While the platform's facilitating conditions and accessibility contribute to its favorability, challenges persist, particularly regarding infrastructure access and the reliability of internet connections. Poor internet connectivity remains a significant barrier to online learning adoption, impacting teaching effectiveness and student engagement. Despite this, CIDOS demonstrates resilience by facilitating access to essential materials and live classes through the BigBlueButton feature on the platform where the lesson could still be accessed up to seven days, even with mobile internet access, mitigating the effects of unreliable campus internet connections, students may still catch up when they have a more stable internet access. However, the need for improved training and continuous support is evident to maximize platform utilization and effectiveness, especially among lecturers with lower ICT knowledge. Addressing these challenges is crucial for enhancing the overall quality and satisfaction of the online learning experience for educators and students alike. To address the challenges, several recommendations can be offered. Firstly, institutions should prioritize enhancing training programs to equip lecturers with the requisite skills for effective online teaching platform utilization, while also providing ongoing support mechanisms such as access to technical assistance and peer mentorship. Secondly, efforts should be made to improve infrastructure access, including upgrading campus internet connections and ensuring reliable internet services for lecturers and students. Platforms like CIDOS should continuously optimize accessibility features to accommodate users with varying levels of ICT knowledge and internet connectivity. Lastly, promoting a culture of sharing best practices and fostering collaborative learning communities among lecturers can facilitate the exchange of innovative teaching strategies for online education, contributing to the overall improvement of online learning experiences.

The research findings support SDG Goal 4 (Quality Education) by emphasizing the importance of preparing lecturers with the necessary knowledge and skills to effectively manage and utilize CIDOS, thereby enhancing teaching and learning outcomes. Ensuring reliable internet access and positive attitudes towards online learning also promotes inclusive and equitable quality education. In line with SDG Goal 9 (Industry, Innovation, and Infrastructure), the study highlights the critical role of technological infrastructure in e-learning, advocating for improved internet connectivity and comprehensive facilities. This supports the development of resilient infrastructure and the promotion of sustainable industrialization and innovation, essential for modern educational environments.

## References

- 1 Abdul Rahim, R., Md Noor, N., & Mohd Din, H. (2021). Penerimaan Sistem E-Pembelajaran bagi menyokong pembelajaran teradun di Institut Pendidikan Guru. *Innovative Teaching and Learning Journal*, 5(1), 83–98.
- 2 Abu Seman, S., Hashim, M., Mohd Roslin, R., & Mohd Ishar, N. (2019). Millennial Learners' Acceptance and Satisfaction of Blended Learning Environment. *Asian Journal Of University Education*, 15(3), 129-141. doi:10.24191/ajue.v15i3.7845
- 3 Adnan, M., & Anwar, K. (2020). Online Learning amid the COVID-19 Pandemic: Students' Perspectives. *Online Submission*, 2(1), 45-51.
- 4 Alenezi, A. (2018). Barriers to Participation in Learning Management Systems in Saudi Arabian Universities. *Education Research International*, Vol. 2018, Article ID 9085914, 8 pages <https://doi.org/10.1155/2018/9085914>
- 5 Appana, S. (2008). A Review of Benefits and Limitations of Online Learning in the Context of the Student, the Instructor , and the Tenured Faculty. *International JI. on E-Learning*, 7(1), 5–22.
- 6 Azhari, F. A., & Ming, L. C. (2015). Review of e-learning Practice at the Tertiary Education level in Malaysia. *Indian Journal of Pharmaceutical Education and Research*, 49(4), 248–257. <http://doi.org/10.5530/ijper.49.4.2>
- 7 Azhani Hashim, Zainora Kamal Ludin & Noor Azizah Mat Isa (2012). Persepsi Pelajar Terhadap Penggunaan CIDOS dalam Aktiviti Pembelajaran. *PSAS Digest*, 189-196.
- 8 Basar, Z. M., Mansor, A. N., Jamaludin, K. A., & Alias, B. S. (2021). The Effectiveness and Challenges of Online Learning for Secondary School Students - A Case Study. *Asian Journal of University Education*, 17(3), 119–129. <https://doi.org/10.24191/ajue.v17i3.14514>
- 9 Chung, E., Subramaniam, G., & Christ Dass, L. (2020). Online Learning Readiness Among University Students in Malaysia Amidst Covid-19. *Asian Journal Of University Education*, 16(2), 45-58. doi:10.24191/ajue.v16i2.10294
- 10 Gilbert, B., John, S., & College, F. (2015). Online Learning Revealing the Benefits and Challenges How has open access to Fisher Digital Publications benefited you ? Fisher Digital Publications.

- 11 Hasnan, M. B., & Mohin, M. B. (2021). Implementation Of LMS-CIDOS In Polytechnic English Language Classroom: Issues And Challenges. *Asian Journal of University Education*, 17(4), 527–537. <https://doi.org/10.24191/ajue.v17i4.16253>
- 12 Hazwani Mohd Najib., Noor Raudhiah Abu Bakar., & Norziah Othman (2016). Isu dan cabaran penggunaan MOOC dalam proses pengajaran dan pembelajaran
- 13 Hazwani Mohd N., Noor Raudhiah Abu B. and Norziah O. (2020). E-Pembelajaran Dalam Kalangan Pelajar Di Sebuah Institusi Pengajian Tinggi Selangor. Selangor. Malaysian atas talian.
- 14 Hall, G. E., & Hord, S. M. (2014). *Implementing Change: Patterns, Principles, and Potholes* (4th ed.). Pearson.
- 15 Hussain, J., & Mohamad Ros, S. (2021). a Study on the Use of E-Learning Among Students in the Department of Trade Polytechnic Tuanku Syed Sirajuddin. *International Journal of Education, Psychology and Counseling*, 6(38), 66–79. <https://doi.org/10.35631/ijepc.638007>
- 16 Irfan, F. and Iman Hermawan Sastra, K. (2020). Teachers Elementary School in atas talian Learning of COVID-19 Pandemic Conditions. Jakarta. *Jurnal Iqra'*.
- 17 Kebritchi, M., Lipschuetz, A., & Santiago, L. (2017). Issues and Challenges for Teaching Successful Online Courses in Higher Education. *Journal of Educational Technology Systems*, 46(1), 4–29. doi:10.1177/0047239516661713
- 18 Kulal, A., & Nayak, A. (2020). A study on perception of teachers and students toward online classes in Dakshina Kannada and Udupi District. *Asian Association of Open Universities Journal*, 15(3), 285–296. <https://doi.org/10.1108/AAOUJ-07-2020-0047>
- 19 Mather, M., & Sarkans, A. (2018). Student Perceptions of Online and Face-to-Face Learning conditions of the Creative Commons Attribution license (CC BY-NC-ND). *International Journal of Curriculum and Instruction*, 10(2), 61–76.
- 20 Mohd Hafiez, A. & Sharifah Nadiyah, R. 2020. Aplikasi Google Classroom di Kolej Komuniti. Kolej Komuniti Selandar: Perpustakaan Negara Malaysia.
- 21 Moore, M. G. (Ed.). (2013). *Handbook of distance education*. Routledge.
- 22 Muhammad, A. & Kainat, A. (2020). Learning Amid The COVID-19 Pandemic: Students' Perspectives. Pakistan. *Journal of Pedagogical Sociology and Psychology*
- 23 Nor Halina Nordin, Norlizawati Hashim & Norhafinas Abd Latib. 2020. Cabaran pensyarah kolej komuniti dalam melaksanakan proses pengajaran dan pembelajaran dalam talian. *E-Proceedings of The Green Technology & Engineering 2020 Virtual Conferences*: 193-202.
- 24 Omani, F., & Celcima, D. (2022). Topic: Students' perceived effectiveness and preference of online lectures- Kosovo study case. *IFAC-PapersOnLine*, 55(39), 169–174. <https://doi.org/10.1016/j.ifacol.2022.12.046>
- 25 Saharudin, N. A. B., Hamzah, M. I. Bin, & Rahman, A. B. B. A. (2017). Tahap Interaksi E-Pembelajaran CIDOS Bagi Kurikulum Baharu Pendidikan Islam ( Level of CIDOS E-Learning Interactions for New Curriculum Islamic Education ). *International Journal of Religion Research in Education*, 1(1), 26–34.
- 26 Sankaran, S. & Norazlinda, S. 2021. Reka bentuk LMS dan pengurusan pembelajaran berasaskan blended learning dalam kalangan pelajar sarjana pendidikan. *Sains Insani* 6(1): 59–65.
- 27 Shear, L., & Lasseeter, A. (2012). Understanding the Implications of Online Learning for Educational Productivity.
- 28 Verawardina, U., Asnur, L., Lubis, A. L., Hendriyani, Y., Ramadhani, D., Dewi, I. P., ... & Sriwahyuni, T. (2020). Reviewing online learning facing the Covid-19 outbreak. *Talent Development & Excellence*, 12.
- 29 Wang, X. C. (2019). E-learning : A review of literature e-learning - A Review of Literature Prepared by, (March).
- 30 Wildana Wargadinata, Iffat Maimunah, Eva Dewi & Zainur Rofiq. (2020). Student's Responses on Learning in the Early COVID-19 Pandemic. Malang, Indonesia. *Journal of Education and Teacher Training*.
- 31 Zainal Abidin, Z. (2014). *Garis Panduan Amalan Terbaik Konsep Pembelajaran Teradun bagi Politeknik-Politeknik Malaysia*. Jabatan Pengajian Politeknik.
- 32 Zulkurnain, H., Muhamad Asrul, M.N. & Norazlina, M. 2021. Analisis penerimaan penggunaan aplikasi Telegram bagi modul latihan penyediaan asas (SPU 1033) di Kolej Komuniti Kota Marudu, Sabah. *International Journal of Humanities Technology and Civilization (IJHTC)* 1(10): 23-36.
- 33 Zulkifli, N., Hamzah, M. I., & Abdul Razak, K. (2020). Isu dan cabaran penggunaan MOOC dalam proses pengajaran dan pembelajaran. *Journal Of Research, Policy & Practice of Teachers & Teacher Education*, 10(1), 78–95. <https://doi.org/10.37134/jrpptte.vol10.1.6.2020>

# The Effectiveness of Lifelong Learning (*PSH-Pembelajaran Sepanjang Hayat*) on Knowledge and Skill Enhancement

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**Abstract.** Lifelong learning program (LLP)(*Pembekajaran Sepanjang Hayat - PSH*) provide opportunities to cultivate a range of skills from early childhood education to retirement, to advance personal and professional learning, and to improve individual knowledge and capabilities in a knowledge-based society. Thus, the purpose of this study was to evaluate how well LLP contributes to participants' increased knowledge and skill sets. Students from Politeknik Muadzam Shah who had taken part in LLP served as the study's respondents. An online questionnaire was completed by 121 participants in total. This study is a quantitative study. A questionnaire was employed as the data collection tool. Descriptive analysis was the analysis technique employed, and SPSS v.26 software was used. The results of the study show that LLP enhances students' knowledge and abilities. The results of the study show that LLP enhances students' knowledge and abilities. These results also imply that academic institutions should keep offering LLP programs to improve students' technical proficiency, preparedness for the workforce, and aspirations for future career success.

**Keywords:** Learning impact, Lifelong Learning, Knowledge, Skills

## 1 Introduction

Prioritizing lifelong learning is crucial for success in today's competitive and ever-changing world. The desire and capacity to learn new things throughout one's life are referred to as lifelong learning (Gunduz, 2023). Lifelong learning enables continuous growth and flexibility in a rapidly changing world. It is essential due to several factors, including globalization, technological advancements, environmental changes, digitization, and unforeseen catastrophes like the COVID-19 pandemic (OECD, 2021). Therefore, everyone, including students, needs to develop awareness to value lifelong learning. According to Field (2010), the definition of lifelong learning suggests that learning should occur from birth to death or throughout an individual's entire existence.

These days, various types of lifelong learning programs (LLP) (*PSH – Pembelajaran Sepanjang Hayat*) platforms are organized by non-formal organizations, such as enterprises, as well as official institutions like educational establishments. According to Jovanova-Mitkovska and Hristovska (2011), all these platforms serve as a continuous learning process, accumulating knowledge that will be essential in the future. Students should recognize that education fosters a lifelong habit of seeking information. Lifelong learning can assist students in organizing, planning, and executing planned learning activities, especially when acquiring new subjects proves challenging for some students. Many students utilize lifelong learning platforms while on campus. However, it remains unclear how much these platforms truly enhance students' knowledge and abilities. Empirical research is necessary to determine the extent to which lifelong learning impacts students' knowledge and skills, addressing these questions. The purpose of this study is to reevaluate the effectiveness of lifelong learning programs in which students have participated.

The results of this study are crucial for re-evaluating the efficacy of lifelong learning programs that students at TVET institutions participate in. Furthermore, assessing how well lifelong learning programs (LLP) are doing at improving participants' knowledge and abilities is essential because it gives a clear picture of how well the program accomplishes its goals of helping participants from a variety of backgrounds develop their competencies and proficiencies. The results of this study not only aid in quantifying the program's direct influence on personal growth but also offer recommendations for enhancing it to better suit the demands of a knowledge-based society.

### 1.1 Objective of the study

The objective of this study was to:

- a) determine how lifelong learning affects students in the Politeknik Muadzam Shah Department of Commerce's ability to learn new things; and
- b) determine how lifelong learning affects students in that department's ability to improve their skills.

## 2 Literature review

Due to global advancements and changes, individuals must continually grow and adapt, emphasizing the importance of practicing lifelong learning (Bohari et al., 2020). Previous research has highlighted the numerous benefits of participating in lifelong learning programs (LLP). According to Hildebrand (2021), lifelong learning can enhance communication skills, improve employment prospects, foster interpersonal abilities, and sharpen the mind. Meanwhile, Buntat et al. (2013) emphasize the value of lifelong learning in adapting to technological advancements, globalization, changes in the economy, quality of life, and safety. Additionally, as noted by the European Community (2007), lifelong learning helps people develop new skills and prepares them for the demands of education, technology, and innovation sectors. Effective pedagogical resources play a crucial role in helping students cultivate the abilities necessary for lifelong learning.

According to Alt et al. (2022), lifelong learning (LLP), is a powerful educational tool that helps individuals continuously learn new things and expand their knowledge. Everyone, including educators, should pursue lifelong learning, as emphasized by Basaran and Sesli (2019), who highlight that educators serve as instructors, advocates for their students, and role models. Furthermore, research has linked lifelong learning to cognitive advantages such as enhanced memory, problem-solving skills, and overall cognitive function. Additionally, LLP can complement advanced knowledge gained from non-traditional educational approaches (Alla, 2024).

## 3 Methodology

This study was carried out at Politeknik Muadzam Shah in Pahang using a quantitative methodology. A total of 121 students took part in the survey by responding online. A sample size of 50 to 100 is enough for a typical study analysis, according to Memon et al. (2020). Consequently, it is deemed sufficient that the researcher chooses a sample of 121 students from all semesters and programs in the Department of Commerce. Table 1 displays the respondents' backgrounds. Students in the Department of Commerce from semesters one through six, including those participating in industrial training, were randomly sampled as part of the sampling technique. To determine mean score values, the gathered data will be statistically examined using descriptive analysis. The mean values will be interpreted as follows, as used in the study by Ngadiman et al. (2019): 1.00–1.99 (Weak); 2.00–2.99 (Low); 3.00–3.99 (Moderate); 4.00–5.00 (High). The results of the data analysis will be presented in table form where the mean scores for each item will be displayed.

## 4 Finding and Analysis

### a) Background of respondents

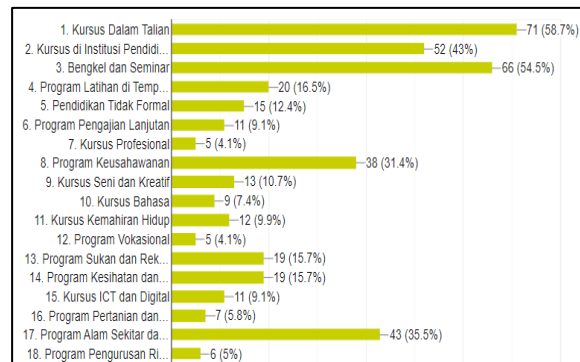
This study is a continuation of the LLP study conducted at Politeknik Muadzam Shah among engineering students (Abdullah et al., 2023) with 75 respondents. Table 1 shows the background of respondents selected from the Department of Commerce to evaluate other aspects in the LLP study. The majority of students are female (66.9%) compared to male (33.1%). In terms of semesters, most students are in the second semester (52.1%), followed by the fifth semester (18.2%) and sixth semester (9.9%). Academic performance indicates that 33.1% of students have a Grade Point Average (GPA) between 2.00 to 2.99, while 30.6% have a GPA between 3.00 to 3.33. A significant number of students, identified as B40, come from lower-class homes, as seen by the fact that 76.9% of students come from families with earnings of RM4360 or less.

**Table 1.** Respondent background

Item		n	%
Gender	Man	40	33.1
	Women	81	66.9
Semester	1.00	9	7.4
	2.00	63	52.1
	3.00	8	6.6
	4.00	7	5.8
	5.00	22	18.2
	6.00	12	9.9
CGPA	2.00 - 2.99	40	33.1

	3.00 - 3.33	37	30.6
	3.43 - 3.67	26	21.5
	3.68 - 4.00	9	7.4
	Semester 1 (No CGPA yet)	9	7.4
Household income	RM4360 and below	93	76.9
	RM4360 - RM9619	19	15.7
	RM9619 and above	9	7.4

Meanwhile, Figure 1 below, shows the types of lifelong learning programs (PSH) in which students have participated. The most frequently attended courses by students are online courses, accounting for 58.7%, followed by workshops and seminars at 54.5%, and courses at educational institutions, referring to those organized by Politeknik Muadzam Shah or any higher education institutions, at 43%.



**Fig. 1.** Student Participation in Various Types of Lifelong Learning Programs

#### b) The Impact of Lifelong Learning on Increasing Knowledge

According to Table 2's data, students' knowledge can be greatly increased by lifelong learning (LLP). An average score of 4.198 indicates that students agree that LLP has greatly advanced their knowledge in their various subjects of study. This indicates how effective LLP is at helping students gain a deeper understanding. Additionally, students who participate in LLP report feeling more secure in their knowledge—an average score of 4.157 indicates that this rise is due to continual learning. Additionally, with an average score of 4.157, LLP assists students in applying the knowledge they have gained in practical settings, demonstrating that LLP improves students' theoretical knowledge as well as their practical skills. All things considered, these findings show that LLP is essential for enhancing and applying students' knowledge, which in turn increases their confidence in their academic subjects.

**Table 2.** LLP's Impact on Knowledge Improvement

Item	Mean	S.D
1. LLP helps me comprehend the subject I study better.	4.198 <sup>1</sup>	0.760
2. In comparison to when I participated in LLP, I now know more.	4.091	0.742
3. Upon taking part in LLP, my confidence in my knowledge has increased.	4.157 <sup>2</sup>	0.753
4. LLP enables me to use the knowledge I've acquired in real-world situations.	4.157 <sup>3</sup>	0.775
5. My desire to learn more about new fields has been sparked by LLP.	4.140	0.809

6. LLP aids in my comprehension of contemporary problems.	4.157	0.796
7. LLP helps me locate reliable information sources.	4.149	0.782

Note: \* A high score was obtained for every item;  
Scores: 1 highest; 2 second highest; 3 third highest

### c) The Impact of Lifelong Learning on the Development of Skills

In accordance with Table 2, Table 3's results show that students' skills can be greatly improved by lifelong learning (LLP). With an average rating of 4.116, students concur that LLP aids in the improvement of their technical skills, such as software usage and job-related skills. This proves that LLP is successful in helping students acquire real-world skills related to their chosen sectors of work. Additionally, with an average score of 4.107, students believe that LLP helps them better prepare for issues they may face in the profession. This suggests that LLP not only improves technical abilities but also gives employees the mental and strategic preparedness they need to take on difficult tasks and circumstances at work. Additionally, with an average score of 4.107, students concur that LLP assists them in achieving their career goals. This demonstrates how important LLP is to helping people plan and achieve their professional goals and fulfil their career goals. Overall, these results suggest that LLP is a program that should be maintained to improve students' technical proficiency, preparedness for the workforce, and accomplishment of their professional goals.

**Table 3.** PSH's Impact on Skill Development

Item	Mean	S.D
1.My technical skills (such as software usage and job skills) are improved by LLP.	4.116 <sup>1</sup>	0.798
2. My soft skill abilities, like leadership and communication are enhanced by LLP.	4.099	0.810
3.LLP aids in my professional success.	4.107 <sup>3</sup>	0.814
4. LLP makes me more equipped to handle obstacles at work.	4.107 <sup>2</sup>	0.783
5. LLP has given me new skills that are applicable to developments in industry and technology.	4.099	0.790
6. My ability to organize my time better is enhanced by LLP.	4.058	0.859
7. LLP improves my ability to solve problems.	4.099	0.790

Note: \* A high score was obtained for every item;  
Scores: 1 highest; 2 second highest; 3 third highest

## 5 Conclusion

One of the primary driving forces behind enhancing literacy, skills, and knowledge among Malaysians is lifelong learning program (LLP). Aligned with the government's goal of creating a successful and educated MADANI Malaysian society, Lifelong Learning (LLP) significantly influences students in Politeknik Muadzam Shah from Department of Commerce; by improving their knowledge and abilities.

