



# I-CReST

INTERNATIONAL CONFERENCE ON RESEARCH  
AND PRACTICES IN SCIENCE, TECHNOLOGY  
AND SOCIAL SCIENCES

LEVERAGING TECHNOLOGICAL ADVANCES AND  
MULTIDISCIPLINARY RESEARCH FOR A SUSTAINABLE FUTURE IN EDUCATION

## PROCEEDING BOOK

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CAWANGAN SELANGOR  
KAMPUS DENGKIL  
MALAYSIA

22 JULY  
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## PREFACE



Assalamu'alaikum warahmatullahi wabarakatuh and greetings.

A warm welcome to this esteemed gathering of academicians, industry players, researchers, graduate students and all participants at the 4th [Virtual] International Conference on Research and Practices in Science, Technology and Social Sciences (I-CReST) 2023. The theme, “Leveraging Technological Advances and Multidisciplinary Research for a Sustainable Future in Education” provides us a path to embark on a journey of exploring a myriad of opportunities and possibilities for impactful academic sharing and networking. Such connectivity paves the way to transforming education through advances in technology, and providing overall enriching teaching and learning experiences for everyone in academia. The theme demonstrates our aspiration to make the best out of technological advances in empowering and making education more sustainable through collaborations in interrelated areas of expertise among scholars across various geographical settings. Education, particularly at institutions of higher learning, has been constantly revolutionised through the emergence of technology, changing its landscape rapidly into one that transcends beyond the physical boundaries. Leveraging technological advances, I-CReST enables us to come together for meaningful academic discourses and sharing of research findings and ideas.

This year’s conference is even more meaningful for all of us at the Centre of Foundation Studies UiTM Selangor Branch Campus Dengkil, as this online academic gathering is made possible through the collaboration with the Ibnu Sina Institute for Scientific and Industrial Research (ISI-SIR), Universiti Teknologi Malaysia (UTM). With a total of 235 abstracts and presentations of research work, the overwhelming responses that I-CReST has received is a testimony of the trust granted to us by the participants within and beyond Malaysia. To add to this, this virtual conference has the support from the Malaysian Zeolite Association (MyZA), with the provision of special awards as a recognition for the research work dedicated to zeolites and inorganic materials.

I would like to extend my utmost gratitude to the Director of the Centre of Foundation Studies, Professor Ir. Dr. Ahmad Farid Abidin, Ibnu Sina Institute for Scientific and Industrial Research, Malaysian Zeolite Association (MyZA), all participants, and especially to the ever-committed I-CReST 2023 Organising Committee, for the undivided support, hard work and contributions to make this conference an impactful and successful one.

Finally, on behalf of the I-CReST 2023 Organising Committee, thank you and welcome! Insha Allah, see you next year in I-CReST 2024.

Dr Fadiatul Hasinah Muhammad  
Chairperson  
I-CReST 2023



## FOREWORD

Assalamu'alaikum warahmatullahi wabarakatuh and greetings

It is a pleasure for us at the Centre of Foundation Studies, UiTM Selangor Branch Dengkil Campus, to welcome all esteemed members from diverse institutions to the 4th [Virtual] International Conference on Research and Practices in Science, Technology and Social Sciences (I-CReST) 2023. It is a privilege to have an array of experts from different backgrounds to collectively realise the conference's theme this year, "Leveraging Technological Advances and Multidisciplinary Research for a Sustainable Future in Education". This book of abstracts is one of the many clear manifestations of the unyielding efforts by everyone involved in I-CReST 2023.



In today's fast-evolving world, technological advancements such as interactive online platforms, virtual reality, and artificial intelligence are becoming a norm to improve accessibility and engagement in education. On a related note, the inseparability between education and research of different backgrounds means that multidisciplinary research can drive more collaborative and useful initiatives. Such initiatives have the potential to create solutions that better equip all the stakeholders with critical thinking and problem-solving skills to address growing global issues within and beyond the education world. By harnessing the power of both technology and multidisciplinary research, a more sustainable future in education can be realised. In short, the theme of I-CReST 2023 - Leveraging Technological Advances and Multidisciplinary Research for a Sustainable Future in Education - is not an elusive dream, but an attainable goal. The organisation of this conference can be the catalyst to turn this goal into reality.

I would like to express my heartfelt gratitude to the dedicated reviewers whose effort made it possible for the high-quality abstracts and manuscripts to be published, not only in I-CReST 2023 proceedings but also in the chosen established academic journals. The extensive work of the conference's committee members, headed by Dr. Fadiatul Hasinah Muhammad, should also be immensely applauded. I sincerely wish that everyone will find I-CReST 2023 a productive setting in materialising one's individual, institutional, national and global goals in education.

All the best and insya Allah, I am confident that I-CReST 2023 has already yielded fruitful outcomes and will continue to create more in the future.

Thank you.

Professor Ir Dr. Ahmad Farid Abidin @ Bharun  
Director  
Centre of Foundation Studies  
Universiti Teknologi MARA (UiTM)  
Cawangan Selangor  
Kampus Dengkil



## ABOUT THE CONFERENCE

The International Conference on Research and Practices in Science, Technology and Social Sciences (I-CReST) is an annual event organised by the Centre of Foundation Studies, Universiti Teknologi MARA (UiTM), Selangor Branch Dengkil Campus, Malaysia. With this year's theme, "Leveraging Technological Advances and Multidisciplinary Research for a Sustainable Future in Education", it aims to provide a constructive virtual avenue for researchers and scholars across the globe to network with each other via the presentation of their impactful research works. The conference focuses on providing a platform for the dissemination of research findings and intellectual discussions on diverse topics relating to utilising technological advances in empowering and making education more sustainable through collaborations in interrelated areas. This conference has a typical format of 20-40 minutes of sharings or presentations by plenary and keynote speakers, as well as invited presenters, who are experts in their respective fields. The slots are subsequently followed by the Q&A or discussion session. This conference has also made it possible for more presentations in the form of pre-recorded videos that are streamed via YouTube, thus promoting more academic engagement. Since its inaugural event in 2020, I-CReST has received tremendous positive responses from participants of various educational and industrial backgrounds. I-CReST 2023 garnered around 235 abstracts and presentations on cutting-edge topics within the scopes of science, technology and social sciences, as well as those of cross-disciplinary nature. The conference also provides opportunities for publication in proceedings with e-ISBN. Selected papers will be considered for publication in journals indexed by WOS/Scopus/MyCite/MyJournal after a thorough peer reviewed process.



## **THEME SYNOPSIS**

I-CReST 2023's main theme addresses **FOUR** (4) tracks to encourage scientific writing/publication across multidisciplinary research in the broad fields of the following.

### **Physical Sciences:**

Medical Physics; Nuclear Physics;  
Photonics; Optics; Spectroscopy; Device  
Physics; Material Science; Polymers;  
Nanotechnology; Solid State Ionics;  
Inorganic and Organic Chemistry; Natural  
Products Chemistry; Catalysis; Renewable  
and Sustainable Energy

### **Biological Sciences:**

Botany; Forestry; Ecology; Zoology;  
Entomology; Microbiology;  
Biotechnology; Genetics; Bioinformatics;  
Nutraceutical; Cosmeceutical;  
Pharmaceutical; Pharmacology;  
Biomedicine; Health Sciences

### **Information Technology, Engineering and Mathematics**

Human-Computer Interaction; Information Virtualization; Modelling and Simulation;  
Computer Security; Wireless and Mobile Communications; Software Engineering; Internet  
of Things; Data Analytics; Multimedia Computing; Information Retrieval; Electronic  
Learning; Artificial Intelligence and Machine Learning; Web Technology; Pure and  
Applied Mathematics; Mathematics Education; Mathematical Modelling; Mathematical  
Statistics; Fuzzy Mathematics and Applications; Operations Research

### **Social Sciences & Humanities**

Education/Pedagogy; Communication Arts; Information Communication;  
Linguistics/Neurolinguistics/Sociolinguistics; Literature and Poetry; Educational  
Management and Leadership; Early Childhood Education; Panicology; Civil Law;  
Economics and Financial Law; Human Right Law; Public Law; Islamic Law; Contract  
Law; Consumer Law; Comparative Law; Commercial Law; Competition Law;  
Constitutional Law; Environmental Law; Family Law



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AND SOCIAL SCIENCES

# PHYSICAL SCIENCES



## I-CReST 2023:089-049 - The Spinel Phase $\text{LiMnTiO}_4$ Doped with Yb as Potential Cathode for Rechargeable Lithium-ion Batteries

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### ABSTRACT

One of the challenges for improving the performance of lithium-ion batteries is the development of suitable cathode materials.  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  has shown promises, but improvements are needed to increase the capacity retention and its specific capacity. In this work, the self-propagation combustion method (SPC) is used to synthesis  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  and its doped with Ytterbium (Yb) and has produces single and pure phase materials. Thus, the essential features of materials synthesized using the SPC method, such as thermal behaviour and crystal structure were thoroughly investigated. Simultaneous Thermogravimetric Analysis (STA) was used to investigate the thermal characteristics of the parent materials,  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  in order to establish the optimal annealing temperature for doped material's phase formation. Based on the thermal profiles obtained, the annealing temperature for  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  with its doped materials,  $\text{LiMn}_{1.9}\text{Ti}_{0.099}\text{Yb}_{0.001}\text{O}_4$  were chosen at  $700^\circ\text{C}$ . X-Ray Diffraction (XRD) was used to investigate the structure for both materials and results revealed that both samples annealed for 24 hours at  $700^\circ\text{C}$  were pure and single phase. From the XRD results obtained, it shows doped Yb in  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  materials is a promising cathode material due to the pure compound and single-phase materials with stable temperature after  $500^\circ\text{C}$ . Thus, it shows a good potential to be used as a cathode material in lithium-ion batteries.

**Keywords:** Cathode; lithium-ion;  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$ ; ytterbium

### 1. INTRODUCTION

Lithium-ion secondary batteries are attractive energy storage devices due to their high energy density, long service life and design flexibility. They have become ubiquitous power sources for mobile applications such as personal electronics and laptop computers. The development of the lithium-ion battery with high capacity and rate capability was largely influenced by the performance of the electrode materials, especially the cathode materials. Common cathode materials used in lithium-ion batteries are layered  $\text{LiCoO}_2$  [1],  $\text{LiNiO}_2$  [2], the olivine  $\text{LiNiPO}_4$  [3], vanadate  $\text{LiNiVO}_4$  [4], spinel  $\text{LiMn}_2\text{O}_4$  [5] and the new spinel  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  [6]. Among these materials, the spinel  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  with tunnel structure for the migration of lithium ions

has been considered to be one of the best candidates because of its low cost, high voltage, nontoxicity, abundance and easy preparation [7]. Basically, the deployment of  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  cathode in practical devices is limited, as it suffers from poor capacity retention due to Jahn-Teller distortion induced metal dissolution.

To overcome this problem, substitution seems to be one of the way. One of the characteristics of transition metal is that it can be easily replaced by either lithium ion or other transition metal ions [8]. As such, substitution of titanium ion with other transition metal is thought to be one of the ways to improve this capacity fading. In this work, substitution of Ti with Ytterbium (Yb) is done by adding a small amount of Ytterbium (Yb) between 0.1 - 5.0 wt %. It is believed to increase the discharge capacity of the cell as its function most probably as to stabilize the structure and improving rechargeability [9].

The simple and conventional method to synthesize these powders is through the self-propagation combustion method (SPC) as it is very fast and gives a well crystalline powder. Thermogravimetric analysis/differential scanning calorimetry (TGA/DSC) analysis is a widely-employed technique for measuring the change in weight of sample as a function of temperature or time in controlled atmosphere [10]. Whereby, X-ray Diffraction (XRD) is another very powerful instrument to identify the structure of the synthesized samples.

In this work,  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  and  $\text{LiMn}_{1.9}\text{Ti}_{0.099}\text{Yb}_{0.001}\text{O}_4$  were prepared by the SPC method with triethanolamine as the combustion agent. Simultaneous Thermogravimetry Analysis (STA) was done for the parent sample, and X-ray diffraction (XRD) analysis were done for both samples as to investigate the thermal behaviour and structure of the samples that was prepared by this synthesis route. This is to determine fundamentally whether these samples have the potential to be used as a cathode material in lithium-ion batteries.

## 2. MATERIALS AND METHOD

### 2.1 Synthesis by Modified SPC Method (SPC)

The starting materials used are nitrates and oxides of the metal or the transition metals. For preparation of  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  and  $\text{LiMn}_{1.9}\text{Ti}_{0.099}\text{Yb}_{0.001}\text{O}_4$  material, lithium nitrate, (Sigma-Aldrich), manganese (II) nitrate hydrate 98% (Aldrich Chemistry), titanium (IV) methoxide 95% (Aldrich Chemistry), and Ytterbium oxide (Aldrich Chemistry) were used. Stoichiometric amounts of the starting materials were dissolved in deionized water and the combustion agent, triethanolamine (TEA) was added to the mixture. The mixture was then heated at 250°C until it combusts as it has reached its ignition conditions. Annealing process were done at 700 °C for 24 hours.

### 2.2 Characterization of Samples

The thermal decomposition of the parent precursor powder of  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  was done using SETARAM SETSYS Evolution 1750 (TGA-DSC 1500). The thermal analysis study includes both thermogravimetric analysis and heat flow analysis. The powder was heated from room temperature to 1100 °C in air with heating rate of 10 °C min<sup>-1</sup>. Then, the selected annealing temperature for samples powder were chosen based from the STA results. XRD was carried out on the annealed powders in order to confirm its structural properties. X-ray diffraction was performed on PANalytical Xpert Pro powder diffraction using Cu K $\alpha$  radiation.



### 3. RESULTS AND DISCUSSION

#### 3.1 Simultaneous Thermogravimetric Analysis (STA)

The thermal characteristics of materials are important as to study their behaviour when subjected to heat. This is to identify the different processes that occur at different temperatures and will eventually help to determine the most suitable annealing temperature. Fig. 1 shows the STA results for  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$ .

The thermal profile of  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  material is shown in Fig. 1. There are three distinct weight losses from the TG/DSC curves that can be observed marked as region I, II and III. The weight loss in region I of about 5.8 % occurring between about 80 °C to 175 °C. This first weight loss in the TG/DSC curve is attributed to the loss of residual water in the precursor. The small weight loss indicates that the precursor synthesized by SPC method is already quite dry. The second weight loss (II) occurs between 175 °C to 250 °C is about 14.9 %. This weight loss is attributed to the decomposition of triethanolamine still left in the precursor. The third weight loss, which is the largest mass loss, that is 60 %, occurred between 250 °C to 270 °C and is accompanied by a large exothermic peak. The total mass loss value is 80.7 %. From 250 °C to 1200 °C, a plateau is seen indicating that the material has been reduced to a stable form. From this region the annealing temperature is determined.

The choice of annealing temperature is very important and is chosen in consideration of obtaining suitably well-formed crystalline structures and at the same time Li should not vaporize from the material. Reduced unstoichiometric amounts of Li in the material will not be good as less amount of Li means less ions will intercalate-deintercalate within the system.

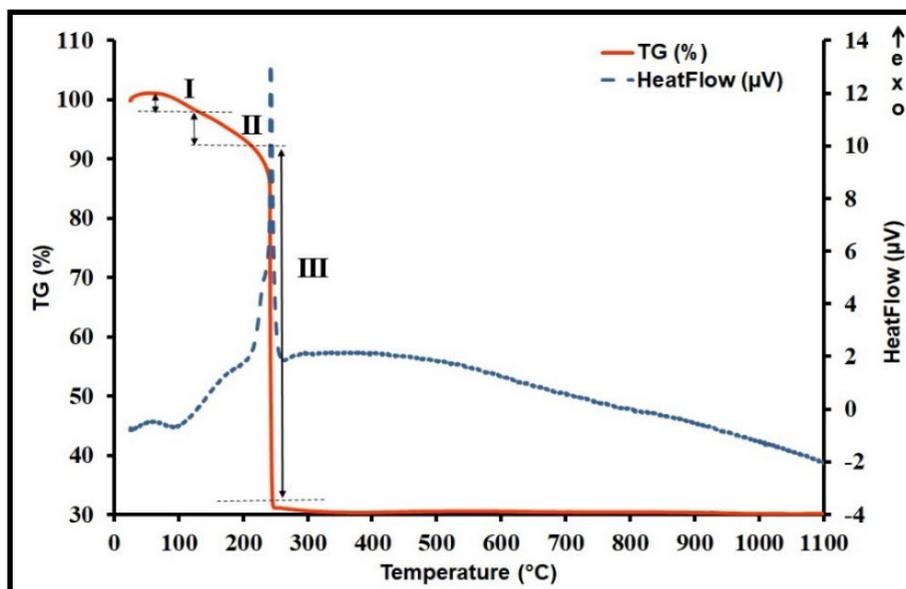


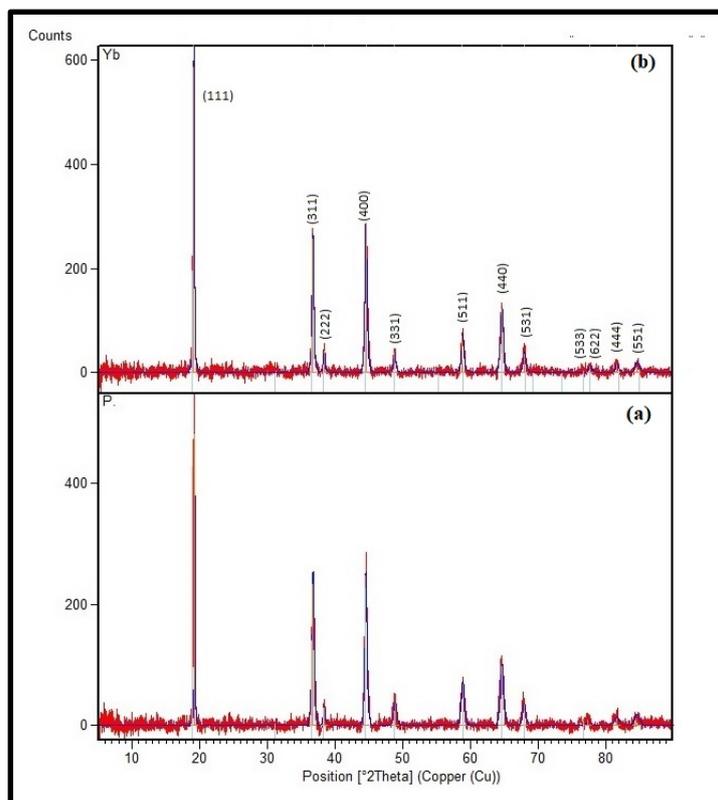
Fig. 1. STA results for  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  sample

#### 3.2 X-Ray Diffraction (XRD)

The X-ray diffraction pattern (XRD) of  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  and doped  $\text{LiMn}_{1.9}\text{Ti}_{0.099}\text{Yb}_{0.001}\text{O}_4$  annealed at 700 °C for 24 hours are shown in Fig. 2. Both samples show a well-defined spinel crystal structure. This shows that Ytterbium ion has successfully substituted in the parent



$\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  structure. All diffraction lines can be indexed and it is in good agreement with the ICDD No. 00-035-0782 indexing from the XRD. It can be clearly observed that the entire fingerprint peaks (111), (311), (222), (400), (331), (511), (440), (531), (533), (622), (444), and (551) are easily identifiable in the XRD patterns. All the diffraction peaks can be indexed with face centered cubic type structure based on spinel crystal system with space group of  $Fd\bar{3}m$ .



**Fig. 2.** XRD results for (a)  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  and (b)  $\text{LiMn}_{1.9}\text{Ti}_{0.099}\text{Yb}_{0.001}\text{O}_4$  samples

It can be seen that in Fig. 2, both materials annealed at 700 °C for 24 hours shows different amount of Yb substituted into Ti that gives different effect on the first peak of the XRD pattern. The first peak of the XRD pattern indicates the crystallinity of the materials. It can be seen doped Yb has higher intensity count compared to parent  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  that is over 600 whereas  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  is around 500. This shows that the substitution does affects the crystallinity of the cathode materials.

#### 4. CONCLUSION

The spinel  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  and doped  $\text{LiMn}_{1.9}\text{Ti}_{0.099}\text{Yb}_{0.001}\text{O}_4$  powders were successfully synthesized by the self-propagation combustion method (SPC) with triethanolamine as the combustion agent. TGA/DSC results showed that the  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  powder can be obtained by annealing the precursor at above 500 °C. The samples annealed at 700 °C for 24 hours showed that the position of peaks and the variation in intensities matches the pattern shown in the standard ICDD data. From the XRD results, the diffraction peaks for both samples can be indexed with face centered cubic type structure based on spinel crystal system. The analysis of XRD clearly showed highly crystalline spinel structures which is among the main factors contributes in obtaining high specific capacities and good cycling materials.

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## I-CReST 2023:092-057 - Synthesis and Characterisation of $\text{LiMn}_{1.9}\text{Ti}_{0.09}\text{Ce}_{0.01}\text{O}_4$ for Cathode Lithium Ion Battery

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### ABSTRACT

Spinel  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  compounds undergo significant capacity fading upon repeated charge-discharge cycling. Due to this difficulty, its anatomic and morphological properties as well as its electrochemical performance can be improved by doping. In this work, the doping of  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  with Cerium (Ce) is performed using the self-propagating combustion (SPC) method. The driving force for this work is to obtain a pure single-phase structure. The SPC method yields single-phase and pure-phase materials. Therefore, fundamental properties such as thermal behaviour, structural and particle size of samples synthesized by SPC method have been studied in details. The thermal properties of the materials were studied by Simultaneous Thermogravimetric Analysis (STA) as to determine the suitable temperatures for phase formation that is 700 °C. The annealing temperature of  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  containing the doped material  $\text{LiMn}_{1.9}\text{Ti}_{0.1-x}\text{Ce}_x\text{O}_4$  ( $x = 0.01$ ) was chosen based on the thermal profile of the samples. All material phases were investigated by X-ray Diffraction (XRD). XRD showed that all samples annealed at 700 °C for 24 hours were pure and single phase. Thus, the doped  $\text{LiMn}_{1.9}\text{Ti}_{0.09}\text{Ce}_{0.01}\text{O}_4$  material has emerged as a good candidate for the cathode materials.

**Keywords:** Cathode; lithium-ion;  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$ ; cerium

### 1. INTRODUCTION

Research in the field of rechargeable lithium-ion batteries has progressed tremendously in the past decade with an increasing demand for portable electronic devices, such as laptop computers and mobile phone, offering batteries with high energy density, flexible and lightweight as well as longer service life [1][2]. Among the various types of batteries, lithium-ion batteries are the most appealing due to their low cost and 40 years of technological development [3][4].

The common materials used for making cathode are lithium manganese oxide, lithium cobalt oxide, lithium nickel cobalt manganese oxide, lithium ion phosphate, and electronic conducting polymers [5]. Lithium cobaltate and lithium nickelate have successfully carved a

niche in this growing battery market over the past decade. However, Co and Ni are toxic chemicals [1]. Other non-toxic, environmentally friendly and low-cost materials with specific capacities close to those of Co-based batteries have been intensively studied to replace these cathode materials.

Lithium manganese oxide spinel  $\text{LiMn}_2\text{O}_4$  has advantages such as non-toxicity, excellent properties, environmental friendliness, abundant nature, low cost, etc., and has a theoretical specific capacity of  $148 \text{ mAh g}^{-1}$  [6]. Lithium manganese spinel has been the subject of intensive research for the past 40 years. However, it has the major drawback of premature loss of capacity, especially at high temperatures. This is because manganese compounds become unstable and break bonds to form different compounds. This structural damage is due to the Jahn-Teller strain [7]. This is the reason why the capacitance tends to decrease during high temperature annealing.

In this study, doping a small amount of Cerium, Ce in Titanium, Ti is one of the ways to improve its specific capacity. Ce is the most abundant of the rare earth elements. It makes up approximately 0.0046% of the Earth's crust by weight [8]. Ce is primarily obtained from the major lanthanide ores, but some is obtained from perovskite, titanium mineral, and allanite, both of which contain sufficient Ce to be viable sources. Production currently stands at 23,000 tons annually per year, but this Fig. is expected to rise as more Ce is used. This is because Ce is a rare chemical that can be found in household items such as televisions, fluorescent lamps and energy-saving lamps [9].

The method used to synthesis of cathode materials for lithium-ion battery is self-propagating combustion (SPC) method. The SPC method has the advantages of short production cycle, fast heating rate, short response time, low energy consumption, low temperature and low cost [10]. This method also achieves better material properties, such as greater surface mechanical properties, higher purity, more uniform particle size and microstructure, and a simpler and faster method to obtain the final precursor at relatively low cost. Furthermore, SPC synthesis requires simple equipment and the production of highly pure and homogeneous final products. The particle size obtained is often in the nano range, but this depends on the duration and firing process.

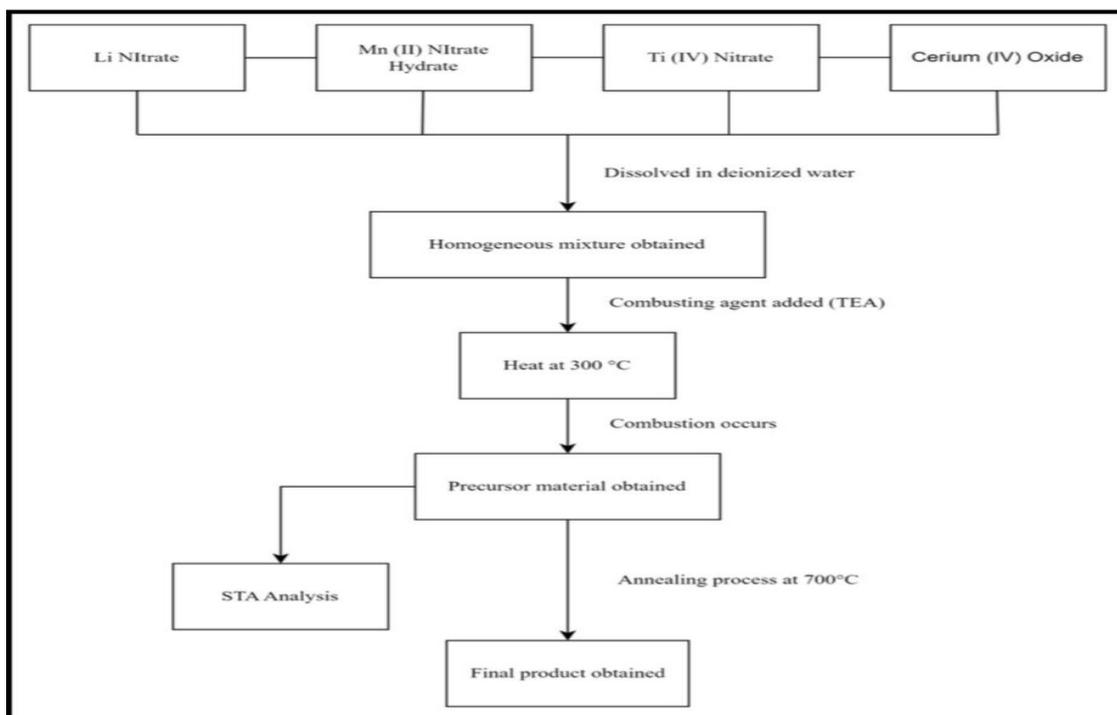
This work also includes the effect of annealing temperature on the materials with temperature of  $700 \text{ }^\circ\text{C}$ . For material characterization, Simultaneous Thermogravimetric Analysis (STA) provides information on thermal stability and composition of the starting materials while X-Ray diffraction (XRD) is used to determine the structure and degree of crystallinity of the sample.

## 2. MATERIALS AND METHOD

### 2.1 Synthesis by Modified Self Propagating Combustion Method (SPC)

The spinels  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  and  $\text{LiMn}_{1.9}\text{Ti}_{0.09}\text{Ce}_{0.01}\text{O}_4$  were synthesized using self-propagating combustion (SPC) method as shown by flow chart in Fig. 1. The starting materials used were lithium nitrate, (Sigma-Aldrich), manganese (II) nitrate hydrate 98% (Aldrich Chemistry), titanium (IV) nitrate 95% (Aldrich Chemistry), and cerium (IV) oxide (Aldrich Chemistry). Stoichiometric amounts of the starting materials were dissolved in deionized water and the combustion agent, triethanolamine (TEA) was added to the mixture. Then, it was heated up to  $300 \text{ }^\circ\text{C}$  until combustion occurs meaning it has reached its ignition conditions. The precursor

material was analyzed using STA to determine its thermal properties. The materials were annealed at 700 °C for 24 hours and grinded to obtain the final products.



**Fig. 1.** Flow chart of the process of self propagating combustion method (SPC)

## 2.2 Characterization of Samples

The methods used for characterization of the samples were Simultaneous Thermogravimetric Analysis (STA) and X-Ray Diffraction (XRD). Thermogravimetric was a technique that involves continuously weighing a sample while the sample is heated at a constant, preferably linear, rate. The resulting mass-to-temperature curves provide information on the thermal stability and composition of the primary sample, the composition and thermal stability of the intermediates, and the composition of the residue. In this study, the thermal decomposition of the parent precursor powder of  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  was done using SETARAM SETSYS Evolution 1750 (TGA-DSC 1500). The thermal analysis study includes both thermogravimetric analysis and heat flow analysis. The powder was heated from room temperature to 1100 °C in air with heating rate of 10 °C  $\text{min}^{-1}$ . Then, the selected annealing temperature for samples powder was chosen based from the STA results.

X-Ray diffraction (XRD) was carried out on the annealed powders in order to confirm its structural properties. This method was performed on PANalytical Xpert Pro powder diffraction using  $\text{Cu K}\alpha$  radiation. In a cathode ray tube, an X-ray source was produced by heating the filament to produce electrons. By applying a voltage, these electrons were accelerated towards a target and bombard the target material. The target material's inner shell electrons are displaced by electrons of sufficient energy to produce characteristic X-Ray spectra. When the sample and detector were rotated, the intensity of the reflected X-Ray was measured. All diffraction patterns were recorded in a detector, which processes the X-Ray signals before converting them

to a count rate. The polycrystalline sample has a diffraction pattern that includes every possible peak because it has so many crystallites.

### 3. RESULTS AND DISCUSSION

#### 3.1 Simultaneous Thermogravimetric Analysis (STA)

The thermal characteristics of materials are important as to study their behaviour when subjected to heat. This is to identify the different processes that occur at different temperatures and will eventually help to determine the most suitable annealing temperature.

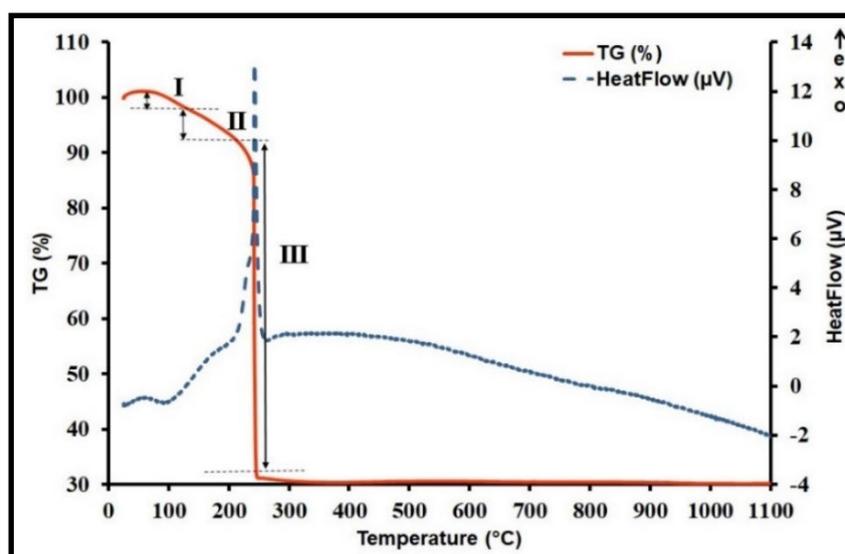


Fig. 2. STA results for  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  sample

The STA results that represent thermal profile of  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  sample is shown in Fig. 2. There are three distinct mass losses from the TG/DSC curves that can be observed labelled as region I, II and III. The mass loss in region I is about 5.8 % occurred between temperature 80 °C to 175 °C. This first mass loss in the TG/DSC curve is attributed to the loss of residual water in the precursor. The precursor synthesized by the SPC method is already quite dry thus contributed to a small mass loss. In region II, the mass loss occurred between temperatures 175 °C to 250 °C is about 14.9 %. This second mass loss is attributed to the degradation of triethanolamine (TEA) that still present in the precursor while the third mass loss in region III, which is the largest (60 %), occurred between 250 °C to 270 °C. It is accompanied by a large exothermic peak. The total mass loss value is 80.7 %. A plateau is seen between 250 °C to 1200 °C indicates that the material has been reduced to a stable state.