The study's findings reveal an improvement in students' knowledge. Through the comprehensive information provided by lifelong learning program, lifelong learning indirectly emphasizes the importance of keeping students relevant in an increasingly competitive job market. Ensuring that students entering various professions are competent and well-versed in a wide range of

disciplines beyond formal academics is highly valuable and should be consistently maintained over time. Students' knowledge levels must continually evolve to meet industry expectations, both today and in the future.

To support the enhancement of students' knowledge, a variety of engaging lifelong learning programs can be implemented involving students, communities, organizations, and companies. Examples include programs showcasing cutting-edge technologies like virtual reality (VR) and augmented reality (AR) in contemporary contexts. Additionally, interest in artificial intelligence (AI) as an educational subject is growing.

Undoubtedly, LLP's established programs significantly contribute to students' skill development. Attending PSH programs yields numerous benefits, including the development of technical skills. Other positive outcomes include better preparedness to tackle workplace challenges and the pursuit of professional ambitions. Given the diverse range of LLP programs available, these positive impacts are expected to significantly benefit polytechnics, producing graduates with high-level skills and strong academic standing. This aligns with the Ministry of Higher Education's deliberate efforts to ensure a LLP-oriented approach toward 2030, with substantial national impact.

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## References

1. Abdullah, A. Z., Sidek, S. Z., & Suhaimi, A. A. (2023) Ke Arah Pembelajaran yang Lebih Efektif: Kajian Keberkesanan Penggunaan E-book C++ di Kalangan Pelajar Politeknik Muadzam Shah. *INTERNATIONAL TVET & ENTREPRENEURSHIP CONFERENCE (ITEC 2023)*. TVET and Entrepreneurship for Sustainable Development.11-12 October 2023, Politeknik Negeri Medan & Politeknik Kota Bharu
2. Hassan, N., Salamon, H., & Rahman, H. A. (2017). Peranan aplikasi teknologi hijau dalam konteks melestarikan alam sekitar menurut perspektif Islam. *E-jurnal Penyelidikan dan Inovasi*. *E-Jurnal Penyelidikan dan Inovasi*. *rmc. kuis. edu. my/jpi/e-ISSN*, 2289-7909.
3. Hussin, N., & Hafit, A. (2018). Green Technology: Awareness among Academic Library Employees. *International Journal of Academic Research in Progressive Education and Development*, 7(3), 161–177.
4. Kaliappan, A., & Hamid, H. (2022). Green Technology and Vocational College: A Preliminary Study. *Online Journal for TVET Practitioners*, 7(1), 49-60.
5. Kassim, N., & Zakaria, E. (2015). Integrasi kemahiran berfikir aras tinggi dalam pengajaran dan pembelajaran matematik: Analisis keperluan guru. In *Conference: Prosiding Seminar Education Graduate Regional Conference (EGRC 2015)*.
6. Manaf, N. A., Razak, M. Z. A., Abd Razak, S. F. F., Muslim, N. A., Nawang, D., Azman, F., ... & Arshad, N. S. M. (2021). Awareness and Knowledge Level of School Teachers on the Use of Green Technology Products: A Pilot Study. *Global Business & Management Research*, 13.
7. Memon, M. A., Ting, H., Cheah, J. H., Thurasamy, R., Chuah, F., & Cham, T. H. (2020). Sample size for survey research: Review and recommendations. *Journal of Applied Structural Equation Modeling*, 4(2), 1-20.
8. Mustapha, R. A. M. L. E. E., Nashir, I., & Maarof, N. (2019). Awareness of green technology among engineering technology students. *Journal of engineering science and technology*, (special issue on ICEES2018), 1-8.
9. Ngadiman, D. W. T., Yacoob, S. E., & Wahid, H. (2019). Tahap Harga Diri Kumpulan Berpendapatan Rendah yang Berhutang dan Peranan Organisasi dalam Sektor Perladangan. *Melayu: Jurnal Antarabangsa Dunia Melayu*, 12(2), 238-254.
10. Salim, N., Jabor, M. K., & Musta'amal, A. H. (2019). The implementation of green technology among polytechnic students. *International Journal of Recent Technology and Engineering (IJRTE)*, 8(4).
11. Yang, C., & Zhao, H. (2011, September). Barriers to Green Technology Innovation in Large and Medium-Sized Enterprises. In *2011 International Conference of Information Technology, Computer Engineering and Management Sciences* (Vol. 4, pp. 175-178). IEEE.
12. Yusoh, M. P., Rosli, N. H., Marzuki, M., Mapjabil, J., Hanafi, N., Nordin, M. N., ... & Idris, N. H. (2022). The Effect of Green Practice Activities on the Understanding of Green Technology Topics in the Secondary School Geography Curriculum. *INTERNATIONAL JOURNAL OF SPECIAL EDUCATION*, 37(3s).

# Job Satisfaction Level Among Lecturers at Kolej Komuniti Miri Sarawak

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**Abstract.** Job satisfaction is defined as the pleasure or positive feeling derived from the work performed. Ensuring employee job satisfaction within an organization is critical to achieving organizational goals. The role of lecturers today is particularly challenging and demanding, as they are not only involved in teaching and learning but are also burdened with administrative and managerial tasks within their institution. This study aims to identify the levels of job satisfaction among lecturers at Kolej Komuniti Miri Sarawak (KKMS). This study utilizes a mixed-method approach, incorporating both quantitative and qualitative surveys. A quantitative study was conducted using a questionnaire distributed to 15 lecturers at KKMS. The questionnaire focused on supervisory roles, career advancement, recognition and appreciation, workplace relationships, and provided facilities or services. Additionally, a qualitative study was conducted by interviewing four lecturers from various grades: DH48, DH44, DH41, and DH34. The study found that the elements of supervisory roles (mean score = 4.51) and workplace relationships (mean score = 4.40) received high positive feedback for both years 2022 and 2023. The element of job responsibilities had the lowest scores for both years (mean scores = 3.84 and 4.07, respectively). The qualitative survey results indicate strong cooperation among colleagues and supervisors, which is a significant strength among lecturers. The findings of this study are intended to assist management in improving workload distribution, enhancing facilities and infrastructure through regular maintenance, and fostering strong supervisory and collegial relationships. This approach aims to maintain the quality of lecturers' work at an optimal level, thereby ensuring job satisfaction among lecturers at the institution.

**Keywords:** job satisfaction level, community college lecturers

## 1 Introduction

The relationship between job satisfaction and organizational success, especially within educational institutions, has been extensively studied in recent years. Job satisfaction among lecturers is crucial as it impacts their motivation, job performance, and commitment to assigned tasks. This, in turn, influences the teaching and learning processes, thereby affecting student outcomes and the institution's reputation.

Recent studies highlight that job satisfaction is positively correlated with professional performance and reduced turnover intentions among teachers. Satisfied teachers are more likely to create effective learning environments, support student motivation, and facilitate successful student learning. This positive impact on student outcomes and institutional reputation is consistent across various educational settings (Wartenberg et. al, 2023) (Culibrk et. al, 2018).

Moreover, job satisfaction enhances prosocial behaviors, work engagement, and overall job performance while reducing health issues and absenteeism. This is significant for maintaining high standards in educational institutions and ensuring that teachers remain committed and motivated (Katebi et. al, 2022)

Lecturers frequently encounter challenges in balancing their teaching responsibilities with administrative duties, especially within the context of institutions like Community Colleges, where lecturers are often required to engage in non-academic tasks. This issue is well-documented in recent studies. For example, a study by Harlow et al. (2022) highlights the growing administrative burdens on faculty members, which can detract from their teaching effectiveness and research productivity. Additionally, Zheng and Sun (2020) found that in some educational settings, the lack of dedicated administrative staff forces lecturers to handle numerous administrative tasks, further complicating their workload balance.

### 1.1 Problem Statement

Lecturers at Kolej Komuniti Miri Sarawak (KKMS) encounter significant challenges in performing their daily tasks. They are required to balance academic responsibilities with administrative and managerial duties, which are essential for ensuring student success and the effective operation of the institution. However, the increasing workloads, limited career advancement opportunities, and insufficient recognition of lecturers' achievements negatively impact job satisfaction at KKMS. Inadequate facilities and a lack of support from administration or management further hinder the effective delivery of teaching and learning



own & Duguid, 2000). Given these challenges, it is essential to evaluate the job satisfaction levels of lecturers at KKMS to identify key issues requiring preventive and improvement measures.

A major concern is the heavy workload, particularly the administrative and managerial duties. Lecturers are frequently required to participate in activities related to the institution's Key Performance Indicators (KPIs), demanding additional time and effort beyond their primary teaching responsibilities. The number of lecturers is insufficient to accommodate the extensive teaching and learning demands alongside their administrative and managerial duties. Some lecturers are burdened with teaching hours exceeding 30 hours per week, which is not advisable and can lead to burnout and decreased job satisfaction.

This study aims to evaluate the level of job satisfaction among lecturers at KKMS by examining various dimensions of job satisfaction, including job responsibilities, career advancement, workplace relationships, and provided facilities. By identifying critical areas that require attention and improvement, this study seeks to provide strategic guidance for management to enhance the satisfaction and performance of lecturers at KKMS.

## 1.2 Research Questions

Based on the problem statement, this study will address the following research questions:

- i. What is the level of job satisfaction among lecturers at Kolej Komuniti Miri Sarawak (KKMS), considering various elements such as supervisory/leadership roles, career advancement, recognition/appreciation, workplace relationships, and provided facilities/services?
- ii. Is there a significant difference in the level of job satisfaction among lecturers between the years 2022 and 2023?
- iii. How are the main factors contributing to the job satisfaction of lecturers at KKMS?
- iv. What are the primary challenges faced by lecturers in performing their duties, and how do these challenges impact their job satisfaction?

## 1.3 Research Objectives

The objectives of this study are as follows:

- i. **Identify Job Satisfaction Levels:** To assess the level of job satisfaction among lecturers at KKMS, focusing on various elements such as supervisory/leadership roles, career advancement, recognition/appreciation, workplace relationships, and provided facilities/services.
- ii. **Identify Differences in Job Satisfaction Levels:** To determine significant differences in the level of job satisfaction among lecturers between the years 2022 and 2023.
- iii. **Explore Key Factors Influencing Job Satisfaction:** To identify the main factors contributing to the job satisfaction of lecturers at KKMS.
- iv. **Explore Main Challenges in Lecturer Duties:** To identify the primary challenges faced by lecturers in performing their duties and how these challenges impact their job satisfaction

## 2 Literature review

Herzberg's two-factor theory emphasizes that job satisfaction is influenced by intrinsic factors such as achievement and recognition, as well as extrinsic factors like working conditions and salary (Herzberg, 1968). In the higher education environment, adequate teaching facilities and support from management also play a significant role in influencing job satisfaction among lecturers (Anvari, Amin, & Seliman, 2010). Furthermore, maintaining a balanced workload and providing opportunities for professional development are critical elements in ensuring job satisfaction among lecturers in an academic context (Johari, Tan, & Zulkarnain, 2018). The availability of resources and administrative support also significantly affects lecturers' job satisfaction, particularly in educational institutions such as community colleges (Mohd Noor & Mohd Salleh, 2014). Continuous evaluations of lecturers' workloads and consistent support from management and administration are essential to ensure the mental health and well-being of lecturers are maintained.

Workplace relationships also play a vital role in ensuring job satisfaction among lecturers. A work environment that fosters positive interactions among employees and supervisors will result in a conducive and collaborative atmosphere, thereby enhancing lecturers' productivity (Sahito & Vaisanen, 2017). The need for readily available ICT facilities is one of the basic necessities in modern educational institutions. Access to robust ICT infrastructure is critical for the effective execution of teaching and administrative tasks (Brown & Duguid, 2000). Comprehensive ICT facilities facilitate lecturers' knowledge delivery and align with the continuous integration of technology into the teaching and learning process. Harmonious and positive relationships among lecturers and supervisors thus influence the work environment and motivate lecturers to be more proactive and productive.

In the work environment of institutions such as community colleges, the primary challenge faced by lecturers is balancing academic responsibilities with administrative or managerial duties. Excessive workloads and lack of support from administration or management are significant sources of job dissatisfaction among lecturers (Salami, 2006). Therefore, understanding these

factors is essential for implementing interventions to prevent and address issues that undermine lecturers' job satisfaction, ensuring the overall effectiveness of the institution's operations, particularly in community colleges.

### 3 Research methodology

This study employs a mixed-methods approach, integrating quantitative and qualitative methods to evaluate the job satisfaction levels of lecturers at KKMS. The research design involves the distribution of questionnaires and conducting interviews to gather comprehensive data.

#### Sample Selection

The sample consists of 15 lecturers from KKMS, as the institution only employs 15 lecturers. Additionally, interviews were conducted with four lecturers from various grades (DH48, DH44, DH41, and DH34) to gain further qualitative insights.

#### 3.1 Instrument for Quantitative Approach

A descriptive research design was adopted, utilizing a questionnaire administered via Google Forms to collect data from the lecturers. The questionnaire included demographic sections and various elements of lecturers' job satisfaction levels, comprising 11 items evaluated using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The elements of job satisfaction are taken from Job Descriptive Index (Smith, Kendall & Hulin, 1969) is a popular measure of job description. The aspects of job satisfaction assessed include:

##### 3.1.1 Job Responsibilities:

Evaluates the extent to which lecturers This section evaluates the extent to which lecturers understand supervisory instructions, receive feedback, and perceive the fairness of workload distribution.

##### 3.1.2 Career Advancement:

This section assesses the opportunities provided to lecturers for attending training, the fairness of performance evaluations, and prospects for career advancement.

##### 3.1.3 Recognition / Appreciation:

This section evaluates the level of appreciation and recognition received by lecturers for their achievements.

##### 3.1.4 Workplace Relationships:

This section assesses the relationships between lecturers and their supervisors and colleagues, as well as the support received.

##### 3.1.5 Facilities and Services:

This section evaluates the quality of work facilities such as workspaces, ICT facilities, and other amenities provided by the institution. The collected data were analyzed using descriptive statistics to identify trends in the level of job satisfaction among lecturers.

#### 3.2 Instrument for Qualitative Approach

Interviews with four lecturers from various grades were conducted to gain deeper insights into their experiences and perceptions regarding job satisfaction. The interviews focused on the following elements:

##### 3.2.1 Challenges in Academic and Administrative or Managerial Tasks:

Understanding the primary challenges faced by lecturers in balancing their academic and administrative or managerial duties.

##### 3.2.2 Opportunities for Career Advancement:

Evaluating lecturers' experiences with training and career advancement opportunities.

##### 3.2.3 Recognition / Appreciation:

Gaining perspectives on the level of appreciation and recognition received by lecturers.

### 3.2.4 Workplace Relationships:

Assessing the relationships and cooperation between lecturers, their colleagues, and supervisors.

Qualitative data from the interviews were analyzed using thematic analysis to identify key themes and issues affecting lecturers' job satisfaction. The interpretation of the mean scores used in this study is provided in Table 1 below.

**Table 1.** Score Mean Interpretation

Score Range	Interpretation
1.00 – 1.80	Very Low
1.81 – 2.60	Low
2.61 – 3.40	Moderate
3.41 – 4.20	High
4.21 – 5.00	Very High

Source: Wiersma, 1995

## 4 Finding and Analysis

Quantitative study: The calculated Cronbach's Alpha for the data is  $\alpha=0.992$ . This indicates an extremely high level of internal consistency among the items in the dataset. Generally, a Cronbach's Alpha value above 0.7 is considered acceptable, so this value suggests that the study data is highly reliable.

### 4.1 Level of lecturer job satisfaction from the Job Responsibilities element

Based on Table 2, the mean score for the level of job satisfaction among lecturers from the Job Responsibilities element is at a high level for both the years 2022 and 2023. Specifically, the mean score for 2022 is 3.84, while for 2023 it is 4.07. Both scores indicate a high level of satisfaction in the lecturer's task area. Although there is an improvement, it remains within the "High" category. However, the mean score for job responsibilities for the year 2022 is the lowest score compared to all elements in both years. This result aligns with the study by Kim et al. (2023), which mentions that job responsibilities for lecturers are often overloaded and can cause stress.

**Table 2.** Mean scores and standard deviations for job satisfaction level in the job responsibilities

No.	Job Responsibilities	2022		2023		Difference in Mean Score (2022 to 2023)
		Mean Score	Standard Deviation	Mean Score	Standard Deviation	
1	Alignment of tasks with interest and abilities	3.82 (High)	0.636	3.93 (High)	0.884	0.11
2	Always enthusiastic and capable of performing assigned task	4.00 (High)	0.50	4.27 (Very High)	0.594	0.27
3	Workload commensurate with abilities and position held	3.71 (High)	0.686	4.00 (High)	0.655	0.29
Overall Level		3.84 (High)	0.096	4.07 (High)	0.153	0.23

### 4.2 Level of lecturer job satisfaction from the Supervisory Roles element

Based on Table 3, the mean score for the level of job satisfaction among lecturers from the Supervisor/Leader element is at a very high level for both 2022 and 2023, with scores of 4.51 and 4.24, respectively. These scores indicate very high satisfaction with the support and leadership provided by supervisors or heads, demonstrating effective management.

These findings are consistent with the study by Mishra and Ghosh (2020), which states that effective communication and supervisor concern for employees have positive effects on job satisfaction. The high scores suggest that lecturers at KKMS benefit from a work environment where they feel comfortable expressing their opinions and providing feedback on various matters. An effective supervisor is characterized by maintaining an open mind and a positive attitude in resolving issues faced by employees, which aligns with the experiences reported by KKMS lecturers. This correlation underscores the importance of supervisory roles in fostering a supportive and communicative work environment that enhances overall job satisfaction.

**Table 3.** Mean scores and standard deviations for job satisfaction level in the Supervisory Roles element

No.	Supervisory Roles	2022		2023		Difference in Mean Score (2022 to 2023)
		Mean Score	Standard Deviation	Mean Score	Standard Deviation	
1	Supervisor's instructions are clear and easy to understand	4.53 (Very High)	0.624	4.20 (High)	0.676	-0.33
2	Supervisor consistently provides feedback and guidance on work performed	4.59 (Very High)	0.507	4.33 (Very High)	0.617	-0.26
3	Supervisor possesses the skills to make good decisions	4.59 (Very High)	0.507	4.27 (Very High)	0.594	-0.32
4	Work allocation by the supervisor is done fairly	4.35 (Very High)	0.702	4.13 (High)	0.743	-0.22
5	Supervisor is open to receiving suggestions/feedback from subordinates and consistently provides encouragement	4.47 (Very High)	0.624	4.27 (Very High)	0.704	-0.20
Overall Level		4.51 (Very High)	0.085	4.24 (Very High)	0.061	-0.27

#### 4.3 Level of lecturer job satisfaction from the Career Advancement element

Based on Table 4, the mean score for lecturer job satisfaction from the Career Advancement element is at a very high level for both 2022, which is 4.24, and 2023, which is 4.33. There is an increase in the mean scores for this element from 2022 to 2023, indicating that lecturers perceive better career advancement opportunities in 2023.

This finding is consistent with the study by Chen et al. (2003), which states that career development programs have a positive impact on job satisfaction, professional development, and productivity. The increase in mean scores suggests that lecturers at KKMS are experiencing enhanced career development opportunities, which aligns with Chen et al.'s assertion that well-organized career development programs inspire job satisfaction and professional growth. Career development encourages employee effectiveness and creativity over the long term, allowing employees to pursue improvements in their careers that lead to higher job satisfaction.

**Table 4.** Mean scores and standard deviations for job satisfaction level in the Career Advancement element

No.	Career Advancement	2022		2023		Difference in Mean Score (2022 to 2023)
		Mean Score	Standard Deviation	Mean Score	Standard Deviation	
1	Having the opportunity to attend appropriate training programs for self-improvement	4.18 (High)	0.809	4.33 (Very High)	0.617	0.15
2	Opportunities to apply what is learned after training	4.06 (High)	0.827	4.27 (Very High)	0.594	0.21
3	Fairness practiced by the supervisor/head in conducting annual performance appraisals (LNPT) and feedback to improve work performance	4.41 (Very High)	0.618	4.47 (Very High)	0.516	0.06
4	Opportunities to perform different tasks from time to time to showcase personal potential	4.24 (Very High)	0.664	4.40 (Very High)	0.507	0.16
5	Bright prospects for continuous advancement in public service	4.29 (Very High)	0.772	4.20 (High)	0.676	-0.09
Overall Level		4.24 (Very High)	0.092	4.33 (Very High)	0.071	0.09

#### 4.4 Level of lecturer job satisfaction from the Recognition or appreciation element

Based on Table 5, the mean score for lecturer job satisfaction from the Recognition/Reward element is at a very high level for both 2022, which is 4.37, and 2023, which is 4.27. Although there is a slight decrease in the mean score for this element, both years still indicate very high satisfaction in terms of recognition and rewards.

This finding is consistent with the study by Yalabik et al. (2017), which mentioned that employees' promotion prospects are a factor that positively influences job engagement. Recognition or appreciation is the major motivator for employees to continue their engagement with the company and fulfill their job satisfaction (Asaari et al., 2019). The high mean scores suggest that lecturers at KKMS benefit from a work environment where their achievements are acknowledged and rewarded, reinforcing their commitment and engagement. This alignment underscores the importance of recognition and reward systems in maintaining high levels of job satisfaction among lecturers.

**Table 5.** Mean scores and standard deviations for job satisfaction level in the Recognition/Reward element

No.	Recognition or Appreciation	2022		2023		Difference in Mean Score (2022 to 2023)
		Mean Score	Standard Deviation	Mean Score	Standard Deviation	
1	Supervisor acknowledges and appreciates good work performance	4.47 (Very High)	0.624	4.20 (High)	0.561	-0.27
2	Fair promotion policies oriented towards abilities and work achievements	4.35 (Very High)	0.606	4.27 (Very High)	0.594	-0.08
3	Provision of Incentives (APC) and other recognitions based on individual performance and excellence	4.29 (Very High)	0.588	4.33 (Very High)	0.488	0.04
Overall Level		4.37 (Very High)	0.018	4.27 (Very High)	0.054	-0.10

#### 4.5 Level of lecturer job satisfaction from the workplace relationships element

Based on Table 6, the mean score for lecturer job satisfaction from the Workplace Relationships element is at a very high level for both 2022, with a mean score of 4.44, and 2023, with a mean score of 4.40. Both years indicate very high satisfaction for this element, demonstrating good relationships and high cooperation between supervisors and lecturers as well as among lecturers' colleagues.

A study by Kim et al. (2023) examines job satisfaction among university employees in a developing country, focusing on relationships with co-workers as a key factor influencing job satisfaction and work engagement. This paper suggests that positive relationships with colleagues significantly enhance job satisfaction and engagement levels among university staff. This finding is consistent with the study at KKMS, where strong workplace relationships and effective collaboration contribute significantly to high job satisfaction levels. The high mean scores at KKMS reflect the importance of fostering positive interactions and cooperation among staff to maintain a productive and supportive work environment.

**Table 6.** Mean scores and standard deviations for job satisfaction level in the Workplace Relationships element

No.	Workplace Relationships	2022		2023		Difference in Mean Score (2022 to 2023)
		Mean Score	Standard Deviation	Mean Score	Standard Deviation	
1	Having a good relationship with the supervisor/leader	4.47 (Very High)	0.514	4.40 (Very High)	0.507	-0.07
2	Having a good relationship with other staff members	4.53 (Very High)	0.514	4.40 (Very High)	0.507	-0.13
3	Colleagues always provide assistance and encouragement	4.41 (Very High)	0.507	4.40 (Very High)	0.507	-0.01
4	Team-building programs foster teamwork spirit and strengthen relationships among staff	4.35 (Very High)	0.606	4.40 (Very High)	0.632	0.05
Overall Level		4.44 (Very High)	0.047	4.40 (Very High)	0.063	-0.04

#### 4.6 Level of lecturer job satisfaction from the Facilities/Services element

Based on Table 7, the mean score for lecturer job satisfaction from the Facilities/Services element overall is at a high level for both years 2022, with a score of 4.14, and 2023, with a score of 4.11. The mean score for this element, although high, indicates the lowest level of satisfaction compared to other elements. There is also a slight decrease in the mean score for this element, highlighting the need for improvements in facilities and services at the college.

This finding aligns with the study by Sattar and Ahmed (2021), which emphasizes the importance of adequate facilities and services in influencing job satisfaction among academic staff. The study suggests that well-maintained facilities and reliable services are crucial for maintaining high job satisfaction and effective job performance. The slight decrease in mean scores at KKMS underscores the necessity for the college management to prioritize enhancements in facilities and services to ensure a conducive working environment for lecturers.

**Table 7.** Mean scores and standard deviations for job satisfaction level in the Facilities/Services element

Bil.	Facilities / Services	2022		2023		Difference in Mean Score (2022 to 2023)
		Mean Score	Standard Deviation	Mean Score	Standard Deviation	
1	Workspaces/Meeting rooms	4.12 (High)	0.697	4.13 (High)	0.743	0.01
2	Pantry facilities	4.06 (High)	0.659	3.67 (High)	0.724	-0.39
3	Restroom facilities	4.18 (High)	0.529	4.40 (Very High)	0.507	0.22
4	Internet/Email at KKMS	4.18 (High)	0.809	4.20 (High)	0.561	0.02
5	Air conditioning system	3.88 (High)	0.993	3.40 (Moderate)	1.242	-0.48
6	Prayer room facilities	4.29 (Very High)	0.558	4.00 (High)	0.756	-0.29
7	Office vehicle facilities	4.35 (Very High)	0.606	4.40 (Very High)	0.507	0.05
8	Operator/Telephone services	4.18 (High)	0.636	4.47 (Very High)	0.516	0.29
9	Office equipment (computers, telephones, printers, and photocopiers)	3.88 (High)	0.697	4.13 (High)	0.640	0.25
10	Overall job satisfaction at KKMS	4.29 (Very High)	0.47	4.27 (Very High)	0.704	-0.02
Overall Level		4.14 (High)	0.150	4.11 (High)	0.218	-0.03

#### 4.7 Mean Scores for Main Elements

Based on Table 8, which shows the mean scores and standard deviations for all main elements of lecturer job satisfaction levels studied, it can be observed that the highest score for 2022 is in the Supervisory Roles element, followed by Workplace Relationships, Recognition/Appreciation, Career Advancement, Facilities/Services, and lastly, Job Responsibilities. In 2023, the Workplace Relationships element received the highest score, followed by Career Advancement, Recognition/Appreciation, Supervisory Roles, Facilities/Services, and finally, Job Responsibilities.

The Supervisory Roles element received the highest score in 2022 but showed a decrease in 2023. Supervisors/Leaders should engage in discussions with lecturers under their supervision to address issues causing dissatisfaction, particularly in academic areas, and implement improvement measures. This is crucial to ensure a harmonious working environment between supervisors and lecturers.

Workplace Relationships emerged as a high level of job satisfaction at KKMS due to the college's work environment, which involves numerous programs and activities requiring high cooperation. Given the relatively small number of lecturers at KKMS, it is essential to maintain good and professional relationships among lecturers. In conclusion, the Supervisor/Leader and Workplace Relationships elements are the main strengths for lecturers at KKMS.

The Recognition/Appreciation element consistently holds the third position for both 2022 and 2023. This indicates that lecturers are generally satisfied with the management's methods of evaluating this aspect, despite a slight decrease in the mean scores from 2022 to 2023.

The Career Advancement element showed a significant increase in mean score, indicating high motivation among lecturers in this area. Lecturers are satisfied with the courses offered to enhance their competencies, demonstrating a maturing attitude towards career advancement, with more lecturers applying for promotions.

Facilities/Services and Job Responsibilities are the elements with the lowest mean scores for both 2022 and 2023. The air conditioning aspect scored moderately in 2023 due to many malfunctioning units at KKMS, making it uncomfortable for lecturers to perform their tasks in an uncondusive environment.

The Job Responsibilities element received the lowest mean score for both 2022 and 2023. This is primarily attributed to the insufficient number of lecturers at KKMS to manage two full-time programs effectively. In addition to their extensive teaching hours per week, lecturers are involved in delivering short courses to the community under the Lifelong Learning Unit during weekends. Lecturers are also directly engaged in the institution's operations through significant managerial and administrative duties, which are integral parts of institutional operations. This additional involvement contributes to the overall workload burden faced by lecturers. Moreover, lecturers are actively involved in efforts to achieve the institution's KPIs. Consequently, lecturers are burdened with not only teaching but also significant organizational management tasks, as highlighted in the study by Hassan et al. (2020).

Overall, the level of job satisfaction among KKMS lecturers slightly decreased by 0.02 from 2022 (mean score = 4.26) to 2023 (mean score = 4.24). However, these scores still fall within the Very High category, indicating a fairly positive outcome. Nevertheless, aspects with moderate mean scores warrant attention to ensure the well-being of lecturers is consistently maintained.

**Table 8.** Minimum scores and standard deviations for job satisfaction level in the main elements studied

No.	Main Element	2022 Mean Score	Main Element	2023 Mean Score
1	Supervisory Roles	4.51 (Very High)	Workplace Relationships	4.40 (Very High)
2	Workplace Relationships	4.44 (Very High)	Career Advancement	4.33 (Very High)
3	Recognition /Appreciation	4.37 (Very High)	Recognition /Appreciation	4.27 (Very High)
4	Career Advancement	4.24 (Very High)	Supervisory Roles	4.24 (Very High)
5	Facilities/Services	4.14 (High)	Facilities/Services	4.11 (High)
6	Job Responsibilities	3.84 (High)	Job Responsibilities	4.07 (High)
	Overall Score	4.26 (Very High)	Overall Score	4.24 (Very High)

**Qualitative Study:** A qualitative study was conducted through interviews with four lecturers of various grades. The findings from the interviews revealed the following:

#### 4.7.1 Challenges in Academic and Administrative or Managerial Tasks:

Challenges in academic and administrative or managerial tasks are highly burdensome for lecturers, sometimes leading them to prioritize other programs or tasks over their primary duties of teaching and learning. This concern was acknowledged by the interviewed lecturers, who stated:

*"We have a lot of different tasks to do, so sometimes, we don't even have time to grade papers. Other urgent work also needs to be done, but it's the lecturers who have to handle it."*

*"...if there's a program, classes have to be postponed because the committee members for the program are always the same people (lecturers)."*

The supervisory role is crucial here as well. Effective supervisors can help distribute tasks more equitably and ensure that lecturers are not overwhelmed by non-academic responsibilities. By providing clear instructions and offering support, supervisors can help lecturers balance their workload more effectively. Furthermore, strong working relationships among colleagues can ease the burden by enabling lecturers to share responsibilities and support each other. This collaborative effort helps mitigate the challenges posed by academic and administrative tasks.

#### 4.7.2 Career Advancement Opportunities:

Lecturers at the college are consistently encouraged to pursue career advancement. However, this issue is perceived differently by lecturers, as revealed in the interviews:

*"We're fine with attending training courses or competency courses, no problem there. But if it involves applying for a promotion, I don't want to leave Miri because my hometown is here."*

These findings suggest that lecturers at KKMS are reluctant to apply for promotions due to their unwillingness to be transferred, as the majority of lecturers at KKMS are locals. The highest management team at headquarters may need to reconsider the existing job grade scheme to make it more accommodating, allowing for career advancement without necessitating relocation. Supervisory roles play a part here as well; supportive supervisors can mentor lecturers and help them navigate their career paths without the pressure of relocation. Strong working relationships also foster a supportive environment where colleagues encourage each other to grow professionally while respecting personal preferences and constraints.

#### 4.7.3 Recognition and Appreciation:

All four interviewed lecturers stated that the management has given them substantial recognition for their work. As mentioned by one of the interviewed lecturers:

*"There aren't many of us here, so we'll definitely get some recognition. Besides, the management is great; they like to give out various forms of recognition."*

This practice needs to be maintained by the management to serve as motivation for lecturers to excel in their tasks. Supervisors play a critical role in recognizing and appreciating lecturers' efforts on a day-to-day basis. Regular feedback and acknowledgement from supervisors can significantly boost morale. Additionally, a strong working relationship among lecturers ensures that colleagues also recognize and appreciate each other's efforts, creating a positive and reinforcing work environment.

#### 4.7.4 Working Relationships:

The relationships and cooperation among lecturers are excellent, as confirmed by the quantitative study. Each lecturer possesses their own expertise and strengths, which complement one another within the college community. One of the interviewed lecturers stated:

*"We're like family here. Sure, we might have arguments, but they don't last long. Where else can we go? There are only a few of us. Despite that, whenever there's a big program, we always perform well because our teamwork is top-notch."*

Such relationships provide a sense of support to lecturers, enabling them to manage their numerous responsibilities collectively. The mature attitude of lecturers must be maintained to prevent conflicts that could disrupt harmony and negatively impact job satisfaction levels at the college. Supervisory roles are vital in fostering these positive relationships. Effective supervisors encourage teamwork and collaboration, helping to build a strong community spirit among lecturers. They can mediate conflicts and ensure that the working environment remains supportive and collegial. Strong working relationships among lecturers are essential for maintaining high levels of job satisfaction, as they enable lecturers to handle their responsibilities more effectively and provide mutual support in times of need.

## 5 Conclusion

Based on the analysis of lecturer job satisfaction data at KKMS for the years 2022 and 2023, it is evident that the task area and the facilities/services provided are elements that require special attention. However, several strengths were also identified that contribute positively to lecturer satisfaction.

The data indicates that the Supervisory Roles and Workplace Relationships elements are major strengths. The high levels of satisfaction in these areas suggest effective management and strong cooperation among colleagues, fostering a supportive and collaborative work environment. Lecturers appreciate the recognition and appreciation they receive from management, which serves as a motivation for them to excel in their tasks.

To ensure a balanced workload that aligns with the lecturers' capabilities and positions, it is recommended that management reduce administrative tasks that may increase the workload of lecturers. This will allow them to focus more on teaching and learning. Furthermore, supervisors should ensure that lecturers clearly understand their tasks and responsibilities, providing clear directions and adequate support to carry out their tasks effectively.

The facilities element also needs special attention from KKMS management. Improving these facilities will enhance lecturer job satisfaction levels, which will, in turn, contribute to the overall performance improvement of the institution.

Addressing these areas will not only improve job satisfaction among lecturers but also enhance the overall effectiveness and efficiency of KKMS, fostering a more supportive and productive educational environment. Recognizing and leveraging the existing strengths while addressing the identified areas for improvement will ensure a more balanced and satisfying work experience for the lecturers.

### 5.1 Implications

#### i. *Quality of Teaching and Learning:*

High job satisfaction levels among lecturers are directly linked to the quality of teaching and learning within the institution. When lecturers experience high levels of satisfaction with their roles, they are more likely to demonstrate greater commitment, enthusiasm, and creativity in their teaching methodologies. This positive attitude contributes to more engaging and effective learning experiences for students. Additionally, satisfied lecturers are more inclined to stay abreast of the latest educational trends and technologies, further enhancing the learning environment. Consequently, the overall academic performance and student satisfaction levels are likely to improve significantly, bolstering the institution's reputation for educational excellence.

#### ii. *Mental Well-being and Motivation of Lecturers:*

Job satisfaction is intrinsically connected to the mental well-being and motivation of lecturers. Elements such as excessive workload and inadequate facilities can contribute to stress, burnout, and diminished job satisfaction. These factors can negatively impact lecturers' mental health, leading to issues such as anxiety and depression, which subsequently affect their performance and productivity. Creating a supportive work environment where lecturers feel valued and well-resourced can help maintain their mental well-being and motivation. Such an environment encourages lecturers to be more engaged and effective in their roles, fostering a positive and productive work culture.



iii. *Image and Reputation of the Institution:*

The job satisfaction levels of lecturers also have a significant impact on the image and reputation of the institution. Institutions known for high lecturer satisfaction are often perceived as desirable places to work and study. This positive perception can attract high-quality staff and students, enhancing the institution's academic standing. Moreover, satisfied lecturers are more likely to act as ambassadors for the institution, promoting it positively within academic and professional communities. Institutions with high job satisfaction levels among staff tend to experience lower turnover rates, ensuring continuity and stability in teaching programs, which further strengthens their reputation.

## 5.2 Recommendations

i. *Workload Management:*

Management should review the distribution of lecturers' workloads to ensure alignment with their capabilities and positions. Special attention must be given to the weightage of lecturers' administrative tasks and those involving the institution's Key Performance Indicators (KPIs). Efforts should be made to reduce excessive administrative duties that may disrupt lecturers' primary roles in teaching and learning, allowing them to focus on academic excellence. Additionally, it is crucial to request more lecturing positions to alleviate the burden on existing staff. Increasing the number of lecturers will help distribute the workload more evenly, ensuring that academic responsibilities are manageable and effectively carried out.

ii. *Improvement of Facilities and Infrastructure:*

The quality of facilities such as meeting rooms, pantries, restrooms, and air conditioning systems should be enhanced and maintained periodically. Regular maintenance of critical facilities like the air conditioning system, meeting rooms, and classrooms is essential to ensure a conducive working environment. Additionally, the provision of a reliable IT tech support team is crucial to address IT-related problems promptly, ensuring smooth integration of technology in teaching and learning sessions. This will help minimize disruptions and enhance the overall efficiency of academic activities.

iii. *Improvement of Communication and Feedback:*

Supervisors should adopt an open-door policy to welcome feedback and encourage open communication, feedback, and discussion with employees. This approach will foster a culture of transparency and trust within the institution. Regular communication between management and lecturers should be conducted to share experiences and encourage suggestions to address arising issues. Furthermore, the provision of mental and emotional support systems, such as counseling sessions and mental health programs for lecturers, should be strengthened. Encouraging participation in these programs will help maintain a healthy and supportive work environment, enhancing the overall well-being of lecturers.

## References

1. Anvari, R., Amin, S. M., & Seliman, S. (2010). Personal needs assessment and lecturers' performance in teaching. *International Journal of Educational Management*, 24(3), 197-210.
2. Asaari, Muhammad Hasmi Abu Hassan, Nasina Mat Desa, and Loganathan Subramaniam. 2019. Influence of salary, promotion, and recognition toward work motivation among government trade agency employees. *International Journal of Business and Management* 14: 48–59.
3. Chen TY, Chang PL, Yeh CW. The study of career needs, career development programmes and job satisfaction levels of R&D personnel: The case of Taiwan. *The International Journal of Human Resource Management*. 2004;14(6):1001-1026
4. Harlow, A. N., Buswell, N. T., Lo, S. M., & Sato, B. K. (2022). Stakeholder perspectives on hiring teaching-focused faculty at research-intensive universities. *International Journal of STEM Education*, 9(1), 54.
5. Hassan, S., Shamsudin, S. R. M., & Yaakub, A. (n.d.). Mengenal pasti tahap kepuasan bekerja di kalangan pensyarah Kolej Komuniti Selandar, Melaka. [Unpublished manuscript]. Kolej Komuniti Selandar. [https://www.academia.edu/38461000/MENGENAL\\_PASTI\\_TAHAP\\_KEPUASAN\\_BEKERJA\\_DI\\_KALANGAN\\_PENSYARAH\\_KOLEJ\\_KOMUNITI\\_SELANDAR\\_MELAKA](https://www.academia.edu/38461000/MENGENAL_PASTI_TAHAP_KEPUASAN_BEKERJA_DI_KALANGAN_PENSYARAH_KOLEJ_KOMUNITI_SELANDAR_MELAKA)
6. Herzberg, F. (1968). One more time: How do you motivate employees? *Harvard Business Review*, 46(1), 53-62.
7. Ismail, N., & Noor, K. M. (2011). Workload and job satisfaction among lecturers at public research universities in Malaysia. *International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*, 5(9), 2038-2042.
8. Johari, J., Tan, F. Y., & Zulkarnain, Z. I. (2018). Autonomy, workload, work-life balance, and job performance among teachers. *International Journal of Educational Management*, 32(1), 107-120.
9. Katebi, A., Haji Zadeh, M.H., Bordbar, A., Salehi, A, M. (2022). The Relationship Between “Job Satisfaction” and “Job Performance”: A Meta-analysis (2021). *Global Journal of Flexible Systems Management*, Volume 23, pages 21-42.
10. Kim, Long., Pongsakornrungrungsilp, P., Pongsakornrungrungsilp, S., Horam, N., Kumar, V. (2023). Key Determinants of Job Satisfaction among University Lecturers. *Social Sciences*, 12:153.
11. Mohd Noor, H., & Mohd Salleh, A. (2014). Factors influencing job satisfaction among lecturers in Kolej Komuniti. *Asian Social Science*, 10(9), 255-263.