From this region the annealing temperature can be determined. The choice of annealing temperature is very important and is chosen in consideration of obtaining suitably well-formed crystalline structures while preventing Li to vaporize from the material. Reduced unstoichiometric amounts of Li in the material will be detrimental electrochemical properties of the material.



### 3.2 X-Ray Diffraction (XRD)

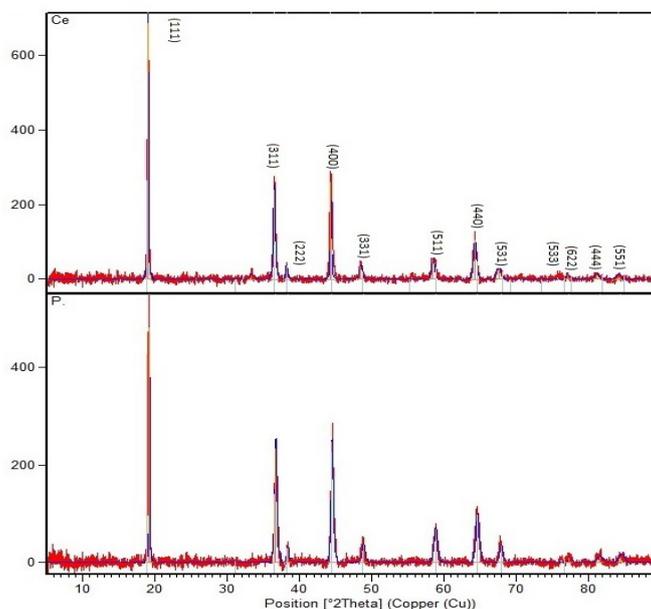


Fig. 3. XRD results for a)  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  b)  $\text{LiMn}_{1.9}\text{Ti}_{0.09}\text{Ce}_{0.01}\text{O}_4$

The X-ray diffraction pattern (XRD) of  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  and doped  $\text{LiMn}_{1.9}\text{Ti}_{0.09}\text{Ce}_{0.01}\text{O}_4$  are shown in Fig. 3. This XRD pattern was obtained by scanning from 10 to 80 degrees with a scan rate of  $2\theta \text{ min}^{-1}$ . Both samples are annealed at  $700^\circ\text{C}$  for 24 hours. Samples showed a well-defined spinel crystal structure that attributed Cerium (Ce) ion has successfully substituted in the parent  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  structure. All diffraction lines can be indexed which in good agreement with the ICDD No. 00-035-0782 indexing from the XRD. It is clearly observed that the entire fingerprint peaks of (111), (311), (222), (400), (331), (511), (440), (531), (533), (622), (444), and (711) are easily identified in the patterns. All the diffraction peaks can be indexed with face centered cubic type structure based on spinel crystal system.

Based on the results, both materials that annealed at  $700^\circ\text{C}$  for 24 hours showed different amount of Ce substituted into Ti create different effect on the first peak of XRD pattern. This phenomenon indicates the crystallinity of the materials. Furthermore, it can be also observed that the doped of  $\text{LiMn}_{1.9}\text{Ti}_{0.09}\text{Ce}_{0.01}\text{O}_4$  presents higher intensity ( $> 600$  counts) compared to parent  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  ( $\sim 500$  counts) proved the substitution does affects the crystallinity of the cathode materials.

## 4. CONCLUSION

In conclusion, spinel  $\text{LiMn}_{1.9}\text{Ti}_{0.1}\text{O}_4$  and  $\text{LiMn}_{1.9}\text{Ti}_{0.09}\text{Ce}_{0.01}\text{O}_4$  powders have been successfully synthesized by self-propagation combustion method, (SPC). TGA/DSC results showed  $\text{LiMn}_{1.9}\text{Ti}_{0.09}\text{Ce}_{0.01}\text{O}_4$  powder can be obtained by annealing a precursor above  $500^\circ\text{C}$ . Annealing the compounds at  $700^\circ\text{C}$  for 24 hours results the position of peaks and the variation in intensities matches the pattern shown in the standard ICDD data. Based on the XRD results, the diffraction peaks for both samples can be indexed and show highly crystalline spinel structures which contributed in obtaining high specific capacities and good cycling materials.

## ACKNOWLEDGEMENT

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## I-CReST 2023:178-286 - The Development of Low Clay Whitewares using Prefired Material

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### Abstract

The development of anti thermal shock whiteware ceramic bodies using a prefired material as the main ingredient. The prefired material used was a newly constructed mixture of selected mineral oxides. After firing at the peak temperature of 1300°C with 180 minutes soaking it exhibited a low CTE value of  $4.4 \times 10^{-6}$  per °C and developed dense regions of sufficient size which were large enough to produce the aggregates. In this study, a whiteware ceramic body was formulated with 75 wt. % prefired material of two median sizes and plastic-bonded with 25 wt. % clay which comprised of equal proportion of a kaolin and ball clay. At the fired lower temperature of 1050°C with 60 minutes soaking, the formulated body showed a low CTE value of  $4.6 \times 10^{-6}$  per °C. The fired formulated body was also found to have 1.9% water absorption, significant translucency and good whiteness as well as passed the quench test.

**Keywords:** Anti-thermal shock whiteware; prefired material; thermal shock resistant

### 1. INTRODUCTION

The modern day applications of triaxial ceramics (t-ceramics) require special functional properties. One of the most important is thermal shock resistance or ‘flameproof’ behaviour. As brittle products these ceramics are susceptible to thermal shock failure when exposed to sudden temperature changes. Any product which has a positive thermal expansion and high compressive strength will rarely fails on heating. Conversely, on cooling the surface is subjected to tensile stress and as the tensile strength of the product is relatively low the failure rate is increased. Hence, low thermal expansions are associated with products having high thermal shock resistance since relatively small stresses are involved [1]. Ideally products with zero thermal expansion over a wide temperature range would be preferred except for the obvious disadvantage for earthenware products of not being able to obtain a satisfactory ‘glaze fit’. The usual percentage expansion of t-ceramics may vary from 0.25% to 0.45% over the temperature range 20° to 500°C. It seems, therefore, that thermal expansion is the most important factor in the control of thermal shock resistance.

To obtain low CTE values the resultant constituents developed on heat treatment of the prefired material body formulation must mainly consisted of crystalline phases having low CTE values such as anorthite ( $\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$ ), mullite ( $3\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$ ) and, diopside ( $\text{CaO} \cdot \text{MgO} \cdot 2\text{SiO}_2$ ) and cordierite ( $2\text{MgO} \cdot 2\text{Al}_2\text{O}_3 \cdot 5\text{SiO}_2$ ). Apart from that the use of a sufficiently dense and an appropriately sized-grained of the prefired material in the final body composition is also expected to increase the fired density and packing efficiency. Subsequently, these will leads to higher strength and, if the grain size of the crystalline phases formed are

larger and whiter, improve translucency and whiteness. Constituted bodies with much lower CTEs will exhibit improved thermal shock resistance (an inversely proportion) or ‘flame proof’ behaviour. A high thermal shock resistant body will be safe to use directly over a gas flame or an electric burner as well as in the oven and even in the microwave. The higher strength will enables safe usage in the dishwasher and, if durable, can be cleaned with metal pads or utensils without scratching or scraping.

In this R&D work an innovative flameproof whiteware ceramic body formulation has been developed constituting only of the newly developed prefired material as the major component and smaller amount of clay. Wood, R. K. (1991) [2] defined whiteware ceramics as highly dense or low glassy phase content or high crystalline to glassy phase ratio, fired products consisting of glazed or unglazed ceramic bodies that are commonly having high degree of whiteness, translucent, high strength and of fine texture. The use of less clay in this formulation will reduce the anisotropic shrinkage of the body when fired without greatly affecting the reactivity of the mixture [3]. The appropriately processed and fabricated test bodies were then subjected to inventive heat treatments at several peak temperatures, which were much lower compared to the conventional firings of premium whiteware ceramics. The materials processing, characterization, formulations, preparation and fabrication techniques and fired properties observed are discussed as below.

## **2. EXPERIMENTAL**

### **2.1 Body Constitution**

#### **2.1.1 The Prefired Material**

The materials selected for constructing the new prefired formulation were industrial grade powders of calcium carbonate ( $\text{CaCO}_3$ ) and magnesium oxide ( $\text{MgO}$ ), high purity finely-ground natural silica sand ( $\text{SiO}_2$ ) and a reagent grade of very low iron-content aluminium oxide ( $\text{Al}_2\text{O}_3$ ) powder. The  $\text{CaCO}_3$  and  $\text{SiO}_2$  were local commercial commodities. The chemical analyses of the component materials are as presented in Table 1. All the selected ingredients are fairly cheap materials which are easily and as well as readily available in the local market.

The developed batch recipe for the prefired material was derived based on the calculation of the anticipated equilibrium final crystalline phases or crystals formation after heat treatment. The expected crystals formed in the heat-treated prefired material body, based on stoichiometric preferential crystals formation, were diopside, anorthite ( $\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$ ) and mullite ( $3\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$ ). The calcium carbonate powder will provide  $\text{CaO}$  in the reaction mixtures for the formation of diopside and anorthite.

Apart as a flux, the inclusion of magnesia in the batch constitution will also promote the formation of diopside. With more than sufficient content of silica in the batch constitution will likewise allow the formation of mullite with the alumina not consumed to form anorthite. The adopted batch recipe or mix formulation is as shown in Table 2.

**Table 1.** Chemical composition of raw materials

Raw materials	Constituents (wt. %)										
	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	K <sub>2</sub> O	Na <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	MgO	CaO	MnO	TiO <sub>2</sub>	LOI
Calcium Carbonate	0.47	0.13	0.07	0.02	0.06	0.03	1.2	58.1	0.01	0.03	39.8
Magnesium Oxide*	0.2	0.15	0.12				98.7	0.87			
Silica Sand	99.4	0.31	0.02					0.02	0.02	0.06	0.18
Aluminium Oxide*	0.05	99.8	0.03		0.1			0.04			

Based on the calculation of equilibrium phase makeup after heat-treatment, the presence of about 5 gm of MgO will formed about 27 gm of diopside with about 7 gm of CaO and about 15 gm of SiO<sub>2</sub>. Likewise the remaining about 3 gm of CaO with about 5 gm of Al<sub>2</sub>O<sub>3</sub> and about 6 gm of SiO<sub>2</sub> will formed about 13 gm of anorthite. Similarly the remaining about 33 gm of Al<sub>2</sub>O<sub>3</sub> will formed about 46 gm of mullite with about 13 gm of SiO<sub>2</sub>.

It is expected that the glassy phase or silica-rich glass will be formed while firing and as such the equilibrium constitution will not be entirely achieved. Nevertheless, if the heat treatment is sufficiently fitting, along with the presence of excesses MgO, Al<sub>2</sub>O<sub>3</sub> and SiO<sub>2</sub>, if any, cordierite crystals is also expected to develop in the fired matrix.

**Table 2.** The adopted batch recipe

Material	%
Calcium carbonate	~ 17.0
Magnesium oxide	~ 5.0
Silica sand	~ 40.0
Aluminium oxide	~ 38.0

## 2.1.2 The Whiteware Ceramic Body

The whiteware ceramic body was constituted using the selected prefired material as the major constituent and local clays as minor components. The clays used comprised of an equal mixture of a ball clay and a kaolin. The high plastic and low iron kaolinitic ball clay used was received from a supplier operating from Trong area in the state of Perak.

## 2.2 Body Preparation

### 2.2.1 The Prefired Material

The prefired material was produced by intimately mixing together the component materials according to the adopted batch recipe. Each material used was weighed-out 'dry' and mixing was done 'wet' with 30 volume percent of solid (30v/o). The slurry obtained was fast-milled for 30 minutes with porcelain grinding media and then poured into a plaster of Paris mould through a muslin cloth placed on the surface of the mould. The semi-dried cake produced was dried further in an oven at 110°C for 24 hours. The dried and soft cake was broken down into powder, mixed with 0.3% CMC powder, and then granulated with water (water content up to the desired level required for plastic pressing). The moist granules were screened through the 850 and 250 µm sieves. The - 850 + 250 µm size fraction granules were placed loosely in refractory crucibles and fired to the predetermined profiles. The fired granules compressed into freely friable lumps which can be removed easily from the crucibles. The lumps were then

milled below 500  $\mu\text{m}$  using a jaw crusher and further reduction of size carried out using a stainless steel pestle in a stainless steel mortar.

In this R&D, the prepared powdered prefired material was pulverised further and sieved into finer two median sizes viz. - 90 + 45  $\mu\text{m}$  (considered as coarser fraction) and - 45  $\mu\text{m}$  (finer fraction). Both fractions were used as body components on a 50-50 basis.

### 2.2.2 The Whiteware Ceramic Body

The whiteware ceramic body was formulated with 75 wt.% prefired material and 25 wt.% clay. The use of less clay in this formulation will reduce the anisotropic shrinkage of the body when fired without greatly affecting the reactivity of the mixture [8]. The materials used were separately weighed-out 'dry' and mixing was done 'wet' with 30 volume percent of solid (30v/o). The slurry obtained was fast-milled for 30 minutes with porcelain grinding media, sieved at 250  $\mu\text{m}$  and the undersized then poured into a plaster of Paris mould through a muslin cloth placed on the surface of the mould. The semi-dried cake produced was dried further in an oven at 110°C for 24 hours. The dried and soft cake was then broken down into powder materials using a porcelain pestle in a porcelain mortar. In producing test buttons or cylindrical pellets of 25 mm and 31.25 mm diameters, some of the powdered materials were granulated with water and then uniaxially pressed in a stainless steel die by means of a hand-operated hydraulic press at 40 MPa. The compacted powders were placed in alumina crucible and sintered at 1050°C, 1100°C, 1150°C, 1200°C and 1250°C for 1 h soaking with similar heating rate of 4 °C/min.

The chemical composition of starting raw materials were determined using X-ray fluorescence (XRF, Shimadzu 1700, Japan). X-ray diffraction (XRD) was carried out to identify the phases present in the sintered bodies using Bruker equipment (Bruker AXS D8 Advance, Germany). The sintered bodies were further examined by measuring some of their physical properties such as linear shrinkage, water absorption, bulk density and flexural strength according to the standard methods as described in ASTM C373. The CTE values of the prepared test pieces (cut and polished from the fired 31.25 mm buttons) were measured using Linseis L75/N1 Dilatometer and the quench tests on the fired 25 mm buttons were carried out by water quench methods according to DIN EN820-3:2004

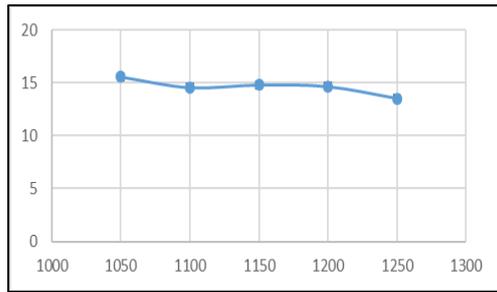
## 3. RESULTS AND DISCUSSION

The crystalline phases and measured CTE values at the various peak temperatures based on the prescribed firing profile are as shown in Table 3. Fig.1 and 2 shows the behaviour of the linear firing shrinkage and water absorption as a function of temperature. The linear firing shrinkage slightly increases depending on the degree of sintering up to firing temperature reaching the optimum sintering temperature which corresponds fittingly to their volumetric densification [3]. At the higher temperature, the percentage of shrinkage is higher resulting the sample is more compacted compare to another sample. The water absorption decreases with increase in sintering temperature due to reduction of the apparent porosity through the liquid phase sintering [5]. Hence, the degree of absorption of water of the sample is low. Therefore, the higher the firing temperature, the lower the degree of water absorption of the body.

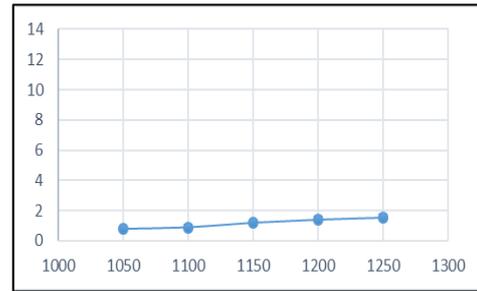


**Table 3.** Crystalline phase and CTE values

Firing Temp. (°C)	Crystalline Phase					CTE values (x 10 <sup>-6</sup> per °C)
	Mullite	Anorthite	Diopside	Cordierite	Cristoballite	
1050	✓	✓	✓	✓	✓	4.6
1100	✓	✓	✓	✓	✓	6.2
1150	✓	✓	✓	✓	✓	5.3
1200	✓	✓	✓	✓	✓	6.6
1250	✓	✓	✓	✓	✓	5.2



**Fig. 1.** Linear shrinkage of whitewares



**Fig. 2.** Water absorption of whitewares

An aim of this R&D work was to develop on various heat treatments the resultant constituents of the prefired material body formulation mainly consisted of crystalline phases having low CTE values. The fired constitution of the buttons examined by XRD detected main body constitution anorthite, diopside, mullite and cristobalite as the main crystal phases (Table 3). The cristobalite is considered to come from unreacted silica which had been transformed or an intermediate silica-rich glassy phase in the heat treatment. The presence of cristobalite can also be taken as indicating reactivity of the reaction. Diopside and anorthite was detected in all the fired bodies. Expectedly the measured CTE values of the prefired material at the selected most severe firing condition were quite high as can be seen in Table 3). At the lowest CTE value recorded (heat-treated at 1050°C for 60 min) Mullite, cristobalite and unreacted silica were the minor crystalline phases detected in all the heat-treated body constitution. Although anorthite phase will also provide lower CTE value, it has refractive index close to the glassy matrix and this could lead to the translucencies observed in matrices of the bodies fired at all the peak temperatures. The mullite phase will confers strength and the resistance to pyroplastic deformation

#### 4. CONCLUSION

The newly constituted prefired material exhibited lower CTE value, better translucency and highly crystalline than the previous formulation. It have been shown that using this prefired material as the main ingredient in the development of a whiteware ceramic has produced a body, which was fired at much lower temperature, with a low CTE values, dense, white, translucent and as such largely suitable for flameproof applications.

This newly developed bodies demonstrate technological properties that are significantly viable for making commercial prefired products. However improvements in body materials and formulations are necessary to further enhance these properties and other characteristics, if any, required by the industry. Other whiteware ceramic batch recipes will be formulated using lesser or more clay component, probable substitution of the existing clay materials and the application

of lower or higher peak temperatures. These future works are to obtain bodies of much superior characteristics that can suitably be produced and commercialized.

## ACKNOWLEDGEMENTS

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## I-CReST 2023:195-150 - Physical Properties of Fired Clay Brick Adding Waste Material as Fluxing Agent

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### ABSTRACT

The development of fired clay brick (FCB) by utilizing waste materials has significantly decreased the usage of the primary source of FCB, which is clay soil (CS). The main objective of this study is to reduce the utilization of clay soils as the constituent component in the FCB making process. In addition, other waste materials such as soda lime silica (SLS) glass and seashells (SS) were added into the mixture. The mixture contains CS, SLS and SS was mixed using the empirical formula of  $(1-x) [40 \text{ SLS} - 60 \text{ CS}] : x (\text{SS}) = 0, 10, 20, 30, \text{ and } 40 \text{ wt\%}$ . 21% of water was added into a batch of 40 g mixture. The admixtures were blended thoroughly, moulded into a rectangular brick shape, and dried for 48 hours before the sintering process at 850 °C using an electrical furnace. The physical properties of FCB were examined as a function of the SS content in the form of apparent density, water absorption, apparent porosity and apparent specific gravity. As a result, the apparent density and water absorption of the FCB increased from 1.912 g cm<sup>-3</sup> to 2.306 g cm<sup>-3</sup> and 12.29% to 18.16% respectively. The apparent porosity percentage and apparent specific gravity decreased from 86.87% to 25.17% and 2.92 g cm<sup>-3</sup> to 1.94 g cm<sup>-3</sup> with an increase of SS content. Thus, the incorporation of SS as CS replacement in FCB could improve and enhance physical developments of bricks and has demonstrated a good finding of the SS as a potential replacement in FCB.

**Keywords:** Clay brick; clay soil; waste materials; soda lime silica glass; seashells

### 1. INTRODUCTION

The numerous examples that can be discovered all over the world that have endured centuries of difficult climatic conditions and wars serve as proof that clay bricks, one of the earliest artificial building materials made by humanity, have proven to be easy to make, tough, and long-lasting. Clay bricks are a common building material. However, more and more clay soil, a non-renewable resource, is being used as the demand for clay bricks increases [1][2]. In addition, the energy required to produce bricks by firing has disadvantages that have led to the development of alternative brick-making processes for improved energy conservation. Since blazing bricks have the disadvantages of consuming a lot of energy, alternative brick-making methods have been developed to achieve better energy conservation [3]. In order to protect the environment and promote sustainable development, many scientists have recently investigated the possibility of making bricks from waste materials [4][5]. Besides that, the use waste materials benefits the economy, the environment and landfill disposal cost [6][7][8]. According to the statistics disclosed by the Ministry of Housing and Local Government (MHLG, 2000), high-income districts such as PetalingJaya and Kuala Lumpur produce an

average amount of organic waste that of almost 48.32%. Paper (23.56%), plastic and rubber (9.57%), metal (59.3%), wood (4.82%), glass and ceramics (4.03%), and textiles (3.97%) [9].

Previous studies on the use of recycled paper in brick manufacture resulted in a brick density reduction of up to  $1.28 \text{ g cm}^{-3}$  [10]. This study will focus on making FCBs from Malaysia's common waste materials that are soda lime silica glass and seashells. In Malaysia, seashells (SS) are a common by-product of the seafood industry and also easily found around the Malaysia beach [11]. Worldwide, 45,000 tonnes of trash seashells are produced annually [12]. Bricks made of clay are simply made by combining clay and water. The development of hardening methods, from sun drying to industrial ovens, allowed strength and durability to increase. Although inadequate raw materials and usage contamination initially decreased the longevity of clay brick, modern urban pollution and incorrect material use accelerate the decay of already-existing bricks, which adds to the overall lack of maintenance found in most buildings.

However, only by understanding how bricks degrade can various techniques and materials be developed to modify these bricks and extending their life lifespan. Since it is difficult to dispose of due to their strong properties, most bricks are sent to landfill where they naturally degrade. Thus, the improper disposal of FCBs has led to serious environmental problems such as land occupancy and greenhouse effects. Studies of using clay soil as a partial sand substitute showed an improvement in material strength. However, several studies are still being conducted to demonstrate the use of waste materials as a replacement for clay soil in manufacture of FCBs from burned industrial waste. Standard burned clay bricks must be made by mixing water, quartz sand, and clay soil [6]. The drying process will then begin, typically taking more than 5 to 7 days of exposure to sunlight for drying to be fully completed. This prolonged drying process aims to prevent the FCBs from cracking due to a rapid cooling process. After that, the dry brick was then placed in a kiln to be fired at temperature up to  $1200 \text{ }^{\circ}\text{C}$ . In contrast, the conventional method of making FCBs will take almost one day while modern technology only needs 2 to 5 hours to complete the firing process using an electrically powered furnace [6]. Soda lime silica glass was added into the mixture to lowering the firing temperature. The purpose of this study is to determine the suitability of seashells as a partial substitute of clay, its impact on physical properties, and to introduce the usage of seafood industrial waste materials with green environment.

## 2. MATERIALS AND METHODOLOGY

In this study, the experimental work was divided into three parts: (1) preparation of raw materials, (2) preparation of Fired Clay Bricks (FCBs), and (3) testing methods for the physical properties of FCBs.

### 2.1 Raw Materials

The starting materials used in this study were water, seashells (SS), soda lime silica glass (SLS), and clay soil (CS). The processes clays soil was obtained from Xstream Craft Deco N Pottery in Kuala Kangsar, Perak. Clay soil was stored in a chiller to retain the moisture of the clay soil. The seashells were obtained and collected from a beach near Dungun, Terengganu. After that, it is washed with tap water thrice to remove the dirt, and sun-dried for one day to prevent of any moisture. Next, the seashells were grinded using a heavy-duty blender and sieve using a 2 mm sieve. The soda lime silica glass (SLS) was acquired from used glass bottles. It was then

washed with tap water thrice to eliminate dirt and ultimately with distilled water for a complete cleanliness. Cleaned thoroughly with distilled water after being washed three times with tap water to eliminate dirt. Then, the glass bottles were placed in an electrical oven for drying process at 82.8 °C for 30 minutes. Finally, the dried glass bottles were crushed, grounded using a heavy-duty blender, and sieved using a 2 mm sieve.

## 2.2 FCBs Preparation

A batch of 40 g mixture was prepared, and 21 % water was added. The granulated powder mixtures were mixed together until reach the homogenous state. Then, they were poured into a rectangular mould with the size of 222 mm x 106 mm x 73 mm (length x width x height). It is suggested that a standard brick size with the ratio of 2:1 is used, for length to width and 3:1 for length to height [13]. In this study, six series of bricks were cast with 74 mm x 30 mm x 24.3 mm dimensions with different SS ratio from 0 to 40 wt.%.

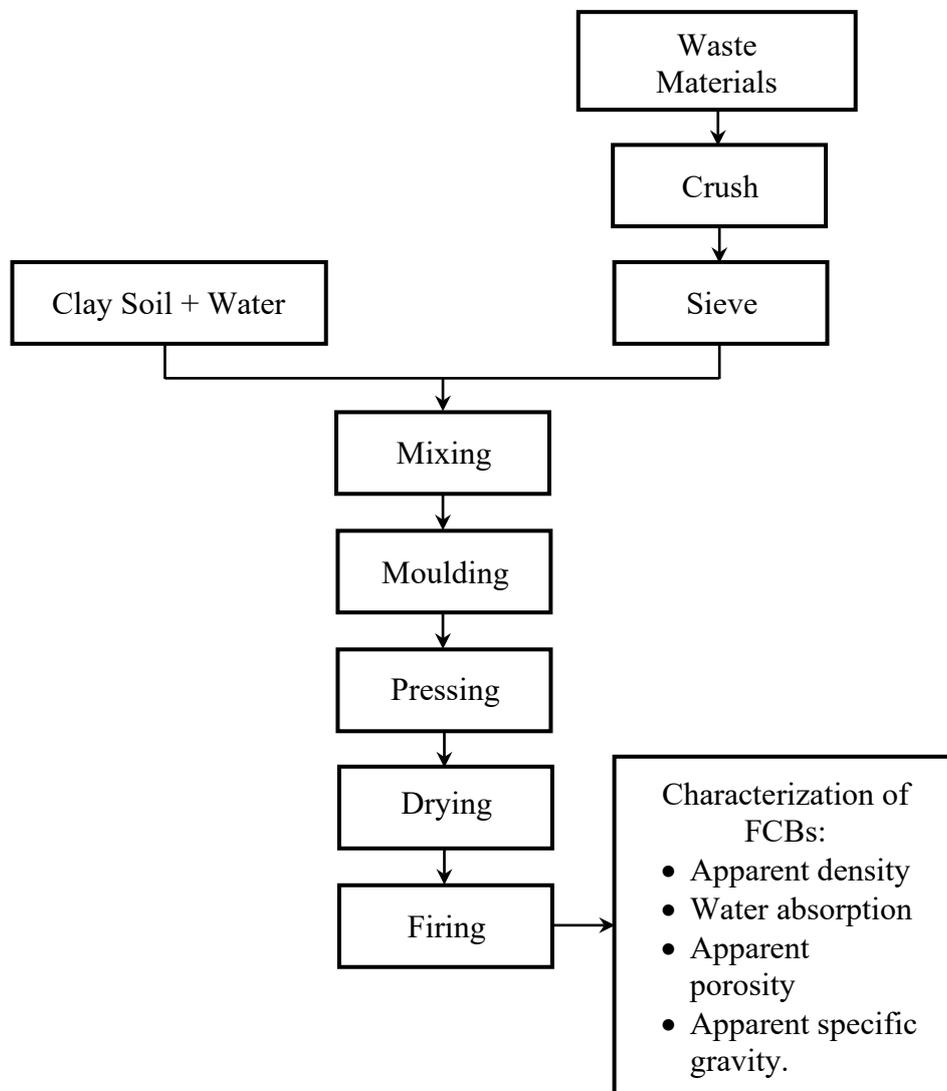


Fig.1. Sample preparation flowchart

The admixture of the clay soil (CS), soda lime silica glass (SLS) and seashells (SS) uses the empirical formula of  $(1-x)$  [40 SLS - 60 CS] where  $x$  (SS) = 0, 10, 20, 30, 40 wt.%. The mixed design ratio of seashell bricks can be seen in Table 1. The mixture was poured into the mould and dried at room temperature for 48 hours. Next, the samples were dried in an electric oven at 45 °C for 1 hour. The dried samples were fired in a laboratory electrical furnace at the rate of 6 °C/min until it reached 850 °C, and held for 1 hour. The physical analysis was conducted apparent density, water absorption, apparent porosity, and apparent specific gravity of the fired clay bricks. Fig.1 shows the experimental flowchart.

**Table 1.** Mixed design ratio of  $(1-x)$  [40 SLS - 60 CS]:  $x$  (SS) = 0,10, 20, 30, and 40 wt.%. FCBs

Sample No.	CS (wt.%)	SLS (wt.%)	SS (wt.%)
S1	100	0	0
S2	60	40	0
S3	60	40	10
S4	60	40	20
S5	60	40	30
S6	60	40	40

## 2.3 Testing Method

### 2.3.1 Apparent Density Test

This analysis concerned the physical behaviors of bricks containing different percentages of SS in sample S1, S2, S3, S4, S5, and S6. Thus, this analysis was done by applying Archimedes 'principle to analyze the effect of the incorporated SS on the density of FCBs. The value of density,  $\rho$  can be identified and interpreted according to the formula in the equation below [11]:

$$\text{Density, } \rho = \frac{m}{V} \quad (1)$$

where  $m$  = mass of FCBs (g) and  $V$  = volume of FCBs (cm<sup>3</sup>).

### 2.3.2 Water Absorption Test

Water absorption test was conducted to investigate how fast FCBs will absorbed water. To classify the kind of brick used in this investigation, percentage rates were applied. The samples were dried in an electric oven at 110 °C for 3 hours to prevent water absorption rates affected by moisture that is already present in the samples. Thus, the samples must be completely saturated. Percentages of water absorption can be calculated as the equation below [11]:

$$\text{Water Absorption (\%)} = \frac{(m_2 - m_1)}{m_1} \times 100 \quad (2)$$

where,  $m_1$ = dry weight FCBs (g)  $m_2$ = wet weight FCBs (g).

### 2.3.3 Apparent Porosity Test

Apparent porosity is defined as the ratio of the volume of the pore space divided by the total volume. The Archimedes buoyancy technique with dry weights, saturated weights, and

suspended weights in water can be used to gauge the apparent porosity of refractory materials. Thus, it can be determined using the formula as follow:

$$\text{Apparent Porosity (\%)} = \frac{(W_{\text{saturated}} - W_{\text{dry}})}{(W_{\text{saturated}} - W_{\text{suspended}})} \times 100 \quad (3)$$

where  $W_{\text{saturated}}$  = weight after immersed (g),  $W_{\text{dry}}$  = weight before immersed (g),  $W_{\text{suspended}}$  = weight in water (g).

### 2.3.4 Apparent Specific Gravity

The proportion between the weight in air of a unit volume of the impermeable component of the aggregate and the weight in air of an equivalent volume of gas-free distilled water at a particular temperature. The following formula can be used to determine apparent specific gravity:

$$\text{Apparent Specific Gravity} = \frac{(W_{\text{dry}})}{(W_{\text{dry}} - W_{\text{suspended}})} \times 100 \quad (4)$$

where  $W_{\text{dry}}$  = weight before immersed (g),  $W_{\text{suspended}}$  = weight in water (g).