12. Mishra, M. & Ghosh, K. (2020). Supervisor monitoring and subordinate work attitudes: a need satisfaction and supervisory support perspective. *Leadership & Organization Development Journal*. Vol. 41 No. 8, pp. 1089-1105.
13. Roslan, S., Sharifah, S., & Ahmad, R. (2012). The impact of work-life balance on job satisfaction and turnover intention among academicians in Malaysian higher education institutions. *International Journal of Business and Social Science*, 3(12), 240-248.
14. Sahito, Z., & Vaisanen, P. (2017). Factors affecting job satisfaction of teacher educators: Empirical evidence from Pakistan. *Journal of Teacher Education and Educators*, 6(1), 5-30.
15. Sattar, A., & Ahmed, Z. (2021). The impact of facilities and services on job satisfaction among academic staff: A case study of higher education institutions. *Journal of Educational Management Studies*, 15(2), 98-112.
16. Smith, P. C., Kendall, L. M., & Hulin, C. L. (1969). *The measurement of satisfaction in work and retirement: A strategy for the study of attitudes*. Rand McNally.
17. Spector, P. E. (1997). *Job satisfaction: Application, assessment, causes, and consequences*. Sage Publications.
18. Shariff, N. M., & Ismail, S. (2017). Job satisfaction among academic staff: A case study of community college in Malaysia. *Journal of Education and Practice*, 8(28), 154-161.
19. Wartenberg, G., Aldrup, K., Grund, Simon., Klusmann, U. (2023). *Satisfied and High Performing? A Meta-Analysis and Systematic Review of the Correlates of Teachers' Job Satisfaction*. *Educational Psychology Review*, 35:114
20. Wiersma, W. (1995). *Research Methods in Education: An Introduction*. 6th. ed. Massachusetts: Allyn and Bacon.
21. Yalabik, Z.Y., Rayton. B.A., Rapti. A. (2017). Factors of job satisfaction and work engagement: A Global Forum for empirical scholarship. *Evidence-Based HRM: A Global Forum for Empirical Scholarship* 5: 248-65.
22. Zheng, J., & Sun, X. (2020). *More is less: Homeroom teachers' administrative duties and students' academic performance*. ScienceDirect

# **Tahu-Qu: Implementation of Quranic Tahsin Activities to Improve The Quality of Recitation of Surah Al-Fatihah Among Students of Kuching Polytechnic Sarawak**

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**Abstract.** Belief in the Scriptures is one of the pillars of faith. The Quran is one of the four scriptures revealed by Allah SWT to the Prophet Muhammad SAW. Reading the Quran is a highly emphasized act of worship in Islam. The sanctity of the Quran must be maintained and preserved. Surah Al-Fatihah is the first surah in the Quran and it is also a surah that must be recited during prayer. Therefore, the Tahu-Qu or Tahu Quran program is designed to improve the recitation of Surah Al-Fatihah. This study was conducted to assess the proficiency level of Surah Al-Fatihah recitation among second-semester Muslim students taking the MPU23032 Islamic Studies course. This action research involved observation, reflection, planning, and action methods. A total of 77 respondents were selected for this study. The research was conducted in three phases: Phase One (Weeks 1-2), Phase Two (Weeks 3-4), and Phase Three (Weeks 5-6). The findings from the implementation of all three phases showed that students exhibited an improvement in the quality of their recitation of Surah Al-Fatihah and showed interest in learning proper recitation techniques. On average, the improvement was 56.2%. The improvement in recitation quality varied among students, with some students reading with less accuracy and others unable to read at all. This indicates that there are factors affecting the quality of recitation among students. A significant factor influencing recitation quality is early exposure starting from home. It is hoped that this study will improve the quality of recitation of Surah Al-Fatihah and that the Quranic Tahsin program will continue.

**Keywords:** Recitation, Tahsin, The Quran

## **1 Introduction**

The Quran is the holy book of Islam and the primary guide for Muslims. Belief in the Quran is part of the pillars of faith. The Quran is also defined as the word of Allah revealed by the angel Gabriel to the Prophet Muhammad SAW. The revelation of the Quran occurred through two methods: it was revealed all at once and gradually over time. The Quran is considered a great miracle granted to the Prophet Muhammad SAW and remains one of the enduring miracles to this day. Therefore, knowledge about the Quran aims to preserve its sanctity (Purba, 2016).

Reading the Quran with proper Tajwid (pronunciation rules) and makhraj (articulation points) is the method and way for Muslims to preserve the sanctity of the Quran. The Quran contains 114 surahs, beginning with Surah Al-Fatihah and ending with Surah An-Nas. Surah Al-Fatihah is required to be recited during prayers as it is part of the prayer pillars. The recitation of Surah Al-Fatihah must adhere to the correct makhraj and Tajwid to ensure the perfection of the prayer. Therefore, it is mandatory for every Muslim to understand the Quran properly and thoroughly, as the Quran meets all human needs (Purba, 2016).

Tahsin Al-Quran means improving and beautifying the recitation of the Quran. The Tahsin Al-Quran program is a specially designed initiative to help individuals improve their recitation by focusing on aspects such as tajwid (rules of recitation), makhraj (articulation points of letters), and fluency. Interventions in this program involve various strategies and approaches to ensure that students can recite the Quran correctly and beautifully. Each verse and letter in the Quran has its own rules so that it can be read properly. Good recitation will have a positive effect on both the reader and the listener.

Therefore, practicing the act of reading the Quran is an obligation that must be fulfilled. This obligation is to ensure a more meaningful life as a Muslim (Ajmain@Jimaain Safar, 2017).

### **1.1 Problem Statement**

Based on observations, the researcher has found that some students do not master the recitation of Al-Fatihah adequately. In other words, many students have not fully grasped the rules of Tajwid and the articulation points of hijaiyah letters, even though Surah Al-Fatihah is the first surah in the Quran and must be recited correctly. Most students face issues in reading the Quran,

particularly in aspects such as oral skills, fluency, Tajwid, and pronunciation. This problem occurs at the levels of primary school, secondary school, and higher education institutions.

The researcher conducted interview sessions with 77 respondents to identify issues in the recitation of Surah Al-Fatihah. The findings from the interviews revealed several factors contributing to the students' difficulties with recitation.

Among them are:

#### *i. Lack of early exposure*

Many students have not received adequate exposure to Quranic reading from a young age. The lack of a systematic approach in teaching Quranic recitation at the early stages of education results in weak foundational skills. This is a problem experienced by many of the interviewed students. The researcher also found that 40 out of 77 students had insufficient early exposure to reading the Quran. As a result, students feel less confident in their recitations. According to Nur Sahara Mesman (2022), parents play a crucial role in encouraging their children to have a positive mindset, achieve success, and be motivated. Therefore, the researcher believes that the role of parents is very important in providing early exposure to Quranic knowledge.

According to Hajarul Bahti Zakaria (2010), a weak foundation in Quranic reading skills and insufficient early exposure cause many children to fall behind and lag in reading the Quran.

#### *ii. Student interest*

Lack of enthusiasm among students to learn Quranic reading is one of the factors preventing them from mastering it effectively. This condition also affects students' interest in reading the Quran. After conducting interviews, the researcher found that 32 out of 77 students lacked interest in reading the Quran. The researcher also discovered that environmental factors and peer influence play a significant role in attracting students' interest.

According to Nur Sahara Mesman (2022), fostering genuine interest will make it easier for parents to impart knowledge in learning. This shows that the commitment of parents in cultivating interest in their children is crucial.

#### *iii. Lack of parental support*

The interviews conducted by the researcher revealed that many students reported receiving insufficient parental support. Furthermore, parents also have very little time to monitor their children's Quranic learning due to their busy work schedules and late returns home each day.

According to Zalizan Mohd Jelas (2005), academic achievement or educational success is reflected in good results, whether at the primary or higher level. Parents play a very important role in providing support and encouragement to their children. This is supported by Noor Su'adah Mohd Zawawi & Zalinah Mohamed (2013). Parents have a significant responsibility to ensure their children excel in their studies.

### **1.2 Purpose of the Study**

This study is important as it will provide a clear picture of the level of mastery in reciting Surah Al-Fatihah among students and identify the main factors contributing to this issue. The results are expected to assist teachers, parents, and other stakeholders in devising more effective strategies to improve Quranic recitation skills among students. Additionally, the study aims to offer practical suggestions for curriculum improvements and teaching methods in educational institutions.

### **1.3 Research objective**

This study aims to:

- a. Identify the elements causing difficulties for students in mastering the recitation of Surah Al-Fatihah.
- b. Determine the level of students' mastery over the rules and pronunciation of Surah Al-Fatihah.
- c. Identify factors influencing students' engagement with Quranic recitation.
- d. Propose effective methods for teaching and learning Quranic recitation.

## **2 Literature Review**

The Jawi, Quran, Arabic, and Fardhu Ain (j-QAF) program, introduced in 2004 by Tun Abdullah bin Haji Ahmad Badawi, who was the Prime Minister of Malaysia at that time, aims to enhance students' religious knowledge in schools by improving Islamic Education subjects. According to Roslina (2017), the goal of this program is to strengthen students' understanding of religion through improvements in Islamic Education. This opinion is consistent with Wan Mohd Khairul (2017), who states that the j-QAF program is implemented according to specific modules and models using effective approaches. It aims to produce knowledgeable and capable citizens. However, the proficiency of primary school students has been questioned when they progress to secondary school, as the mastery of Quranic recitation, particularly Surah Al-Fatihah, is scrutinized.

Aspects such as oral skills, reading fluency, eloquence, and proper tajwid rules and pronunciation are weaknesses in Quranic reading among students at all educational levels. This statement is supported by Mohd. Faisal, Zawawi, and Rahimi (2008), who note that many Muslims in Malaysia, despite recognizing the hijaiyah letters, cannot read the Quran fluently, or can read but not smoothly, with some not recognizing the letters at all.

According to a study by Ibrahim, Sharifah Norhuda, Yusharina, and Muhammad Muzakir (2016), students' mastery of tajwid rules is very weak. This was discovered through a test involving the reading of three verses from Surah Al-Fatihah. The results indicated that no students could master all the verses accurately. Therefore, students need to enhance their knowledge of tajwid to ensure accurate recitation of Quranic verses.

### 3 Methodology

The study selected students from the Islamic Studies course (MPU23032) from the Department of Information and Communication Technology, Kuching Polytechnic Sarawak. This is because the Islamic Studies course includes a practical prayer test as part of continuous assessment affecting students' grades. The recitation of Surah Al-Fatihah is one of the elements in this practical prayer test. A total of 77 students were chosen as respondents for this study.

#### 3.1 Study Concept



**Fig. 1.** Kemmis & McTaggart Study Model

#### 3.2 Intervention Activities

The following outlines the interventions in the Tahsin Al-Quran program:

**Table 1.** Tahsin Al-Quran Class Schedule (Surah Al-Fatihah)

No.	Week	Syllabus
1	First	Tajwid and pronunciation of letters
2	Second	Tajwid and pronunciation of letters
3	Third	How to read Surah Al-Fatihah
4	Fourth	How to read Surah Al-Fatihah
5	Fifth	Methods for reciting Surah Al-Fatihah
6	Sixth	Methods for reciting Surah Al-Fatihah
7	Seventh	Recitation test

#### 3.3 Main Components of the Tahsin Al-Quran Intervention Program

The Tahsin Al-Quran activities through the Tahu-Qu program use repetitive reading methods and direct correction from the lecturer. This section will explain the main components of the Tahsin Al-Quran program, including before, during, and after the intervention.

### 3.3.1 Before the Intervention

Students were asked to read Surah Al-Fatihah, verses 1-7. The purpose of this reading was to assess the quality and mastery of their recitation of Surah Al-Fatihah and to identify any existing issues. *Table 2* shows that the quality of the reading was very weak.

**Table 2.** Activities Before the Intervention

Activity	Implementation	Assessment
Checklist (Week 1)	Explanation of the activity by the lecturer for students to start reading Surah Al-Fatihah. Reading was done in turns as per the lecturer's schedule. Initially, the lecturer demonstrated the correct reading, following tajwid and pronunciation. Students then took turns reading.	Assessment by the lecturer was based on the provided checklist. Student reading was at a very weak level with errors in tajwid rules and pronunciation.

The assessment before the intervention revealed many errors and weaknesses in reading, including tajwid and pronunciation issues.

### 3.3.2 During the Intervention

The researcher conducted the intervention to help students improve the quality of their recitation of Surah Al-Fatihah. The intervention involved three phases. *Table 3* shows the intervention implementation across three phases.

#### Phase 1

The researcher explained to the students the rules of tajwid and correct pronunciation for reading Surah Al-Fatihah. This explanation was crucial for exposing students to tajwid rules and letter pronunciation. Students were then asked to repeat their readings in front of the lecturer and individually to improve their recitation quality. The duration of Phase 1 was 2 weeks (the first and second weeks).

**Reflection of Phase 1:** The assessment by the researcher indicated that student reading was still weak with errors in tajwid and pronunciation, though 45.5% of students showed improved reading quality compared to before the intervention.

#### Phase 2

Phase 2 started in the third and fourth weeks. In this phase, the researcher taught students the correct way to read Surah Al-Fatihah with a focus on tajwid, pronunciation, and pause points. Repetitive practice was conducted to improve letter articulation according to tajwid. Students were also advised to practice individually and were exposed to reading Surah Al-Fatihah in prayer as both imam and follower.

**Reflection of Phase 2:** The assessment in this phase showed improved quality in Surah Al-Fatihah recitation among students. By the fourth week, 45 students, equivalent to 58.4%, showed improvement. Additionally, students understood the techniques of reciting Surah Al-Fatihah in prayer, whether as an imam or follower.

#### Phase 3

In Phase 3, the researcher began by re-explaining the methods of reciting Surah Al-Fatihah. Although the methods were covered in Phase 2, this repetition ensured that students mastered them well. After the explanation, students were asked to form small groups. This small group activity aimed to facilitate student questions and identify emerging problems. Students were also asked to read with their group members, and if mistakes were made, other group members would provide corrections. This method aimed to assess students' understanding of the learning and teaching from Phases 1 and 2.

**Reflection of Phase 3:** Through observation and students' recitations, the researcher found that 51 students, or 64.9%, showed improvement in the quality of their Surah Al-Fatihah recitation. Students were able to read with proper tajwid and pronunciation.

**Table 3.** Activities During the Intervention

Activity	Implementation	Assessment
Phase 1 (Weeks 1 and 2)	The researcher explained tajwid and pronunciation rules for Surah Al-Fatihah. Students repeated reading in front of the lecturer and individually to improve quality.	Student reading was still weak with errors in tajwid and pronunciation.
Phase 2 (Weeks 3 and 4)	The researcher taught the correct way to read Surah Al-Fatihah, focusing on tajwid, pronunciation, and pause points. Repetitive practice and individual exercises were included.	Improvement in the quality of Surah Al-Fatihah recitation among students.
Phase 3 (Weeks 5 and 6)	Explanation of Surah Al-Fatihah recitation methods was repeated. Small group activities were conducted for peer feedback and issue identification.	Improved and smoother reading quality. Correct letter pronunciation.

### 3.3.3 After the Intervention

The post-intervention activity was a reading test conducted in the seventh week. The test was administered by the researcher along with an invited instructor.

The results of the test showed that the level of mastery in reciting Surah Al-Fatihah among students had improved. There was significant progress in the pronunciation of letters and tajwid rules.

**Table 4.** Activities After the Intervention

Activity	Implementation	Assessment
Reading Test (Week 7)	Students were asked to demonstrate their recitations.	Student reading was very good with improvements in recitation quality.

## 4 Findings / discussion

This study, conducted through observations and interviews with 77 respondents on the mastery of Surah Al-Fatihah recitation, was divided into three phases. Observations and interviews revealed that students' mastery of Surah Al-Fatihah recitation was very low, influenced by various factors.

In the first phase, observations and students' reading demonstrated that their mastery of Surah Al-Fatihah was weak. The lecturer used direct correction methods to address these issues. Findings from Phase 1 led to the use of the Tahsin Al-Fatihah method in Phase 2, which focused on correcting tajwid, pronunciation, and letter articulation. This approach showed improvements in reading quality. In Phase 3, the study showed enhanced mastery of Surah Al-Fatihah, with significant improvements in tajwid, pronunciation, and articulation. This indicates that the Tahsin Al-Fatihah method and teacher guidance can effectively improve students' reading quality.

## 5 Recommendations for Improvement

Based on the action research conducted, it is suggested that future studies focus on improving Quranic recitation quality. Further research could explore additional approaches to enhance Quranic reading skills. The study concludes that Quranic reading proficiency can be improved using the Tahsin method, which involves reading in front of a teacher and receiving feedback on errors. The Tahsin method not only improves students' reading but also engages their interest in continuous Quranic reading. A good and accurate recitation of Surah Al-Fatihah positively impacts the reader. According to Ibrahim Mohd Sobki (2016), proper mastery of tajwid in Surah Al-Fatihah enhances understanding and appreciation of the surah, which is important for every Muslim. The content of the surah also has positive effects on mental, spiritual, and life perspectives.

## 6 Conclusion

Good mastery of Surah Al-Fatihah recitation can be achieved through proper learning techniques and skilled teachers. It is a responsibility for every Muslim since Surah Al-Fatihah is recited in every rakaat of prayer. Learning tajwid and correct recitation techniques is an initiative for Muslims to improve their reading quality. The study found that many students underestimate the importance of reciting Surah Al-Fatihah, assuming they are skilled due to frequent repetition. However, the study revealed that many students recognized errors in their recitation, particularly in tajwid and pronunciation. Main reasons for poor mastery include lack of guidance and encouragement from family and specific guidance on Surah Al-Fatihah. Nevertheless, Surah Al-Fatihah recitation can be improved with proper teacher guidance. Several programs and activities have been proposed to address these issues, and it is hoped these suggestions will help students enhance their reading quality.

## References

1. Ajmain@Jimaain Safar, M. F. (2017). Amalan Membaca Dan Menghafaz Surah-Surah Dalam Al-Quran Murid Beragama Islam Di Sekolah Kebangsaan Cina. *Malaysian Online Journal Of Education*, 45-49.
2. Daud Ismail, W. M. (2014). Perkembangan Dan Masalah Pembelajaran Al-Quran Dalam Program Jqaf Di Malaysia. *Jurnal Antarabangsa Pengajian Islam* 36(2), 57-66.
3. Hajarul Bahti Zakaria, M. H. (2010). Isu Dan Cabaran Guru Dalam Pendidikan Al-Quran Pelajar Bermasalah Penglihatan. *Proceedings of The 4th International Conference on Teacher Education*.
4. Ismail, R. (2017). *Tahap Penguasaan Bacaan Surah Al-Fatihah Dalam Kalangan Murid-Murid Tahun Enam Program j-Qaf SK Sungai Pusu*. Gombak: Universiti Kebangsaan Malaysia.
5. Jelas, Z. M. (2005). Prestasi Akademik Mengikut Gender. *Jurnal Pendidikan*, 93-111.
6. Mohamed, N. S. (2013). Peranan Ibu Bapa Membantu Meningkatkan Kecemerlangan Akademik Anak-Anak. Johor Bahru: Universiti Teknologi Malaysia.
7. Mohd Faisal Mohamed, Z. I. (2008). Celik Al-Quran: Cabaran dan Realiti Dalam Pendidikan Islam Di Sekolah. *Masalah Pendidikan*, 241-253.
8. Nor Sahara Mesma, Z. A. (n.d.). Cabaran Dan Peranan Ibu Bapa Dalam Memperkasakan Pembelajaran Jawi Semasa Pandemik Covid-19. *Jurnal Dunia Pendidikan*.
9. Purba, F. (2016). Pendekatan dalam Studi Al-Quran: Studi tentang Metode dan Pendekatan Al-Quran. *Jurnal As-Salam*, 27.
10. Sobki, I. M. (2016). Penghayatan dan Penguasaan Surah Al-Fatihah di Kalangan Pelajar: Kajian Kes di Universiti Teknologi Mara Cawangan Pahang. *Konferensi Akademik*.



# The Effectiveness of the "Peer Academic in Commerce" (PAC) Programme Among Students of the Commerce Department at Polytechnic Kuching, Sarawak

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**Abstract.** The "Peer Academic in Commerce" (PAC) programme at Polytechnic Kuching, Sarawak aims to bolster the academic and personal development of students within the Commerce Department. This initiative utilizes a mentor-mentee framework, where experienced students guide their peers through various academic and personal challenges. Many students in the Commerce Department struggle with course repetitions and lack essential skills in accounting and calculations. These challenges can hinder their academic progress and personal development. The PAC programme seeks to address these issues by providing structured mentoring to improve academic performance, motivation, confidence, leadership, cooperation, and social relationships. This study employs a mixed-methods approach, utilizing both quantitative and qualitative data. Survey and feedback from participating students will be analyzed to assess the impact of the PAC programme. The target population includes Commerce Department students from semesters 1 to 5. Data collection will focus on academic achievements, personal development, communication skills, and other benefits derived from the programme. Preliminary analysis indicate that the PAC programme positively influences students' academic performance and personal development. Mentored students exhibit higher motivation, confidence, and leadership skills. Additionally, the program fosters improved cooperation and social relationships among participants. Enhanced communication skills are also reported as a significant benefit. The PAC programme at Polytechnic Kuching, Sarawak demonstrates significant effectiveness in supporting students' academic and personal growth. The mentor-mentee system proves particularly beneficial in addressing the challenges faced by students, especially those who repeat courses. This study highlights the value of structured peer mentoring in higher education and provides insights for enhancing similar programmes in other academic settings.