## 3. RESULTS AND DISCUSSION

### 3.1 Apparent Density

Result for density analysis, presented in Table 2 reveals the density effect on the utilization of SS in FCBs design. As can be seen in Fig. 2, the apparent density of the FCBs increases continuously from 1.912 g cm<sup>-3</sup> to 2.306 g cm<sup>-3</sup> with increasing percentage of SS added to the FCBs. It was suggested that the increased in apparent density is due to the increase of waste material (SS) content in FCBs. The apparent density increases when the glass content is increased from 30 wt.% to 40 wt.% [14]. However, the apparent density in S1 cannot be calculated because the FCBs were totally broken. This has been suggested due to the lack of a binder between the clay soil and other constituents, causing FCBs to become more brittle and easy to break. Thus, the composition of 40 wt% of SLS as the binder in FCBs is the best composition.

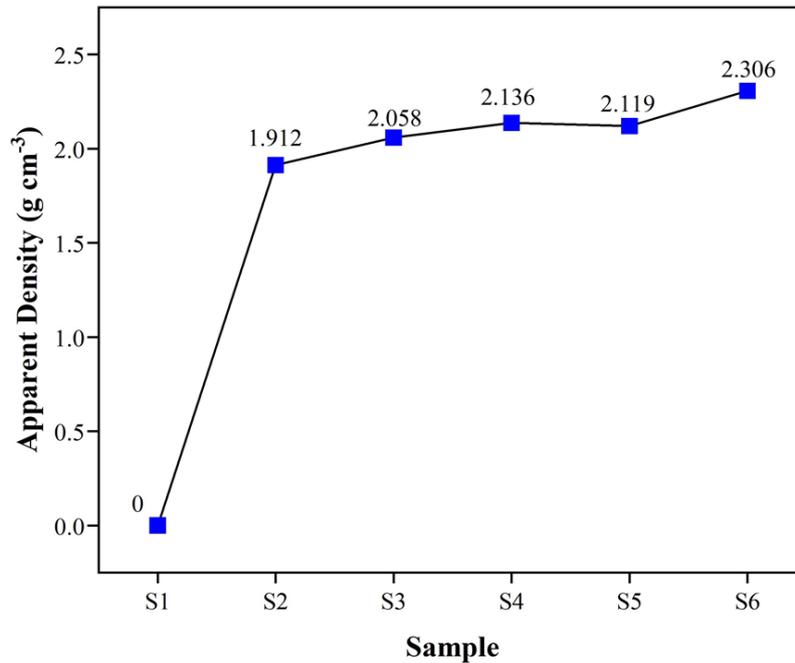


Fig. 2. Apparent density of clay bricks with different wt.% of SS

**Table 2.** Apparent density, water absorption, apparent porosity, and apparent specific gravity of FCBs

Properties	Sample of FCBs					
	S1	S2	S3	S4	S5	S6
Apparent density (g cm <sup>-3</sup> )	Totally broken	1.912	2.058	2.136	2.119	2.306
Water absorption (%)	17.11	12.29	13.89	15.05	18.16	17.33
Apparent porosity (%)	86.87	26.39	27.68	26.24	28.04	25.17
Apparent specific gravity	Totally broken	2.92	2.76	2.36	2.15	1.94

### 3.2 Water Absorption

Table 2 shows the result of the water absorption analysis for each sample. Based on Fig. 3, the histogram shows that when the SLS glass was inserted into the FCBs, the percentage of water absorption decrease drastically from 17.11% in S1 to 12.99% in S2. The percentage of water absorption increased continuously until the sample contained 30 wt.% of SS (S5). However, there was a slight decrease in S6 containing 40 wt.% of SS. The increased in water absorption could be due to the increasing amount of opening pores, induced by a number of glass particles dripping out onto the brick surface [11][14]. The fired glass phases will cause fired clay to be fused together. The FCBs became denser as the SS content increased. This result is experimentally confirmed by an increase in apparent density [14].

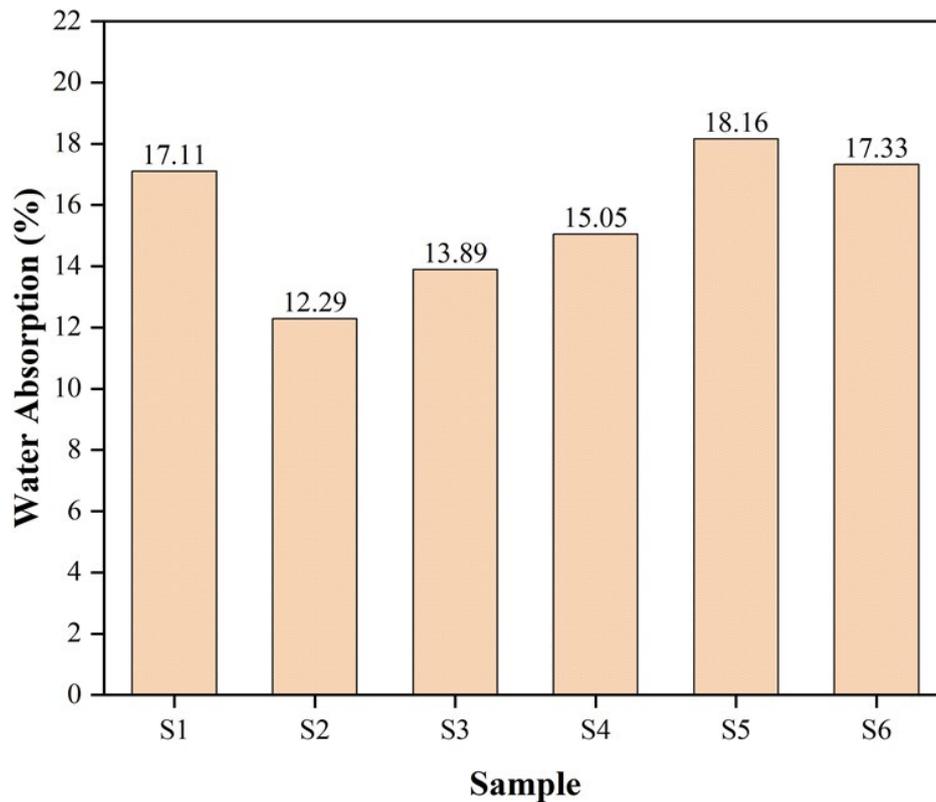


Fig. 3. Percentage of water absorption of clay bricks with different wt.% of SS

### 3.3 Apparent Porosity

Result of apparent porosity are presented in Table 2 and plotted in Fig. 4. According to data collected in this study, the percentage of apparent porosity is significantly decreased from 86.87% (S1) to 26.39% (S2) when SLS were introduced into the FCBs. However, the percentage of apparent porosity started to increase from 26.39% in S2 to 28.04% in S5 and again decrease to 25.17% in S6. The increased in the percentage of apparent porosity is due to the increase of wt.% of SS content in FCBs. Increasing in apparent porosity will make the clay bricks absorb more water, thus increasing the water absorption due to the larger number of open pores [14].

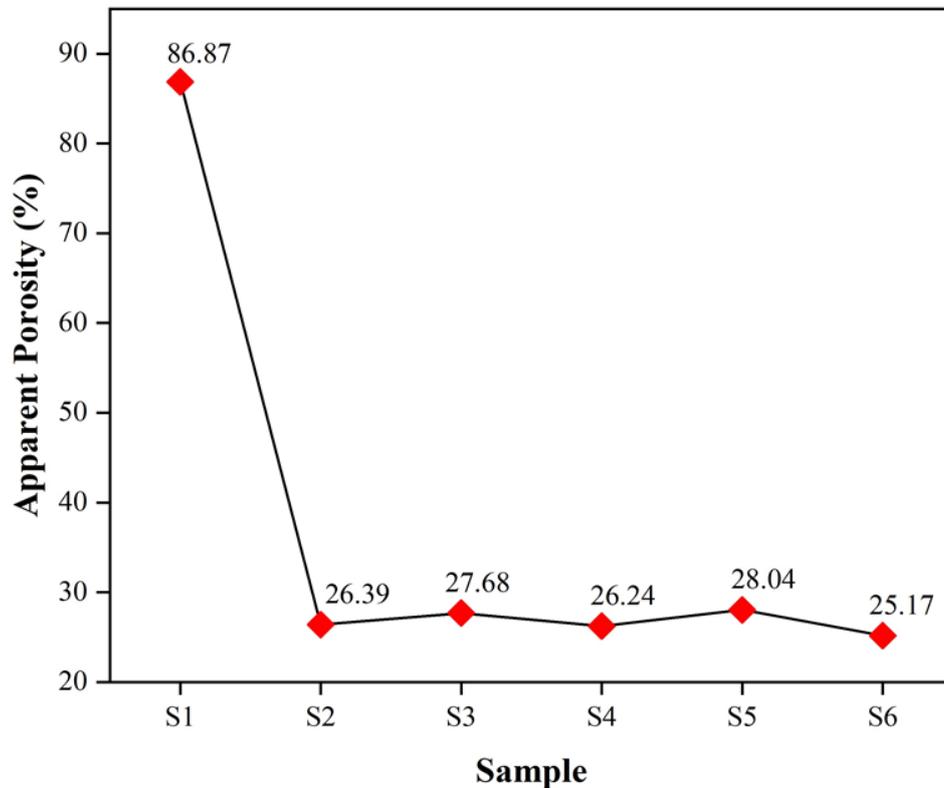


Fig. 4. Percentage of apparent porosity of clay bricks with different wt.% of SS

### 3.4 Apparent Specific Gravity

Table 2 shows the result in apparent specific gravity for each sample and plotted in Fig. 5. It can be seen that, the apparent specific gravity showed a decreasing trend when the waste material (SS) was added into the FCBs. The apparent specific gravity of S1 that only contained CS cannot be calculated since the S1 is totally broken. The apparent specific gravity decreased from  $2.92 \text{ g cm}^{-3}$  (S2) to  $1.94 \text{ g cm}^{-3}$  (S6) with the increasing in SS content. It was suggested, the increasing of SS content in FCBs, will resulted decreased in the apparent specific gravity [12].

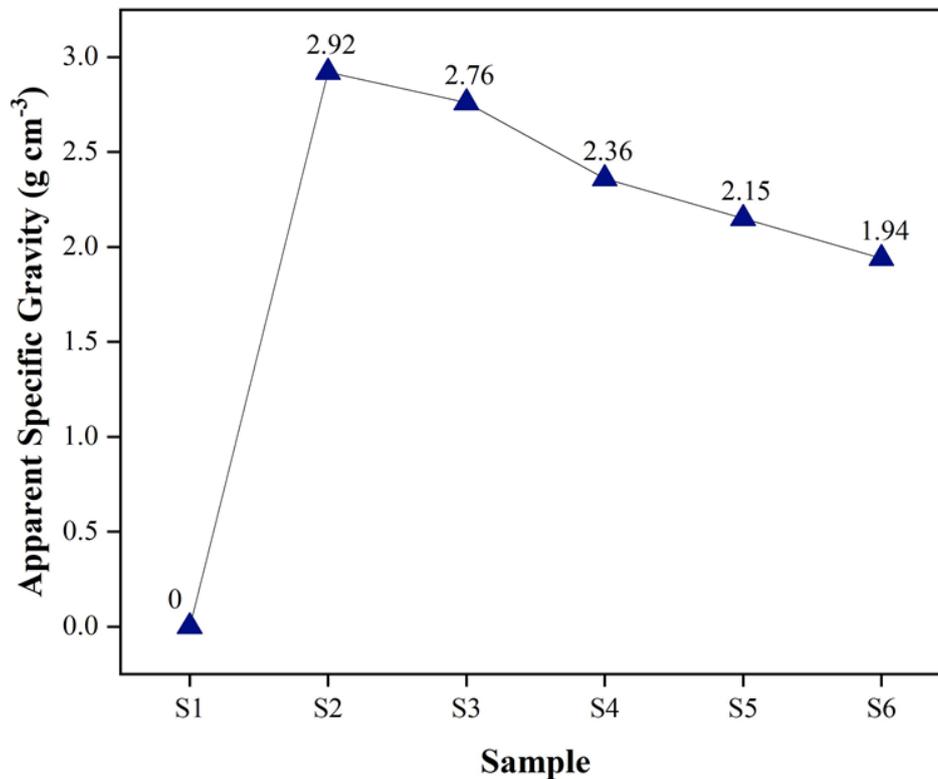


Fig. 5. Apparent specific gravity of clay bricks with different wt.% of SS

#### 4. CONCLUSION

Based on the findings of this study, the FCBs were successfully fabricated with the incorporation of waste materials as the precursors. SLS glass bottles and SS can be mixed with clay in different proportions to prepare good quality bricks. The results showed that with a proper firing temperature at 850°C, sea shells addition up to 40 wt.% did not harmfully influence the properties of the FCBs, and it was able to meet the minimum requirements in a wide range of applications. The apparent density and water absorption of the FCBs increased as the sea shells content increased. However, the percentage of apparent porosity and apparent specific gravity decreased when the content of sea shells increased. It can be concluded that the SS powder is compatible to be used as a constituent component in FCBs. Overall, S6 resulted the highest density, loss of water absorption, low apparent porosity and apparent specific gravity. The addition of 40 wt% of SS is suitable to improve the properties of FCBs, thus suggesting it being the optimum percentage that is suitable to be used in the design of FCBs.

#### ACKNOWLEDGEMENT

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## **I-CReST 2023:274-255 - Optical Frequency Combs Generation and Switching in Silicon Microresonators Under the Influence of Two-Photon Absorption**

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### **ABSTRACT**

The generation of optical frequency combs in high-quality Kerr-nonlinear microresonator has a promising application for optical switching. To produce a practical optical switching device, a strong material nonlinearity is needed for achieving an ultra-low optical switching power. However, due to silicon's relatively weak nonlinear optical properties, silicon-based optical switches require a tremendous amount of optical power to change its refractive index and hence demonstrate the switching operation. To address this limitation, an optical switch is developed using a microresonator structure made of silicon, and the switching operation is demonstrated using nonlinear effects driven by a soliton pulse. The soliton pulse causes free-carrier concentration via two-photon absorption effect, which increases the refractive index change and nonlinearity of the silicon waveguide. The silicon microresonator then accumulates the switching-required nonlinear phase shift.

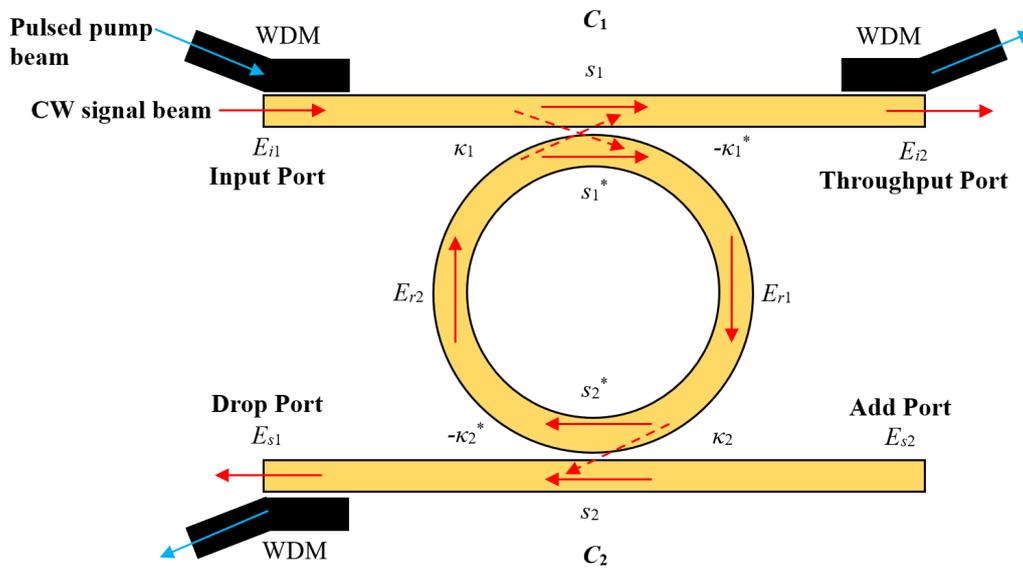
**Keywords:** Microresonator; frequency combs; optical soliton; optical switch; nonlinear effect

### **1. INTRODUCTION**

Optical switching operations where light beams guide the flow of other light beams has been a longstanding goal for the development of highly integrated optical systems [1]. Optical switches are important in numerous applications for communication, computing and sensing [1-5]. There has been a significant interest in optical switches consisting of silicon waveguide since the low-absorption wavelength windows of silicon materials are ideal for optical fiber communication. However, due to silicon's relatively weak nonlinearity, silicon-based optical switches require extraordinarily high switching power [6-8]. This is the primary limitation that must be addressed in order to develop a high-performance optical switch. In this work, an optical microresonator structure is used to confine the light and enhance the nonlinearity in silicon waveguide. Nonlinear effect is also considered to enhance the nonlinearity where a soliton pulse is introduced to create a two-photon absorption (TPA) effect in the silicon structure. TPA dominates the nonlinear loss processes in silicon materials at high light intensities in C-band communication wavelength region [9-12]. Utilizing soliton is essential for overcoming the limitations of current optical switches where it can pave the way for a new technology that provides an optical switch with an ultra-low power, ultra-fast, ultra-compact, and ultra-high capacity. Hence, the purpose of this study is to describe and develop a theoretical model necessary to improve the performance of the proposed optical switch.

## 2. THEORETICAL CONSIDERATION AND CONFIGURATION

This section describes the design and outputs for the optical switching in an add-drop microresonator structure as shown in Fig. 1. The enhancement of the microresonator's nonlinearity amplifies the effect of refractive index change. The change in refractive index causes the phase shift, which in turn initiates the switching. For the silicon microresonator optical switch, a pumping technique based on a pulsed laser beam with input power is used to increase the nonlinearity. Soliton pulsed laser beam functions as a pump beam, with a wavelength distinct from the continuous wave (CW) signal beam. Controlling the free-carrier concentration through the TPA effect modifies the refractive index. The nonlinear effect determine and govern the switching power of the optical switch.



**Fig. 1.** Microresonator optical switch based on an add-drop microresonator structure

The transfer matrix method is used to derive the electrical field amplitudes of  $E_{s1}$ ,  $E_{s2}$ ,  $E_{r1}$ ,  $E_{r2}$ ,  $E_{i1}$  and  $E_{i2}$  in the proposed optical switch and the relationships are given by these set of equations,

$$E_{r1} = -\kappa_1^* E_{i1} + s_1^* E_{r2} a_1 e^{j\frac{\phi}{2}}, \quad (1)$$

$$E_{s1} = s_1 E_{i1} + \kappa_1 E_{r2} a_{1/2} e^{j\frac{\phi}{2}}, \quad (2)$$

$$E_{s2} = \kappa_2 E_{r1} a_{1/2} e^{j\frac{\phi}{2}} + s_2 E_{i2}, \text{ and} \quad (3)$$

$$E_{r2} = s_2^* E_{r1} a_1 e^{j\frac{\phi}{2}} - \kappa_2^* E_{i2}. \quad (4)$$

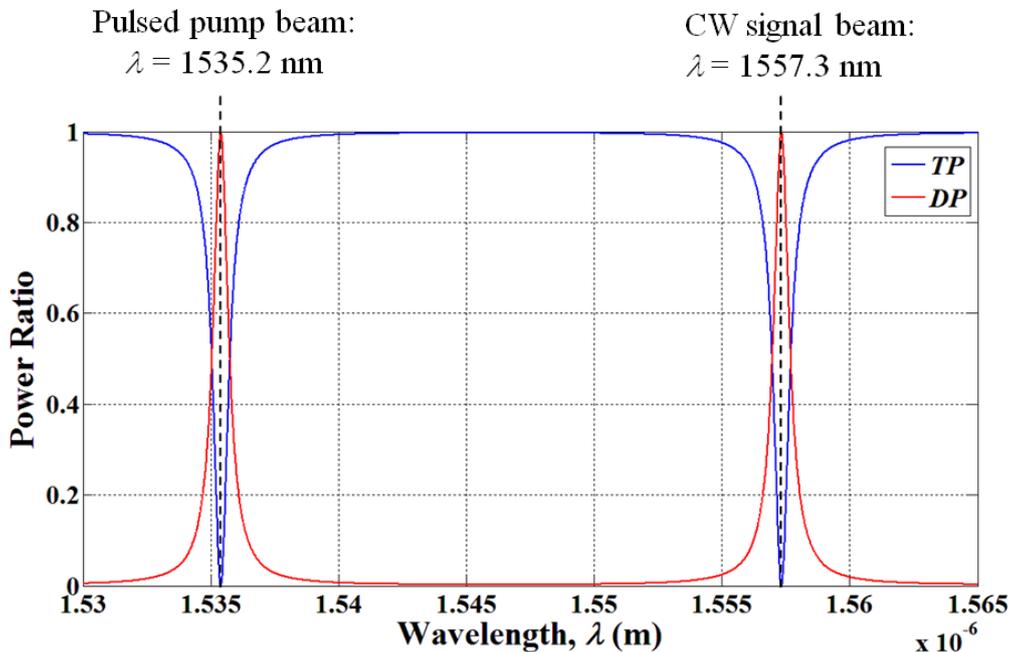
Here,  $a_{1/2}$  is the half round trip loss and  $\phi_{1/2}$  is the half round phase shift.  $s_1$  and  $s_2$  are the transmission coefficient of couplers  $C_1$  and  $C_2$ , respectively.  $\kappa_1$  and  $\kappa_2$  are the coupling coefficient of couplers  $C_1$  and  $C_2$ , respectively. The condition of  $s_i^2 + \kappa_i^2 = 1$  where ( $i = 1, 2$ ) must be satisfied. By letting  $s_1 = s_2 = s$ , and  $a = 1$  to neglect all of the losses, we obtain the power ratio at the drop port (DP) and the power ratio at the throughput port (TP) as given by the equations below.

$$DP = \frac{(1 - s^2)^2}{1 - 2s^2 \cos \phi + s^4}, \text{ and} \quad (5)$$

$$TP = \frac{2s^2(1 - \cos \phi)}{1 - 2s^2 \cos \phi + s^4}. \quad (6)$$

Here  $\phi = \phi_0 + \Delta\phi$  is the phase shift in one circle of the ring where  $\phi_0$  represents the linear part and  $\Delta\phi$  represents the nonlinear part. To associate the optical switch with a real device, the parameter values are chosen to match those of actual devices. The waveguide made of silicon with an effective refractive index,  $n_{\text{eff}}$  of 3.47, the ring radius,  $r$  of 5  $\mu\text{m}$ , the coupling power,  $\kappa$  of 10% and the transmission coefficients,  $s_1$  and  $s_2$  of 0.95 each are chosen. The input CW signal beam are tuned into the microresonator due to its resonance wavelengths,  $\lambda$  of 1535.2 nm and 1557.3 nm.

In the switching operation, a CW signal beam is launched into the system via the input port. Simultaneously, a soliton pulsed pump beam is introduced into the system via wavelength-division multiplexing (WDM). Both CW signal beam and the soliton pulsed pump beam are simultaneously propagate within the waveguide and microresonator on the cavity resonant wavelength modes as shown in Fig. 2. The CW signal beam and the soliton pulsed pump beam exit via  $TP$  or  $DP$  depending on the phase shift of the microresonator created by TPA effect. The change of the silicon material refractive index,  $\Delta n$  is induced by the soliton pulsed pump beam power [13].



**Fig. 2.** Power ratio as a function of wavelength,  $\lambda$  in a C-band region for a lossless symmetrical add-drop microring resonator optical switch configuration with  $s_1 = s_2 = 0.95$ ,  $n_{\text{eff}} = 3.47$  and  $r = 5 \mu\text{m}$



### 3. MODELING OF AN OPTICAL SWITCH INDUCED BY TWO-PHOTON ABSORPTION EFFECT

This section begins by considering the case under cross pumping by a femtosecond pulsed laser, which induces TPA in the silicon material. The pump beam with power  $P$  at wavelength different to the signal wavelength. The pump powers will induce the refractive index change  $\Delta n$ . According to the K-K relationship,  $\Delta n$  is related to absorption  $\Delta\alpha$  of materials. As we know that when a laser beam transmits in a waveguide, the rate of change of intensity  $I$  with distance  $z$  is,

$$\frac{dI}{dz} = -\alpha I - \beta_T I^2. \quad (7)$$

Here,  $\alpha$  and  $\beta_T$  are the single-photon absorption coefficient and the two-photon absorption coefficient, respectively. Proverbially,  $\beta_T$  is much smaller than  $\alpha$ . When the intensity  $I$  is very weak, for example in continuous wave light, we only consider the action of single-photon absorption, namely, the second term in right side of Eq. (7) can be neglected. If we consider 3-order nonlinearity, the Kerr effect should be considered,  $\Delta n$  is proportional to the intensity  $I$ .

However, when the light intensity is very strong, for example in femtosecond pulses, the second term on the right-hand side of Eq. (7) will be dominant. In this case, every pair of photons will induce a free electron and a free hole simultaneously. This makes changes in the free carrier concentration including a change of electron concentration  $\Delta N_e$  and a change of hole concentration  $\Delta N_h$ . The free carrier concentration change will lead to the absorption change,

$$\begin{aligned} \Delta\alpha &= \Delta\alpha_e + \Delta\alpha_h, \\ &= -8.5 \times 10^{-18} \Delta N_e - 6.0 \times 10^{-18} \Delta N_h, \end{aligned} \quad (8)$$

where  $\Delta N_e$  is the electron-concentration change and  $\Delta N_h$  is the hole-concentration change. By using the K-K relationship, the refractive index changes  $\Delta n$  can be obtained from the experimental spectrum of nonlinear absorption  $\Delta(\omega)$ . Therefore, the refractive index change at wavelength of  $1.55 \mu\text{m}$  is given by,

$$\begin{aligned} \Delta n &= \Delta n_e + \Delta n_h, \\ &= -8.8 \times 10^{-22} \Delta N_e - 8.5 \times 10^{-18} (\Delta N_h)^{0.8}. \end{aligned} \quad (9)$$

Provided that the change in the free carrier concentration is  $\Delta N = \Delta N_e = \Delta N_h$ , Eq. (9) becomes

$$\Delta n = -8.8 \times 10^{-22} \Delta N - 8.5 \times 10^{-18} (\Delta N)^{0.8}. \quad (10)$$

Because the free-carrier concentration  $N$  is generated predominantly by TPA, and

$$\frac{dI}{dz} = \left( \frac{dN}{dt} \right) 2h\nu = -\beta_T I^2, \quad (11)$$

the generation rate of the free carrier concentration is given by,

$$\frac{dN}{dt} = \frac{\beta_T I^2}{2h\nu} \quad (12)$$

where  $I$  is light intensity;  $h\nu = E_{ph}$  is the photon energy,  $\beta_T$  is the TPA coefficient. Then the free-carrier-concentration change created by a single pulse is given by,

$$\Delta N = \frac{\beta_T}{2h\nu} \int_{-\infty}^{\infty} I^2 dt. \quad (13)$$

Presuppose a soliton pulse pump beam produced by a tunable mode-locked Ti:Sapphire femtosecond laser at a 90-MHz repetition rate induces TPA effect in the silicon material, hence the light intensity of the incident temporal soliton is,

$$I = \frac{P_0}{A_{\text{eff}}} \text{sech}^2(\tau), \quad (14)$$

where  $\tau = \frac{T}{T_0}$ .  $T$  is time and  $T_0$  is the pulse width,  $P_0$  is the peak power and  $A_{\text{eff}}$  is the effective cross section area. The Eq. (14) becomes,

$$I = \frac{P_0}{A_{\text{eff}}} \text{sech}^2\left(\frac{T}{T_0}\right). \quad (15)$$

By substituting Eq. (15) into Eq. (13), then, the free-carrier-concentration change created by a single soliton pulse is given by

$$\begin{aligned} \Delta N &= \frac{\beta_T}{2h\nu} \int_{-\infty}^{\infty} \left(\frac{P_0}{A_{\text{eff}}}\right)^2 \text{sech}^4\left(\frac{T}{T_0}\right) dt \\ &= \frac{\beta_T P_0^2}{2h\nu A_{\text{eff}}^2} \frac{[T_0 \sinh\left(\frac{T}{T_0}\right)] [2\cosh^2\left(\frac{T}{T_0}\right) + 1]}{3\cosh^3\left(\frac{T}{T_0}\right)}. \end{aligned} \quad (16)$$

For a stream of soliton pulses, the relationship between the peak power  $P_0$  and the average power  $P_{\text{avg}}$  is

$$\frac{P_0}{P_{\text{avg}}} = \frac{T_B}{T_0}, \quad (17)$$

$$\therefore P_0 = \frac{T_B}{T_0} P_{\text{avg}}, \quad (18)$$

where  $T_B$  is the pulse separation. Using Eq. (10), (16) and (18), the relationship between the refractive index change and the average power of the pump beam can be obtained as,

$$\Delta n = 8.8 \times 10^{-22} \frac{\beta_T P_{\text{avg}}^2 T_B^2}{2h\nu A_{\text{eff}}^2 T_0} \left( \frac{[\sinh\left(\frac{t}{T_0}\right)] [2\cosh^2\left(\frac{t}{T_0}\right) + 1]}{3\cosh^3\left(\frac{t}{T_0}\right)} \right)$$



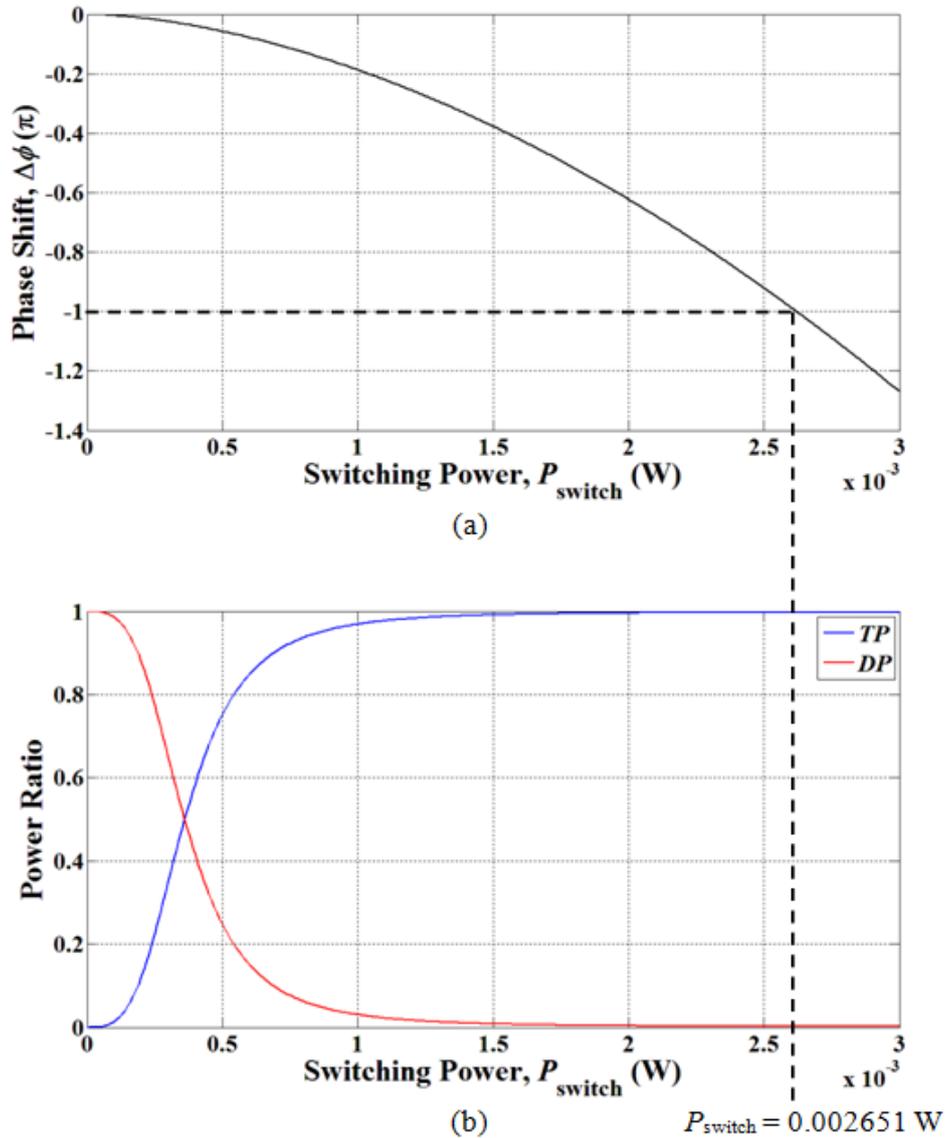
$$+ 8.5 \times 10^{-18} \left( \frac{\beta_T P_{\text{avg}}^2 T_B^2 \left[ \sinh\left(\frac{t}{T_0}\right) \right] \left[ 2\cosh^2\left(\frac{t}{T_0}\right) + 1 \right]}{2h\nu A_{\text{eff}}^2 T_0} \frac{\left[ \sinh\left(\frac{t}{T_0}\right) \right] \left[ 2\cosh^2\left(\frac{t}{T_0}\right) + 1 \right]}{3\cosh^3\left(\frac{t}{T_0}\right)} \right)^{0.8} \quad (19)$$

The phase shift equation to determine the switching power can be rewritten by,

$$\Delta\phi = \frac{2\pi L}{\lambda} \left[ \begin{array}{l} 8.8 \times 10^{-22} \frac{\beta_T P_{\text{avg}}^2 T_B^2}{2h\nu A_{\text{eff}}^2 T_0} \left( \frac{\left[ \sinh\left(\frac{t}{T_0}\right) \right] \left[ 2\cosh^2\left(\frac{t}{T_0}\right) + 1 \right]}{3\cosh^3\left(\frac{t}{T_0}\right)} \right) \\ + 8.5 \times 10^{-18} \left( \frac{\beta_T P_{\text{avg}}^2 T_B^2 \left[ \sinh\left(\frac{t}{T_0}\right) \right] \left[ 2\cosh^2\left(\frac{t}{T_0}\right) + 1 \right]}{2h\nu A_{\text{eff}}^2 T_0} \frac{\left[ \sinh\left(\frac{t}{T_0}\right) \right] \left[ 2\cosh^2\left(\frac{t}{T_0}\right) + 1 \right]}{3\cosh^3\left(\frac{t}{T_0}\right)} \right)^{0.8} \end{array} \right] \quad (20)$$

The phase shift  $\Delta\phi = \pi$  for complete switching is induced by the threshold switching power given by  $P_{\text{avg}}$ . During the simulation, the real practical data are used in order to produce a meaningful all-optical switch device. The operating wavelength for the soliton pulsed pump beam is  $\lambda = 1535.2$  nm, the continuous wave signal beam is set at  $\lambda = 1552.3$  nm, the ring radius is chosen as  $r = 5$   $\mu\text{m}$ , the couplers are set to be identical where  $s = s_1 = s_2 = 0.95$ , the effective refractive index of the silicon is set at  $n_{\text{eff}} = 3.47$  and the nonlinear refractive index is  $n_2 = 4 \times 10^{-18}$   $\text{m}^2/\text{W}$ .

The dimensions of the silicon waveguide is selected as  $A_{\text{eff}} = 450 \times 250$   $\text{nm}^2$ , the TPA parameter is set at  $\beta_T = 5 \times 10^{-12}$   $\text{m}/\text{W}$ . The pulse duration, pulse repetition rate, and pulse separation are set at  $T_0 = 100$  ps,  $B = 80$  MHz and  $T_B = 1.25 \times 10^{-8}$  s, respectively. The photon energy of the operating wavelength is  $E = 1.294 \times 10^{-19}$  J. All of these actual parameters are substituted into our derived model as presented by the Eq. (20) to obtain the switching power. The model shows that the switching power of 2.651 mW at  $\pi$  phase shift. Then the output CW signal beam is switched from *TP* to *DP* as depicted in Fig. 3.



**Fig. 3.** The illustration of the switching power induced by TPA effect for the proposed all-optical switch by using a soliton pulse: (a) Phase shift,  $\Delta\phi$  as a function of the switching power,  $P_{\text{switch}}$  and (b) power ratio at the drop port,  $DP$  and throughput port,  $TP$  as a function of the switching power,  $P_{\text{switch}}$  in a silicon add-drop microring resonator with the real device parameters  $\lambda = 1535.2 \text{ nm}$ ,  $r = 5 \mu\text{m}$ ,  $s = s_1 = s_2 = 0.95$ ,  $n_{\text{eff}} = 3.47$ ,  $n_2 = 4 \times 10^{-18} \text{ m}^2/\text{W}$  and  $A_{\text{eff}} = 450 \times 250 \text{ nm}^2$ ,  $\beta_T = 5 \times 10^{-12} \text{ m/W}$ ,  $T_0 = 100 \text{ ps}$  and  $T_B = 1.25 \times 10^{-8} \text{ s}$

#### 4. CONCLUSION

Based on a symmetrical silicon add-drop microresonator structure, an optical switch configuration has been devised. Such a design requires phase shift for switching between the  $TP$  and  $DP$  to occur. During and outside resonance, the ratio of power at both ports has been established. At a switching power of 2.651 mW, the TPA-based switching operation has been demonstrated.

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## I-CReST 2023:316-284 - Photovoltaic Charging Station

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### ABSTRACT

This Photovoltaic Charging Station (PCS) was developed for the purpose of teaching aids related to the generation of electrical energy from renewable energy sources. The problem of the cost for purchasing and maintenance of solar trainer teaching aids in an institution is generally a major factor in the development of this research study as it is designed in a small size, thus economic, easy and light weight to carry for demonstration or teaching purposes at class or any suitable location. This affordable teaching aid can be built as an effort to help the student that enrol DET30053 Power System Course about the conversion of natural source to electrical energy and off-grid switching system applications. The method of this charging station development is to use a self-propelled photovoltaic system consisting of a series of photovoltaic solar panel connected to a main board that containing measuring meters, battery, power inverters, charge controllers and circuit breaker. Location is an important factor in carry out of this system because the higher sunlight obtained, the higher the electricity. Current flows from the battery to the charging module of each branch and stored in the lead acid battery and the charge controller acts to prevent overcharging to the battery. The results of this study show that the conversion of electrical energy using off-grid PV systems is effective, convenient and economical for the use of low-voltage electrical and electronic devices. Therefore, these teaching aids can help provide a clearer and more detailed understanding of the concepts of energy conversion and individual photovoltaic generation as well as provide ideas to students for applying renewable energy in everyday life.

**Keywords:** Teaching aid; renewable; solar panel; charging station; off-grid

### 1. INTRODUCTION

The availability of teaching materials plays a significant role in the process of teaching and learning. Nowadays, there are various tools and resources that can aid in teaching, such as audio, video, mobile applications, interactive prototypes, and trainers. These teaching aids assist educators in explaining their knowledge more effectively and help students grasp the content better. There are numerous advantages to using teaching aids, including the ability to retain concepts more effectively, motivate students, develop clear and tangible images, provide comprehensive examples of conceptual thinking, create an engaging learning environment, and offer hands-on experiences for students. In technical and engineering fields, teaching aids are particularly important as they provide complete examples of conceptual thinking and direct experiences for students.

Power System Course DET30053 covers topics such as environmentally friendly electronic power generation, transmission, distribution, and consumerization. Two of the five

topics covered in this course are integration to power system and generation. In the introduction to power system topic, students learn about the basic concepts of renewable and non-renewable energy production. They are required to classify energy sources and understand their uses. In the generation topic, students need to comprehend the principles and methods of energy production from each source. A solid understanding of these two main topics is crucial for students to effectively explain concepts, functions, applications, and the impact of energy systems. The final exam for this course consists of essay questions that require students to provide information and demonstrate the relevance of energy use in current developments.

It is widely known that students enrolling in polytechnic come from various educational backgrounds, including technical and vocational streams as well as regular schools. Some students may have never been exposed to the basics of electricity, making it challenging for them to understand concepts through theory alone. Describing connectivity methods, functions, and applications through written descriptions, drawings, or videos found online can cause students to lose focus and often forget the information even after being briefed by lecturers. To address this issue, a photovoltaic charging station has been developed to allow students to simulate wiring before actually performing it. This station uses a simple circuit that demonstrates how energy is generated, which can help spark students' interest in studying electricity generation from alternative sources.

## 1.1 Problem Statement

The two fundamental components of the engineering teaching and learning process are theoretical learning and practical learning. Students take part in laboratory and practical sessions, and the practical implementation process is crucial for them to conduct "hands-on" technological experiments. For students to become engineers specifically working in this industry, "hands-on" experience is crucial.[1] Additionally, the "hands-on" approach can guarantee comprehension of the subject covered conceptually, reinforced by verification through technological experimentation. In the Electrical and Electronic Engineering Programme, the Power System is a discipline core subject that students must enrol in this course for semester 3 and is a prerequisite for the Renewable Energy Course DEG30013, which is also a discipline subject that these students must complete before graduate. Typically, a solar trainer that is huge and expensive is used in the practical implementation procedure for this course. The practical implementation procedure took a long time to finish. In result some students had to extend the amount of time they spent in the lab to finish their practical studies. Because the lab is only open during specific hours, this scenario makes it challenging for students to use and understand the working principle in short duration. If instructors and students can create a solar trainer model that is more portable, less complicated, and can be made by themselves at a reasonable cost, the problem can be solved. The solar trainer that is provided at the laboratory is also enormous and immobile, which makes it challenging for students. Students tested a PCS as a result of this. In regard to it, a research was done on students to determine how they felt about using the model that was develop.

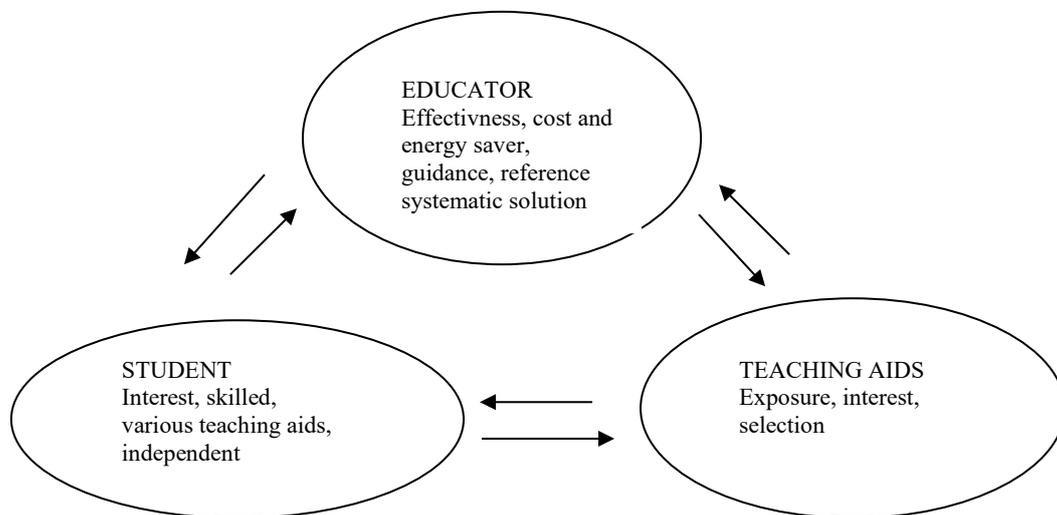
## 1.2 Objective

As a result of the stated issues, Photovoltaic Charging Stations are developed. Therefore, a study on students' perceptions of the construction and use of PCS was conducted. The first objective of the study is to find out the students' perception about the suitability and convenience of PCS as teaching aids in the DET30053 Energy System class. In addition, the

second goal of the study is to find out the development of a photovoltaic charging system that can be used as a power supply in public areas (outdoor activities) to charge mobile phones and other electronic equipment needed by students while they are in the area around the institution.

## 2. LITERATUR REVIEW

Numerous studies currently look at how instructional tools might help students improve and broaden their knowledge. This resource can help students retain all of the material they have been taught, which will increase their knowledge. The analysis findings demonstrate that students are enthusiastic about the teaching-aid-infused learning environment.[2] Students believe that these instructional tools can benefit in their learning. Fig. 1 illustrates the Relationship model of educator, student and teaching aids during the teaching and learning process in their studies.



**Fig. 1.** Relationship model of educator, student and teaching aids

Teaching aid are valuable tools for technical educators to enhance their explanations and improve the understanding of learning content, surpassing the limitations of traditional descriptions without teaching aids[2]. Therefore, it is crucial for technical educators to stay updated on teaching techniques and their impact on student learning processes. They should continuously strive to enhance the quality of learning by developing various trainers, aiming to positively influence their students and cultivate individuals who can contribute to the country's development[3]. The use of teaching aid plays a significant role in teaching and learning, aiding students in comprehending the practical aspects of skills. Moreover, teaching aid can enhance the quality of teaching and learning and boost student motivation[4]. In order to examine perception development and usage of study products, the research technique for this article focuses on two key aspects, namely Product Development and Research Instrument section.

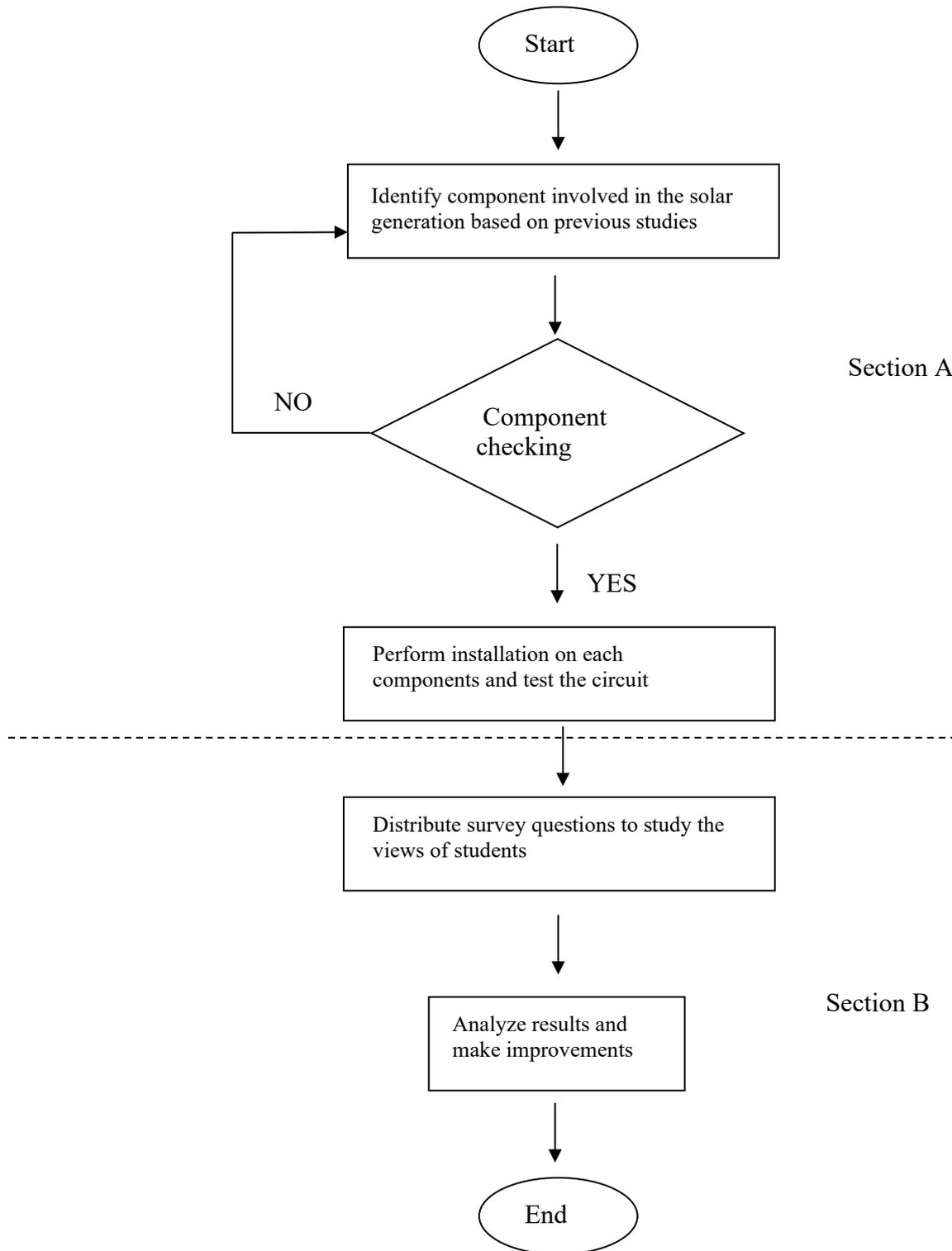
Furthermore, the amount of information available to learners is rapidly increasing. This information comes in various forms such as text, images, videos, and audio. Consequently, educator is faced with the task of teaching students how to effectively navigate through this vast amount of information. This includes teaching them how to find reliable sources, question

the authenticity and accuracy of information, connect new knowledge with what they already know, and understand its importance in relation to their existing understanding [3].

In order to promote global competence, it is important to establish classroom environments that allow students to freely and respectfully share their opinions with both their teachers and peers. Students should also have the ability to choose the media they want to use, as well as the tools and methods they prefer, in order to support their learning.[5] While traditional tools were once the primary means of supporting student learning, digital learning tools are now being utilized by a limited number of teachers in their teaching practices. It is important to note that technology alone does not facilitate learning unless specific learning tasks are clearly outlined. The true advantages of technology lie in its ability to foster collaboration, creativity, and communication. Educator must employ teaching resources to impart knowledge to their students. In order to give excellent teaching and learning, lecturers must manage the "Photovoltaic Charging Station" with the proper technique and approach. To generate students who are in accordance with the most recent essentials, it is also crucial that Photovoltaic Charging Station development, which keeps up with technical advancements be implemented [2] contend that adopting a technology-based teaching strategy instead of a more conventional one benefits students.

### **3. METHODOLOGY**

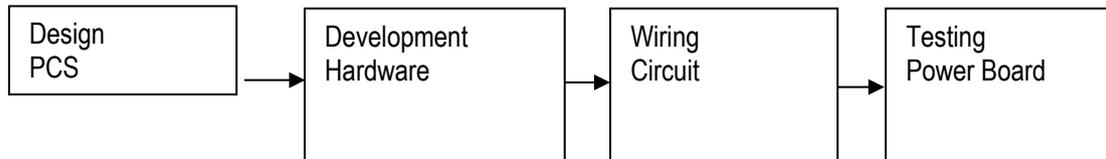
The research methodology for this article focuses on two main sections, which is section A is Model Development and section B is Research Instrument Section, in order to analyze perception development and utilization of study items as illustrate in Fig. 2.



**Fig. 2.** Flowchart of study methodology

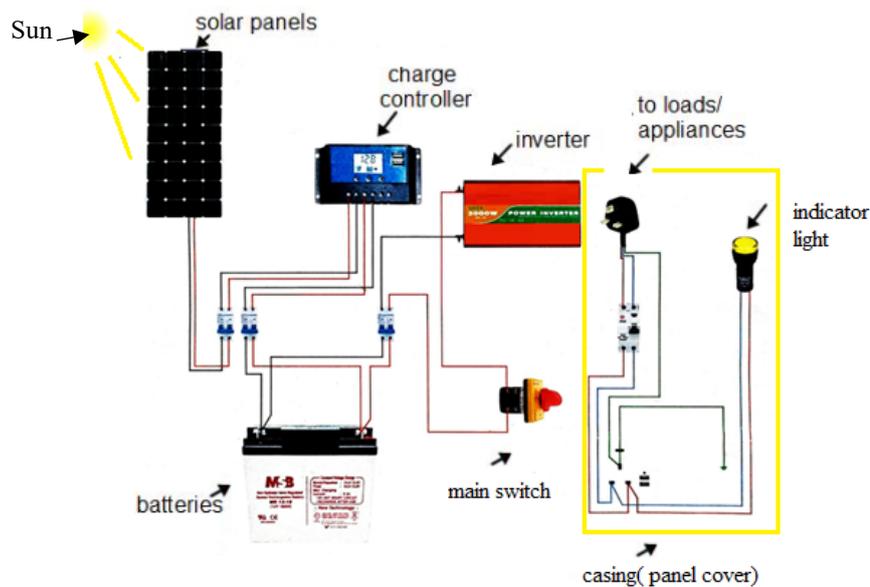
#### 4.1 Model Development

This Photovoltaic Charging Station development process involves four stages: basic design, hardware development, internal wiring and testing. Fig. 1 shows the diagram of PCS development process.



**Fig. 3.** PCS development process

The wiring circuit construction is simple and easy to understand as shown in Fig. 4 involves in 2 main part which is the connection photovoltaic solar panel and the main board that contain of charge controller, power inverter, battery and protective equipment.



**Fig. 4.** Wiring circuit of photovoltaic charging station

Fig. 5 shown that PCS can be installed at anywhere for teaching and learning process or student activities. Mobile phones and other electronic devices such as laptop can be charged in public areas using charging station as power sources.



**Fig. 5.** PCS installation and applications

### 3.1 Research Instruments

The study's instrument makes use of quantitative techniques. 33 students enrolled in Course 30053 were given this collection of questions as a research sample. 33 individuals altogether, with 15 women and 18 males making up the sample's sex composition. The collection of study questions is divided into two parts: part A comprises demographic information about the respondents, and part B contains five items. The purpose of the questionnaire research was to evaluate the usefulness of the teaching tool and the advantages it provided to the pupils. Items were assessed to determine how well each responder answered the study's objective questions using a likert scale.[6] The scale is set up as shown in Table 1:

**Table 1.** Likert scale

Level of agree	Scale
Not agree at all	1
Not agree	2
Undecided	3
agree	4
Strongly agree	5

The data and information obtained from the questionnaire are processed descriptively and analyzed based on the mean score and overall mean average. Mean interpretation of the findings research through questionnaires was analyzed using the mean level and mean scores as shown in Table 2.

**Table 2.** Score min

Level of agree	Scale
Not agree at all	1.0-1.4
Not agree	1.5-2.4
Undecided	2.5-3.4
Agree	3.5-4.4
Strongly agree	4.5-5.0

The information and data collected from the questionnaire are processed in a descriptive manner, and the mean score and overall mean average are used as the basis for analysis. This

study's instrument is a questionnaire that was modified from [7]. However, the item has been changed in light of the project's development appropriateness results.

#### 4. DATA ANALYSIS AND RESULT

A descriptive analysis of the data is performed. Table 3 details how the Photovoltaic Charging Station design evolved and was used in the Power System course. In this table, it is discovered that the mean score falls within the **Agree** range, with a total average mean value of 4.43. This data clearly demonstrates that the respondents are more likely to comprehend the working principles of solar energy.

**Table 3.** Mean value for aspects of comprehension

No	Items	Min
1	I like teaching and learning interactively in class session.	4.57
2	I feel that this PCS circuit can give an understanding of the system of producing electricity from solar energy.	4.36
3	I feel this PCS is in accordance with Topic 2 (DET30053 Power System).	4.39
4	I find it easier to understand the electric power generation system using solar power by using PCS	4.48
5	I feel that PCS always attract me to be more focus and more enthusiastic while studying solar energy.	4.36
Mean average		4.43

Table 4 show the mean average is about 4.44 total as average score for user comfort aspect. The data categorized within the **Agree** range. This score show clearly demonstrates that the respondents are more likely and agree that the design and size of PCS is suitable and they feel comfort and easy to handle the PCS

**Table 4.** Mean value for user comfort aspects

No	Items	Min
6	I feel that the use of PCS saves time for lecturers to explain to the students.	4.54
7	I like the size of PCS while using in the class	4.39
8	I find that PCS is a mobilizing teaching aid	4.42
9	I find that PCS always give me an easiest way to do a practical work.	4.42
Mean average		4.44

Table 5 below shows the interpretation of the level for the mean range of each aspect of the assessment. Based on Table 4, the level interpretation for both aspects belongs to the Scale of Agree and Strongly Agree to the development of PCS

**Table 5.** Level interpretation for mean range against each aspect of evaluation

Assessment Aspects	Overall Mean Average	Stage Interpretation
Comprehension	4.43	Agree
Comfort	4.44	Agree

#### 6. CONCLUSION

A photovoltaic charging station of this small size is portable, quick to install the circuit, cheap to build, and economical for instructors and students. The results of the survey on the features of this system indicate that the majority of respondents concur that this photovoltaic charging

station enhances students' understanding of the teaching and learning process for the Power System subject, is user-friendly, and can be used by students and lecturers as one of the facilities to obtain supplies of electricity around the institution without needing access to the institution building.

## ACKNOWLEDGEMENT

The authors are incredibly grateful to the Sultan Haji Ahmad Shah Polytechnic students and lecturers that helped us during the development of this teaching aid and ultimately made this study success.

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## BIOLOGICAL SCIENCES

## I-CReST 2023:131-112 - Micropropagation of Shoots of *Orthosiphon stamineus*: The Comparison of Silver Nanoparticles Synthesis from Field-grown and *In-vitro* Shoot Culture

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### ABSTRACT

*Orthosiphon stamineus* (*O. stamineus*) is an herb plant with high antioxidant properties and has been reported to treat several diseases such as, diabetes and simple urinary tract infection (UTIs). The antioxidant compounds in *O. stamineus* are responsible for reducing and capping processes during silver nanoparticles synthesis. The manipulation of the phytochemical content in the *O. stamineus* plant can be achieved by a tissue culture system. Therefore, this study aimed to optimise shoot biomass by manipulating 6-benzylaminopurine (BAP) concentrations using axenic shoot culture. Nodal segments were cultured on Murashige and Skoog (MS) plates supplemented with 1–7 mg L<sup>-1</sup> BAP for 6 weeks and subcultured fortnightly. The aqueous were extracted and analyzed for antioxidant activities (DPPH and FRAP). UV-Visible spectroscopy was used to characterize the formation of silver nanoparticles (AgNPs). Results showed that nodal explants treated with 4 mg L<sup>-1</sup> BAP produced the highest number of shoots (15.80 ± 0.76) and shoot length (6.63 ± 2.32 cm). As for antioxidant assays, the highest FRAP value (7200.00 ± 103.02 μM Fe (II)) and the lowest EC<sub>50</sub> (56.65 ± 0.17 μg mL<sup>-1</sup>) were obtained for 4 mg L<sup>-1</sup> BAP as compared to other treatments. In addition, surface plasmon resonance (SPR) showed in the range of 430 – 440 nm with a higher intensity (0.978) than field grown extract, which was at 0.417. However, agglomerated AgNPs were observed for *in vitro* plant extracts. In conclusion, BAP-induced extracts of *O. stamineus* had successfully induced high antioxidant activities and AgNP formation but low in capping agents. Further investigation is needed to identify the phytochemical that serves as the capping agent in the synthesis of stable silver nanoparticles from *in vitro* shoot cultures of *O. stamineus*.

**Keywords:** *Orthosiphon stamineus*; silver nanoparticle; plant tissue culture

### 1. INTRODUCTION

*O. stamineus* is a great choice for medicinal and pharmaceutical purposes since it could serve several pharmacological functions such as anti-diabetic [1] and anti-inflammatory [2]. It is also believed to treat diseases such as diabetes and simple urinary tract infection (UTIs). All these values of *O. stamineus* might be due to the presence of vital bioactive compounds. In response to the call for green technology in nanoparticles synthesis, in this experiment, *O. stamineus* extract was utilized for the synthesis of silver nanoparticles, with the aim of leveraging its

bioactive compounds to serve as both reducing and capping agents. The extract of *O. stamineus* was mixed with silver nitrate and during the process, silver ion  $\text{Ag}^+$  was reduced to  $\text{Ag}^0$  with the help of compounds with C-O, C-H, and O-H functional groups [3]. However, due to the high demand for *O. stamineus*, *in vitro* cultivation using micropropagation techniques was employed to enhance biomass production and enable manipulation of phytochemicals. This capability comes from the remarkable potential of plant tissue culture to yield hundreds of plantlets from a single mother explant within a relatively short period, especially when plant growth regulator (PGR) is introduced in the media agar [4]. With the substantial biomass and enriched bioactive compounds obtained through the *in vitro* culture of *O. stamineus*, there is a hopeful expectation of achieving a higher yield of silver nanoparticles with superior quality when compared to field-grown *O. stamineus*.

## 2. MATERIALS AND METHOD

Plants of *O. stamineus* were cultivated in a greenhouse at UTM's Faculty of Science. Six-week-old *in vitro* plants and nodal segments from field-grown *O. stamineus* were used. Both sets of nodal segments underwent surface sterilization: *in vitro* segments were rinsed six times with sterilized distilled water, while field-grown segments were washed under running tap water, immersed in 70% ethanol, and agitated in a Clorox-Tween 20 mixture. This method is retrieved from Nawi and Samad [5] with slight modification. *In vitro* plants were maintained in a controlled environment with a temperature of 25°C, a 16-hour photoperiod, and 1000 lux light intensity.

For the BAP (6-Benzylaminopurine) treatment, 1 cm long nodal segments from six-week-old *in vitro* plants were placed on Murashige and Skoog (MS) plates containing varying concentrations of BAP (ranging from 1.0 to 7.0 mg L<sup>-1</sup>). Each plate held five explants, and there were five repetitions for each treatment. Uniform culture conditions, including temperature, were maintained for all cultures. After six weeks of cultivation, data on the number of shoots produced per explant, the percentage of shoot regeneration, shoot length, and shoot weight were recorded.

After harvesting the biomass, the next step involved extracting the bioactive compounds from the plant samples. To ensure the removal of any dust or impurities, the plant samples were washed several times with deionized water and subsequently dried in a 60°C oven. The drying process was monitored by weighing the samples every hour until a constant weight was achieved.

In this study, antioxidant analyses included two assays: DPPH (2,2-diphenyl-1-picrylhydrazylhydrate) and FRAP (Ferric Reducing Antioxidant Power). The DPPH assay followed Ojha *et al.* [6] protocol using a 96-well microplate filled with 100  $\mu\text{L}$  of absolute ethanol. Serial dilutions of the 2 mg mL<sup>-1</sup> sample were made across columns, and 0.04% DPPH was added to rows A-E. Absorbance was measured at 517 nm. The FRAP assay was also conducted as described by Ojha *et al.* [6] with a dilution of 2 mg mL<sup>-1</sup>. Absorbance was measured at 593 nm. IBM SPSS Statistics 20 was used for statistical analysis, calculating EC50 values using one-way ANOVA with Dunnett and Tukey HSD post-hoc testing. Dunnett's test compared treated samples to L-ascorbic acid, the control.

Once completely dried, the samples were ground into a fine powder and mixed with deionized water in a ratio of 1:50 (w/v). This mixture was then transferred to a Falcon tube and

centrifuged at 6000 rpm for 20 minutes to separate any debris or solid particles. The centrifugation process allowed for the collection of a clear liquid, referred to as the filtrate.

To further purify and concentrate the bioactive compounds, the filtrate was filtered using filter paper (e.g., Whatman No. 1). The resulting filtrate was then transferred back into a Falcon tube and subjected to freeze-drying in a freeze drier for 24 hours. Freeze-drying is a method of removing water from a substance without causing damage to the biological material.

Following the freeze-drying process, the concentrated filtrate was diluted in deionized water to achieve a final concentration of 2 mg mL<sup>-1</sup>. This diluted solution was then ready for further analysis and experimentation to investigate the bioactive compounds present in the extracted material. The extract was mixed with 0.001M of silver nitrate (AgNPs). The presence of AgNPs was determined by UV-Vis Spectrophotometer.

### 3. RESULTS AND DISCUSSION

#### 3.1 Effect of BAP on Shoot Biomass of *O. stamineus*

Fig. 1 shows *O. stamineus* shoot regrowth from nodal segments treated with 1-7 mg L<sup>-1</sup> BAP. Six-week-old *O. stamineus* plants were treated with BAP at different concentrations. Shoots treated with 1-2 mg L<sup>-1</sup> BAP had larger, true leaves and appeared green, while those treated with 3-4 mg L<sup>-1</sup> had smaller and tapered leaves, appearing yellowish green. However, the bushiness of the shoots decreased as the BAP content increased. The smaller and tapered shoots might be due to vitrification caused by higher cytokinin concentrations [7]. The effect of BAP on shoot biomass is tabulated in Table 1 below.