**Keywords:** Mentor, Mentee, Academic Guidance

## 1 Introduction

The word "mentor" has Greek roots and can imply "friend," "counsellor," or "reliable teacher." Mentors are usually individuals with experience in providing help to those who need it. A mentee is an individual who benefits from this support. Mentoring is a guiding relationship that occurs between a more experienced person called a 'mentor' and a less experienced person called a 'mentee' (Chiles, 2007). In higher education settings, students frequently encounter difficulties in mastering specific courses, especially those that involve basic skills in accounting and calculations. To address this issue, the Commerce Department at Polytechnic Kuching, Sarawak introduced the "Peer Academic in Commerce" (PAC) programme. This initiative adopts a mentor-mentee system designed to provide guidance to students who are facing academic difficulties.

The mentor-mentee system has demonstrated its effectiveness in enhancing both academic performance and personal development among students. Past research indicates that mentoring programs or similar initiatives offer substantial advantages, particularly for students who are repeating courses. Despite existing evidence supporting the efficacy of mentor-mentee relationships in diverse educational settings, there is a lack of specific studies examining their application within the Commerce Department, specifically within the PAC programme. Therefore, this study aims to evaluate the effectiveness of the PAC programme within the Commerce Department at Polytechnic Kuching, Sarawak. It seeks to assess how the program impacts students who are repeating courses and require support in key subjects such as Accounting, Business Mathematics, Economics, Principles of Management, and Business Law.

Through the analysis of surveys and student feedback, this study will provide a deeper understanding of how the PAC programme can enhance academic performance, increase student motivation, and build supportive relationships among students in the Commerce Department of Polytechnic Kuching, Sarawak.

## 2 Literature review

### Influence of surrounding people

Despite the added value of the mentor-mentee relationship in higher education, students continually face challenges, especially those repeating courses and needing help with basic subjects such as accounting, mathematics, and economics. This mentoring programme has undoubtedly shown positive effects on academic achievement and personal development. However, there is a gap in existing research as no prior studies have specifically examined the impact of the PAC programme on students within the Commerce Department at Polytechnic Kuching, Sarawak.

Existing research has highlighted the importance of mentoring in improving academic success, fostering soft skills, and encouraging social integration (Gehreke, 2024). Nevertheless, the distinct challenges faced by students in the Commerce Department, as targeted by the PAC programme, require more focused investigation. The lack of tailored studies on the effectiveness of PAC programme in addressing academic struggles and promoting holistic student development leaves a critical gap in understanding the programme's potential impact.

Therefore, this study aims to fill this gap by thoroughly examining the success of PAC programme in helping students in the Commerce Department who are repeating courses and require support in fundamental subjects. The lack of specific research on the PAC programme in the Commerce Department leaves uncertainties regarding its impact on academic outcomes, personal development, and the improvement of soft skills. A comprehensive investigation of the results and implications of the PAC programme is essential to inform evidence-based interventions and contribute to the broader discourse on mentoring in higher education, particularly in the Commerce Department at Polytechnic Kuching, Sarawak.

## 3 Research objectives

The objectives of this research are to:

3.1 Determine the extent to which the PAC programme, based on the mentor-mentee system in the Commerce Department, can improve the academic performance of students who are repeating courses and need specific guidance in the offered courses.

3.2 Identify the benefits of the mentor-mentee concept in students' personal development, particularly in aspects such as motivation, confidence, leadership, cooperation, and social relationships.

3.3 Evaluate the improvement in students' communication skills as a result of participating in the PAC programme.

## 4 Literature review

The contemporary landscape of higher education is marked by the dynamic interaction between challenges and opportunities, with a particular focus on addressing the academic difficulties faced by students. In response to this need for targeted interventions, the emergence of mentoring programs such as the PAC programme has gained attention. This review of previous studies aims to explore the research conducted on the effectiveness of the mentor-mentee system in higher education, with a particular focus on the objectives outlined in the current study.

### a) The Mentor-Mentee System in Higher Education:

The mentor-mentee relationship is widely recognized as a valuable tool for enhancing students' educational experiences. The concept of mentoring, rooted in the Greek term "mentor," meaning a trusted friend or advisor, has been applied in various educational contexts. Previous studies have shown that mentor guidance has positively contributed to academic success, personal development, and overall student satisfaction (Tammy et al, 2003). This relationship often involves an experienced mentor guiding a less experienced mentee in academic, career, and personal development.

### b) Effectiveness of Mentoring Programs:

Research consistently shows that mentoring programs positively impact students' academics. For example, a meta-analysis by (Zi Yan, 2022) found that students engaged in mentoring programs showed greater academic achievement compared to self-study. The role of the mentor in providing guidance, support, and constructive feedback has been identified as a key factor in a student's success (Birgit et al, 2014). These findings lay the foundation for understanding the potential benefits of mentoring programmes like PAC programme in addressing academic challenges.

### c) Coaching Programmes and Academic Interventions:

Programme like PAC, designed to target students repeating courses and needing help with basic subjects such as accounting, mathematics and economics, align with the broader scope of academic mentoring and intervention initiatives. A study by (Aaron

E. Black, 2000) highlighted the importance of autonomy support and competency building in academic interventions. PAC's focus on identifying and addressing students' strengths and weaknesses aligns with these principles, suggesting that the program may positively impact academic outcomes.

#### d) Impact on Soft Skills and Social Development:

Beyond academic performance, the mentor-mentee relationship has been linked to the development of soft skills, including leadership, communication, and teamwork (Kevan W. Lamm, 2017). Supporting the development of a well-rounded individual, mentor-mentee programs focus primarily on individual guidance. Therefore, it is crucial for a mentor to understand the psychology and emotional development of the mentee being guided. Aspects such as the mentee's thoughts, emotions, motivation levels, and actions are influenced by their personality and background. Knowledge of the mentee's psychology allows the mentor to understand the challenges faced by the mentee and to find strengths and develop the mentee's potential (Zuria, 2011). Improving communication skills is particularly relevant in the context of PAC, where peer interaction plays a key role.

The solid foundation of the mentor-mentee system in higher education and the impact of academic mentoring programs have been emphasized by previous studies. Consistently, these studies demonstrate the positive effects of mentoring on academic performance, personal development, and social integration. The continued focus on the PAC programme and its objectives aligns with existing research on effective mentoring strategies, indicating that this programme can significantly address academic challenges and foster holistic student development. Analyzing survey responses in the Commerce Department at Polytechnic Kuching, Sarawak is expected to provide valuable insights into the outcomes and implications of the PAC programme.

## 5 Research Methodology

### a) Respondents

The respondents consisted of 77 students who were mentees who participated in the PAC programme in the Session I 2023/2024.

### b) Research Instrument

In this study, the researcher-developed questionnaire was rigorously tested for reliability and accountability. Cronbach's alpha results of 0.781 confirmed the reliability of the items, and field experts validated the content, ensuring its suitability for the research. Utilizing questionnaires allows the researcher to gather impersonal and uniform responses from participants. One of the key advantages of questionnaires is that they ensure confidentiality while obtaining accurate information from respondents (Aziz et al., 2017). The questionnaire items were adapted from Rahamat (2017) and modified to suit the current study's needs. The findings were analyzed using SPSS software version 22.0. The questionnaire comprises four sections which are:

- i. Respondent demographic
- ii. Evaluating the effectiveness of the PAC programme
- iii. Identifying the benefits of mentor guidance
- iv. Assessing the programme's influence on communication skills

For the respondent's demographic, the items included are programme, gender, semester, course name and status for the course taken in the PAC programme. The questionnaire uses a Four-Point Likert Scale as shown in Table 1.

**Table 1.** Likert Scale

Scale	1		2	3	4
Justification	Strongly disagree		Disagree	Agree	Strongly Agree

The findings of the study will be displayed as a mean value. A descriptive analysis was done to obtain a mean value. The mean value will be translated to the following, as used in Lendell's (2000) study in Table 2.

**Table 2.** Mean Score Frequency

Mean Score	Frequency
1.0 to 2.0	Low
2.1 to 3.0	Medium
3.1 to 4.0	High

## 6 Results and analysis

Overall, the data indicates that the PAC programme is effective in enhancing academic achievement, developing communication

skills, and strengthening participants' social relationships.

For the objective of assessing the effectiveness of the PAC programme, participants believe that participation in the PAC programme helps improve their performance in the courses they take. The programme also assists participants in understanding and mastering concepts that were previously difficult to grasp, and it has a positive impact on overall academic achievement.

**Table 3.** Assessing the effectiveness of the PAC programme

No	Item	Mean Score	Level
1	The PAC programme has helped improve achievement in the courses taken within PAC.	3.5195	High
2	Does the PAC programme help you understand and master concepts that previously caused difficulties in your learning?	3.4286	High
3	Does the PAC programme have a positive impact on your overall academic achievement?	3.4935	High

To evaluating the programme's influence on communication skills, mentors in the PAC programme significantly contribute in boosting participants' learning motivation. The experience with mentors helps participants gain confidence in retaking courses and handling academic difficulties. Moreover, with mentor guidance, it helps participants recognize potentials and strengths within themselves that were previously overlooked.

**Table 4.** Evaluating the benefits of mentor guidance

No	Item	Mean Score	Level
1	Does your mentor help boost your learning motivation?	3.5844	High
2	Has your mentor helped you gain confidence in repeating courses and dealing with academic challenges?	3.5455	High
3	Has mentorship helped you see potential and strengths within yourself that you hadn't realized before?	3.5455	High

Finally, for the objective of assessing the effectiveness of the PAC program on communication skills, participation in the PAC programme enhances participants' communication skills with mentors and peers. The communication skills acquired through the PAC programme are beneficial in learning activities and idea sharing. The PAC programme also helps strengthen social relationships among students in the Department of Commerce.

**Table 5.** Evaluating the effectiveness of the PAC programme on communication skills

No	Item	Mean Score	Level
1	Does the PAC programme enhance your communication skills with mentors and peers?	3.5974	High
2	Do you feel that the communication skills acquired through the PAC programme have been beneficial in learning activities and idea sharing?	3.5844	High
3	Has the PAC programme helped strengthen social relationships among students within the Department of Commerce?	3.5974	High

## 7 Conclusion

Based on the collected data and survey results, it is evident that the PAC programme has proven effective in achieving its intended objectives as mentioned in our study above. Participants have reported significant benefits in terms of academic achievement, development of communication skills, and social relationship enhancement within the Commerce Department.

The role of senior students as mentors is seen to be crucial in the learning of junior students and students who repeat courses. The PAC programme involves interactions among individuals or groups, focusing on actions such as guidance, support, and

advice. Mentors emphasize not only academic and psychological support for their peers but also provide guidance, appreciation, and care. They help improve skills such as decision-making, problem-solving, and stress management, aiming to mentor their peers into becoming productive members of society and contributors to the nation and community.

### Suggestions for future research:

**1 Longitudinal Study:** Conduct a longitudinal study to track participants' academic progress and career outcomes over an extended period to assess the long-term impact of the PAC programme.

**2 Qualitative Insights:** Complement quantitative data with qualitative research methods such as interviews or focus groups to gain deeper insights into participants' experiences and the nuances of how the PAC programme influences their learning and personal development.

**3 Comparative Analysis:** Compare the effectiveness of the PAC programme across different departments or institutions to identify factors that contribute to its success and areas for improvement in diverse academic settings.

**4 Effectiveness in Specific Courses:** Explore the effectiveness of the PAC programme in specific courses or disciplines to understand if its impact varies depending on the subject matter or complexity of concepts.

**5 Role of Mentors:** Further investigate the specific roles and attributes of mentors within the PAC programme that contribute most significantly to participant outcomes, such as learning motivation, confidence building, and skill development.

By expanding research in these areas, future studies can provide a more comprehensive understanding of how peer-assisted learning programs like PAC programme can be optimized to better support academic achievement, communication skills development, and social integration among students.

### References

1. Aaron E. Black, E. L The effects of instructors' autonomy support and students' autonomous motivation on learning organic chemistry: A self-determination theory perspective. *Science Education*, 740-756. (2000)
2. Aziz, N. A. A., & Ahmed, M. T. E-Pembelajaran dalam Pengajaran dan Pembelajaran Bahasa Melayu di IPG Kampus Ipoh. *Jurnal Penyelidikan Dedikasi*, 11. (2017)
3. Birgit Leidenfrost and Barbara Strassnig, M. S.-C. The Impact of Peer Mentoring on Mentee Academic Performance: Is Any Mentoring Style Better than No Mentoring at All? *International Journal of Teaching and Learning in Higher Education* , 102-111 (2014)
4. Chiles, T. The construction of an identity as 'mentor' in white collar and academic workplaces: A preliminary analysis. *Journal of Pragmatics*, 730-741. (2007)
5. Gehreke, L., Schilling, H., & Kaufeld, S. Effectiveness of peer mentoring in the study entry phase : A systematic review. *Reveiw of Education*, 12, e3462. <https://doi.org/10.1002/rev3.3462>. (2024)
6. Kevan W. Lamm, R. S. The Mentoring Experience: Leadership Development Program Perspectives . *Journal of Agricultural Education*, 58(2), 20-34. (2017)
7. Rahamat, R. B., Shah, P. M., Din, R. B., & Abd Aziz, J. B. Students' readiness and perceptions towards using mobile technologies for learning the english language literature component. *The English Teacher*, 16. (2017)
8. Tammy D. Allen, L. T. Relationship Effectiveness for Mentors: Factors Associated with Learning and Quality. *Journal of Management*, 469-486. (2003)
9. Zi Yan, H. L.-C. Effects of Self-assessment and Peer-assessment Interventions on Academic Performance: A Meta-Analysis. *Educational Research Review*. (2022)
10. Zuria. Pendekatan Humanistik dalam Pengajaran & Pembelajaran. In M. A. EMBI, *Panduan amalan pengajaran & pembelajaran berkesan* (pp. 247-264). UKM. (2011)

# Study of Green Space Changes in Miri Times Square Using Orthophoto Data Approach

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**Abstract.** Study aims at developing a Prototype of short Electronic Distance Measurement (EDM) Baseline Test Site for survey Grade Receiver based in Politeknik Kuching Sarawak (PKS). This Short EDM Baseline test site consists a six pillars with total distance of 214.616m. Although it is a prototype of Short EDM Baseline Test Site, the students can feel the experience of doing Global Navigation Satellite System (GNSS) instrument calibration work in a real situation. This will indirectly improve their psychomotor skills, which is crucial for Technical and Vocational Education and Training (TVET) institution likewise in PKS. Students able to train themselves individually and their safety is guaranteed as the training is carried out in campus. In addition, it is time and energy effective because students do not have to wait for their turn to measure at the actual site located far from the campus. The methodology used is following the standard procedure below 10 mm which signifies reliability of the compared data.

**Keywords:** green area, Times Square Miri, orthophoto data, land use change, urbanization

## 1 Introduction

The change in green space in urban areas is a topic that is gaining more and more attention in the study of urban planning and ecology. Green spaces, such as parks, urban forests, and recreational areas, are important for the ecological and social well-being of urban residents. They function as green lungs that help filter air, reduce temperature, provide habitats for flora and fauna, and offer spaces for recreation and social interaction (Bolund & Hunhammar, 1999; Jim & Chen, 2006).

The "Times Square" area in Miri, Sarawak, has seen rapid development in the past few decades. This development, despite driving economic growth, also raises concerns about the reduction of green areas that are important for the well-being of urban residents (Tan et al., 2013). Loss of green space can have negative effects such as increased air pollution, decreased quality of life, and reduced biodiversity (Pauleit et al., 2005; Jim & Chen, 2020). The approach of using ortho-photo image data is very effective for studying changes in the extent of green space. An ortho-photo image is an aerial photo that has been geometrically corrected to provide an accurate representation of the Earth's surface at a specific time. This technology enables detailed and accurate analysis of changes in land use and green space over time (Chen et al., 2016). Through the analysis of orthophoto images, this study aims to understand the patterns and trends of green space changes around Miri's "Times Square". This study is important to identify affected areas, understand the causes of such changes, and assess the impact of development on urban ecosystems. The data obtained can help policymakers in formulating effective conservation strategies and ensure more sustainable urban development in the future.

## 2 Literature review

The changing extent of green space in urban settings has become an important topic of research in urban planning and environmental management. Urban green spaces offer a variety of ecological and social benefits, including enhanced air quality, reduced urban heat island effects, and recreational areas for people (Kabisch et al., 2015; Richards et al., 2020).

### 2.1 The importance of green space in urban areas

Green spaces in cities are essential for citizens' well-being. According to research, green spaces can lower stress and promote mental health while also providing opportunities for physical activity (Shanahan et al., 2016). Wolch, Byrne, and Newell (2014) found that appropriate access to green spaces is crucial for attaining social fairness in urban situations.

## 2.2 Approach using orthophoto image data

Ortho-photo images have emerged as a valuable tool for evaluating land use and green space changes. Orthophoto pictures are aerial photographs that have been geometrically adjusted to produce an accurate representation of the Earth's surface. This technique can detect minor changes in the size of green spaces with excellent accuracy (Amorim et al., 2019).

A study by Chen et al. (2016) shown that ortho-photo images can be utilized to map urban land use changes and provide clear insights into how green spaces evolve over time. Gao et al. (2021) employed ortho-photo images to investigate the dynamics of green spaces and their impact on urban heat islands in Shanghai, China, and discovered that a major drop in green spaces led to a rise in urban temperatures.

## 2.3 Factors affecting green space change

Changes in the extent of green spaces are often influenced by various factors, including infrastructure development, population growth, and changes in urban planning policies (Zhao et al., 2023). A study by Jim and Chen (2020) in Hong Kong found that rapid urban development has led to the fragmentation of green spaces, reducing areas available for recreation and environmental protection.

## 2.4 Impact of green space change

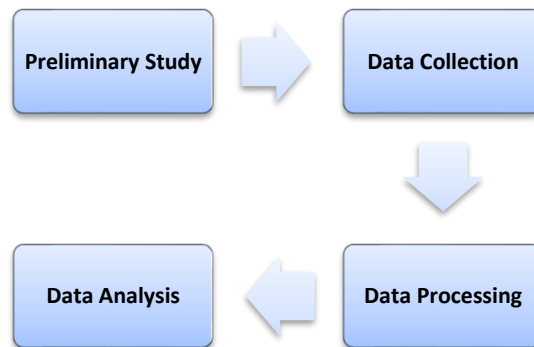
Changes in the availability of green areas have a profound impact on the urban environment and citizens' well-being. Reduced green space can contribute to poor air quality, higher temperatures, and a loss in residents' psychological well-being (Kabisch et al., 2017). Richards et al. (2020) discovered that enhancing green spaces in cities can help to minimize the effects of climate change while also improving urban people's well-being.

## 2.5 Case study in Miri, Sarawak

The study of changes in green space extent surrounding the "Times Square" region in Miri, Sarawak, utilizing the ortho-photo image data technique is important for understanding land use dynamics in this fast-developing area

## 3 Methodology

This study aims to analyze changes in the extent of green space around the Miri 'Times Square', using an orthophoto image data approach. The methodology of this study involves several main steps according to the priority of the process. The process starts with preliminary research and then data collection. The data obtained is processed using appropriate software and finally, the results are analyzed.



**Fig. 1.** The study methodology

### 3.1 Preliminary study

Preliminary research is done by choosing a suitable location as the study area. The selection of software depends on the appropriateness to achieve the objectives of the study

#### 3.1.1 Selection of Study Location

The study area chosen to be the study area is around Miri 'Times Square'. The boundaries of the study area were determined using current maps and orthophoto images covering Miri's 'Times Square' and the surrounding area. This area was selected due to its status as a zone of rapid development, meaning that the amount of green space there could vary significantly.

#### 3.1.2 Software Selection

ERDAS Imagine is a widely used software for remote sensing and geospatial analysis. It offers strong image processing features,

allowing researchers to precisely and efficiently analyze satellite and aerial images. This study uses ERDAS Imagine conducting detailed spatial analysis, providing accurate and valuable insights.

This study also uses Global Mapper V18.2.0 to perform geospatial analysis, ensuring accurate and detailed results such as the determination of coordinate point values. Global Mapper V18.2.0 is comprehensive GIS software known for its user-friendly interface and extensive data processing capabilities. It supports various spatial data formats and offers powerful tools for mapping, analysis, and visualization.