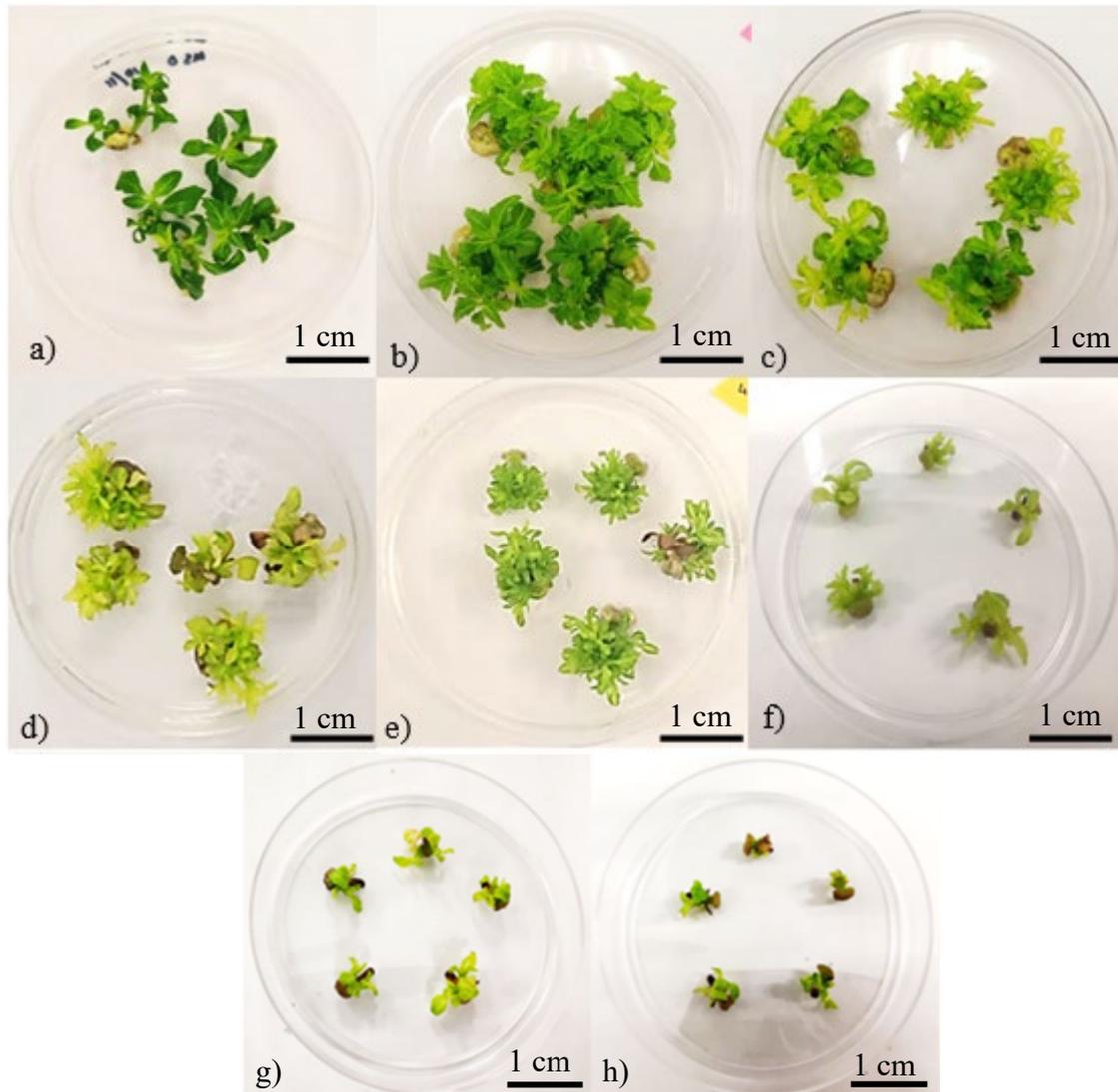
**Table 1.** Effect of BAP on shoot induction of *O. stamineus*.

Treatment (mg L <sup>-1</sup> )	No. of Shoot	Percentage of shoot regeneration (%)	Shoot length (cm)	Fresh weight (g)
MS0	2.47 ± 0.24 <sup>f</sup>	100 <sup>a</sup>	2.86 ± 0.59 <sup>b,c</sup>	0.18 ± 0.03 <sup>b,c</sup>
1 BAP	7.4 ± 0.30 <sup>c</sup>	100 <sup>a</sup>	6.75 ± 0.14 <sup>a</sup>	0.44 ± 0.04 <sup>a,b</sup>
2 BAP	8.6 ± 0.95 <sup>d,e</sup>	100 <sup>a</sup>	5.75 ± 0.20 <sup>a,b</sup>	0.39 ± 0.03 <sup>b,c</sup>
3 BAP	14.87 ± 0.66 <sup>b</sup>	100 <sup>a</sup>	5.57 ± 0.46 <sup>a,b</sup>	0.74 ± 0.35 <sup>a</sup>
4 BAP	17.00 ± 0.31 <sup>a</sup>	100 <sup>a</sup>	8.06 ± 3.93 <sup>a</sup>	0.28 ± 0.01 <sup>b,c</sup>
5 BAP	10.87 ± 0.37 <sup>c</sup>	100 <sup>a</sup>	0.68 ± 0.07 <sup>c</sup>	0.22 ± 0 <sup>b,c</sup>
6 BAP	9.67 ± 0.13 <sup>c,d</sup>	100 <sup>a</sup>	0.81 ± 0.07 <sup>c</sup>	0.24 ± 0.02 <sup>b,c</sup>
7 BAP	9.33 ± 1.73 <sup>c,d,e</sup>	100 <sup>a</sup>	0.79 ± 0.01 <sup>c</sup>	0.27 ± 0.05 <sup>b,c</sup>

One-ANOVA sample test; Post-Hoc test (Bonferroni) comparison of *in vitro* *O. stamineus* (MS0, 1 BAP – 7 mg L<sup>-1</sup> BAP). Data were expressed as mean ± standard error mean (SEM) of analysis (N=15). Different letters (a,b,c,d,e,f) shown significant level between means at \*p<0.05. Same letter indicates no significant difference between the means (p>0.05).

After six weeks of cultivation, all treatments achieved a 100% shoot induction rate. Furthermore, each explant resulted in the formation of 2 to 17 shoots. 4 BAP successfully had the highest number of shoots with the highest shoot length too. The successfully induced shoots exhibited varying lengths, ranging from 0.79 to 8.06 cm, and their fresh weight measurements ranged from 0.05 to 1.13 g.

Shoots grown from the treatments of 1-7 mg L<sup>-1</sup> BAP showed a morphology with a pattern that could be observed. Fig. 1 shows the treated shoots mentioned.



**Fig. 1.** Shoots regenerated from nodal segments of *O. stamineus* variety a) 0 mg L<sup>-1</sup> of BAP, b) 1 mg L<sup>-1</sup> of BAP, c) 2 mg L<sup>-1</sup> of BAP, d) 3 mg L<sup>-1</sup> of BAP, e) 4 mg L<sup>-1</sup> of BAP, f) 5 mg L<sup>-1</sup> of BAP, g) 6 mg L<sup>-1</sup> of BAP, h) 7 mg L<sup>-1</sup> of BAP

From Fig. 1, the control group, MS 0, displayed the darkest green shoots, while the other treated shoot cultures showed lighter green colors. Among the various BAP concentrations (1-7 mg L<sup>-1</sup>), 1 mg L<sup>-1</sup> BAP resulted in the bushiest shoots. Shoots treated with 1 and 2 mg L<sup>-1</sup> BAP exhibited broad and true leaves and were bushier than those in the MS 0 control. However, these shoots had fewer leaves, grown closely together, leading to thinner and tapered shoots. The observed hyperhydricity in the shoots, characterized by translucent, shortened, and brittle appearance, along with easy detachment from nodal segments, is attributed to factors like oxidative stress, impaired nitrogen metabolism, and endogenous hormone imbalance, possibly induced by the high cytokinin BAP concentration in the culture media [8]. For this part, 4 mg L<sup>-1</sup> BAP had been chosen for further antioxidant assays due to its high concentration of BAP and tolerable biomass produced.

### 3.2 Antioxidant Assays of Shoot Biomass of *O. stamineus*

Antioxidant assays involved in determining the antioxidant potential of *in vitro* *O. stamineus* extract are DPPH and FRAP assays.

#### 3.2.1 2,2-diphenyl-1-picrylhydrazyl Assay (DPPH Assay)

The DPPH assay is based on the principle of neutralizing free radicals. Antioxidants present in the plant extract interact with the DPPH molecule, which serves as a free radical, causing the DPPH to change its color from deep purple to yellow (DPPH-H). The yellow color indicates that the DPPH radicals have been scavenged by the antioxidants in the plant extract [9]. Fig. 2 illustrates the color change from purple to yellow in the DPPH assay.



**Fig. 2.** Colour changes of DPPH solution after 30 min incubation indicating the presence of antioxidant agents

In the DPPH assay, the EC<sub>50</sub> represents the concentration of the sample required to achieve a 50% inhibition of DPPH radicals through the action of hydrogen ions from antioxidants.

**Table 2.** EC<sub>50</sub> values of L-ascorbic acid and *O. stamineus* shoot extracts

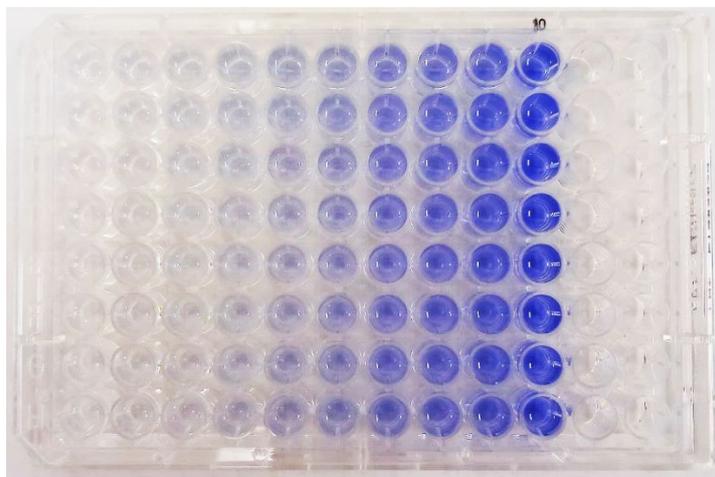
Sample	DPPH (IC <sub>50</sub> ) (µg/ mL)
L-Ascorbic acid	2.97 ± 1.50 <sup>#</sup>
Field-grown extract	751.00 ± 20.50 <sup>a</sup>
MS 0	69.33 ± 7.31 <sup>c</sup>
1 BAP	107.13 ± 3.96 <sup>b</sup>
2 BAP	76.33 ± 2.67 <sup>c</sup>
3 BAP	211.70 ± 3.37 <sup>b</sup>
4 BAP	56.65 ± 0.17 <sup>c</sup>

One-ANOVA sample test; comparison of DPPH against samples of control, field-grown *O. stamineus* and *in vitro* *O. stamineus* (control, 1 BAP – 4 BAP). Dunnett t-tests (< control)<sup>#</sup> treat one group as a control, and compare all other groups against it at  $p < 0.05$  significance level. Tukey-HSD comparison subset group between all groups, different alphabets (a, b, c) indicate significant different at  $p < 0.05$  level. Same alphabet indicates non-significant different ( $p > 0.05$ ).

Table 2 shows the EC<sub>50</sub> values for L-ascorbic acid, field-grown and treated (1-4 mg L<sup>-1</sup> BAP) *O. stamineus*. A lower EC<sub>50</sub> value indicates a stronger scavenging activity. Good antioxidants present in the plant extract contribute to this robust scavenging ability. All the *in vitro* shoot cultures exhibited superior responses in combating DPPH radicals compared to the field-grown extract. According to Jadid *et al.* [10], the antioxidant strength can be classified into three classes; EC<sub>50</sub> of 10-50 µg/mL denotes strong antioxidant activity, EC<sub>50</sub> of 50-100 µg/mL denotes intermediate antioxidant activity, while EC<sub>50</sub> with more than 100 µg/mL denotes weak antioxidant activity. The EC<sub>50</sub> value of the field-grown extract is 751.00 ± 20.50 µL, indicating the weakest scavenging property. The antioxidant activities of MS 0, 2, and 4 mg L<sup>-1</sup> BAP is classified as intermediate, while the field-grown extract, along with 1 and 3 mg L<sup>-1</sup> BAP, displayed weak antioxidant activities.

### 3.2.2 Ferric Reducing Antioxidant Power (FRAP)

The FRAP assay is employed to assess the antioxidant potential of both field-grown and *in vitro* cultures of *O. stamineus*. This test operates based on the principle of electron transfer, wherein the Fe<sup>3+</sup> - TPTZ complex is reduced to Fe<sup>2+</sup> - TPTZ complex, leading to a color change from colorless to blue. Table 3 presents the FRAP values of *O. stamineus* obtained from *in vitro* culture, which includes shoot biomass induced from nodal segments grown in MS Media with no plant growth regulator (control), as well as in MS Media with concentrations of 1 - 4 mg L<sup>-1</sup> BAP.



**Fig. 3.** Blue colour change of the solution indicates the reduction of Fe<sup>3+</sup>- TPTZ complex to Fe<sup>2+</sup>- TPTZ complex after 30-min of incubation.

By plotting the standard curve of ferrous sulfate (FeSO<sub>4</sub>) with concentrations ranging from 5 to 100 µM, the FRAP value was determined. The graph enabled the derivation of the linear equation  $y = 0.0007x + 0.3871$ , with an R<sup>2</sup> value of 0.9504. The results were then expressed in terms of µM Fe<sup>2+</sup> per gram of dry weight of the plant crude to demonstrate the extract's reduction ability. The corresponding data is presented in Table 3.

**Table 3.** Ferric-reducing Antioxidant Power (FRAP)

Sample	FRAP $\mu\text{M Fe (II)/g}$
Field-grown extract	1733.33 $\pm$ 101.98 <sup>a</sup>
MS 0	3019.05 $\pm$ 109.83 <sup>b</sup>
1 BAP	4085.71 $\pm$ 75.59 <sup>c</sup>
2 BAP	4742.86 $\pm$ 103.02 <sup>d</sup>
3 BAP	4447.62 $\pm$ 98.80 <sup>c,d</sup>
4 BAP	7200.00 $\pm$ 103.02 <sup>e</sup>

One-ANOVA sample test; Post-Hoc test (Bonferroni) in comparison of FRAP against samples of field-grown variety of *O. stamineus* and *in vitro* *O. stamineus* (MS0, 1 – 4 mg L<sup>-1</sup> BAP). Data were expressed as mean  $\pm$  standard error mean (SEM) of analysis (N=15). Different letters (a,b,c,d) shown significant level between means at \*p<0.05. Same letter indicates no significant difference between the means (p>0.05).

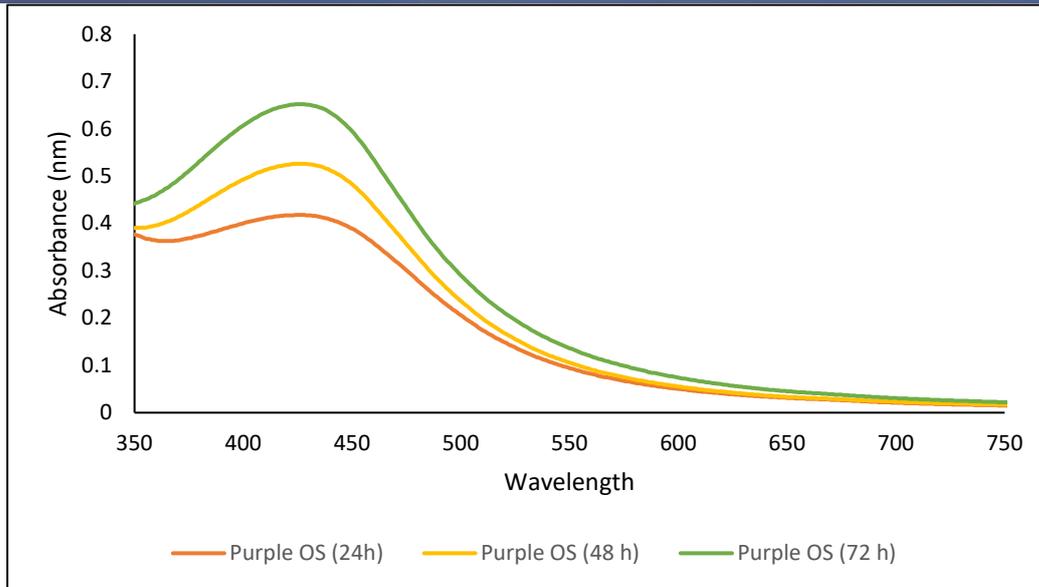
Table 3 displays the FRAP values obtained from the extract of field-grown and *in vitro* culture of *O. stamineus*, measured at 593 nm. In the case of *in vitro* culture, the shoot biomass induced in MS 0 served as the control for this assessment. The statistical analysis of FRAP values was conducted using SPSS with one-way ANOVA and Post-Hoc test (Bonferroni). The test compared the FRAP values among the samples of field-grown and *in vitro* culture (MS 0, 1-4 mg L<sup>-1</sup> BAP) of *O. stamineus*.

The FRAP values of *O. stamineus* biomass showed distinct patterns. The field-grown sample had the lowest FRAP value of 1733.33  $\pm$  101.98  $\mu\text{M Fe (II)/g}$ . Among the *in vitro* cultures, the lowest FRAP value was observed in MS 0, while those supplemented with 1 - 4 mg L<sup>-1</sup> BAP displayed higher FRAP values. The highest FRAP value of 7200.00  $\pm$  103.02  $\mu\text{M Fe (II)/g}$  was observed in shoot biomass grown in 4 mg L<sup>-1</sup> BAP. Both field-grown and *in vitro* cultures exhibited remarkably high reducing power, exceeding the extremely high threshold of 625  $\mu\text{M Fe (II)/g}$ , as defined by Abdullah *et al.* [11]. With increasing BAP concentration, the FRAP values also increased, except for a slight drop observed in shoot biomass induced in 3 mg L<sup>-1</sup> BAP. Overall, the *in vitro* culture demonstrated higher FRAP values compared to the field-grown sample.

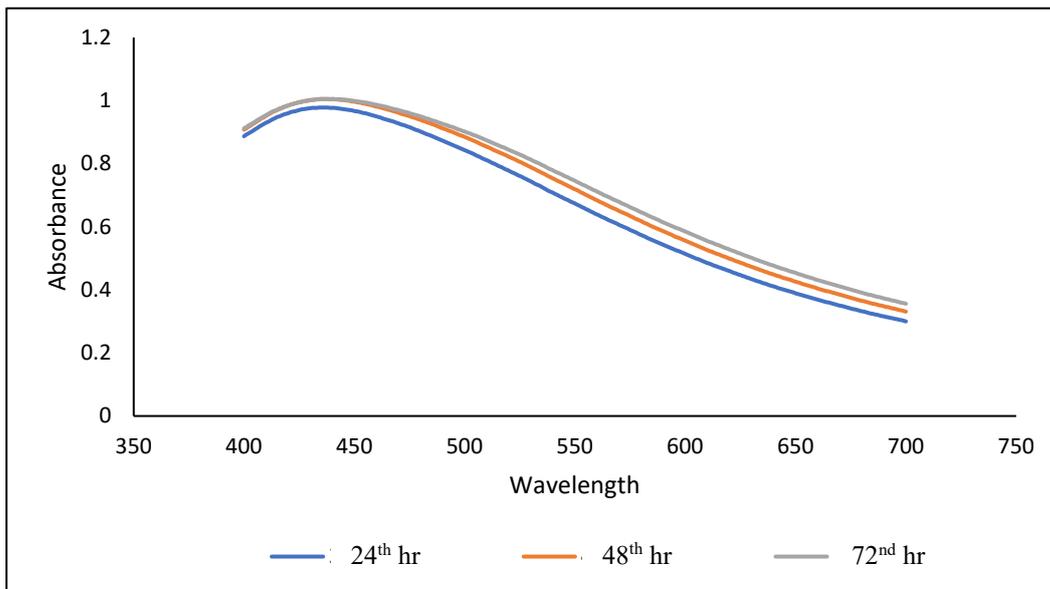
The use of elicitors may impact the antioxidant potential of *O. stamineus* shoot biomass from nodal segments. FRAP values significantly differed between *in vitro* and field-grown samples. Introduction of BAP in MS Media led to a remarkable increase in FRAP values, particularly at 4 mg L<sup>-1</sup>. Higher FRAP values indicate increased presence of antioxidants and reduced Fe<sup>3+</sup> to Fe<sup>2+</sup>. *In vitro* shoots' high reducing power is likely influenced by BAP introduced in the MS Media.

### 3.3 Synthesis of AgNPs from *O. stamineus* extract

The shoot culture of six-week-old plants was collected and extracted. The extract was then combined with 0.01 M silver nitrate (AgNO<sub>3</sub>) to synthesize AgNPs. The extracts used for this process were obtained from MS 0 (control), as well as from cultures treated with 1 mg L<sup>-1</sup> BAP, 2 mg L<sup>-1</sup> BAP, 3 mg L<sup>-1</sup> BAP, and 4 mg L<sup>-1</sup> BAP. Fig. 4 depicts the UV-visible spectra of the AgNPs synthesis after 24 hours using the extracts.

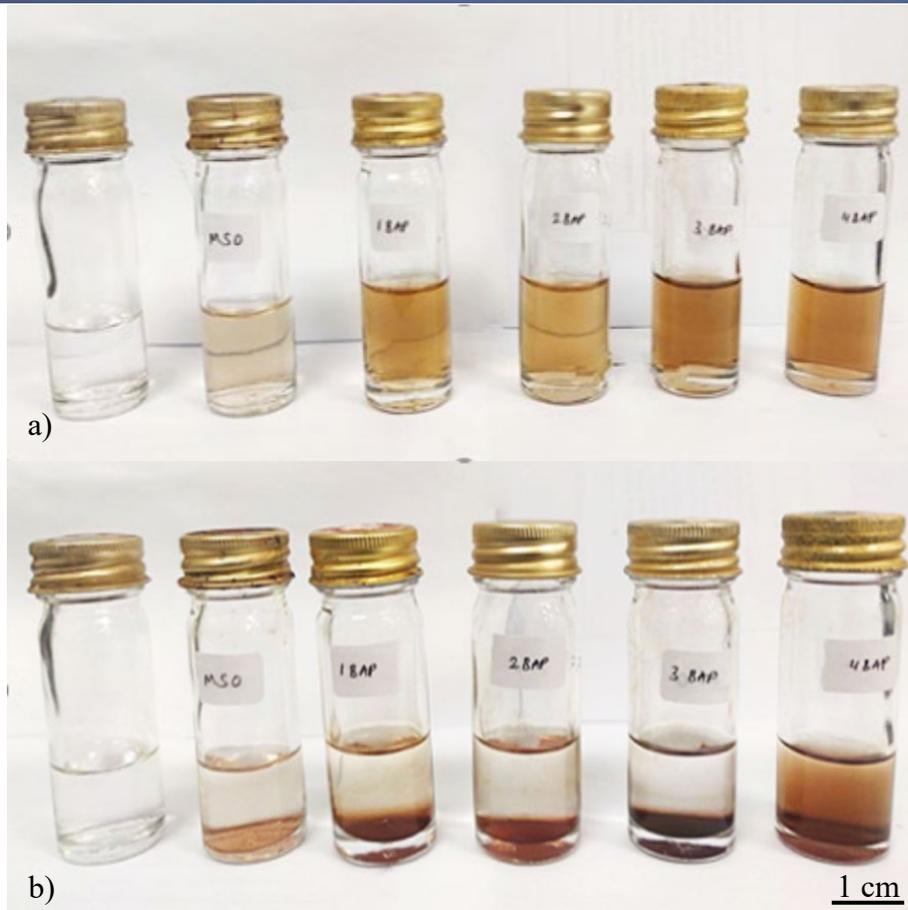


**Fig. 4.** Synthesis of AgNPs from field grown *O. stamineus*



**Fig. 5.** Synthesis of AgNPs from in vitro culture of *O. stamineus*

Fig. 4 shows the result of UV-Vis spectra of AgNPs synthesis from *O. stamineus* field-grown extract while Fig. 5 is the result from *in vitro* culture of *O. stamineus*. The SPR peaks at 429 nm for field-grown and at 439 nm for *in vitro* culture of *O. stamineus*. Comparing Fig. 4 to Fig. 5, AgNPs from in vitro culture shows higher SPR compared to field-grown culture for each of hour taken (24<sup>th</sup>, 48<sup>th</sup> and 72<sup>nd</sup>). According to Aritonang *et al.* [12], the shifting of the SPR peak relates to the size of silver nanoparticles. A bigger size of nanoparticles would shift the peak wavelength to the right, and smaller nanoparticles to the left. However, in this case, the size of AgNPs from both extracts might not have much difference.



**Fig. 6.** The colour change of *O. stamineus*-AgNPs mixture. a) After 30 mins, b) After 24 hours

Fig. 6 illustrates the color of the *O. stamineus*-AgNPs mixture. In (a), it is evident that the *in vitro* shoot of *O. stamineus* could rapidly reduce  $\text{Ag}^+$  to  $\text{Ag}^0$  within just 30 minutes, as indicated by the brown color formed, signifying the formation of AgNPs. According to Bhutto *et al.* [13], this reduction process is facilitated by secondary metabolites containing a hydroxyl group. *O. stamineus* contains various phenolic compounds, including caffeic acid, ferulic acid, methyl caffeate, protocatechuic acid, rosmarinic acid, salvianolic acid, and vanillic acid [14]. These phenolic compounds not only act as reducing agents in AgNPs formation but also serve as capping agents, stabilizing the AgNPs and preventing aggregation, which is a critical step in the synthesis process.

However, the colloidal mixture obtained from AgNPs synthesis did not remain stable over time, as evident after 24 hours when the formation of aggregated AgNPs occurred, eventually settling on the container's surface as seen in (b). This outcome notably contrasted with the synthesis process using field-grown extract. It is possible that the *in vitro* shoot culture of *O. stamineus* contains bioactive compounds capable of reducing  $\text{Ag}^+$  in silver nitrate to  $\text{Ag}^0$ . However, there might be a disparity in the bioactive compounds present between the *in vitro* culture and the field-grown *O. stamineus*. This distinction could potentially be attributed to the absence of a stabilizing agent in the *in vitro* culture, leading to the aggregation of AgNPs.

#### 4. CONCLUSION

In conclusion, this study demonstrates that among BAP concentrations ranging from 1 to 4 mg L<sup>-1</sup>, 4 mg L<sup>-1</sup> resulted in the highest number of shoots but the lowest fresh weight value (g). Each BAP concentration led to a 100% shoot regeneration rate. The shoot culture treated with 4 mg L<sup>-1</sup> BAP exhibited the lowest EC50 value in the DPPH assay, indicating potent antioxidant activity. Compared to the field-cultivated culture, the BAP-treated shoot culture displayed higher antioxidant activity. Additionally, the FRAP testing revealed that the antioxidant activity of the 4 mg L<sup>-1</sup> BAP-treated culture was the most significant. On an industrial scale, utilizing 4 mg L<sup>-1</sup> BAP could yield a large amount of *O. stamineus* biomass with high antioxidant activity. Furthermore, AgNPs could be synthesized from *in vitro* *O. stamineus* culture, exhibiting higher intensity of SPR compared to AgNPs produced from field-grown culture. However, further investigation is needed to understand the reason behind the agglomeration of AgNPs from the *in vitro* extract of *O. stamineus*.

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## I-CReST 2023:174-169 - Biodegradation of Microplastics by Plastic-Degrading Bacteria: A Review

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### ABSTRACT

Plastic has been prevalent due to its unique properties, such as flexibility and cost-effectiveness. Once the plastic waste is released into the environment, it can degrade over time, producing many smaller plastic fragments called microplastics (MPs). MPs pose a global threat to ecosystems and human health due to their extensive use and accumulation in the environment. This study aims to review the scientific literature on MPs in the environment and identify the strategy towards managing the MPs for the foreseeable future. Degradation of MPs using microbes such as bacteria has grasped the attention of researchers around the globe to study microbial strategy to enhance MPs degradation in the environment as it is an eco-friendly alternative. In this study, online science database (such as Scopus and Science) has been used to investigate the biodegradation of MPs in the environments by narrowing it down to 'Biodegradation', 'Degradation', 'Human' and 'Microplastics' categories. More than 100 articles involving MPs pollution and biodegradation by bacteria were published between 2017 and 2023 were identified. Thus, the articles were reviewed and revealed that the extent of MPs pollution towards human health remain poorly understood. The microbial strategy of bacteria to degrade MPs in the environment and the factors that affect the process also needs more understanding and information. Hence, this article reviewed current knowledge regarding the sources, distribution, pathways, and risks associated with MPs contamination including adverse effects on human health. The article also focuses on the several steps mechanism of biodegradation, factors influencing biodegradation and existing species of bacteria to degrade MPs. This work will be a reference for new researchers to use this effective strategy for plastic pollution removal.

**Keywords:** Microplastics; toxicity; biodegradation; plastic-degrading bacteria

### 1. INTRODUCTION

Plastics can be classified into two types which are natural and synthetic plastics. Synthetic plastic is a polymer composed of petrochemicals with a high molecular weight linked together in a long chain [23,28]. Glass, metals, and wood have all been replaced by plastic in a variety of applications over the past 50 years [6] and have been widely used in human life due to their unique properties such as flexibility, low weight and cost of effectiveness [31]. The accumulation of plastics in the environment is projected to reach approximately 11 billion

tonnes by 2025 [78]. This is because plastics have been utilised extensively across various social economies such as apparels, food packaging, automobiles and beauty products [37].

A significant amount of waste that made of plastic makes its way into the environment via various routes as a direct consequence of inadequate management and disposal practices, which contributes significantly to the problem of environmental pollution [35]. After plastic waste is released into the environment, it can degrade over time and produce a large number of smaller plastic fragments or minute particles due to the interaction of various physical and chemical processes. MPs can be found in various locations, ranging from the equator to the poles, and from deep-sea sediments to Mount Everest as polyester MPs were discovered at an elevation of 8440 metres [38].

The United Nations Environment Programme (UNEP) Yearbook 2014 identifies MPs as one of ten emerging contaminants that could pose a threat to human health and other organisms in all ecosystems [69]. In a search by Deng *et al.* [22], the presence of MPs can result in various adverse health effects for aquatic species as they mistake these tiny plastic particles for food and digest them. MPs also have made their way into the terrestrial ecosystem, which already acts as a landfill for waste plastics. MPs also can easily seep from soil into underground water and pollute other sources of water, which can be worrisome, especially for the ecosystems [7]. Furthermore, due to its toxicity, the persistent hazardous contamination of MPs in the environment may affect living organisms such as animals and humans [48].

Besides that, the conventional means of waste disposal, such as landfilling, incineration, and chemical treatment, must be adequate for managing abundant amounts of waste plastic [70]. If conventional waste management is not done properly, it will lead to the bioaccumulation of plastic waste in the environment. Furthermore, due to the smaller size of the MPs, this conventional waste management method is inapplicable to degrade these plastic residues effectively. In contrast to the conventional waste management in eradicating plastic residues, biological techniques are deemed to be an eco-friendlier alternative [2]. For instance, microbial degradation method [6]. This is because microorganisms are capable of metabolising a vast range of inorganic and organic compounds, as well as having the ability to alter various contaminant compounds, including plastic polymers [8]. Various microorganisms degrade a particular class of plastics.

It has been discovered by Chattopadhyay [16] that a wide variety of microorganisms, including bacteria, fungi, and algae, are capable of degrading polymers. However, among all these microorganisms, bacteria are one of the most prevalent that have been used to degrade synthetic polymers. Nevertheless, the current knowledge on the mechanisms involved in the MPs degradation process and the effectiveness of bacteria species that can act as biodegrading agents still appears limited. In addition, the factors influencing the microbial activity in degrading MPs are poorly understood, necessitating additional research.

Therefore, the present study provides up-to-date and comprehensive information on the prevalence of MPs in various environmental matrices, including soil, marine, and food chains. Various sources of MPs and their routes to the environment and humans also were reviewed. The primary objectives of this review are as follows: (i) to understand the toxicity of MPs towards the environment and human health, (ii) to review the potential of bacteria species that can degrade synthetic plastic residues, and (iii) to discuss the mechanism of MPs degradation by bacteria.

This review will be a significant effort to find a high-degree biodegrading bacteria that can help solve the problem of the long-term deposition of microplastics in the environment and ecosystem because it can affect both animals and humans [15,26,27]. The use of biological processes for the degradation of plastic and its transformation into bioproducts with added value offers a method that is both environmentally friendly and sustainable for addressing this enormous environmental burden [6]. The management of waste made of plastic is a serious issue, and biodegradation techniques have a significant amount of unexploited potential to open up new avenues in this field [7,76]. In the future, it will also benefit the government or non-government organisations to upgrade the environment and nature standards by discovering specific good bacteria that can be used to eliminate contamination caused by plastic residues. This can be done by finding particular good bacteria that can be used to eliminate contamination caused by plastic residues.

## 2. METHODOLOGY

A methodology was used in this review to investigate plastic-degrading bacteria on microplastics. The research sources for this review were the following: Web of Science (<http://apps.isiknowledge.com>), Scopus (<http://www.scopus.com/>), and ScienceDirect (<http://www.sciencedirect.com/>). These online databases were used by the author to narrow down the criteria. Biodegradation, degradation, synthetic microplastics, bacteria, mechanism, and factor ranked among the most frequently searched phrases. This method allowed for the selection of published papers on the bacterial degradation of non-biodegradable plastic polymers. Publications on the degradation of plastics that are biodegradable were excluded, and a greater emphasis was placed on publications published within the last five years unless there is a lack of recent literature on the topic. The analysis was restricted to only including journals, books, and publications proceedings written in English to ensure that the most reliable materials and publications represented the academic fields. Finally, a comprehensive screening process was conducted on 100 papers to review, analyse, categorise, and present their findings with the relevant sections, ensuring that the paper's scope was adequately covered.

## 3. MICROPLASTICS

In the early 1974s, researchers Smith and Carpenter (1972) first discovered the existence of microplastics in the Atlantic Ocean [25]. According to Frias & Nash [29], the term microplastics was initially introduced to define the deposition of microscopic plastic fragments in marine sediments as well as in European waters' aquatic environments. On the other hand, Dissanayake *et al.* [26], discovered that these fragments are also present in the terrestrial environment instead of only in aquatic environments. Hence, there has been a resurgence in the scientific community's interest in microplastics which leads to systematise definition and classification of plastic debris.

ISO/TR 21960:2020, published by the International Organization for Standardization, classifies solid plastic particles insoluble in water as microplastics with a diameter of 1 mm, large microplastics with a diameter of 1 mm to 5 mm [18]. The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) also has defined microplastics as "plastic particles with a diameter of fewer than 5 mm, which may also include particles within the nanoscale which is 1 nanometre (nm) [29] which contributed to the further global dissemination of the definition.

Microplastics can be classified into two categories, primary microplastics (PMPs) and secondary microplastics (SMPS). The area's most severely contaminated by these MPs are urban landfills, urban areas and beaches. Agriculture ecosystems also have been greatly affected due to contamination of MPs [27]. Overall, the omnipresence of microplastics in the environment, such as marine and terrestrial, has been the main concern, especially for aquatic organisms, as they can be mistaken for prey and accidentally consumed by the predator [33]. Table 1 depicts the most common sources of microplastic environmental pollution.

**Table 1.** Common environmental microplastic pollution sources

Source of Microplastics	Reference
<b>Primary source</b>	
Personal care products (PCPS)	[40]
Air blasting technology	[81]
Industrial abrasive	[23]
Cosmetics	[33]
<b>Secondary source</b>	
Macroplastic fragmentation	[63]
Fishing	[2]
By-products of industrial processes	[43]

### 3.1 Sources of Microplastics

#### 3.1.1 Primary Microplastics

Plastics that are explicitly produced in microscopic dimensions and have been used in industrial, domestic, and commercial are known as primary microplastics (PMPs) [21,29]. This microscopic dimension is known as microbeads, which can be manufactured from polyethylene (PE), polyethylene terephthalate (PET), and polypropylene (PP) with sizes ranging from 10 to 100 micrometre ( $\mu\text{m}$ ) in diameter spheres and commonly manufactured to be used in self-care products [40]. Personal care products include facial cleansers, exfoliating scrubs, and toothpaste [7,68]. Other than that, it also has been used in products like shower gel, cleansing paste, eye shadow, lipstick and children's products [23, 33].

PMPs are also used as abrasives in cleaning products and other industrial uses. For instance, MPs are utilised in air blasting technology in the form of abrasive media such as acrylic and polyester with sizes between 0.2 to 2 mm to replace a variety of natural materials due to their stability, long-lasting, inexpensive, and simple produce, besides being the most effective cleaning agent [81]. The manufacturing industry, automotive, aviation industries, marine industry, and boating are all common users of air blasting technology to remove colour, rust, as well as other pollutants from steel surfaces before applying new coatings [43].

#### 3.1.2 Secondary Microplastics

SMPs, known as secondary microplastics, are produced; as a result, the deterioration of macro size into smaller plastic fragments. This occurs as a result of degradation and fragmentation by UV solar radiation [63] as well as other weathering processes which involve improperly managed waste, such as plastic materials that have been thrown away or items that have been lost unintentionally, such as fishing net [2,49,52]. Gola *et al.* [33], also stated that the fragmented products produced due to the physical fragmentation, biological action, and



mechanical abrasion [2,7,13] of sizeable-sized plastic are a significant source of secondary microplastics.

In contrast to PMPs, SMPs are significantly more common and prominent in terms of particle size. A wide variety of sizes, shapes, colours, and types of polymers can be found in secondary microplastics due to the pervasive degradation of plastics in their natural environments [44]. This is due to the fact that the breakdown of any larger plastic item can result in the production of SMPs [1]. The primary and secondary microplastic particle samples are shown in their magnification forms in Fig. 1. Primary particles have spherical shapes in the range of 10-100  $\mu\text{m}$  size, while most of the secondary particles are larger pieces with more irregular shapes that range in size and colour [40].

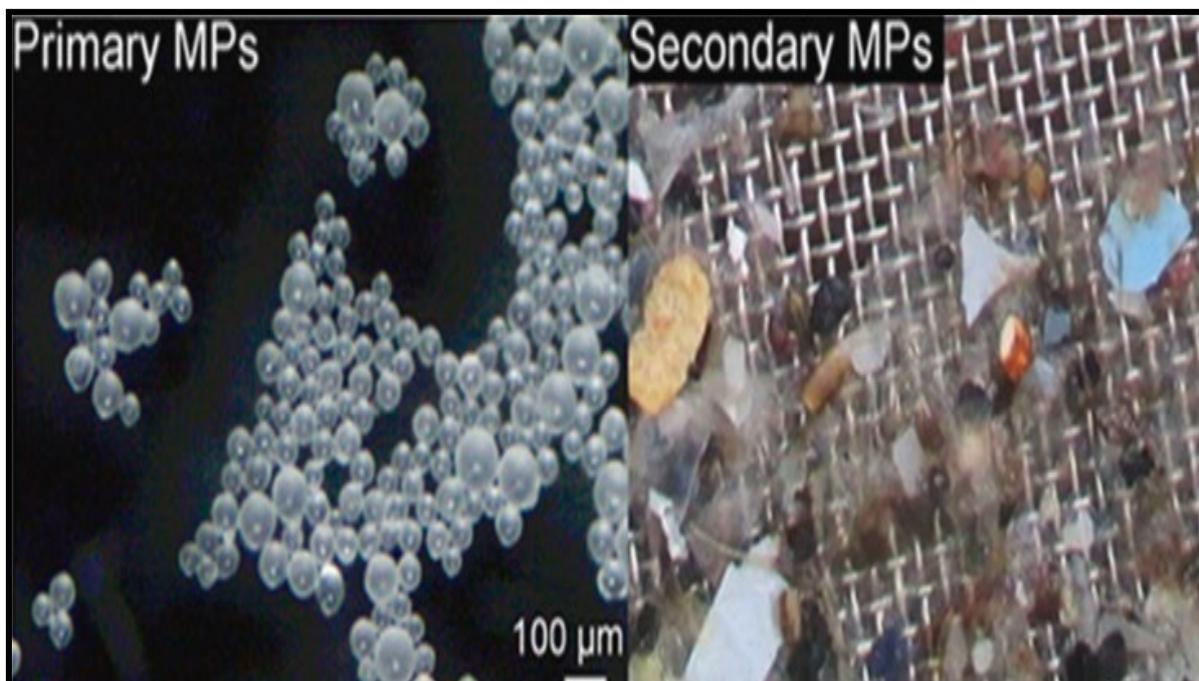
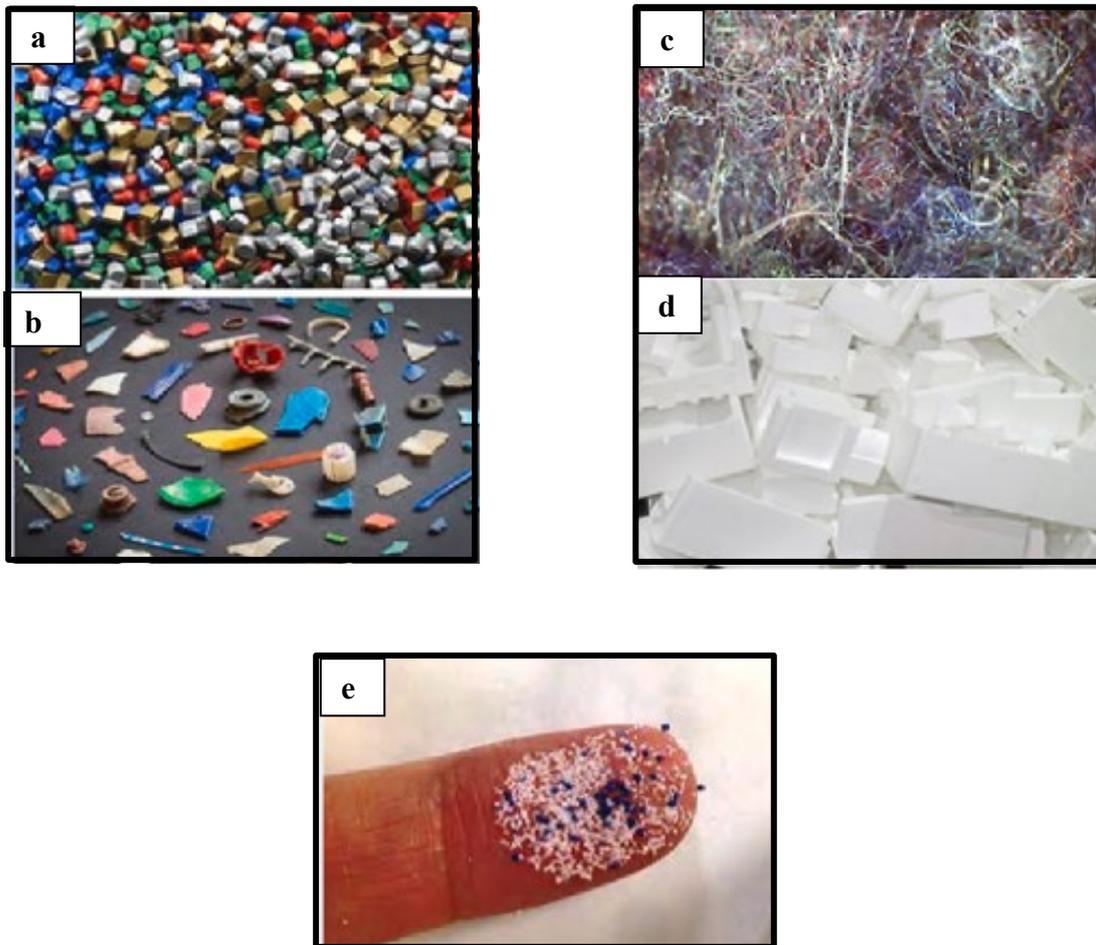


Fig. 1. Example images of primary and secondary microplastics [40]

## 3.2 Types and Composition of Microplastics

### 3.2.1 Shape and Size

The fact that MPs are relatively small makes them the primary factor contributing to their bioavailability. MPs can exist in different forms, such as fragments, granules, fibres, foams and microbeads, as shown in Fig. 2 [51,66]. The size of the MPs particles also can be varied. MPs with a diameter less than 0.5 mm, followed by 0.5-1 mm and 1-5 mm, can be found in surface water and sediments of the West River in China [37] while in the terrestrial environment, the MPs size ranged from 20  $\mu\text{m}$ -5 mm and 1-5 mm [67]. Based on these findings, it is clear that MPs' particle size varies greatly and differs by region due to the different transformations, such as abrasion and weathering [2].

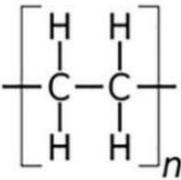
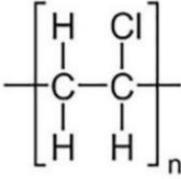
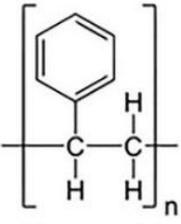
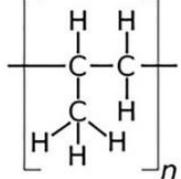
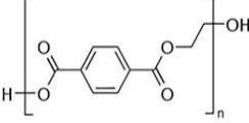


**Fig. 2.** Microplastic forms (a) granule, (b) fragments, (c) fibre, (d) foams, (e) microbeads [2]

### 3.2.2 Chemical Properties

MPs were made up of a variety of synthetic polymer components, including polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), polystyrene (PS) and polyethylene terephthalate (PET) [2,30]. A compilation of the properties and applications of the polymers is given in Table 2. Among these polymers, PE and PP are semi-crystalline polymers, while PVC and PET are amorphous polymers with no crystalline structures. In contrast to crystalline polymers, which exhibit rigid crystalline regions, amorphous polymers are easily degraded [75]. Crystallinity is an essential polymeric property that plays a role in determining the density of MPs [90]. Therefore, when the plastics degrade into MPs, the crystallinity will affect the MPs' density [58]. For instance, semi-crystalline polymers such as PP and PE, are denser than seawater, making them easy to sink on the bottom of the seawater [7].

**Table 2.** Properties and applications of the polymers [7,54,59,71,92]

Polymer	Chemical Structure	Chemical Formula	Properties	Applications
Polyethene (PE)		$(C_2H_4)_n$	Chemical resistance Excellent electrical insulation Semi-crystalline	Films Shopping bags Toiletty bottles
Polyvinyl chloride (PVC)		$(C_2H_3Cl)_n$	Sensitive to UV radiation Resistant to inorganic chemicals and acids Amorphous	Pipes Cling wrap Medical devices
Polystyrene (PS)		$(C_8H_8)_n$	High transparency Limited flexibility Amorphous	CD cases Toys Cassetteboxes
Polypropylene (PP)		$(C_3H_6)_n$	High melting point Lightest polymer Semi-crystalline	Medicine bottles Condiments bottles Plastic straw
Polyethylene terephthalate (PET)		$(C_{10}H_8O_4)_n$	High resistance to alcohols Medium barrier to oxygen Amorphous	Electric components Food packaging Jar

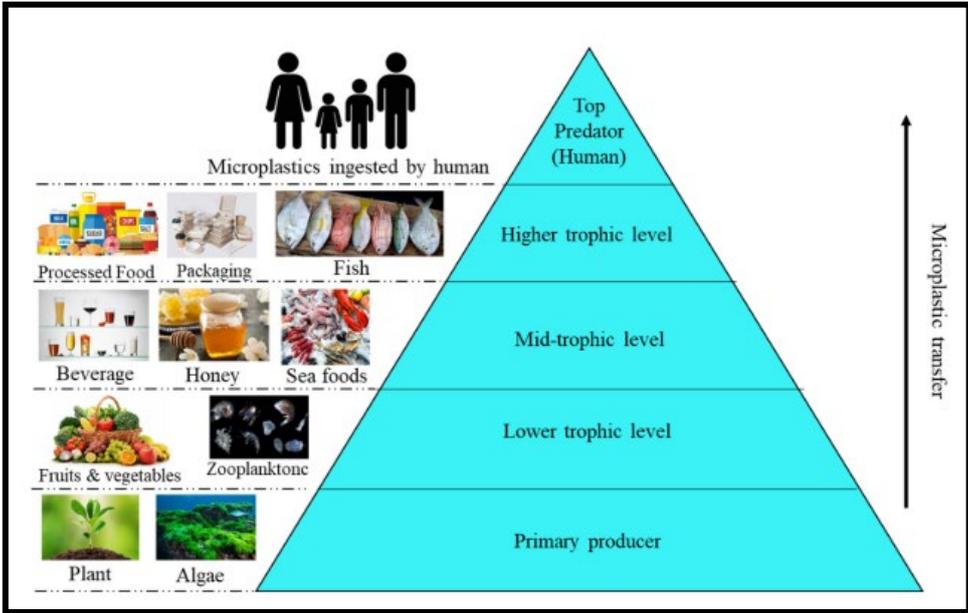
### 3.3 Sources of Exposure, Transport, and Distribution of Microplastics toward Human

Ingestion, inhalation, and skin contact are the three primary routes MPs can enter the human body. The possible routes that microplastic particles take as they make their way through the human food chain are represented in Fig. 3 [44,50]. This means that MPs can be obtained in significant quantities directly through consumption or indirectly through trophic transfer. According to the reports by the Food and Agriculture Organisation, MPs have been found in various marine organisms that are needed in the human diet, such as crustaceans, fish and molluscs. These particular species are also commonly captured in marine environments and extensively cultivated in the aquaculture sector [68]. Furthermore, an average of approximately one MPs particle's size between 1 to 600  $\mu\text{m}$  can be found in 1 g of fish tissues [69]. Therefore, humans are directly exposed to MPs through the consumption of fish, molluscs, and crustaceans.

Moreover, according to the research conducted by Mamun *et al.* [50] various types of packaging materials, such as water bottles, beverage cartons, and glass bottles, were revealed that are releasing MPs. Besides that, MPs also have been discovered in human water consumption. For instance, water that is packaged in bottled and tap water [64]. Rose *et al.* [68]

discovered that ale exhibited the highest recorded concentration of MPs at 28 particles/L, followed by an energy drink at 7 particles/L, and iced tea at 6 particles/L. due to factors such as limited availability in certain regions, inconsistent consumption patterns, and differences in dietary behaviours. However, further scientific evidence is required to differentiate between MPs that are directly and indirectly ingested by the human body.

Besides that, MPs also have been detected in the air, which indicates another route for the contamination of MPs. For instance, textile fibre significantly contributes to environmental contamination, comprising approximately 33% of MPs [51]. Inhalation also can arise from various sources, including apparel, construction materials, incineration of waste in landfills, and abrasions caused by plastic products [2]. Undoubtedly, the act of inhaling MPs is more prevalent in occurrence compared to the act of ingesting them. However, further research is needed as only some regions are exposed to construction materials and incineration, especially in the suburban regions.



**Fig. 3.** Possible routes that microplastic particles take as they make their way through the human food chain [50]

### 3.4 Negative Effects of MPs on the Human Health

The combination of ingestion and inhalation routes to MPs poses numerous risks to human health. Reportedly, MPs adversely affect human health, but their precise effects remain largely unknown. According to Lima *et al.* [48], MPs have been found in crops such as wheat, implying a possible threat of MPs contaminants in the food supply chain. In addition to contaminated food, packaging and plastic containers can also serve as contamination sources [50]. Xie *et al.* [86] did a few *in vivo* studies and found that by consuming PS-MPs can significantly impact reproductive function. This was demonstrated by a reduction in the number of sperm cells, an increase in the rate of sperm deformity, and decreased sperm motility. In addition, the concentration of testosterone in the sperm and the activity of enzymes involved in sperm metabolism are both reduced by MPs [82].

Besides that, plastic additives contain several toxic effects on human health as shown in Table 3. According to studies, numerous unusual substances, including a wide range of antioxidants, have been used as plastic additives [73]. Regrettably, some plastic antioxidant additives, such as Bis (2,4-di-tert-butyl phenyl) phosphate, can be detrimental to human health as they can lead to cytotoxicity. In general, various kinds of plastics containing numerous chemical additives are used in plastic bottles, municipal water chains, and pipework can release toxic antimony at high temperatures ranging from 60 to 85 °C [55,71]. This research indicates that MPs additives could be released into the environment and have a detrimental effect on human health. However, neither the toxic chemicals released from MPs nor their cumulative and combined toxicities are fully understood. Future research should address these knowledge gaps and issues regarding the consequences of MPs towards human health.

MPs can act as pollutant vectors to organisms by forming a biofilm that releases a signal to increase bioavailability and enter the food chain after being consumed by organisms [90]. The development of biofilms on MPs can alter their characteristics, including their hydrophobicity, density, roughness, size, and functional group. They can transport the pathogenic microorganisms to target tissues while shielding them from the immune system, eventually resulting in pro-inflammatory responses and tissue damage [2]. Furthermore, the MPs particles pose a significant risk to pulmonary health due to their smaller dimensions, facilitating their penetration and prolonged lung retention [51]. In addition, exposure to MPs inhibits the activity of enzymes during digestion, which decreases lipid digestion because of the formation of oil droplets from the MPs [72]. The overall negative effect of MPs on marine and terrestrial environments and humans was summarised in Table 4.

**Table 3.** The presence of heavy metals in plastic products and their consequences for human health [14]

<b>Heavy metals</b>	<b>Usage of additives</b>	<b>Effects on human health</b>
Arsenic (As)	Biocides	Carcinogen: gastrointestinal damage; death; congenital disabilities.
Aluminium (Al)	Stabilisers, inorganic pigments and flame retardants	Breast cancer
Bromine (Br)	Flame retardants	Genotoxicity and apoptosis
Barium (Br)	Inorganic pigments and UV stabilisers	Breast cancer, metal–oestrogen,; and mental illnesses
Cadmium (Cd)	Heat stabilisers, UV stabilisers and inorganic pigments	Affect metabolism; postmenopausal osteomalacia; and lipid peroxidation
Lead (Pb)	Heat stabilisers, UV stabilisers and inorganic pigments	High blood pressure; abortion; nervous system disruption and cell damage.
Mercury (Hg)	Biocides	Mutagen or carcinogen; DNA molecular structure disruption and brain damage
Titanium (Ti)	UV stabilisers and inorganic pigments	Cytotoxicity on human lung and colon epithelial cells.

**Table 4.** Summary of the MPs toxicity affects human

Research study	Results and limitations	References
MPs contamination in human in general	MPs can be obtained in significant quantities either directly through consumption or indirectly through the human food chain, inhalation and skin contact. The study still lacks details and scientific evidence to distinguish between MPs that are ingested directly and indirectly by the human body and their effect.	[50]
PS-MPs can significantly impact reproductive function	Researchers have done vivo studies and found that PS-MPs can reduce the number of sperm cells, decrease sperm mobility and increase the rate of sperm deformity. However, the studies only focus on the male reproductive system instead and lack sufficient studies on the female reproductive system.	[86]
Plastic additives contains heavy metals that can affect human health	Various kinds of chemical additives used for their specific end-use can cause detrimental effects to humans, such as cytotoxicity, as they can leach into the environment. The toxic chemicals released by MPs and their cumulative and combined toxicities are only partially understood due to a lack of details.	[67]

#### 4. MICROBIAL-MEDIATED MICROPLASTIC DEGRADATION

Some of the microorganisms, such as bacteria, possess enzymes that can decompose and utilise synthetic plastics as a source of carbon and energy, which have been discovered by researchers. Plastic-degrading enzymes, also called plasticases, can selectively target the chemical bonds present in plastics [6]. This results in the degradation of the plastic material into simpler compounds that can subsequently be metabolised [52].

##### 4.1 Degradation through Bacteria

Bacteria are classified as prokaryotic organisms characterised by the absence of a nuclear membrane and the presence of a nucleoid region containing naked DNA. Bacterial cells are characterised by their relatively diminutive size, typically measuring between 1 and 10  $\mu\text{m}$  [6]. Bacteria are the most important organisms for nutrient transformation and circulation in the environment, as they can decompose natural or synthetic complex polymers [13]. Hence, extensive research has been conducted to investigate their crucial contributions to bioremediation. It has been demonstrated that they can degrade a wide range of substances, including petroleum, metal compounds, antibiotics, and plastic polymers [3].

Various bacterial species from *Bacillus*, *Rhodococcus*, and *Pseudomonas* genera have been studied using approaches such as pure culturing, cloning, and even computational techniques to investigate their significant ability to degrade MPs [31]. Fascinatingly, these plastic-degrading bacteria can be isolated from a variety of environmental niches, including cold marine environments [24], dumpsites [55], and insects' guts [46].



The most crucial benefit of bacteria is that they make it easier for researchers to study the metabolic pathways and understand how different environmental factors affect the degradation of MPs [13]. The review of Amobonye *et al.* [6] also revealed that its simple binary division mechanism facilitates a higher reproduction rate than other organisms, thereby promoting the biodegradation of MPs. This means that the utilisation of pure strains enables the identification of metabolic pathways for assessing the impact of diverse environmental circumstances on the degradation of MPs. Moreover, these bacteria utilise polymer materials as their sole carbon source when in a minimal nutrient medium [10], thereby resulting in a decrease in the dry weight, molecular distributions of polymers, and alterations in both the chemical and morphological structure [58]. This indicates that these bacteria can potentially mitigate MPs pollution in the environment.

Furthermore, biofilm development is crucial for the bacterial degradation of MPs as it will allow the adhesion of bacteria colonies to the surfaces of MPs and increase colony persistence [2]. Even though the majority of the studies focused on the biodegradability of isolated bacterial strains, it has been found that, in nature, bacteria frequently act symbiotically in consortia, which has also been demonstrated in several studies [13]. Moreover, there is a wide variety of external factors that can have a positive or negative impact on the rate of microbial biodegradation. Some of these factors have been the research focus on accelerating the bacterial degradation of various plastic polymers *in vitro* [32]. The information on bacterial species and polymer reduction percentage obtained from various studies were integrated in Table 5. The results of biodegradation vary depending on the used strain and the length of incubation.

#### 4.1.1 Consortium Bacterial Species

A microbial consortium refers to a group of two or more species of bacteria that coexist in a symbiotic relationship which can be either ecto- or endosymbiotic [13]. The bacterial population residing within the consortium exhibits greater efficacy and resilience in degrading contaminants [45]. Moreover, toxic metabolites generated by a particular strain can serve as a substrate for another strain. The enhanced biodegradation efficiency observed in these consortia may be attributed to their ability to achieve degradation levels that surpass those achieved by individual pure strains [58]. Hence, the researcher conducted multiple endeavours to facilitate the degradation of MPs through a consortium of bacteria on the laboratory scale.

A recent study by Hossain *et al.* [36] found that a consortium isolated from soil comprising three bacteria, including *Enterobacter sp.*, *Pseudomonas arguinoso*, and *Enterobacter cloacae*, can degrade LDPE by 64% and PP by 63% within a culture period of 160 days. Similarly, a microbial consortium was isolated from soil samples collected in Suva, Fiji Islands, comprising *Listeria*, *Bacillus*, *Micrococcus*, and *Vibrio* species that were used to degrade LDPE. However, the biodegradation rate was only 5% [80].

Besides that, another species-enriched consortium, *Bacillus* and *Paenibacillus*, isolated from landfill, has reduced 22.8% of the average diameter of PE through the degradation process in 60 days in an aqueous medium containing PE-MPs as sole carbon [90]. Similarly, Li *et al.* [46] also revealed that a bacteria consortium, *Bacillus sp.* and *Paenibacillus sp.*, that were isolated from a municipal landfill can degrade MPs, mainly PE. A removal efficiency of 14.7% for PE-MPs was attained when it was utilised as the exclusive carbon source at a concentration of 1 g/L in a minimal medium. Furthermore, according to Mohanan *et al.* [53], both of these bacteria strains, *Pseudomonas citronellol* and *Bacillus flexus*, have demonstrated the ability to

create a biofilm that is tightly packed on the plastic's film surface of PVC, reducing the polymer average molecular weight as it utilised the PVC as the carbon source to growth. Based on these findings, the utilisation of a consortium that is enriched with species belonging to *Bacillus sp.* and *Paenibacillus sp.* can effectively degrade MPs.

In addition, a study by Skariyachan *et al.* [72] found that thermophilic bacterial consortia consisting of *Aneurinibacillus sp.* and *Brevibacillus sp.* isolated from garbage sites and WWTP showed increasing degradation of high and low-density PE and PP. The research findings indicate that using bacterial co-cultures resulted in superior degradation performance compared to applying individual bacterial strains in their pure forms [73]. Recently, the ability to degrade LDPE beads was observed in consortia consisting of *Stenotrophomonas sp.* and *Achromobacter sp.* [69]. The biodegradation of MPs is a complex process that entails the interactions of multiple microbial species and numerous enzymes. Despite this, a significant lack of bacteria can degrade pollution and the genes they require.

**Table 5.** Degradation of microplastics polymers and bacterial consortium species

Bacteria	Sources of the Bacteria/s	Type of MPs	Polymer reduction (%)	Degradation duration	Reference
<b>Bacteria Consortium</b>					
<i>Enterobacter sp.</i> , <i>Pseudomonas aeruginosa</i> , and <i>Enterobacter cloacae</i>	Soil	LDPE	64%	160 days	[36]
<i>Enterobacter sp.</i> , <i>Pseudomonas aeruginosa</i> , and <i>Enterobacter cloacae</i>	Na	PP	63%	160 days	[36]
<i>Aneurinibacillus sp.</i> and <i>Brevibacillus sp.</i>	Na	LDPE, HDPE and PP	2%, 3% and 2%	140 days	[2]
<i>Listeria sp.</i> , <i>Bacillus sp.</i> , <i>Micrococcus sp.</i> , and <i>Vibrio sp.</i>	Soil	LDPE	5%	na	[80]
<i>Bacillus sp.</i> and <i>Paenibacillus sp.</i>	Landfill	PE	22.8%	60 days	[90]
<i>Bacillus firmus</i> ,	Landfill	PE	14.7%	na	[46]
<i>Bacillus amyloliquefaciens</i> , <i>Bacillus cereus</i> and <i>Pseudomonas aeruginosa</i>	Soil	PS	18.23%	56 days	[71]
<i>Pseudomonas citronellolis</i> and <i>Bacillus flexus</i>	Soil	PVC	18.58%	90 days	[71]

PE, Polyethylene; LDPE, Low-density polyethylene; HDPE, High-density polyethylene; PU/PUR, Polyurethane; PVC, Polyvinylchloride; PP, Polypropylene; ATCC, *American Type Culture Collection*; na, not available

## 5. MPs DEGRADATION

### 5.1 Abiotic degradation of MPs

Abiotic degradation is caused by environmental factors, including UV radiation, air, mechanical forces, heat, and moisture [94]. The disintegration of micro-size into nano-size plastic debris is usually influenced by the mixture of environmental factors and the properties

of the polymer through abiotic and biotic mechanisms. Among the various abiotic degradable methods for MPs degradation, photo, thermal, and physical degradation have been thoroughly studied [4,59,84,90]. The degradation of MPs in natural environments typically initiates through abiotic mechanisms, such as photodegradation and thermal oxidation processes, rather than biotic mechanisms, which break large MPs into more minor MPs [71]. This is because abiotic usually occurs before biotic to facilitate the breakdown of the complex and larger polymers, thereby enabling biotic degradation to occur more efficiently on smaller polymer molecules [32]. These result in the formation of polymers with reduced molecular weight, which can be more efficiently depolymerized by microbial action. However, according to Pan *et al.* [59], there will be no reduction in the relative molecular weight of the polymer during the abiotic degradation process. Therefore, additional research is required to investigate this matter.