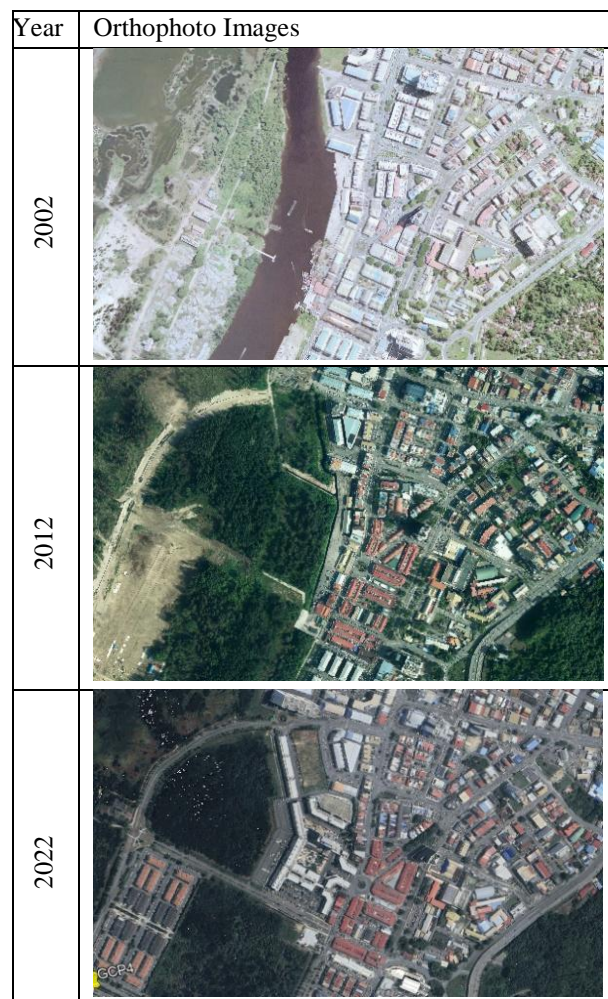
### 3.2 Data collection

The primary data used in this study is an ortho-photo image obtained from the Sarawak Land and Survey Department (JTS). The ortho-photo image covers images of the study location for the years 2002, 2012, and 2022. In addition, secondary data such as images from Google Maps, urban planning reports, demographic data, and population statistics were also collected to support the analysis. Table 1 shows population information for Miri District from 2000 to 2020.

The images obtained from JTS are then marked accurately for the determination of the selected study area. Constraints occur during the selection of that control point. This happens because the orthophoto image results obtained (2002-2022) have some distortion and some are received in different file formats. Control points are marked on the image based on the specified coordinate values, where the control point value and its area are set the same for the three images. Based on the final selection of coordinate control points on the orthophoto image, the area of the selected study area is 111 hectares. The results of the selection of this study area are shown in Figure 2.

**Table 1:** Miri district population data from 2000 to 2020. (Miri City Council)

Year	Population
2000	228,231
2010	300,543
2020	356,900



**Fig 2.** Orthophoto Image of the study area from 2002 to 2022



The population growth rate is increasing year by year, as shown in Table 1. Between 2000 and 2010, there was an increase of 72,312 individuals, and between 2010 and 2020, there was a rise of 56,357 people.

Miri City is one of the experimental projects implementing the Global Action Plan for Sustainable Development in the Twenty-first Century, often known as Local Agenda 21. It promotes collaboration among local governments, the public sector, and the commercial sector in environmental management to achieve sustainable development and a higher standard of living.

### 3.3 Data processing

Data processing consists of multiple phases, as follows:

#### 3.3.1 Geometric Positioning

To ensure spatial accuracy, orthophoto images were geometrically adjusted using Global Mapper V18.2.0 software. The determination of coordinate reference point on the image is determined to facilitate the selection process of the study location in the three images and ensure data processing becomes easy. Refer to Table 2 for information on coordinate values.

**Table 2:** Coordinates for the selected study locations.

POINT	LONGITUDE	LATITUDE
1	134° 01' 29.1968" E	47° 59' 06.5862" N
2	134° 02' 27.9093" E	47° 59' 06.7971" N
3	134° 02' 28.0983" E	47° 58' 42.6913" N
4	134° 01' 29.3909" E	47° 58' 42.4817" N

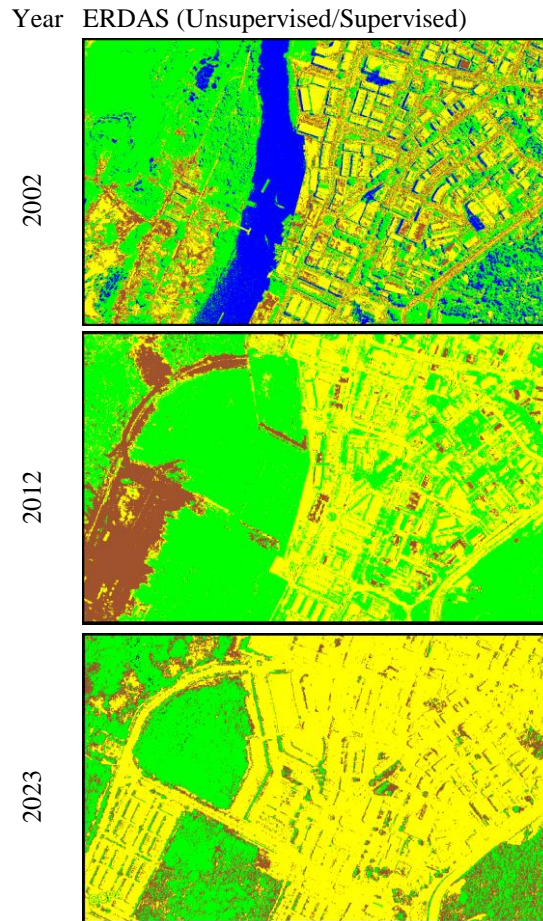
#### 3.3.2 Image classification

Orthophoto images from different years were compared to determine the changes that occurred. The orthophoto images were classed to differentiate between green and non-green space areas. The selected orthophoto images are processed using ERDAS Imagine software through specific classification. In this process, unsupervised and supervised methods are used.

The unsupervised method involves clustering image pixels based on their spectral characteristics without the need for reference data. On the other hand, the supervised method requires a reference data set to train the classification algorithm and ensure more accurate and specific results.

The object-based or pixel-based categorization approaches were used to identify the areas under investigation. The combination of these two methods helps produce a comprehensive and accurate analysis.

The classification of orthophoto images processed through the ERDAS Imagine software is determined based on specific pixel colors. The Green color represents green area, yellow represents the development area, blue represents the water body, and black represents other unspecified. The results of classification images of green area value changes recorded and mapped for each year are shown as illustrated in Figure 3.



**Fig. 3.** Thematic map of image classification results using ERDAS Imagine software

### 3.4 Data analysis

Data analysis was carried out to identify patterns and trends in changes in green open space areas. This involves spatial analysis and statistical analysis. For spatial analysis, ERDAS Imagine software is used to analyze the spatial changes in green space areas. A thematic map has been produced to show changes in green space over time (Figure 3). Statistical analysis is used to identify the relationship between changes in green space areas and influencing factors such as infrastructure development, population density, and urban planning policies.

The results of the study can be shown in the percentage of change and the size of the affected area. It shows that the largest percentage of green area reduction occurred from 2002 to 2012 when there was a sudden loss of green area.

If compared to the three orthophoto images, the Miri River in 2002 is not visible in the 2012 image as well as in the 2022 image. This happened because most of the riverside areas and old Miri River basins were reclaimed to pave the way for the development of the resort town of Miri. A man-made canal has been built to replace the original route of downstream ships entering the Miri River basin.

## 4 Result and discussion

The main idea of the study is to show the percentage and size of the area that has changed around Miri Times Square. Changes to this green space are then displayed in a thematic map as shown in Figure 3.

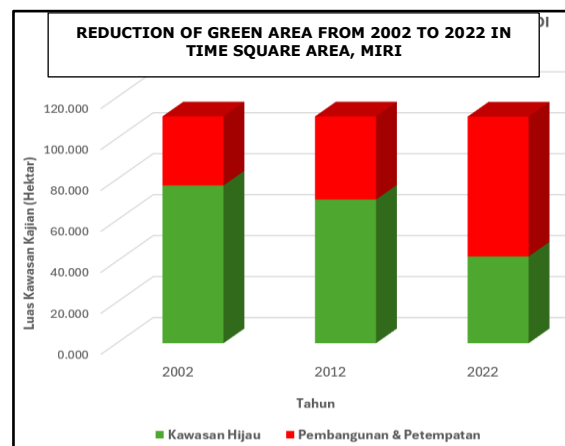
### 4.1 Percentage of green space area reduction:

The analysis shows a significant decrease in green space from 2002 to 2022. The size of green space decreases in direct proportion to the increase in developed areas, (Refer to Table 3). In 2002, green areas covered 77,040% of the entire study area (including rivers). While in 2012, the green area decreased to 70.148% which is a decrease of 6.892%. Then decreased by 27.807% in 2022 where the green area continued to decrease drastically to 42.341% compared to the total area of the study area.

**Table 3:** Percentage of green space area vs. Areas of development according to the year of study

Year	2002	2012	2022
Green Area	77.040%	70.148%	42.341%
Development/ Settlement	33.704%	40.587%	68.289%
Unused Data After Classified	0.256%	0.265%	0.370%
Total Area (Hectares)	111	111	111

Based on the resulting graph in Figure 4, it was found that there was a significant decrease in green space throughout the study period from 2002 to 2022. The effect of the reduction of green areas is due to the rapid development of Miri City. This includes increased development areas, tourism, housing, commercial, and infrastructure improvements.



**Fig. 4.** Graph Showing the decrease of Green Area From 2002 To 2022 In Time Square Area, Miri

## 5 Final conclusions and recommendations

The encouraging element behind this study was orthophoto image processing with remote sensing software. This study proved two major objectives. The first is to depict the percentage and area of green areas shrinking directly with the increase in development areas around Miri Times Square. The second is to produce a thematic map based on the resulting orthophoto image processing.

The loss of green areas has had several negative impacts, including increased global warming, water quality, and population density. Unplanned development can reduce the quality of life for urban people. Based on data analysis, several proposals can be made for more effective and sustainable green space planning and management. To make Miri a livable city, sustainable growth must be aligned with long-term goals, as surpassing a city's capacity can have a detrimental impact on people.

All parties need to play a role in maintaining the sustainability of green areas. One of the practices that can be done is the mangrove swamp forest replanting program and so on. As a recommendation, green practices must be expanded and implemented with green technology. For example, sustainability projects such as the Low Carbon City Launch program should be introduced to the community. Every program conducted should be able to attract the interest and attention of all parties so that awareness can be raised to continue the urban sustainability agenda, making Miri a more livable and safer city. Also, use green light technology in offices, government buildings, shopping malls, and other public areas. This is because green technology lighting can reduce the increase in Earth's temperature, the greenhouse effect, and ozone depletion.

In conclusion, this study provides important insights into the challenges and opportunities in sustainable urban development. The results of this study can be used as a guide to policymakers in devising a more effective conservation strategy to ensure sustainable urban development in the future. Furthermore, this study can be continued by expanding the study area by selecting some major urban areas of each district to study and expand the area. In addition, research using images from Google Maps can be attempted to obtain equivalent results.

## Acknowledgement

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## References

- 1 Amorim, J. H., Rodrigues, V., Tavares, R., Valente, J., & Borrego, C. (2019). "The Influence of Green Spaces on Air Quality in Urban Areas." *Science of The Total Environment*, 654, pp. 131-138
- 2 Bolund, P., & Hunhammar, S. (1999). "Ecosystem Services in Urban Areas." *Ecological Economics*, 29(2), pp. 293-301.
- 3 Chen, L., Zhao, T., & Wu, J. (2016). "Spatial Assessment of Urban Green Spaces in Shanghai, China Using a Satellite Image-Based Index." *Sustainability*, 8(1), 50.
- 4 Gao, Y., Li, X., Xu, W., Wang, T., & Zhu, L. (2021). "Urban Green Space Dynamics and Their Influence on Urban Heat Islands: A Case Study of Shanghai, China." *Urban Forestry & Urban Greening*, 59, 126991.
- 5 [https://miri.sarawak.gov.my/web/subpage/webpage\\_view/209/mirido](https://miri.sarawak.gov.my/web/subpage/webpage_view/209/mirido)
- 6 <https://www.mycensus.gov.my/index.php/census-product/publication/census-2010/659-population-distribution-and-basic-demographic-characteristics-2010>
- 7 [https://sarawak.gov.my/web/home/article\\_view/240/175](https://sarawak.gov.my/web/home/article_view/240/175)
- 8 [https://www.academia.edu/31276458/Miri\\_as\\_a\\_Coastal\\_City](https://www.academia.edu/31276458/Miri_as_a_Coastal_City)
- 9 Jim, C. Y., & Chen, W. Y. (2006). "Perception and Attitude of Residents toward Urban Green Spaces in Guangzhou (China)." *Environmental Management*, 38(3), pp. 338-349.
- 10 Jim, C. Y., & Chen, W. Y. (2020). "Impacts of Urban Development on Green Space Fragmentation in Hong Kong." *Geographical Research*, 58(2), pp. 189-204.
- 11 Kabisch, N., van den Bosch, M., & Laforteza, R. (2017). "The Health Benefits of Nature-Based Solutions to Urbanization Challenges for Children and the Elderly – A Systematic Review." *Environmental Research*, 159, pp. 362-373.
- 12 Kabisch, N., Qureshi, S., & Haase, D. (2015). "Human–Environment Interactions in Urban Green Spaces – A Systematic Review of Contemporary Issues and Prospects for Future Research." *Environmental Impact Assessment Review*, 50, pp. 25-34.
- 13 Pauleit, S., Ennos, R., & Golding, Y. (2005). "Modeling the Environmental Impacts of Urban Land Use and Land Cover Change—A Study in Merseyside, UK." *Landscape and Urban Planning*, 71(2-4), pp. 295-310.
- 14 Richards, D. R., Passy, P., & Oh, R. R. Y. (2020). "Impacts of Population Density and Wealth on the Quantity and Structure of Urban Green Space in Tropical Southeast Asia." *Landscape and Urban Planning*, 204, 103951.
- 15 Shanahan, D. F., Franco, L., Lin, B. B., Gaston, K. J., & Fuller, R. A. (2016). "The Benefits of Contact with Nature for Mental Health in Urban Areas." *BioScience*, 66(4), pp. 310-320.
- 16 Tan, P. Y., Wang, J., & Sia, A. (2013). "Perspectives on Five Decades of the Urban Greening of Singapore." *Cities*, 32, pp. 24-32.
- 17 Wolch, J. R., Byrne, J., & Newell, J. P. (2014). "Urban Green Space, Public Health, and Environmental Justice: The Challenge of Making Cities 'Just Green Enough'." *Landscape and Urban Planning*, 125, pp. 234-244.
- 18 Zhao, Q., Liu, H., & Wang, X. (2023). "Assessing Urban Green Space Quality and Its Impact on Urban Livability: A Case Study of Shenzhen, China." *Journal of Environmental Management*, 327, 116855.

# Determinant of Saving Behavior Among Students in Higher Learning Institution

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**Abstract.** Around the world, emergency savings are increasingly seen as a crucial element for enhancing people's financial resilience against unexpected life events and financial stress. Savings are vital because they help people withstand unexpected events, such as hospital visits or job losses, which can have enduring psychological, financial, and practical impacts. This issue has highlighted the need to educate young adults on the fundamental importance of supplementing their savings to ensure the adequacy of their future endeavors. The purpose of this study is to investigate the relationship between factors that influence saving habits. Financial literacy, parental socialization, peer influence and self-control have been recognized as determinants of saving behavior. Researchers have used descriptive analysis, correlation analysis and multiple regression analysis in this study. Person Correlation Coefficient analysis has been applied to examine the significant relationship between independent variables with dependent variables. The results show that financial literacy, parental socialization and peer influence has a positive relationship with saving behavior. However, self-control has a negative relationship with saving behavior. Multiple regression results showed that B-value for parental socialization is the strongest variable that influences saving behavior of students in higher learning institutions (B-value = 0.773). There is also a positive relationship between independent variables (financial literacy, peer influence and self-control) and dependent variables (savings behavior).

**Keywords:** Saving Behavior, Financial Literacy, Parental Socialization, Peer Influence, Self-control

## 1 Introduction

Saving is crucial for everyone's future endeavors. We need to save for financial security, to meet future goals, handle emergencies, and plan for retirement. Nor Akmar Yaakub, Head of the Financial Education Department at the Credit Counselling and Management Agency (AKPK), stated that a March online study by the Department of Statistics Malaysia assessed the impact of Covid-19 on the economy and individuals. The study found that 71.4 percent of self-employed individuals have savings that can last for a month, while 82.7 percent of those in the private sector have sufficient financial savings for two months. Overall, Malaysians lack adequate emergency savings for long-term unexpected events. Prof Datuk Dr. Shazali Abu Mansor, a Senior Professor at Universiti Malaysia Sarawak (UNIMAS), emphasized that most Malaysians do not have enough savings to handle emergencies, especially during the pandemic, and therefore had to rely on government assistance and subsidies (AKPK, 2020). There are several factors that can lead to saving habit. The habit of saving should be cultivated from childhood. It's never too late to develop a savings habit during higher education. It can help them to have a good financial planning when they have their own income.

According to Hasni (2014), everyone can learn how to save money, but without proper practice and guidance, along with bad spending habits, they may find it difficult. Saving habits can be taught from childhood with good awareness and guidance from parents. These habits can be practiced throughout life, starting at a young age, continuing through school, higher education, and into adulthood, when they earn their own income, support a family, and plan for retirement.

Julia Chan (2023) reported that statistics from The Malaysian Consumer and Borrower Settlement Association (4PM) show that between 2019 and August 2023, the highest number of bankrupt individuals were aged 35 to 44, totaling 13,757 people. This was followed by those aged 55 and above, with 5,549 people. Previously, Youth and Sports Minister Hannah Yeoh noted that bankruptcy is the most serious issue affecting youth today, surpassing drug abuse. The Insolvency Department's statistics revealed 5,695 bankruptcy cases in the past year, including 419 individuals aged 25 to 34, most of whom are employed. She mentioned that the government has various short-term and long-term strategies to address bankruptcy, especially among youth, through the Institute of Leadership Development and Excellence (i-LEAD), which offers modules and special programs focused on financial literacy for young people.

The researcher suggested that small children should be taught cash management early on, so they can apply these skills when they pursue their studies. It is evident that a lack of financial literacy can negatively influence their saving habits, impacting them

during their education.

Besides financial management skills or financial literacy, the researcher aims to explore other factors affecting saving habits, with a focus on students of Politeknik Ungku Omar as higher learning institution. The researcher has identified factors such as financial parental socialization, peer influence, and self-control as key influences on saving habits.

## 2 Literature Review

Saving in a simple definition is 'the excess of income over all expenditure', where the expenditures are also mentioned as consumption, which is life contributions and insurance (if any), and the saving behavior is the money keeping activity after they use it for their own wealth (Denton, Fretz, & Spencer, 2011).

In financial, saving can best defined as the action of deducting current expenses for a certain time frame, where we can have the balance and also the acts of keep or not to use any money now, with the intention to use it later (Browning & Annamaria, 1996).

Savings is to put some portion of money from the income that was earned and keep it for emergency or future planning. There are several factors that can influence people to save such as literacy of the financial knowledge, peer influence, parental socialization and also self-control.

Atkinson and Messy (2012) define financial literacy as a combination of being aware of, knowledge, skills, behavior that is necessary for a suitable financial decision and to reach its own financial wealth.

Financial literacy is widely defined as the knowledge, understanding, and application of financial terms and concepts to make sound decisions that yield optimal results. Some studies use specific areas of interest to operationally measure financial literacy. These areas include knowledge of savings, borrowing, investment, budgeting, and overall financial knowledge (Chen and Volpe, 1998).

According to Khalisharani (2022), Indonesian students surpass Malaysian students in financial literacy, whereas Malaysian students exceed Indonesian students in terms of financial attitude and behavior. The majority of Malaysian students were categorized as having a moderate financial literacy and were only good at understanding cash flow management.

Everyone, especially the younger generation, needs to possess strong financial literacy. With good financial literacy, they are more likely to make better financial decisions and engage in effective financial planning.

In previous studies by Otto (2012), emphasized the importance of distinguishing between the economic worlds of children, adolescents, and adults, and guiding children in saving theories by demonstrating good saving habits. She also mentioned that saving skills can be developed through the relationship between children and parents and should be learned early in life. Otto's theoretical framework was based on Katona's theory of saving, which was used to assess the saving habits of respondents. Parents can use their authoritative power to encourage their children to save money, provided they are successful savers themselves (Otto, 2009).

In their study, Duflo and Saez (2001) found that peer effects significantly influence retirement savings decisions. The survey, conducted in the United States, utilized data from 12,172 employees across 358 departments of a large university. The study aimed to examine the relationship between the role of information and social interaction in retirement plan decisions. The findings suggested that members of the same group share a common environment, which may influence their behavior. This is because people with similar preferences tend to belong to the same group, leading to a correlation between group behavior and individual behavior, ultimately affecting their saving habits.