### 5.1.1 Photodegradation

Photodegradation is the transformation of materials degraded by ultraviolet irradiance. This degradation process begins with light absorption, as natural light is the major source of polymer degradation. UV radiation emitted by the sun will induce a photo-oxidative process, breaking the C-H bonds on the polymer backbone and producing free radicals [24]. Subsequently, the free radicals will react with O<sub>2</sub> to produce peroxy radicals, resulting in the formation of peroxides [90]. The decomposition of peroxides can result in the formation of various compounds, including alcohols, carboxylic acids, ketones, aldehydes, or esters. This, in turn, can lead to the chain separation of the polymer [47] and reduce the molecular weight of the polymer [46]. As the molecular weight of the polymer is reduced, the material will become more susceptible to fragmentation as the surface area increases [3]. This method alters the external appearance of materials, such as the yellowing of plastics, flaky surfaces, and embrittlement [3,58]. Moreover, the process of biodegradation for synthetic polymers that are insoluble in water, such as PE and PVC, usually commences after abiotic actions, which may comprise photodegradation [47].

### 5.1.2 Thermal Degradation

Depending on the particular type of plastic polymer and its properties, plastic's thermal degradation can occur at high temperatures, typically at or above 100 °C [5]. Similarly, the study conducted by Chamas *et al.* [15] also revealed that certain landfills and industrial composters had been documented to reach temperatures ranging from 80 to 100 °C, thereby expediting the thermal degradation rates. Hence, when the polymeric structure of the plastics is exposed to temperatures higher than it is supposed to be, there will be changes in the properties of the polymers as the components of the long chain backbone of the polymer will break and generate free radicals [58]. One of the examples of heat-treatment of plastic waste is incineration [90]. However, this degradation method is inapplicable due to the small size of MPs. Furthermore, thermal degradation mechanisms under standard environmental conditions are considered insignificant, especially in cold conditions such as marine environments [32].

### 5.1.3 Physical Degradation

The process of physical degradation ensues as a polymer is subjected to various environmental factors such as mechanical forces, oxygen, temperatures, and water [84]. For instance, mechanical degradation is a process by which plastics deteriorate due to the action of outside

forces. The crash and scratches of plastic materials' surface with stones and sands brought about by waves [3] and wind are two environmental phenomena that can give rise to external forces.

Plastics exposed to thawing and freezing cycles in marine ecosystems can also experience mechanical degradation due to these cycles [94]. Moreover, research findings indicate that the fragmentation of 99.8% of PS-MPs to nano plastics (NPs) can occur within 24 hours through the simulation of wave breaking [27]. This shows that physical degradation also can affect the size of the MPs. However, MPs may have limited susceptibility to abiotic degradation, such as physical degradation, as it only alters the physical surface and size of the polymer instead of the C-C backbone of the polymer [36].

Despite of this, the abiotic degradation method is only partially practical as it typically only breaks down plastics into polymer molecules with a lower molecular weight, and there needs to be more evidence and information on whether the complete degradation of plastic polymers is achieved.

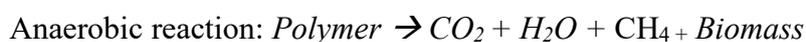
## 5.2 General Biotic Degradation of MPs

The process by which the enzymatic machinery of living organisms breaks down organic substances is known as biodegradation. Plastic biodegradation refers to the process by which plastic polymers undergo changes in characteristics such as their strength properties, colour, structural properties, form, and molecular mass as a result of microbial degradation. [28]. This method uses naturally occurring or inoculated microorganisms and their enzymatic and non-enzymatic hydrolysis to break down MPs and release environmentally safe metabolites [84]. In addition, biodegradation techniques are more environmentally friendly and do not require high temperatures or complex reagents [3]. Plastics can be biodegraded anaerobically or aerobically. In landfills and sediments, plastics can be degraded anaerobically, aerobically in nature, and partially aerobically and anaerobically in compost and soil [54]. The general biodegradation processes are illustrated in Fig. 4.

***Aerobic biodegradation*** - Aerobic biodegradation, also referred to as aerobic respiration, is a crucial component of the natural elimination of pollutants at numerous hazardous waste disposal sites. Aerobic microorganisms utilise oxygen (O<sub>2</sub>) as an electrophile and degrade organic material and produce biomass, carbon dioxide (CO<sub>2</sub>) and water (H<sub>2</sub>O) [28].



***Anaerobic biodegradation*** – Anaerobic biodegradation, the breakdown of organic pollutants by microorganisms in the absence of oxygen, is also an essential part of the process by which contaminants at hazardous waste sites are naturally reduced [93]. Some anaerobic bacteria break down organic compounds into more minor compounds using nitrate, sulphate, iron, manganese, and carbon dioxide as their electron acceptors, producing CO<sub>2</sub>, H<sub>2</sub>O and methane (CH<sub>4</sub>) [28].



According to Skariyachan *et al.* [73], the biodegradation process can be categorised into a few different phases, which are (1) Biofilm formation, (2) Biodeterioration, (3) Biofragmentation, (4) Assimilation and (5) Mineralisation. The primary biodegradation mechanism involves microorganisms adhering to the polymer surface and colonising the exposed surface. After colonisation, the polymer is degraded by an enzyme through a process known as hydrolysis. The enzyme first binds to the polymer substrate before catalysing the hydrolytic cleavage. Polymers degrade into low molecular weight oligomers, dimers, and monomers during biodegradation before finally mineralizing into  $\text{CO}_2$ ,  $\text{H}_2\text{O}$  and  $\text{CH}_4$  [6,58].

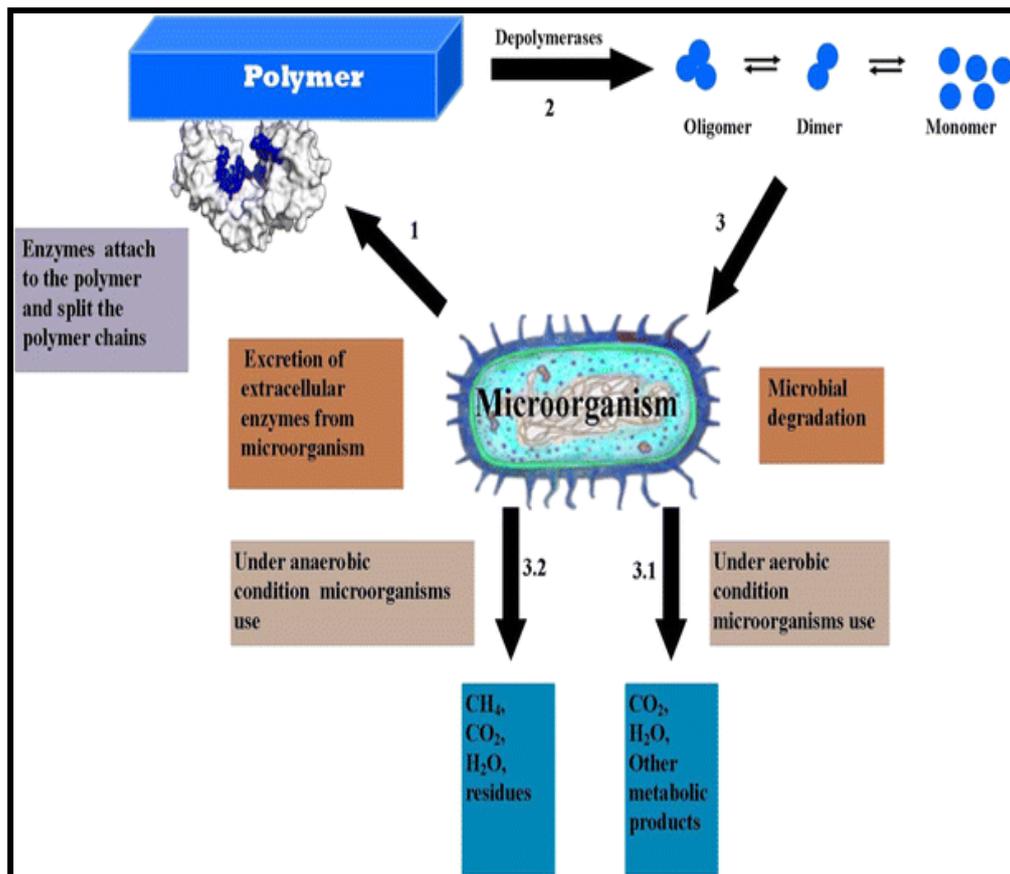


Fig. 4. General polymer biodegradation [28]

## 6. FACTORS AFFECTING PLASTIC BIODEGRADATION

When analysing the biodegradability of a polymer material, it is crucial to consider the potential impact of the environment [20,34]. Various factors, such as crystallinity, chemical composition, oxygen availability, temperature, pH, and the presence of additives can exert an influence on microbial activity and the process of degradation.

### 6.1 Physicochemical Properties of Microplastics

#### 6.1.1 Crystallinity

The crystallinity of a polymer can be categorised into amorphous, crystalline and semicrystalline, depending on the arrangement of the polymer's molecular chains [76]. The degree of crystallinity of MPs is one of the most critical factors that determine the ability of

bacteria to degrade MPs, as a high crystallinity level reduces the elasticity and increases the durability of the MPs [34]. On the other hand, Cui *et al.* [19] discovered that MPs with amorphous regions are less densely packed and have more branching structures, making them susceptible to bacterial attack. This means that the degradation in amorphous regions is more frequent than in rigid crystallinity regions. Furthermore, the amorphous region is high permeability compared to the crystalline region, which helps to accelerate the degradation process of MPs as the chemical bonds in the polymer are easier to break down [32].

### 6.1.2 Chemical Structure/Composition

MPs that possess carbon atoms as the side chain exhibit lower biodegradability compared to MPs with no side chain, as carbon atoms exhibit high resistance to degradation [32]. For instance, PS and PU MPs contain ester bonds in the side chain, are simple and prone to hydrolyse compared to the carbon side chain, and can easily be attacked by bacteria during biodegradation [5]. PET also comprises ester bonds; however, the polymer structure contains a significant proportion of aromatic terephthalate units, which minimises chain mobility and reduces resistance toward biodegradation [6].

### 6.1.3 Size

The particle size breakage of MPs is a crucial determinant of their toxicity and migration in the environments [95]. In comparison to MPs with larger sizes, those with smaller sizes have a more excellent ratio of surface area to volume. This is because the high surface area provides more sites for bacterial colonisation and enzyme attachment, which could result in a faster rate of biodegradation and rate of chemicals leaching out [32]. However, the photo-ageing study on PVC MPs indicates a negative correlation between their dichlorination efficiency and particle size [27]. Hence, further research should focus on enhancing the adhesion and colonisation between bacteria and MPs' size to maximise the degradation's efficacy.

### 6.1.4 Additives

Various types and amounts of different additives have been added to enhance and improve the longevity of polymers—for instance, pigments, plasticizers, lubricants, prooxidants, and antioxidants [14]. According to researchers, these additives may impact the degradation process of MPs. Ge *et al.* [32] research revealed that the formation of hydrogen bonds between PVC MPs and plasticizer acetyl 1,8-octane diol ricinoleate-levulinate's polar structures resulted in an interruption in the dichlorination process and inhibition of thermal degradation in PVC MPs. Furthermore, studies also show that these additives may be toxic to the bacteria [54]. For example, an extremely toxic polymer additive in PU, dibutyl tin dilaurate, has antimicrobial effects, which inhibit microbial degradation of the polymer [6]. However, it has been found that adding prooxidant additives such as metal salt, Co, and Mn has enhanced the biodegradability of PS foam [53]. Similarly, the incorporation of additives like starch and prooxidant makes photo- and thermal-degradation more likely to occur [47]. Despite this, the impact of additives on the degradation of MPs remains inadequately understood, necessitating further research to enhance our understanding of this phenomenon.

## 6.2 Environmental Conditions

### 6.2.1 Oxygen

Oxygen (O<sub>2</sub>) is crucial in biodegradation of MPs in the environment. [29]. According to researchers, oxygen is the precursor of reactive oxygen species (ROS) generation, and ROS is known to be a significant part of the degradation process of MPs [20]. Hence, the polymer-free radicals must react with O<sub>2</sub> to produce hydroperoxide, followed by ROS, to effectively accelerate the MPs' degradation [32]. O<sub>2</sub> also plays a significant part in the aerobic biodegradation process. This is because O<sub>2</sub> is an electron acceptor in the oxidation process of microbial enzymes, and most bacteria populations thrive in aerobic conditions [83]. Most bacteria also need O<sub>2</sub> for respiration and metabolic activities [5]. Hence, understanding the relationship between O<sub>2</sub> availability and biodegradation is crucial for optimising degradation as it can also influence the bacteria species involved.

### 6.2.2 Temperature

High temperatures can promote biodegradation efficiency by increasing enzyme activity [6]. For instance, in a study conducted by Chen *et al.* [17], the efficacy of removing MPs was compared between hyperthermophilic composting technology (hTC) at a temperature of 70°C and traditional thermophilic composting technology (cTC) at a temperature of 40°C after 45 days. The results indicated that the removal rate of MPs in cTC was only 4.5%, whereas the removal rate in hTC reached 43.7%. This difference was attributed to the ability of the high temperature in hTC to maintain the activity of thermophilic bacteria such as *Bacillus*, *Geobacillus*, and *Thermus* [92]. However, enzymes composed of proteins are susceptible to changes in temperature [90]. Thus, excessively high temperatures are unsuitable for the survival of most bacteria, thus resulting in the deactivation of certain enzymes [49].

### 6.2.3 Humidity

The hydrolysis rate and solubility of plastic polymers are both simulated by humidity in the environment, thereby promoting their degradation [32]. This is due to the high chain separation rate that will subsequently enhance microbial action sites on the polymeric chains to facilitate a better biodegradation process [7]. For instance, a previous study revealed that PE's compound chain separation process was fivefold higher at a relative humidity of 100% compared to a relative humidity of 45% at a temperature of 60 °C [15]. Nonetheless, the hydrolysis rate does not increase when the humidity levels increase when the temperature reaches 80°C or above. This is because the rate of thermal-oxidative degradation surpasses that of hydrolysis at these levels of temperatures [6].

### 6.2.4 pH

pH levels significantly influence the degradation rate of plastic polymers, as it plays a critical role in the population of microorganisms and the activity of enzymes [3]. For example, at pH 7, *P. aeruginosa* can significantly degrade PE in the aqueous environment. However, when in an acidic condition, which is below pH 7, the degradation process of PE is considerably impeded compared to the alkaline condition [54]. This is because of the severe inactivation of the bacteria. Furthermore, some of the studies also discovered that the ester bonds in crystalline regions of polymers are susceptible to attack by radicals in alkaline (OH<sup>-</sup>) and acidic (H<sub>3</sub>O<sup>+</sup>) solutions which influence the degradation rate [47]. Despite this, there is a need for further

research to determine the ideal pH range for MPs biodegradation by different species of bacteria.

## 7. FUTURE PROSPECTS

The following aspects need to be taken into consideration in upcoming research, as indicated by the summary and compilation of the contents of the current research:

- Assessing the level of environmental pollution and the consequent biological effects due to microplastics heavily relies on measuring their quantity. Therefore, the crucial goal for upcoming studies is to develop a consistent and reliable method for accurately identifying and studying microplastics in the environment. A more thorough exploration could involve determining the prevalence of microplastics through quantification techniques.
- The potential use of bacteria's capacity to break down plastic shows potential in creating effective approaches for handling plastic waste. This involves progressing bioremediation methods, employing bioaugmentation approaches, and harnessing bacterial enzymes for the large-scale degradation of plastic in industrial environments.
- Evaluating the ecological effects and unforeseen outcomes linked to the breakdown of microplastics through natural processes is of great significance. Additional research is necessary to appraise the ecological disturbances and overall viability of strategies for biodegrading microplastics, achieved by studying how plastic-degrading bacteria interact with existing microbial populations.

## 8. CONCLUSION

Microplastics in the environment has garnered heightened interest nowadays. A thorough reviewed has been conducted on the various issues about the sources of exposure, transport and distribution of MPs and their potentially adverse impacts to human. It is also crucial to determine the chemical and physical properties of MPs in conducting reliable toxicological evaluations. Hence, to attain most effective degradation of MPs, an innovative approach that exhibit sustainability, temporal efficiency, and cost-effectiveness need to be explore. Numerous researchers have reported multiple microorganisms including bacteria in the process of plastic degradation, highlighting their important role in this process. Various bacterial species that have the potential to degrade plastic polymers has been derived from bacterial consortium also has demonstrated enhanced efficacy in plastic degradation as a result of the synergistic interactions between the microorganisms and their enzymes.

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## CONFLICT OF INTEREST STATEMENT

The authors concur that this study was conducted without personal, commercial, or financial conflicts of interest. They also declare the absence of any conflicting interests with the funders.

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## INFORMATION TECHNOLOGY, ENGINEERING & MATHEMATICS

## **I-CReST 2023:031-009 - Assessing Open and Distance Learning (ODL) Platform Using Electronic Customer Relationship Management (ECRM) Features: The Case of UFUTURE for UiTM**

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### **ABSTRACT**

ODL is an extension of e-learning which was created and developed to have direct or indirect influence on teaching and learning environment. ODL focuses on open access to education by offering flexible learning opportunities to individuals and groups of students. Today, ODL system growing fast because of the Internet development and revolution. To adapt with the current learning system, UiTM has developed an ODL platform named UFUTURE. As a new platform, UFUTURE has received tremendous positive feedbacks from its target users. In this paper, we discuss the findings of our study on the assessment of UFUTURE that was carried out based on 42 ECRM features. The assessment been conducted through structured web observation. Findings from this study can be used as guidelines in the process of improving the services of UFUTURE and as references for other institutes that are in the process of developing ODL platform.

**Keywords:** ODL; e-learning; UFUTURE; ECRM; distance learning

### **1. INTRODUCTION**

Open and distance learning (ODL) is a system of education wherein lecturers and students need not to be present either at same place or same time and is flexible in regard to modalities and timing of teaching and learning.

ODL concept assist in handling large number of students from different parts of the world. At an institutional level, learning using this technology may be considered as a cost-effective teaching method [6]. Through ODL, students been given opportunity to study at own pace and at any time. According to Croxto [8] online courses with high levels of interactivity lead to higher levels of student motivation, improved learning outcomes, and satisfaction over less interactive learning environments.

However, there are challenges that faced by students and lecturers when dealing with ODL. One of the main challenges is capability to access to technology especially for underdeveloped areas and poor infrastructure. Pedagogical skills of online lecturers are also a challenge in online teaching. Online lecturers need to acquire relevant skills to teach online, they are also

challenged to develop curricula of an exploratory nature that engages students with hands-on, inquiry-based learning.

In UiTM, a series of effort had been carried out in order to overcome all those challenges. Students and lecturers have been given ongoing training from time to time on the ODL implementation. This is very vital in ensuring the objectives of ODL can be fulfilled. The development of UFUTURE is an effort to overcome those challenges as it is in house development that tailored to UiTM needs. UFUTURE is an ODL platform for UiTM that serve to deliver learning content via online to any students who wants to take a course with no limit of attendance. UFUTURE integrates full time and part time students, MOOCs and upcoming UiTM teaching and learning processes. UFUTURE objectives are to enhance the quality of learning and teaching, meet the learning style and need of students and improve user-accessibility and time flexibility to engage students in the learning process. The platform started being used by lecturers and students in September 2019.

This study is conducted as one of the processes of assessing the effectiveness of UFUTURE as ODL platform for UiTM students based on 42 Electronic Customer Relationship Management (ECRM) features. The assessment been conducted using web observation technique. Findings from this study can be used as guidelines in the process of improving the services of UFUTURE and as references for other institutes that are in the process of developing ODL platform.

## 2. METHODS

In conducting this study, an extensive web observation on UFUTURE has been carried out. Web observation is a way of collecting data through web observing. Web observation as data collection method is classified as a participatory study because the researcher has to immerse herself in the setting where her respondents are, while taking notes and/or recording. Advantages of observation data collection method include direct access to study phenomena, high levels of flexibility in terms of application and generating a permanent record of phenomena to be referred to later.

Observation as a data collection method can be structured or unstructured. In structured or systematic observation, data collection is conducted using specific variables and according to a pre-defined schedule. Unstructured observation, on the other hand, is conducted in an open and free manner in a sense that there would be no pre-determined variables or objectives. For this study, structured observation has been applied in the process of assessing the ODL platform by using ECRM features as the assessment variables.

For this study, structured web observation has been conducted. This part is carried out based on the 42 ECRM features. These features been used as variables in the assessment process. The methodology adopted in this study is illustrated schematically in Fig.1.

<b>Research Questions</b>	Which ECRM features that UFUTURE fulfill as ODL platform?
<b>Research Objectives</b>	To assess UFUTURE based on ECRM features
<b>Research Approaches</b>	<ul style="list-style-type: none"> <li>▪ Empirical Study</li> <li>▪ Literature Review &amp; Theoretical Study</li> </ul>
<b>Research Methods</b>	Structured Web Observation on UFUTURE using 42 ECRM features
<b>Research Findings</b>	Assessment on UFUTURE as ODL platform

**Fig. 1.** A schematic overview of the methodology adopted in this study

### 3. OPEN AND DISTANCE LEARNING (ODL)

The fundamental aspects involved in ODL process can be identified as technology infrastructure, ODL platform, content for ODL platform and participants. In adopting ODL platform, technological and educational are the two major perspectives/aspects to ensure the quality of the learning process [4],[11].

ODL platform technology encompassing the infrastructure and should enable users to generate, host and provide learning content efficiently. The pedagogical aspect concerns the content of learning and its application to increase students' understanding.

Synchronous and asynchronous learning processes are the two important modalities or styles of learning through ODL platform. In synchronous learning, students and teachers are all online at the same time and communicate from different locations [7]. They distribute and receive learning materials through telephone, video conference, the Internet, or talk. Participants can share their thoughts and communicate with one another during this form of learning, and receive specific questions and solutions. Synchronous learning is becoming more common as technology and Internet bandwidth capabilities increase.

Asynchronous learning is a form of learning that allows participants to pause and resume at any time [7]. The students and teachers cannot both be online at the same time in this form of learning. Email, blogs, discussion boards, eBooks, CDs, DVDs, and other technologies can be used in asynchronous learning. Students can learn at their own pace, download documents, and communicate with teachers and co-students. Many students prefer asynchronous learning over synchronous learning because they can take online classes at their leisure and avoid disrupting their regular schedules.

### 4. ELECTRONIC CUSTOMER RELATIONSHIP MANAGEMENT (ECRM)

Customer relationship management (CRM) is a comprehensive business and marketing strategy that integrates technology, process and all business activities around the customers [1],[2],[5],[10],[15]. There is logic to CRM being central focus for business. At its most basic level there clearly is nothing more important than customer as a satisfied customer buy more, more loyal and more profitable over their lifetime [1],[5],[10],[15]. Therefore, CRM has been important topic of conversation in the academic and business arenas. CRM automates and centralize customer contacts, allows the development of products and services by better understanding underlying customer behaviour provides a way to handle customer questions and complainers, and provide direct immediate information to sales, marketing and employees as needed to better serve the customer [5], [14]. The internet has been provided with a platform to deliver CRM function on web which is known as electronic customer relationship

management (ECRM). According to Sterne [13], ECRM has three general areas which are presales information (corporate and product), e-commerce services and post-sales support.

Pan and Lee [12] stated that CRM strategy provides seamless integration of every area of business that relate to customers namely marketing, sales, customers service and field support through integration of people, process and technology. On the other hand, with the invention of internet-based technology, ECRM systems will expand the traditional CRM techniques by integrating technologies of new electronic channels with electronic business applications into the overall enterprise CRM strategy. Both CRM and ECRM systems have unique characteristics that support customer business interaction.

The concept of ECRM involves the integration of web channels into the overall enterprise CRM strategy [14],[15]. The objective of ECRM is to drive consistency within all channels related to sales, customer sales and support, and marketing initiatives to achieve a seamless customer experience and maximize customer satisfaction, customer loyalty and revenue. Anton and Postmus [3] has identified 25 factors that combine to be an index of ECRM activities of the firm with another 17 additional features defined by Feinberg and Kadan [9]. The 42 ECRM features are into four categories as shown in Table 1.

**Table 1.** 42 ECRM features based on four different categories [3],[9]

No	E-CRM Features	Description
<b>A. General ECRM features</b>		
1	Site customization	Sites that offer customization features allow users to filter the content they see.
2	E-mail	Different ways to contact the business provider are offered such as e-mail.
3	Fax	Different ways to contact the business provider are offered such as fax.
4	Toll-free numbers	Different ways to contact the business provider are offered such as toll-free numbers.
5	Postal address	Different ways to contact the business provider are offered such as postal address.
6	Call back button	Different ways to contact the business provider are offered such as call back button.
7	Voice over IP	Different ways to contact the business provider are offered such as voice over IP.
8	Bulletin board	Different ways to contact the business provider are offered such as bulletin board.
9	Local search engine	Local search engine allows customers to search on keywords to locate quickly specific answers on the website.
10	Membership	Customers are allowed to request a password which allows the customers to continue surfing on password protected web pages within the website.
11	Mailing list	Customers can receive more information through the customers email address by add details in the list of receive automated emails.
12	Site tour	Customers can follow a tour through the website.
13	Site map	Site map is a hierarchical diagram of web pages on the website which also known as site overview, site index, or site map.
14	Introduction for first time users	Customers who enter the website for the first time should be provided with this feature as an introduction page. The introduction page should contain information regarding ways in using the website.
15	Chat room	Customers can interact with each other and with the website, customers will create contents of the website.



- 16 Electronic bulletin board Customers can post a message through a special page.
- B. E-Commerce Features**
- 17 Online purchasing Customers can purchase products or services online.
- 18 Customization possibilities Customers should be allowed to customize their service or product online before ordering.
- 19 Purchase condition The purchase and contractual conditions should be able to view online. Purchased conditions contain shipping policies, return policies, warranty, guarantee and other company commitments.
- 20 Preview product Preview product feature enable customers to view products before purchase. The products can be viewed in a motion picture or a demo.
- 21 Product information online Customers can get product information online.
- 22 Links Customers can easily and seamlessly link to complementary products from other companies through external links.
- C. Post-Sales Support Features**
- 23 FAQ Frequent asked questions and their answers should be available to be read in the website by customers.
- 24 Problem solving Enables customers to solve problems regarding products or services by themselves through online self-help routines.
- 25 Complaining ability Complaints and problems can be detailed online. A website should have a specific area for customers to log in their complaints and get action.
- 26 Spare parts Website should allow customers to order spare parts and complementary products or services online.
- D. Additional ECRM Features**
- 27 Affinity program Affinity program is affiliations with philanthropic agencies or organizations
- 28 Product highlights Product highlights give benefits to particular product or service that been highlighted.
- 29 Request for catalogue Customers can request for catalogue that contains list of products or service offered by the website.
- 30 Quick order ability Quick order ability will increase customers satisfaction as ordering process is through only three click orders.
- 31 Ease of check out Ease of check out is subjective rating feature. This feature gives ability for customers to check out easily.
- 32 Ability to track order status Ability to track order status feature enable customers to track and check their order status either order is success or vice versa.
- 33 Gift certificate purchase Gift certificate purchase is a certificate that is given to customers as appreciation method from companies.
- 34 Store locator This feature provides customers with company address and location
- 35 On-sale area On-sale area is highlighted place on opening web page by highlighting sale items.
- 36 Member benefits Member benefit feature provide description of benefits of shopping or belonging to site
- 37 Order Order feature supply customers ability to place an order within three clicks.
- 38 Speed of download pages Speed of downloading is important feature in attracting customers' attention.
- 39 Account information Account information grant customers with ability to view and change their own personal information in the website. This feature should be available for registered customers.



40	Customer service page	User friendly websites are supposed to provide customer service page that contains details that can be use by customers which led them to customers services of the website company.
41	Company history/profile	This feature provides customers with information regarding the website company through the website page or by providing link that relate the website to company corporate website.
42	Posted privacy policy	Website should have a privacy policy and post it on their website to be viewed by customers. The policy will assure customers that their personal information and purchasing details are securely held.

## 5. RESULT AND DISCUSSION

In the process of assessing UFUTURE using the 42 ECRM features, the results obtained are presented in Fig.2. The assessing process are based on extensive structured web observation as explained in previous section. Through extensive web observation, it has been identified that 32 out of 42 ECRM features can be found in UFUTURE. 5 ECRM features are not provided and another 5 features are not applicable. The 5 ECRM features that are not listed in UFUTURE are not providing fax, toll free number, call back button, voice over IP (VOIP) and site tour feature. Not applicable in the web observation referring to features that does not suit with UFUTURE business process. This is due to the reason that UFUTURE is currently run without charging any payment or fees to the users either students or lecturers. Hence, there are some features that does not applicable to be assessed in UFUTURE. The features that are not applicable to be assessed are online purchasing, customization possibilities, purchase condition, links and on-sale area.

From the findings, it can be concluded that UFUTURE consists of more than 86% of ECRM features (excluding the not applicable features) thus ensure its functionality and deliverability. Fig. 2 present findings on the assessment of UFUTURE based on ECRM features.

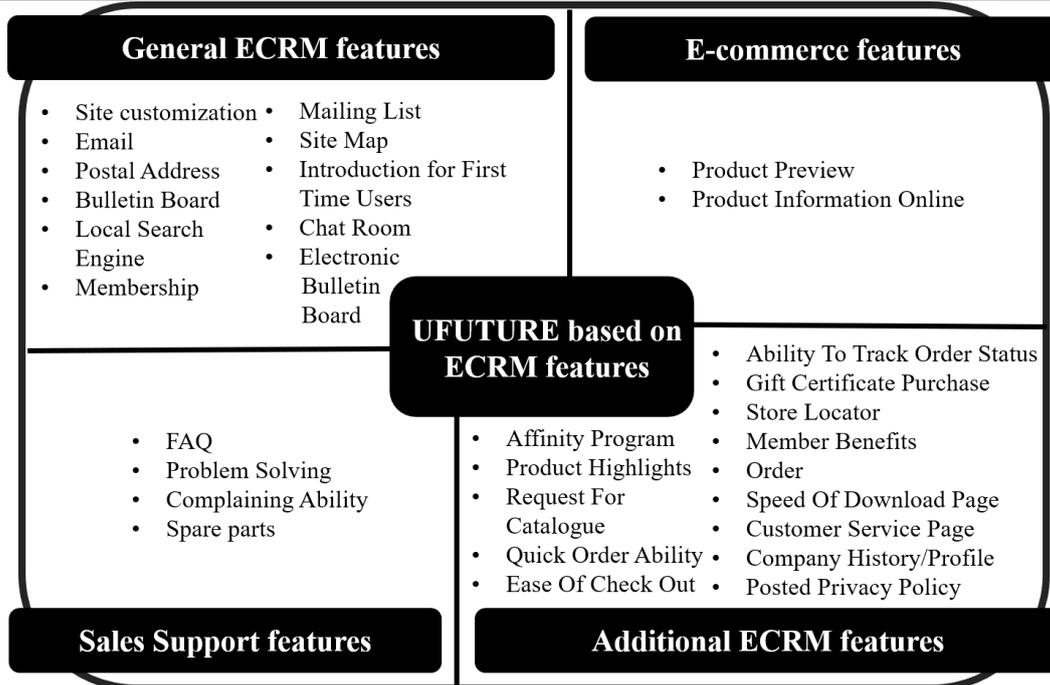


Fig. 2. Assessment of UFUTURE based on ECRM features

## 6. CONCLUSION

ODL has changed the landscape of teaching and learning. Today, lecturers and students need not to be presented either at same place or same time and is flexible in regard to modalities and timing of teaching and learning. This paper presents the findings of this study on the ODL components in UFUTURE and the assessment of UFUTURE using 42 ECRM features. Besides that, study indicates that UFUTURE consists of 32 of ECRM features. From the findings, it can be concluded that UFUTURE consists of more than 86% of ECRM features (excluding the not applicable features) thus ensure its functionality and deliverability. In conclusion, UFUTURE provides all essential requirements to serve as an ODL platform for UiTM.