In a prior study conducted by Esenvalde (2011), it was demonstrated that saving habits show a positive correlation with peer influence. The study involved 272 respondents who completed online questionnaires.

According to Lim, Sia, and Gan (2011), self-control significantly impacts saving behavior. This study, conducted in Malaysia, involved distributing 500 survey questionnaires to participants aged 21 and above. The researchers found that an individual's ability to maintain self-control for saving depends on the strength of two opposing forces: desire and willpower. The findings indicate that people are more likely to save if they can control themselves by implementing sound budgeting and economic cost assessments.

### 2.1 Hypothesis Development

H1: There is a linear relationship between financial literacy and saving behavior.

H2: There is a linear relationship between parental socialization and saving behavior.

H3: There is a linear relationship between peer influence and saving behavior.

H4: There is a linear relationship between self-control and saving behavior.

## 3 Methodology

Research design of this study is adopting the quantitative approach that is using survey method. The research data will be collected once using questionnaire. The population of the study is the student in semester 5 from Commerce Department, Politeknik Ungku Omar (PUO). The population of semester 5's students from Commerce Department in PUO is 217 students.

140 students are considered to be representative (sample size) and considered as the minimum sample size at a confidence level according to Krejcie Morgan formula (Sekaran, 2004).

This study uses the convenience sampling method in obtaining the sample study. The survey consisted of 54 items in two sections composed of Part A & B. Part A are asking on respondent's profile consisted of 8 items. Part B measuring the variables of dependent and independent variables that consist of 46 items.

The choice of response for each of the item used in the instrument is using the four-point Likert Scale; 1= Strongly Disagree, 2= Disagree, 3= Agree and 4= Strongly Agree. Statistical analyses used for the data analysis were descriptive statistics, frequency distribution and correlation analysis.

The determination of internal consistency on the index of instrument on the index of instrument is using reliability analysis by obtaining the Cronbach's Alpha coefficient (Cohen and Swerdlik 2002). Bryman and Bell (2003) states that Cronbach's Alpha values were in the range of 0 (indicating no internal reliability) and 1 (indicating internal reliability was perfect). This study used the value of 0.6 and above proposed by Hair et al. (2006).

Pearson correlation coefficient (r) has been used in the study to measure the strength and direction of the relationship between two variables. The value lies between -1 to +1. If  $r = 1.0$  or positive value; there is a perfect positive linear relationship. If  $r = -1.0$  or negative value; There is a perfect negative linear relationship. No correlation is indicated if  $r = 0$ . In determining the strength of the relationship, this study used the guideline proposed by Hatcher (2003).

## 4 Finding and Analysis

### 4.1 Demographic Information

The result showed that about 77.9% of the participants were female and the rest of 22.1% were male. Racial composition of the sample was 108 (77.1%) of the participant were Malay, 5 (3.6%) were other or 'multiracial' and 27 (19.3%) for both Chinese and Indian. Respondents from each courses are taken equally, in which from DKB (Diploma in Banking and Finance), DIB (Diploma in Islamic Banking), DAT (Diploma in Accountancy), DPM (Diploma in Business Management) and DRM (Diploma in Retail Management). It shows in Table 1.

**Table 1.** Respondent's profile

Items		N	%
Gender	Male	31	22.1
	Female	109	77.9
Race	Malay	108	77.1
	Chinese	6	4.3
	Indian	21	15.0
	Others	5	3.6
Course	DKB	28	20.0
	DIB	28	20.0
	DAT	28	20.0
	DPM	28	20.0
	DRM	28	20.0

Based on Table 2 below, it shows that the allowance range RM100-RM300 is the most given by their parents than other range that consist of 55.7%. Range RM501-RM100 is the less allowance given by their parents which is only 3.6%. This may be due to the status of family income that can affect their expenses.

**Table 2.** Allowance given by their parents per month

Allowance					
RM10 - 100	RM 100 - 300	RM 301 - 500	RM 501 - 1000	> RM 1000	Total
27	78	27	3	5	140
19.3%	55.7%	19.3%	2.1%	3.6%	100%

Table 3 showed that most of the students spend RM101 – RM300 per month that consists of 40% of the respondents. Only 2.9% spend RM501 – RM600 per month. In this case, it showed RM501 – RM600 was least spent by students per month.

**Table 3.** How much students spend per month.

Spending					
RM10 - 100	RM 101 - 300	RM 301 - 500	RM 501 – 600	> RM 600	Total
40	56	32	4	8	140
28.6%	40%	22.8%	2.9%	5.7%	100%

#### 4.2 Reliability Analysis

Table 4 shows the results of reliability analysis for 5 variables which saving behavior, financial literacy, parental socialization, peer influence and self-control. The result from Table 4 indicated that the Cronbach Alpha for the variables were reliable which are above 0.6. The value of each Cronbach Alpha are ranged from 0.839 to 0.928.

Saving behaviour intention constituted of 9 items with the cronbach alpha 0.863; financial literacy have 11 items with alpha value of 0.910; for parental socialization the result cronbach alpha is 0.839 with 9 items; the peer influence variable show data of cronbach alpha is 0.849 with 6 items; and the self – control with 11 items with the cronbach alpha is 0.928. The result concluded that the measurement scales of the variables were stable to measure the variables under study.

**Table 4.** Cronbach's Alpha Coefficients

Variable	Cronbach Alpha
Saving behavior	0.863
Financial literacy	0.910
Parental socialization	0.839
Peer influence	0.849
Self-control	0.928

#### 4.3 Descriptive Analysis

Descriptive report using mean scores of each of the independent and dependent variable focus in this study were presented below.

##### Financial Literacy

The overall mean for this independent variable is 3.02 (refer to Table 5). The highest mean for Financial Literacy are at 3.09 (FL 9) and the lowest mean at 2.94 (FL 6). It shows that the respondents agree that financial literacy can influence people to save.

**Table 5.** Descriptive Statistics of Financial Literacy

Items (Overall mean = 3.02)		Mean
FL1	I have better understanding of how to invest my money	3.05
FL2	I have better understanding of how to manage my credit use	3.01
FL3	I have a very clear idea of my financial needs during retirement	2.99
FL4	I have the ability to maintain financial records for my income and expenditure.	3.01
FL5	I have little or no difficulty in managing my money	3.01
FL6	I have better understanding of financial instruments (eg. bonds, stock, T-bill, future contract, option and etc.)	2.94
FL7	I have the ability to prepare my own weekly (monthly) budget	3.06
FL8	I rather consume now than in the future	2.98
FL9	I would be more successful in my saving by learning more about saving	3.09
FL10	I prepare a list of required items ahead of time before shopping	3.02
FL11	I regularly put money in savings account	3.07



### Parental Socialization

Overall mean of parental socialization showed the value of mean is 3.13 (refer Table 6). Majority of the students agree that parental socialization can influence students to save. The highest mean are at 3.19 (PS 2) and the lowest mean at 2.99 (PS 5). It shows that the respondents agree that parental socialization can influence people to save.

**Table 6.** Descriptive Statistics of Parental Socialization

Items (Overall mean = 3.13)		Mean
PS1	My parents are good example for me when it comes to money management	3.14
PS2	I always talk about money management with my parents	3.19
PS3	It's good when my parent control my spend	3.11
PS4	It's a good thing to ask my parents to keep hold of my money sometimes to help me save	3.11
PS5	My parents are proud of me for saving	2.99
PS6	I appreciate it when my parents give me advice about what to do with my money	3.14
PS7	I save money because I don't think my parents should pay for things I don't really need but like it	3.23
PS8	Saving is something I do regularly because my parents wanted me to save when I was little	3.15
PS9	My parents want me to save money	3.14

### Peer Influence

Overall mean of peer influence showed the value of mean is 2.93. Majority of the student agree that peer influence can affect saving behavior among students (refer to Table 7). The highest mean are at 3.04 (PI1) and the lowest mean at 2.89 (PI4).

**Table 7.** Descriptive Statistics of Peer Influence

Items (Overall mean = 2.93)		Mean
PI1	As far as I know, some of my friends regularly do save with a saving account	3.04
PI2	I always discuss about money management issue with friends	2.91
PI3	I always compare the amount of saving and spending with my friends	2.92
PI4	I feel social pressure to save	2.89
PI5	I always involve in money spending activities with friends	2.94
PI6	When I meet up with my friends, we regularly spend money	2.90

### Self-control

Overall mean of self – control showed the value of mean is 2.71. Majority of the student agree that self - control can affect saving behavior among students. (refer to Table 8). Highest mean is 3.07 (SC11) and the lowest mean at 2.49 (SC6). Nonetheless, with an overall mean of 2.71 which is consider very close to agree statement, it shows that the respondents agree that self-control can also influence people to save.

**Table 8.** Descriptive Statistics of Self-control

Items (Overall mean = 2.71)		Mean
SC1	I don't save, because I think it's too hard to save some money	2.57
SC2	I enjoy spending money on things that aren't practical.	2.75
SC3	When I get money, I always spend it	2.66
SC4	"I see it, I like it, I buy it" describes me.	2.52
SC5	"Just do it" describes the way I buy things.	2.59
SC6	"Buy now, think about it later" describes me.	2.49
SC7	I'm easily attracted by lure. I always failed to control myself from spending money.	2.59
SC8	When I set saving goals for myself, I rarely achieve them	2.80
SC9	I am more concerned with what happens to me in short run than in the long run.	2.88
SC10	I save money only because I have to	2.89
SC11	I assure that I purchased item which are reasonable price	3.07

### Saving behavior

Overall mean of student perception towards saving behavior showed the value of mean 3.13 (refer to Table 9). The highest mean is 3.20 (SB6) and the lowest mean 3.04 (SB1).

**Table 9.** Descriptive Statistics of Saving Behavior

Items (Overall mean = 3.13)		Mean
SB1	I put money aside on a regular basis for future	3.04
SB2	In order to save, I often compare prices before I make a purchase	3.11
SB3	In order to save, I often consider whether the real necessity before I make a purchase.	3.14
SB4	In order to save, I always follow a careful monthly budget.	3.09
SB5	I always have money available in the event of emergency	3.16
SB6	In order to save, I plan to reduce my expenditure.	3.20
SB7	I save to achieve certain goals.	3.17
SB8	I save until the end of my semester.	3.10
SB9	Saving is something that feels like a natural part of my everyday life	3.16

### 4.4 Correlation Analysis

The correlation analysis between dependent variable and independent variables understudy was shown on Table 10. It was revealed that there was positive relationship between saving behavior and financial literacy,  $r = 0.336$ ,  $n = 140$ ,  $p = 0.000 < 0.05$ . However, there are also weak positive relationships between saving behavior and parental socialization which is  $r = 0.180$ .

Based on guideline proposed by Hatcher (2003), medium correlation ranges from 0.1 to 0.49. Therefore, it can conclude that financial literacy and parental socialization has a weak positive relationship with saving behavior. There is also a weak positive relationship between peer influence and saving behavior which is  $r = 0.177$ . This means that changes in saving behavior are correlated with financial literacy, parental socialization and peer influence. But for self – control, the  $r = -0.150$ , it showed that there is negative relationship between saving behavior and self-control.

**Table 10.** Correlation Coefficient

		SB	FL	PS	PI	SC
SB	Pearson Correlation	1	.336**	.180*	.177*	-.150
	Sig. (2-tailed)		.000	.033	.036	.078
	N	140	140	140	140	140
FL	Pearson Correlation	.336**	1	-.044	.350**	-.042
	Sig. (2-tailed)	.000		.606	.000	.620
	N	140	140	140	140	140
PS	Pearson Correlation	.180*	-.044	1	.019	.029
	Sig. (2-tailed)	.033	.606		.828	.735
	N	140	140	140	140	140
PI	Pearson Correlation	.177*	.350**	.019	1	.429**
	Sig. (2-tailed)	.036	.000	.828		.000
	N	140	140	140	140	140
SC	Pearson Correlation	-.150	-.042	.029	.429**	1
	Sig. (2-tailed)	.078	.620	.735	.000	
	N	140	140	140	140	140

\*\**. Correlation is significant at the 0.01 level (2-tailed).*

\**. Correlation is significant at the 0.05 level (2-tailed).*

#### 4.5 Hypothesis testing

Pearson Correlation Coefficient analysis will be used to test of the hypotheses of this study. Researcher need to determine the significance of the correlation by calculate the test statistic, find the degree of freedom and find the critical value. After that, the conclusion for the hypothesis can be determine by comparing the test statistic to the critical value.

**Table 11.** Hypothesis testing

H	r	t	Critical value	Decision
H1 (FL)	0.336	4.1905	1.9773	Support
H2 (PS)	0.180	2.1495		Support
H3 (PI)	0.177	2.1127		Support
H4 (SC)	-0.150	-1.7822		Not supported

Table 11 shows that H1, H2 and H3 was accepted while H4 was rejected.

H1: There is a linear relationship between financial literacy and saving behavior. This hypothesis was supported by research done by Hasni (2014). She can conclude that the saving habits have a significant relationship with financial literacy of Gen Y. The students with higher financial literacy are more likely to save compared to student without financial literacy, and it is proven through this study.

This is further supported by the fact that students with financial literacy understand and recognize the importance of saving (Cude et al., 2006).

H2: There is a linear relationship between parental socialization and saving behavior. This hypothesis was supported by research done by Hasni (2014). There was a significant relationship between parental socialization and saving habits among Gen Y.

This is further supported by Chai et al. (2012), finding shows that parental socialization and saving behavior are positively related ( $p < 0.05$ ).

H3: There is a linear relationship between peer influence and saving behavior. These results align with studies by Duflo et al. (2001) and Beshears et al. (2010), which demonstrated that individuals' behavior is likely influenced by peers. Peers serve as significant reference points for individuals, making it easy for one's behavior to be shaped by peer influence.

Moreover, it is also supported by research done by Hasni (2014) and Chai et al (2012) and find out that peer influence has a significant relationship with saving habits.

H4: There is no linear relationship between self-control and saving behavior. These results align with the studies by Siti Khadijah et al (2018), there is a negative correlation was detected for self-control. For every unit increase in self-control will cause a decrease of 0.251 in saving behaviour provided other variables remain constant. From the previous research, one stated that self-control was not related to saving preschool children (Kamawar et al., 2018). This supports the results of rejecting H4.

The finding is inconsistent with our expectation since it is expected to have a positive correlation. This result contradicts with other findings such as by Kim and Hanna (2017) where their finding showed high self-control will result in more saving.

#### 4.6 Multiple Linear Regression Analysis

Table 12 shows Multiple Linear Regression Analysis was run to find out whether financial literacy, parental socialization, peer influence and self-control are significant with saving behavior. Major findings shown of regression analysis indicate that ( $R=0.721$ ) means that there is a high positive relation between independent variables and dependent variables.

**Table 12.** Multiple Linear Regression Analysis

Model	Unstandardized Coefficients	Standardized Coefficients	t-value	Sig. (P-value)
	B-value	Beta-value		
Financial Literacy	B = 0.170	$\beta = 0.189$	2.719	0.007
Parental Socialization	B = 0.773	$\beta = 0.931$	4.457	0.000
Peer Influence	B = 0.264	$\beta = 0.325$	0.553	0.000
Self-control	B = 0.030	$\beta = 0.015$	0.990	0.000
F- value	55.251			
F-Sig.	0.000			
R	0.721			
R <sup>2</sup>	0.605			
Adjusted R <sup>2</sup>	0.598			

\*\*Degree of Confidence: 95%, Sig. ( $p < 0.05$ )

Independent variables (financial literacy, parental socialization, peer influence and self-control) for 60.5 % significant variance of saving behavior ( $R^2 = 0.605$ ). Adjusted  $R^2 = 0.598$  should be the same or close to the R value and F value = 55.251 which is higher than 1, sig = 0.000 indicates that the model used in this study is fit. B-value is used to measure the strength of independent variables towards dependent variables. It identified that B-value for parental socialization is the strongest variable that influences saving behavior of students in higher learning institutions (B-value = 0.773). Standardized coefficient beta values among financial literacy, parental socialization, peer influence and self-control are ( $\beta = 0.189, 0.931, 0.325$  and  $0.015$ ). And it also shows that parental socialization is the most influenced to saving behavior of students. The results for parental socialization, financial literacy and peer influence were consistent with a study done by Siti Khadijah et al (2018). The result for self-control is similar to findings by Kim and Hanna (2017) where their finding showed high self-control will result in more saving. Researchers found that the results for self-control is different in correlation analysis (negative relationship) and multiple regression analyses (positive relationship). It is possible for individual variables to have negative correlations with the dependent variable, while in a multiple regression model, the same variables can have positive relationships with the dependent variable. This phenomenon occurs due to the presence of multicollinearity or when the variables are highly correlated with each other. Multicollinearities happen when independent variables are highly correlated with each other, the individual effect of one variable on the dependent variable can change when other variables are included in the model.

## 5 Conclusion

The aim of this study is to investigate the factors influencing saving behavior among students at higher learning institutions. The results indicate that all four factors examined contributed to the students' saving behavior. Specifically, financial literacy, parental socialization, and peer influence showed a positive relationship with saving behavior, while self-control demonstrated a negative relationship. However, when researchers run a multiple regression analysis, all four independent variables have a positive relationship with savings behavior. This study provides insights into the saving behavior of students in higher learning institutions and highlights the importance of cultivating good saving habits in younger generations.

Researcher can do a future study on other factors such as financial self-efficacy, financial management skills, self-dominance, family influence, financial attitude, personal income, risk tolerance, attitude toward saving, and sociodemographic factor.

As this study only confined to higher learning institutions students of Politeknik Ungku Omar, future research is recommended to get a respondent from other polytechnic or other higher learning institutions such as universities or college to

generate a more accurate data on saving behavior of higher learning institutions students.

In summary, having good saving habits helps people create effective financial plans and make sound financial decisions. This habit can also help people from being declared bankrupt. This habit needs to be cultivated from childhood for a better future endeavor.

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## References

1. Agensi Kaunseling Dan Pengurusan Kredit. (2020, November 1). *Saving awareness still lacking*. <https://www.akpk.org.my/saving-awareness-still-lacking>
2. Atkinson, Adele & Messy, Flore-Anne. (2011). Assessing financial literacy in 12 countries: An OECD/INFE international pilot exercise. *ResearchGate*.10.657-665. 10.1017/S1474747211000539.
3. Atkinson, A. and Messy, F. (2012) Measuring Financial Literacy: Results of the OECD/International Network on Financial Education (INFE) Pilot Study. *OECD Working Papers on Finance, Insurance and Private Pensions*, No. 15, OECD Publishing. [http://www.oecd-ilibrary.org/finance-and-investment/measuring-financial-literacy\\_5k9csfs90fr4-en](http://www.oecd-ilibrary.org/finance-and-investment/measuring-financial-literacy_5k9csfs90fr4-en)
4. Beshears, J., Choi, J. J., Laibson, D., Madrian, B. C. & Milkman, K. L. (2010). *The effect of providing peer information on retirement savings decisions*. California: Stanford University.
5. Browning, M., & Annamaria, L. (1996). Household Saving: Micro Theories and Micro Facts. *Journal of Economic Literature*, 34, 1797- 1855.
6. Bryman and Bell (2008), *Business Research Methods*. Oxford University Press, Oxford.
7. Chai, M. T., Chia, Y. K., Fong, S. N., Lew, W. C., & Tan, C. T. (2012). *Determinants of Saving Behaviors among The University Students in Malaysia*. Universiti Tunku Abdul Rahman. Retrieved January 15, 2014, from UTAR Institutional Repository: <http://eprints.utar.edu.my/607/1/AC-2011-0907445.pdf>
8. Chen, Haiyang & Volpe, Ronald. (1998). An Analysis of Personal Financial Literacy Among College Students. *Financial Services Review*. 7. 107-128. 10.1016/S1057-0810(99)80006-7.
9. Cohen and Swerdik (2002), *Psychological testing and assessment Bostan*. Mcgraw-Hill Higher Education.
10. Cude, B. J., Lawrence, F. C., Lyons, A. C., Metzger, K., Lejeune, E., Marks, L., et al. (2006). College Students and Financial Literacy: What They Know and What We Need to Learn. *Eastern Family Economics and Resource Management Associations*.
11. Denton, F., Fretz, D., & Spencer, B. (2011). *Independence and Economic Security in Old Age*. Toronto: UBC Press.
12. Duflo, E. & Seaz, E. (2002). The role of information and social interactions in retirement plan decision: Evidence from a randomized experiment. *Quarterly Journal of Economics*, 118, 815-842.
13. Esenvalde, I. (2011). *Psychological predictors of savings behavior: contrasting the impact of optimism and burnout on self-control, achievement motivation and savings behavior*. Alliant International University, Los Angeles.
14. Hair et.al (2006), *Multivariate data analysis*. New Jersey: Pearson International Edition
15. Hasni, Hashim (2014) *Factors that influence saving habits among Gen Y: Case study on students of Politeknik Sultan Azlan Shah*. Masters thesis, Universiti Utara Malaysia.
16. Hatcher, L 2003. *Step-By-Step Basic Statistics Using SAS: Students Guide*. SAS Institution Inc. Cary, NC, USA.
17. Julia Chan (2023, October 26). *Report: Increasing bankruptcy among youths worrying, consumer group calls for govt intervention*. Malaymail.[https://www.malaymail.com/news/malaysia/2023/10/26/report-increasing-bankruptcy- among-youths-worrying-consumer-group-calls-for-govt-intervention/98439#:~:text=4PM's%20statistics%20from%202019%20to,and%20above%20\(5%2C549%20people\)](https://www.malaymail.com/news/malaysia/2023/10/26/report-increasing-bankruptcy- among-youths-worrying-consumer-group-calls-for-govt-intervention/98439#:~:text=4PM's%20statistics%20from%202019%20to,and%20above%20(5%2C549%20people)).
18. Kamawar D, Connolly K, Astle-Rahim A, Smygwyat S, Vendetti C. *Preschoolers' Saving Behavior: The Role of Planning and Self-Control*. Child Dev. 2019 Jul;90(4):e407- e420. Doi: 10.1111/cdev.13037. Epub 2018 Jan 31. PMID: 29383708.
19. Khalisharani, Hanin & Johan, Irni & Sabri, Mohamad Fazli. (2022). The Influence of Financial Literacy and Attitude Towards Financial Behaviour Amongst Undergraduate Students: A Cross-Country Evidence. *Pertanika Journal of Social Sciences and Humanities*. 30. 449-474. 10.47836/pjssh.30.2.03.
20. Kim, G. J., & Hanna, S. D. (2017). *Do self-control measures affect saving behaviour?* Retrieved from <https://www.researchgate.net/publication/318659247>
21. Lim, C.S., Sia, B.K., & Gan, G.J. (2011). The analysis of psychological factors affecting savers in Malaysia. *Middle Easter Finance and Economic*, 12, 77-85.
22. Otto, A. (2009). *The Economic Psychology of Adolescent Saving*. Retrieved February 5, 2014, from Open Research Exeter: <https://ore.exeter.ac.uk/repository/bitstream/handle/10036/83873/OttoA.pdf?sequence=1>
23. Otto, A. (2012). *Saving in Childhood and Adolescence*. Retrieved February 5, 2014, from Center for the Social Development WUSTL: <http://csd.wustl.edu/Publications/Documents/WP12-20.pdf>
24. Sekaran, U. (2004). *Research Methods For Business (Fourth Edition)*. John Wiley & Sons, Inc.
25. Siti Khadijah Omar, Marziah Mokhtar, Azlin Shafinaz Arshad, Adlan Ahmad Bakri, Wan Ahmad Khusiari Wan Chek, Nik Fazlin Hiriyati Nik Jaafar and Azira Husin (2018). An Analysis of the factors affecting the Saving Habits of University Preparatory Students. *Asean Entrepreneurship Journal* Vol.4 (2), 136-144, 2018 (e-ISSN 2637-0301).

# Students' Perceptions on the Use of AI Application Tools in Writing Cover Letters

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**Abstract.** Cover letters are essential for job applications, but fresh graduates often struggle to create effective cover letters due to several reasons, such as unfamiliarity with best practices and time constraints. This research investigates students' perceptions of using AI-powered tools in writing a cover letter for job applications. By utilizing natural language processing (NLP) algorithms, machine learning models, and semantic analysis, these tools provide personalized feedback, suggest improvements, and guide learners through the cover letter creation process. In this study, ChatGPT and Grammarly are used as tools to help students write cover letters. The activity involved 37 Electrical and Mechanical Department students who enrolled in a compulsory course - DUE 50032 Communicative English 3. The writing activity took 6 hours to complete, and the students were required to compose a cover letter for an assignment with the aid of ChatGPT and Grammarly with close guidance from the course lecturers. Subsequently, they completed a questionnaire that measured their perceptions. The findings revealed that the participants had a positive experience in using ChatGPT and Grammarly to improve the quality of their writing. Additionally, these AI applications were reported to have three benefits: practicality, user-friendliness, and reduced stress. The survey underscores teachers' role in guiding students to use appropriate AI prompts, verifying online grammar check results for accuracy, and promoting the ethical use of AI tools in producing schoolwork.

**Keywords:** Technology, AI Applications, Soft Skills, Cover Letter Writing.

## 1 Introduction

In today's competitive academic and professional landscape, letter writing stands out as an essential soft skill that undergraduates must master (Bhatnagar & Bhatnagar, 2012; Nazari, et. al., 2021). Writing effective cover letters is a critical skill for job seekers, and the ability to produce polished, error-free documents can significantly impact their chances of securing employment. This skill is important as it reflects one's ability to communicate effectively, succinctly, and professionally. Whether it is drafting a cover letter for a job application, writing a personal statement for a scholarship, or sending a formal email to a professor, the ability to compose well-structured and articulate letters can significantly influence an undergraduate's success. Moreover, letter writing nurtures critical thinking and attention to detail, fostering a comprehensive understanding of the importance of tone, context, and audience in written communication.

Therefore, integrating letter writing into the curriculum not only prepares students for immediate academic and career opportunities but also equips them with lifelong communication skills. Traditionally, writing instruction in English as a Second Language (ESL) classrooms involves direct instruction from teachers, focusing on grammar, vocabulary, and the mechanics of writing. While effective in many ways, this approach presents several challenges for teachers. Educators often struggle to balance between correctness and form with creativity and critical thinking. Activities such as sentence drills, paragraph writing, and the use of model texts to illustrate different writing styles and genres, though structured, can become monotonous and disengaging for students. Additionally, the substantial input and feedback required from teachers during the stages of brainstorming, drafting, revising, and editing can be overwhelming, especially with large classes. Teachers also face the difficulty of addressing the diverse proficiency levels within a classroom, where some students may have limited vocabulary, others may struggle with sentence structure, and many encounter problems with coherence and cohesion in their writing (Lin & Morrison, 2021; Selvaraj & Aziz, 2019). These challenges highlight the need for more innovative and supportive instructional methods.

However, the introduction of AI tools can address these challenges and enhance the learning experience. AI applications such as ChatGPT and Grammarly represent a significant shift in how writing can be taught and learned in an era where digital narratives dominate. AI-powered applications can generate human-like responses (Zhan, Xu, & Sarkadi, 2023). These smart applications assist during and after the writing process, offering interactive and personalized feedback, facilitating brainstorming

and idea generation, and providing real-time language assistance, potentially addressing many of the writing issues faced by ESL learners (Alharbi, 2023). This dynamic approach can complement traditional methods, offering a more engaging and supportive environment for developing writing skills. Integrating AI tools into ESL instruction can thus transform the learning experience, making it more adaptive to individual needs and more aligned with the contemporary world's digital literacy demands.

Furthermore, incorporating AI tools like ChatGPT and Grammarly into the modern teaching method prepares ESL learners for real-world scenarios, enhancing their employability. Studies have shown that the use of AI-powered writing tools can significantly enhance writing quality and boost student engagement (Chang et al., 2021; Marzuki et al., 2023). Therefore, integrating ChatGPT and Grammarly into ESL writing instruction is a strategic approach to equip students with the necessary skills and confidence to succeed in their professional careers.

## 2 Objectives

This study is based on the use of ChatGPT and Grammarly to enhance the respondents' cover letters for an assignment. This is based on the premise that the integration of AI-powered writing assistance tools that offer real-time, personalized feedback would enhance the quality of the writing. ChatGPT, an AI language model developed by OpenAI, helps learners generate ideas and structure their thoughts, which is particularly beneficial for those who struggle with the initial stages of writing. By providing customized suggestions for specific job applications, ChatGPT can generate relevant and compelling cover letters. Additionally, the study also utilizes Grammarly for accurate use of grammar, punctuation, and style, allowing learners to instantly correct errors and refine their writing. This combination of tools addresses common ESL writing issues such as limited vocabulary, grammatical errors, and difficulties with coherence and cohesion (Warshauer & Grimes, 2008). The study seeks to explore students' perceptions on utilizing the AI applications, namely ChatGPT and Grammarly, to improve their writing skills based on the 6-hour guided instruction to produce cover letters.

## 3 Methodology

This action research was carried out at Polytechnic in Kuching, Sarawak. The respondents in this study are 37 fourth and fifth-semester students from the Electrical Engineering and Mechanical Engineering departments. The participation in this study was based on convenience sampling. The participants were briefed on the ethics regarding the study. They were assured that their identity would not be disclosed and that the information collected would be kept confidential and used only for the purpose of this research. The respondents were of similar proficiency levels based on their Sijil Pelajaran Malaysia (SPM) English language results. The participants were between the ages of 21 and 23. One student enrolled in the polytechnic after graduating from a local community college, while the remaining students enrolled after completing their SPM. The students were enrolled in a fourteen-week course in Communicative English 3, with six hours covering 2 classes (of 3 hours each) dedicated to cover letter writing. They were also given time for self-study. At the end of the writing lesson, students had to compose a cover letter for a job application as an assignment.

The course lecturer introduced two AI-powered applications (ChatGPT 3.5 series and Grammarly free version) to assist the students in writing the cover letter. In the first three hours of the class, the students were taught the purpose of cover letter writing, specifically for job applications, and how to structure it. They also learned about style and tone and the importance of customization. Additionally, there was a demonstration of using ChatGPT to generate cover letter drafts by providing job-specific prompts. The students were given the chance to practice using different prompts to familiarize themselves with the prompting process.

Once they grasped the prompting strategies, the students were taught to add a personal touch to the ideas suggested by ChatGPT. This involved adding their own voice and perspective or tailoring the content to fit the specific writing context and audience. The course instructor believes that this is the most important step and should not be skipped, as 'humanizing' the content given by ChatGPT reflects individual style and insights, reduces plagiarism, and thereby maintains the originality of one's cover letter writing. In the subsequent hours, the instructor selected a job advertisement for writing practice, and students engaged in a brainstorming session before using ChatGPT to generate prompts and editing. Towards the end of the lesson, students were also taught how to use Grammarly to check their grammar and spelling. Then, students were instructed to apply the skills that they had learned to the job advertisement they had chosen for the assignment.

In the final stage, students were required to respond to a 13-item questionnaire (via Google Form) regarding their experience in using ChatGPT and Grammarly after submitting their cover letter writing assignment. The questionnaire was administered ethically by explaining its purpose. Participation was voluntary. The 13 questionnaire items were formulated based on the researchers' comprehensive understanding of cover letter structures and mechanics. Additionally, the items were refined through discussions among the researchers. This explanation succinctly conveys the basis and process behind the formulation of the questionnaire items. The questionnaire had two parts. The first part gathered basic information such as age, department, and internet access. Part two comprised 13 items with a 5 Likert Scale ranging from 'strongly disagree' to 'strongly agree.'

## 4 Finding and discussion

The survey aimed to gauge participants' perceptions of using ChatGPT and Grammarly for a specific writing task. The 13 five-point Likert scale items presented to the students showed a high mean value (more than 2.5), indicating strong agreement with

the statements. These mean scores demonstrate a strong positive reception from students towards the use of ChatGPT, both independently and in conjunction with Grammarly. The mean values for each item are detailed in Table 1 below.

**Table 1.** Mean values for each statement on participants' perception.

No	Statements	Mean
1	Using ChatGPT in the classroom helps me better understand how to write a cover letter in English.	4.86
2	ChatGPT and Grammarly enhance my learning experience when writing cover letters in class.	4.70
3	I find the feedback from ChatGPT useful for improving my cover letter.	4.78
4	Using ChatGPT in the class makes the cover letter writing process more engaging.	4.62
5.	Grammarly helps me to identify and correct English language mistakes in my cover letter.	4.70
6.	I feel more prepared to write a cover letter after using ChatGPT and Grammarly	4.70
7.	Using ChatGPT in class encourages me to write more creatively in my cover letter.	4.70
8.	Using ChatGPT for my cover letter makes the English writing process less stressful.	4.78
9.	ChatGPT provides valuable examples that help me to write a better cover letter.	4.78
10.	I find it easy to integrate suggestions from ChatGPT into my cover letter.	4.78
11.	My lecturer's guidance is important in effectively using ChatGPT when writing a cover letter.	4.78
12.	The combination of ChatGPT and my teacher's input improves the quality of my cover letter.	4.78
13.	Overall, I am satisfied with using ChatGPT for cover letter writing in the classroom.	4.75

Based on Table 1, the results of the survey indicate that students have positive perceptions of using ChatGPT and Grammarly to write cover letters in the ESL classroom. The statement "using ChatGPT in the classroom helps me better understand how to write a cover letter in English" received the highest mean score of 4.86, suggesting that students feel significantly more confident in their understanding of cover letter writing when supported by ChatGPT. Additionally, the combined use of ChatGPT and Grammarly is seen to enhance the learning experience, with a mean score of 4.70, indicating that these tools effectively support students in developing their writing skills. The findings are in accordance with the research done by Ngo (2023), which acknowledges that AI tools provide virtual intelligence services that help learners grasp the mechanics of writing and offer timely, formative feedback that is often missing in traditional educational settings. Students find the writing process more engaging with the use of ChatGPT, as evidenced by the high mean of 4.62 for the statement on engagement. This supports the idea that interactive AI tools can make learning activities more dynamic and interesting, which is crucial for maintaining student motivation (Moybeka et al., 2023).

Both ChatGPT and Grammarly were perceived to enhance the learning experience in writing cover letters, with a mean score of 4.70. Students also found the feedback provided by ChatGPT particularly useful, with a high mean score of 4.78. This suggests that the AI's personalized feedback plays a significant role in helping students improve their cover letters. Similarly, the ease of integrating ChatGPT's suggestions into their writing was rated highly (mean score of 4.78), demonstrating the practicality and user-friendliness of the tool. Moreover, ChatGPT and Grammarly were recognized for making the writing process less stressful (mean score of 4.78), a significant benefit for ESL learners who often experience anxiety over language accuracy and fluency.

Grammarly's role in identifying and correcting English language mistakes is also highly rated (mean score of 4.70). This finding is supported by research that highlights Grammarly's effectiveness in helping students recognize and correct grammatical errors, thereby improving their writing quality (O'Neill, & Russell, 2019).

Using ChatGPT and Grammarly makes students feel more prepared to write cover letters, as reflected in the mean score of 4.70. furthermore, using ChatGPT encourages creativity in writing (mean score of 4.70). This suggests that AI tools not only assist with technical aspects of writing but also inspire students to explore and provide varied examples, fostering a more creative writing process.

Using ChatGPT helps reduce the stress associated with writing in English, as indicated by a high mean score of 4.78. The ease of integrating ChatGPT's suggestions into their writing (mean score of 4.78) further underscores the tool's user-friendliness. These aspects are crucial as they contribute to a more positive and less intimidating learning environment, which is essential for effective language acquisition. The survey results also highlighted the importance of the teacher's role in effectively using ChatGPT. The statement "my lecturer's guidance is important in effectively using ChatGPT when writing a cover letter" received a mean score of 4.78, underscoring that while AI tools are highly beneficial, the presence and support of an instructor remain crucial. The combination of ChatGPT and teacher input also improved the overall quality of cover letters, reflected in the same mean score of 4.78. This indicates that a blended approach, integrating AI tools with traditional teaching methods, provides the most effective support for ESL students.

Overall satisfaction with using ChatGPT for cover letter writing in the classroom is very high, with a mean score of 4.75. this overarching satisfaction suggests that integrating AI tools like ChatGPT and Grammarly into the classroom setting is highly effective and well-received by students.



## 5 Conclusion

The integration of the two AI-powered applications (ChatGPT and Grammarly) in this writing task indicates that there are substantial benefits for the students. These tools provided real-time feedback, generated ideas, and offered ‘personalized’ assistance, which would not be possible in a traditional writing lesson. Based on the findings, this paper believes it is time for English language instructors to complement writing lessons with AI applications as it can create a supportive learning environment catering to the student's needs.

This small-scale study has shown that integrating AI assists the instructor in individualizing the approach and empowers the student to become more autonomous in completing their writing tasks. The study also opines that students are poised to become more confident in academic and professional communication through these applications. Similarly, other studies done by Younis, et. al. (2023), Grassini (2023), Nazari, et. al. (2021) and Yan (2023) have indicated that ChatGPT and Grammarly have the potential to serve as effective instructional tools for language educators to improve students’ writing skills. While this paper advocates the use of these AI tools in writing instruction, its adoption must be conducted ethically so that students do not compromise on academic integrity issues (Zhan, Xu, & Sarkadi, 2023). Also important, as stated by Ngo (2023) is not to be too reliant on these tools, as this can curtail the development of critical thinking and problem-solving skills.

## References

1. A. Younis, H., Osamah Mohammed, Muthmainnah, Sahib, T. M., Akhtom, D., Hayder, I. M., Salisu, S., & Shahid, M. (2023). ChatGPT evaluation: Can it replace Grammarly and Quillbot tools? *British Journal of Applied Linguistics*, 3(2). <https://doi.org/https://doi.org/10.32996/bjal.2023.3.2.4>
2. Alharbi, W. (2023). AI in the Foreign Language Classroom: A Pedagogical Overview of Automated Writing Assistance Tools. *Education Research International*, 2023. <https://doi.org/10.1155/2023/4253331>
3. Bhatnagar, N. & Bhatnagar, M. (2012). *Effective communication and soft skills: Strategies for success*. Pearson Education & ICFAI University Press.
4. Chang, T. S., Li, Y., Huang, H. W., & Whitfield, B. (2021). Exploring EFL students’ writing performance and their acceptance of AI-based automated writing feedback. *2nd International Conference on Education Development and Studies*, 31–35. <https://doi.org/https://doi.org/10.1145/3459043.3459065>
5. Grassini, S. (2023). Shaping the future of Education: Exploring the potential and consequences of AI and ChatGPT in educational settings. *Educ. Sci.*, 13(7), 692. <https://doi.org/https://doi.org/10.3390/educsci13070692>
6. Lin, L. J. F. & Morrison, B. (2021). Challenges in academic writing: perspectives of Engineering faculty and L2 postgraduate research students. *English for Specific Purposes*, 63, 59–70. <https://doi.org/https://doi.org/10.1016/j.esp.2021.03.004>
7. Marzuki, Widiati, U., Rusdin, D., Darwin, & Indrawati, I. (2023). The impact of AI writing tools on the content and organization of students’ writing: EFL teachers’ perspective. *Cogent Education*, 10(2). <https://doi.org/https://doi.org/10.1080/2331186X.2023.2236469>
8. Moybeka, A., Syariatun, N., Tatipang, D., Musthoza, D. A., Dewi, N. P. J. L., & Tineh, S. (2023). Artificial intelligence and English classroom: The implications of AI toward EFL students’ motivation. *Edumaspul: Jurnal Pendidikan*, 7(2), 244402454. <https://doi.org/https://doi.org/10.33487/edumaspul.v7i2.6669>
9. Nazari, N., Shabbir, M. S., & Setiawan, R. (2021). Application of Artificial Intelligence powered Digital Writing Assistant in Higher Education: Randomized Controlled Trial. *Heliyon*, 7(5). <https://doi.org/https://doi.org/10.1016/j.heliyon.2021.e07014>
10. Ngo, T. T. A. (2023). The perception by university students of the use of ChatGPT in education. *International Journal of Emerging Technologies in Learning (IJET)*. <https://doi.org/https://doi.org/10.3991/ijet.v18i17.39019>
11. O’Neill, R. & Russell, A. M. (2019). Grammarly: Help or hindrance? Academic learning advisors’ perceptions of an online grammar checker. *Journal of Academic Language and Learning*, 13(1), A88–A107.
12. Selvaraj, M., & Aziz, A. A. (2019). Systematic Review: Approaches in Teaching Writing Skill in ESL Classrooms. *International Journal of Academic Research in Progressive Education and Development*, 8(4). <https://doi.org/10.6007/ijarped/v8-i4/6564>
13. Warshauer, M. & Grimes, D. (2008). Automated Writing Assessment in the Classroom. *Pedagogies: An International Journal*, 3(1), 22–36. <https://doi.org/https://doi.org/10.1080/15544800701771580>
14. Yan, D. (2023). Impact of ChatGPT on learners in an L2 writing practicum: An exploratory investigation. *Education and Information Technologies*, 28, 13943–13967. <https://doi.org/https://doi.org/10.1007/s10639-023-11742-4>
15. Zhan, X., Xu, Y. F. & Sarkadi, S. (2023). Deceptive AI ecosystems: The case of ChatGPT. *CUI '23: Proceedings of the 5th International Conference on Conversational User Interfaces*, 1–6. <https://doi.org/https://doi.org/10.1145/3571884.3603754>



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