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## I-CReST 2023:031-042 - Courseware of Islamic Adab for Year Two Students Based on UDL Principles

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### ABSTRACT

KAFA Class is an abbreviation of Fardhu Ain Religious Class for primary students in few states in Malaysia. For KAFA Classes, there are eight to nine subjects been thought in class for year 1 to year 6 students. Since its presence, all subjects have been thought using traditional method (in class through face to face method by using textbooks and activities books). During the pandemic of Covid-19, teachers are facing difficulties in teaching online as there is very minimal source of teaching materials that be accessed online. Hence, this study is conducted responding to the issue. For this study, focus has been set for year 2 students that taking Islamic Adab subjects. Sekolah Kebangsaan Tembak, Kedah has been chosen as focus KAFA Class. In this school, KAFA classes are held in the evening session every day. The main objective of this study is to design and develop standalone courseware for Islamic Adab for year 2 students. The design process starts with preliminary studies to gather information on courseware requirement from selected respondents (teachers and students) from Sekolah Kebangsaan Tembak, Kedah. The preliminary findings been mapped to Universal Design Learning (UDL) which focus on three main theory components which are engagement, representation, and action and expressions. From there, the ADDIE model had been applied in the development process. The phases involved in development process are analysis, design, development, implementation, and evaluation. As to complete the testing phase, the courseware then undergoes functionality and usability testing with the chosen respondents. Findings from the testing results indicate that the courseware developed meet all requirement set at the early planning stage and is suitable to be used in teaching Islamic Adab for year 2 students.

**Keywords:** Islamic courseware; multimedia courseware; Islamic adab; KAFA; Islamic class

### 1. INTRODUCTION

KAFA Class is an abbreviation of Fardhu Ain Religious Class for primary students in a few states in Malaysia. For KAFA Classes, there are eight to nine subjects have been thought in class for year 1 to year 6 students. Since its presence, all subjects have been thought using the traditional method (in class through the face-to-face method by using textbooks and activities books).

During the pandemic of Covid-19, teachers are facing difficulties in teaching online as there is very minimal source of teaching materials that be accessed online. Hence, this study is conducted responding to the issue. For this study, focus has been set for year 2 students that taking Islamic Adab subjects. Sekolah Kebangsaan Tembak, Kedah has been chosen as focus KAFAs Class. In this school, KAFAs classes are held in the evening session every day. The main objective of this study is to design and develop standalone courseware for Islamic Adab for year 2 students. The design process starts with preliminary studies to gather information on courseware requirements from selected respondents (teachers and students) from Sekolah Kebangsaan Tembak, Kedah.

The preliminary findings have been mapped to Universal Design Learning (UDL) which focuses on three main theory components which are engagement, representation, and action and expressions. From there, the ADDIE model had been applied in the development process. The phases involved in the development process are analysis, design, development, implementation, and evaluation. As to complete the testing phase, the courseware then undergoes functionality and usability testing with the chosen respondents. Findings from the testing results indicate that the courseware developed to meet all requirements set at the early planning stage and is suitable to be used in teaching Islamic Adab for year 2 students.

## **2. COURSEWARE FOR TEACHING AND LEARNING**

Multimedia applications are used in education to give teaching content to students as a source of information. Multimedia apps are also utilized to develop knowledge and skills and encourage student or teacher collaboration. Following the crisis in the country, multimedia learning has increased. [3] stated this over the years, social multimedia has gained credibility as a reliable source of information and a platform where organizations, students, and employees can interact with experts and audiences. Courseware is learning content designed for use with a computer and provided as a toolkit for teachers or mentors or as a lesson for students [4], [5]. Courseware can cover any subject. [3], [4], [5] said that the courseware is believed to be useful for teachers to assess students' progress and evaluate their dedication to education. This has proven that courseware is very important in the present era to lead the world toward modernization.

Although the use of courseware is expanding in Malaysia, it is still not being fully utilized due to other variables such as time limits and internet issues. As a civilization as a teaching profession, it is an asset in generating experts in a field and developing toward a high-tech country [5], [10]. Traditional learning materials, such as textbooks, are combined with current materials, such as electronic publications, in today's teaching and learning materials for schools.

## **3. COURSEWARE BASED ON UDL PRINCIPLES**

UDL is a teaching and learning strategy that ensures that all students have an equal chance of succeeding. It can assist in comprehending what non-UDL is all about when it comes to finding a way to instruct all students. UDL, on the other hand, took the opposite strategy. [1], [7] reveal the basis of UDL is grounded in emerging insights about brain development, learning, and digital media. They observed that the disconnect between an increasingly diverse student population and a one-size-fits-all curriculum would not produce the academic achievement gains sought [1], [7]. Efficient lesson planning with a UDL enables teachers to meet students'

individual needs more effectively [2], [8]. Engagement, representation, action, and expression are the three main principles of UDL. There has been a lot of research done to show the possibilities and functionality of UDL in real classrooms and online classrooms.

Firstly, are guidelines for representation that provide options for the perception that offer ways of customizing the display of information, offer alternatives for auditory information, and offer alternatives for visual information. Some learners grasp information most efficiently through printed text, while others are more responsive to visual or auditory representation. Most important, when multiple representation methods are used, learning and transfer of information occur because the learner has made a connection between and within concepts [1], [7], [8]. Furthermore, students have different perspectives on and understandings of the material offered to them. Those with sensory impairments, learning challenges, linguistic or cultural issues, and so on, may require distinct approaches to content.

Next is for actions and expression that provide options for physical action which varies the methods for response and navigation and optimizes access to tools and assistive technologies. Students' abilities to navigate the learning environment and articulate what they know are described in terms of actions and expressions. Students' abilities to navigate the learning environment and articulate what they know are described in terms of actions and expressions. Individuals with significant movement disorders, those with strategic and organizational difficulties, those with language barriers, and others, for example, approach learning tasks in very different ways. As a result, some people can express themselves well in writing but not in speech, and vice versa. This research has been said by the author. [5], [7] stated that in online and blended learning environments, students may experience learning barriers that are more pronounced than in the traditional classroom. When designing online instruction, teachers can use digital tools along with instructional strategies to reduce those barriers.

Finally, there's engagement. Due to a lot of elements that might influence individual variation in influence, such as neurology, culture, personal relevance, subjectivity, and background knowledge, students range substantially in their capacity to engage or be motivated to learn. Some children prefer to work alone on spontaneous and unusual tasks, while others prefer to collaborate with their peers. There is no single best way to engage all students in all situations; providing a variety of engagement options is critical. By teaching strategies for self-regulation and individual coping skills, providing guided practice and support to sustain the effort, and giving students various ways to achieve the same goal in a safe learning environment. Using a variety of engagement methods can benefit diverse groups of learners in different ways without diluting academic achievement. Not every plan will work in every classroom, or for every subject area that she does that you are comfortable with and that works for your discipline and learners. For Islamic Adab, the three principles will be implemented appropriately in the planning process for this study to ensure that the study's objectives are met. The following methods will be used to apply the principles. For engagement, the study will focus on providing options for recruiting internet and options for sustaining effort and persistence. For representation, the study will focus on providing options for perception dan comprehension. Lastly, for action and expression, the study will focus on providing options for physical action and options for expression and communication.

#### 4. RESEARCH DESIGN

For this study, three main objectives have been set up. All three objectives have their own approach and method in order to ensure each objective is successfully accomplished. The methodology adopted in this study is illustrated schematically in Table 1.

**Table 1.** A schematic overview of the methodology adopted in this study

Research Objective	To identify components for courseware of Islamic Adab for Year Two students	To develop courseware of Islamic Adab for Year Two students	To evaluate the functionality courseware of Islamic Adab for Year Two students
<b>Research Approach</b>	<ul style="list-style-type: none"> <li>• Empirical Study</li> <li>• Theoretical Study</li> <li>• Project development</li> <li>• Literature</li> </ul>		<ul style="list-style-type: none"> <li>• Functionality testing</li> </ul>
<b>Research Method</b>	<ul style="list-style-type: none"> <li>• Survey questions to users (teachers and students)</li> <li>• SPSS is used for data analysis</li> </ul>		<ul style="list-style-type: none"> <li>• Supervisor</li> <li>• IT experts</li> <li>• Users</li> </ul>

#### 5. DEVELOPMENT FOR COURSEWARE OF ISLAMIC ADAB FOR YEAR TWO STUDENTS

Analysis, design, development, implementation, and evaluation make up the ADDIE model. It is a system for designing educational materials, tools, and performances. The ADDIE method offers instructional designers a framework for developing and improving training content inside of a business. The ADDIE approach follows a systematic framework that allows teachers to know what to do after each step and is effective for both offline and online teaching styles [6], [9]. Table 2. shows the phases applied in this study.

**Table 2.** The project development methodology

Phase	Activity	Outcome
<b>Planning</b>	<ul style="list-style-type: none"> <li>• identify the aim for a suitable proposed title for the project</li> <li>• recognize the problem statement</li> </ul>	<ul style="list-style-type: none"> <li>• the title of the project is courseware of islamic adab and akhlak for year two students based on udl principles.</li> <li>• problem statement</li> <li>• aim to achieve the objective</li> </ul>
<b>Analysis</b>	<ul style="list-style-type: none"> <li>• identify the key project materials</li> <li>• research and review the literature</li> <li>• determine if the requirement is functional or non-functional.</li> </ul>	<ul style="list-style-type: none"> <li>• the project's content requirements</li> <li>• literature review</li> <li>• functional and non-functional requirements</li> </ul>
<b>Design</b>	<ul style="list-style-type: none"> <li>• develop a site map</li> <li>• develop Use Case Diagram, Context Diagram (CD), Data Flow Diagram (DFD), Entity Relationship Diagram (ERD)</li> </ul>	<ul style="list-style-type: none"> <li>• site map</li> <li>• Use Case Diagram, Context Diagram (CD), Data Flow Diagram (DFD), Entity Relationship Diagram (ERD)</li> </ul>
<b>Development Testing</b>	<ul style="list-style-type: none"> <li>• design a user interface</li> <li>• create the system</li> <li>• testing the functionality</li> </ul>	<ul style="list-style-type: none"> <li>• Interface</li> <li>• fully functional system</li> <li>• functionality</li> </ul>

Fig. 1, Fig. 2, and Fig. 3 show the sample interfaces of Courseware for Islamic Adab for year two students.

## 6. TESTING AND EVALUATION OF COURSEWARE FOR ISLAMIC ADAB FOR YEAR TWO STUDENTS



Fig. 1. Main interface of Courseware for Islamic Adab for year two students



Fig. 2. Interface of teaching video in Courseware for Islamic Adab for year two students



Fig. 3. Interface of activities in Courseware for Islamic Adab for year two students

The courseware was evaluated through a collaborative effort involving a supervisor (1 person), IT experts (2 persons), and users (teachers and students). Table 3 shows summarized result of the testing and evaluation of Courseware for Islamic Adab for year two students that have been conducted.

**Table 3.** Testing and evaluation of Courseware for Islamic Adab for year two students

Tester	Factor				
	Interfaces	Functionality	Content	User Friendliness	Reliability
Supervisor	80%	80%	80%	80%	75%
It Experts	80%	75%	80%	75%	80%
User (Teachers)	90%	80%	85%	80%	80%
User (Students)	85%	80%	80%	80%	80%

During testing and evaluation, testers are required to rate the performance of Courseware for Islamic Adab for year two students based on five main criteria. Each factor is divided into sub-factor. The testing and evaluation results showed that the courseware developed for this study meets the requirements and provides a positive learning experience for students.

## 7. CONCLUSION

The main objective of this study is to design and develop standalone courseware for Islamic Adab for year 2 students. The preliminary findings been mapped to Universal Design Learning (UDL) which focus on three main theory components which are engagement, representation, and action and expressions. From there, the ADDIE model had been applied in the development process. The phases involved in development process are analysis, design, development, implementation, and evaluation. As to complete the testing phase, the courseware then undergoes functionality and usability testing with the chosen respondents. Findings from the testing results indicate that the courseware developed meet all requirement set at the early planning stage and is suitable to be used in teaching Islamic Adab for year 2 students.

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## **I-CReST 2023:038-027 - The Importance of E-Exercise Book Reinforcement in Partial Fraction Learning**

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### **ABSTRACT**

This research aims to identify and subsequently correct the problems faced by students in learning the decomposition of partial fractions. The results of the pre-quiz show that students do not understand how to decompose partial fractions. In this study, 10 Civil Engineering Diploma students were selected as a sample of the study. E-exercise book is used as a form of training book in teaching and learning to solve problems faced by students during learning and teaching improper partial fractions. An interview instrument was used in this study. The research began with classroom observations during the teaching and learning process. A pre-quiz was administered before the e-exercise book was used as an intervention for 5 weeks. Quiz 1, quiz 2, and quiz 3 were administered after the implementation of the e-exercise book among students. Then, students were interviewed after 3 quizzes. The findings of the study show that the e-exercise book successfully improves students' understanding of basic concepts and manipulative skills in learning improper partial fractions.

**Keywords:** E-exercise book; partial fraction learning; PIKK

### **1. INTRODUCTION**

Partial fractions are widely used in applications of control theory, calculus, differential equations, pure mathematics, and practical mathematics. (Kwang & Xin, 2018; Manoj, Ashvini & Hole, 2020; Kim & Lee, 2016). However, learning and teaching fractions is still considered very problematic, and this issue continues to attract the attention of academics and educational researchers around the world (Wijaya, 2017).

A poor grasp of concepts will cause students to experience problems in learning when the teaching process is conducted. Existing concepts that the student has indirectly affected the student's internalization of new concepts. Fung, Kutnick, Mok, Leung, Lee, Mai, & Tyler (2017) states teacher factor is a good indicator of student achievement in mathematics. Tchoshanov, Quinones, Shakirova, Ibragimova, and Shakirova (2017) proved teachers' knowledge of a certain topic affects the student's way of solving mathematical problems and students' problem-solving abilities. Furthermore, the teachers' mastery of "Knowledge of Specific Contents" (PIKK) creates an effective learning environment (Koponen, Asikainen, Viholainen, & Hirvonen, 2019). This is due to the PIKK being recognized as an important knowledge domain and is needed by teachers for teaching (Mazlini, Marzita, & Effandi, 2017).

## 2. REFLECTION ON PAST TEACHING AND LEARNING

According to Chinnappan (2005) dan Clarke, Roche, & Mitchell (2008) to understand partial fractions, students need to have solid basic algebraic skills where algebraic thinking and gradual reasoning are formed. The research conducted by Taban dan Cadorna (2018) also shows students at the tertiary level have a weak grasp of partial fraction concepts. This is also similar in Politeknik Kuching Sarawak, lecturers found that mastery of sub-topic 1 partial fraction in engineering math amongst semester 1 students for the three cognitive domains (knowledge, application, and reasoning) is at a low level. This is proven by the observation of the researcher when administering partial fraction tests to students. The students' stressful reaction when answering partial fractions clearly shows they do not understand and know how to answer the questions given. Results from interviews with students reveal that they do not understand the question and do not know the correct method to solve the question given. Therefore, they could not complete the exercise that was given. This observation is like Tabans and Cadornas's (2018) finding who also found that students lack concept knowledge of partial fractions, manipulating skills, calculation errors, and technical errors in using the calculator.

Facing this problem, a reflection is made by the researcher to evaluate the teaching and learning that was conducted, whether the lecturer is teaching too fast until leaving the weak students behind. Investigation of this question was done by the researcher through face-to-face interviews. All students gave positive feedback on the lecturer's teaching method stating the lecturer's lesson was clear and the language used was easy to understand. At the same time, the researcher also guided the students in solving the problems, however, the outcome of the lesson was still unsatisfactory to the researcher. When tested with the partial fraction equation, students still can't identify the difference between properties of partial fraction denominators that consists of the linear denominator, linear repeats, quadratics that can be factored perfectly, or quadratics that cannot be factored perfectly. Besides that, the researcher also noticed some students cannot express the denominator of the semi-proper partial fraction with different properties. In this instance, the researcher concurs with Taban and Cadorna (2018) who found that students lack the concept knowledge of partial fractions and manipulating skills.

## 3. RESEARCH FOCUS

The researcher identified students' lack of understanding of basic concepts of improper partial fractions as the source of the problem. It is not impossible to overcome students' lack of comprehension of a mathematical concept. Feedback from the students state that the explanation in the existing textbook is not easy to understand. Therefore, the researcher takes the initiative to create an e- exercise book which is a virtual exercise that serves as a guideline and reinforcement in the learning process. The advantage of this e-exercise book is that the researcher summarizes the characteristics of the denominator of partial fractions in the form of a flow chart that is easier to understand and refer. Through the e-exercise book, the researcher hopes to reinforce the student's understanding of concepts and manipulation skills for proper partial fractions in students. The researcher believes that students must be guided closely and in a structured manner. Newton (2015) believes this to be more so, according to him exercise is important to train students in learning mathematics. Even in using e- exercise books is considered conventional; this method has a positive impact and is an important feature in the math learning process. The more a student does exercise the more proficient person is in using math strategies to solve problems. If the mastery of a concept and formula manipulation is not achieved, this problem will impede learning mathematics 2 in the following semester and

subsequent levels of education. indirectly, doing exercises will help students in higher level education where they can solve math problems faster either in comprehension or procedural.

#### **4. RESEARCH OBJECTIVE**

##### General Objectives

The objective of this research is to increase the mastery of partial fraction decomposition concepts and formula manipulations in students learning partial fractions using the reinforcement of an e-exercise book.

##### Specific objectives

The specific objective of this research is to increase the understanding of partial fraction decomposition concepts and formula manipulating skills in students in recognizing and differentiating characteristics of denominators of partial fractions via e-exercise book reinforcement exercises. This is important so students could break down the denominators of partial fractions according to formula determinants accurately.

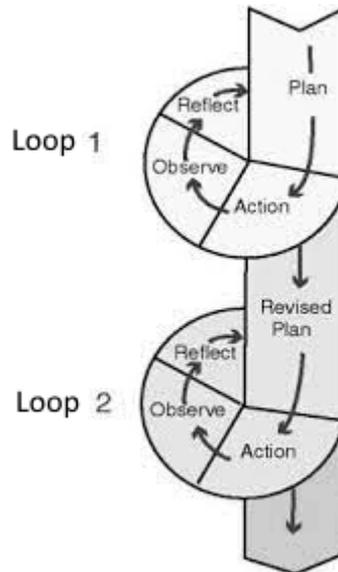
#### **5. TARGET GROUP**

The target group that is involved in this research is a group of 10 students who have taken the Civil Engineering Diploma all of whom are male students. They are chosen according to their low quiz marks for the 2 2021/2022 sessions.

#### **6. RESEARCH METHODOLOGY**

The action research method used for this research is the action research model that is in a loop form according to Kemmis dan Mc Taggart (1988). The framework of the action research conducted consists of a recycled loop phases model in Fig. 1. Each loop has four phases which are (1) plan (2) action, (3) observe and (4) reflect. According to Kemmis and Mc Taggart (2005), action research is a form of self-reflection that is done collectively to increase rationality and equality in work routines and education and society. Therefore, in this research, the researcher implements the e-exercise book teaching and learning method in the teaching and learning of partial fractions.

## Action research Loop



Source: Maznah et al. (2006)

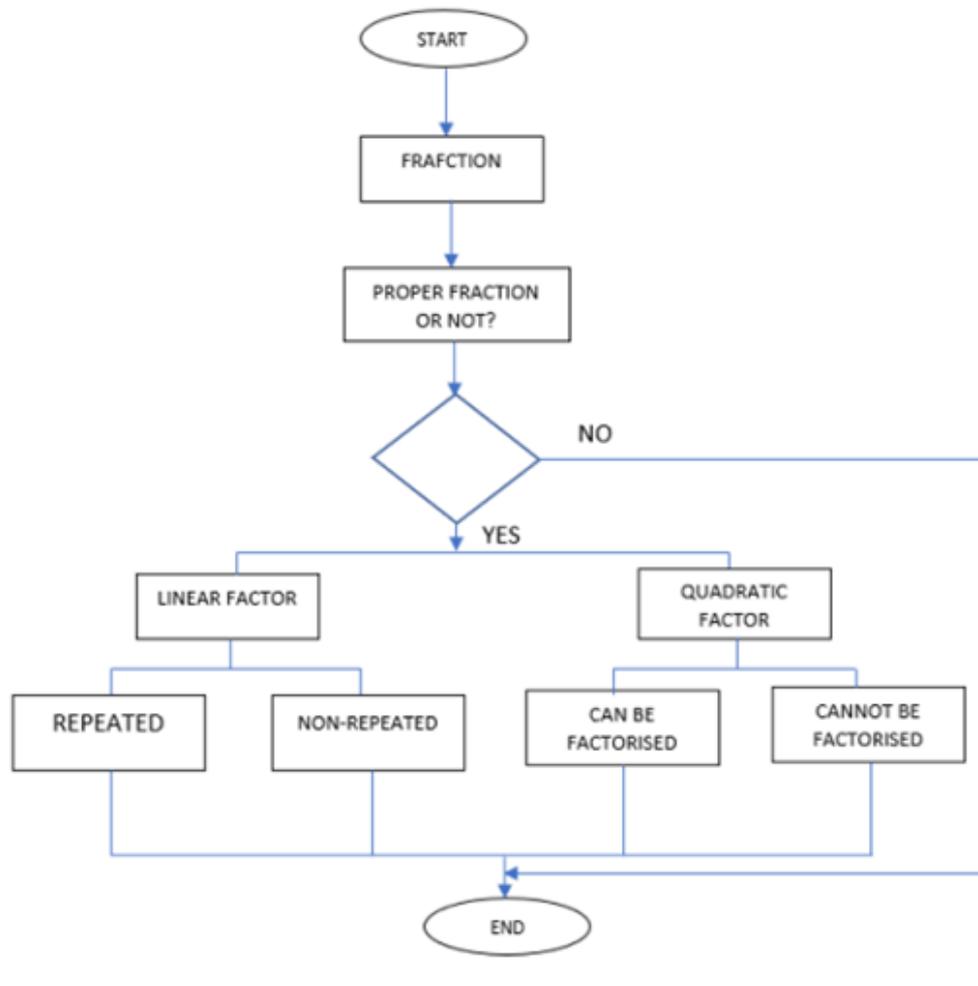
**Fig. 1.** Kemmis and Mc. Taggart Model. (2006)

This research involves 2 loops. In loop 1, phase 1, the researchers identify the cause of students not being able to solve partial fractions in the quiz via the face-to-face interview with students while doing self-reflection. In phase II, the researchers make abbreviated notes of partial fractions in flow chart form shown in Table 1 and Table 2 in the e-exercise book. Simultaneously in phase III observing student feedback towards the teaching of learning method using the e-exercise book while collecting data. In phase IV (reflection) the data collected is analysed for the effectiveness of e-exercise book usage in solving the understanding concepts and manipulating skills in students while solving partial fraction skills. The same procedure is used for the second loop to answer the research question.

## 7. BREAKING DOWN PARTIAL FRACTIONS

**Table 1.** Breaking down the denominator of a partial fraction.

Type	Factor in denominator	Term in partial fraction decomposition
Proper Fraction with Linear Factor	$\frac{p(x) + q}{(x + a)(x + b)}$ $a \neq b$	$\frac{A}{x + a} + \frac{B}{x + b}$
Proper Fraction with Repeated Factor	$\frac{p(x) + q}{(x - a)^n}$	$\frac{A}{ax + b} + \frac{B}{(ax + b)^2} + \dots + \frac{C}{(ax + b)^n}$
Proper Fraction Quadratic factor (cannot be factorised)	$\frac{p(x) + q}{(x^2 + bx + c)}$	$\frac{Ax + B}{x^2 + bx + c}$
Proper Fraction Combination of Linear and Quadratic Factor (cannot be factorised)	$\frac{px^2 + qx + r}{(x - a)(x^2 + bx + c)}$	$\frac{A}{(x - a)} + \frac{Bx + C}{x^2 + bx + c}$



**Fig. 2.** Flow chart semi-proper partial fractions according to linear and quadratic denominators

After data analysis, it is found the cause of students' problem in understanding and solving semi-proper partial fractions was confusion with partial fraction denominators which consists of many categories and unclear explanation in the textbook doesn't help in solving the student's problem. Therefore, the researcher takes the initiative to simplify the partial fraction denominators as in Fig. 2. The equivalent formula with the equivalent partial fraction denominators is shown in Table 1. In this research, the focus of the researcher is to have students identify features of semi-proper partial fractions according to simplification in the Table 2 flow chart. The researcher explains to the students that the linear partial fraction denominator can be broken down into 2 categories which are: (1) linear whereby the  $x$  denominator of the partial fraction has a power of 1 (2) linear recursion where the linear denominator of the partial fraction has a power recursion of  $n$  times. Whereas to identify semi-proper partial fractions that have a quadratic type of denominator, the researcher tells the students when the power of  $x$  for partial fraction denominator is 2, it is therefore in the quadratic category. Just like linear, the denominator for quadratic type partial fraction is also broken down into two types which are: (1) can be resolved by factorisation and (2) cannot be resolved by factorisation. In this regard, for simplifying factorisation findings, the researcher teaches students to solve quadratic expressions of the denominator of a partial fraction using the calculator 'eqn' function. If the student successfully solves the quadratic equation using the

calculator 'eqn' function, therefore it is a quadratic denominator that can be factored and vice versa if expression in the denominator of a partial fraction can't be solved using the calculator 'eqn' function, hence, this partial fraction denominator is a quadratic expression that can't be factored. After students successfully identify the denominator characteristic for semi-proper partial fractions, students are shown equivalent formula according to partial fraction denominator characteristics shown in table 1.

## 8. PRELIMINARY SURVEY

To identify and verify the problems faced by the students, observations, interviews exercises and pre-quiz was conducted in this action research. 10 students from the Civil Engineering Diploma course participates in this research. They are chosen according to their poor quiz results. (Refer to Table 3)

## 9. OBSERVATIONS

Throughout the teaching and learning process, the researcher sees the students in class while they're doing the reinforcement exercises that involve semi-proper partial fractions. Each completed exercise given is examined thoroughly to identify the cause of the mistakes made by the students.

## 10. REFLECTION

It is found that students couldn't answer the proper fraction questions in the reinforcement exercise accurately. Student mastery of basic concepts and algebraic fraction skills is poor, and students' answers were unfounded. Students only answer according to their incorrect instincts. They don't understand and can't differentiate semi-proper partial fraction denominator characteristics as many students asked when they're confused with partial fractions that are comprised of linear denominators, linear recursion, quadratics that can be perfectly factored or quadratics that cannot be perfectly factored. The researcher takes the initiative to do revisions with the students before the pre-quiz was administered. Pre-quiz is done before students are introduced to the e-exercise book.

## 11. ANALYSES OF PRE-QUIZ RESULT

4 quizzes were administered throughout this research which are pre-quiz, quizzes 1, 2 and 3. Each quiz contains 4 questions consisting of partial fractions with linear denominators, repeated linear denominators, perfectly factorable quadratic denominators and unfactorable quadratic denominators. The pre-quiz through to quiz 3 was written to test students' basic concept mastery and manipulative skills where they are required to break down the partial fraction denominators. The researcher wants to see how much of the basic concepts can the students understand to break down partial fraction denominators according to formula. Pre-quiz is done before the researcher introduces the e-exercise book to students. Whereas quizzes 1, 2 and 3 are administered after the researcher has used the e-exercise book. The pre-quiz results are shown in Table 2. Only one of the ten participants was able to answer the questions correctly.

**Table 2.** Pre-quiz result

Number of correct questions	Pre-Quiz (Number of students)
4	0
3	0
2	0
1	1

## 12. INTERVIEW SESSION WITH STUDENTS

Throughout the teaching and learning process, the interview process with the students was done to identify the cause of the confusion the students had. The interview sessions were done face-to-face in class. Excerpts from the interview confirm this phenomenon:

Researcher: How much do you understand about semi-proper partial fractions?

Student: I do not understand semi-proper fractions. I'm so confused and don't know how to distinguish the partial fraction denominators.

Researcher: Was the explanation in class too fast? You could refer to the engineering math 1 textbook if you are unclear.

Student: No ma'am, your explanation was slow enough. I don't know but I still can't follow. I did refer to the textbook, but I still can't break down partial fractions. I become dizzy and lose focus when I see semi-proper fractions.

## 13. REFLECTION

Feedback from the student interview revealed that students are always confused with proper partial fractions with denominators that are comprised of quadratic and repeat linear denominators. Sometimes they also get confused and lose focus when given proper partial fraction question that is comprised of factorable denominators and unfactorable denominators. The students had referred to the textbooks but are still confused.

## 14. INITIATING INTERVENTION (QUIZ 1 TILL QUIZ 3)

To solve the problems that the students encounter, the researcher has revamped the partial fractions note in the current textbooks. The researcher endeavoured to simplify the notes in the textbooks. The researcher created an e-exercise book whereby all simplified notes for partial fraction denominator characteristics are tabulated along with explanations as shown in Table 2. This functions to serve as a reinforcement exercise to ease and improve student recognition skills of partial fraction denominator characteristics according to formula when breaking down partial fraction denominators. The examples in the e-exercise book are also explained to students until they can understand the basic concepts of the partial fraction. This is important so students can understand questions and recognise characteristics of partial fraction denominators to improve manipulating skills so the students can break down the partial fraction correctly according to the formula that is given. According to Taban dan Cadorna (2018), the understanding of basic partial fraction concepts is important and allows students to build organised strategies to solve problems regarding improper fractions systematically. Though this improves students' achievement in this regard, there is still much to be done by the researcher to understand how the student thinks and rationalises math problems.

## 15. STUDENT INTERVIEW SESSION

Interview sessions were conducted with the 10 students to get their feedback after the researcher introduces the partial fraction simplification table in the e-exercise book as an alternative reference. The majority of the students report having difficulty understanding partial fraction denominator characteristics before using the e-exercise book. They say the table in the e-exercise book helps them a lot to differentiate characteristics of partial fractions clearly and aids understanding and retention. When questioned further, it is found that the e-exercise book abbreviated notes makes their referencing of formula a lot simpler according to the denominator characteristics of the partial fraction. After the e-exercise book usage, students report the e-exercise book gave them confidence and clarity in answering fraction quizzes systematically and with more confidence.

## 16. REFLECTION

After checking and analysing all the given questions in quiz 1 through quiz 3, the researcher found that most students were able to master the basics of partial fractions better and their manipulative skills have also improved. They began able to identify and differentiate characteristics of partial fractions that are made up of linear, recurring linear, and quadratic denominators that can be factored perfectly and unfactorable quadratic denominators.

## 17. QUIZ 1, QUIZ 2 AND QUIZ 3 RESULTS ANALYSIS

The results for quiz 1 through quiz 3 are as in Table 3, and included in the table are pre-quiz results for comparison. The pre-quiz result shows only 1 student was able to solve the question properly. Most of the students were unable to solve the quiz given. After the researcher introduces the simplification table in the e-exercise book as an alternative reference, the number of students who can solve the questions in quiz 1 increased to 5 people whereby they only successfully solve questions 1 and 2. Subsequently, the number of students who successfully answer the questions in Quiz 2 and Quiz 3 increased to 5 out of 10 people. 3 students answered question 3 accurately and 2 students were able to answer all four questions correctly and accurately. However, there are still 3 or 4 students who made mistakes while answering the quiz given while using the calculator to find the quadratic factor function, copying the question and breaking down the power of the partial fraction's denominator, basic algebraic mistakes. This situation is also recorded in the research findings in Taban dan Cadorna's (2018) paper. Fig.3 shows the student's mistakes when breaking down the partial fraction denominator before and after using the e-exercise book.

**Table 3.** Pre-quiz, quiz 1, quiz 2 and quiz 3 results

Number of correct questions	Pre-Quiz (Number of students)	Quiz 1 (Number of students)	Quiz 2 (Number of students)	Quiz 3 (Number of students)
4	0	0	0	2
3	0	0	2	3
2	0	3	3	2
1	1	2	0	3



**Example 1**

Before I

Date: .....

$$\frac{3(2x+5)}{x^2+8x} = \frac{A}{x} + \frac{B}{x^2} + \frac{C}{8x}$$

$$\frac{3(2x+5)}{x^2+8x} = \frac{A}{x} \left[ \frac{x^2+8x}{x^2+8x} \right] + \frac{B}{x^2} \left[ \frac{x^2+8x}{x^2+8x} \right] + \frac{C}{8x} \left[ \frac{x^2+8x}{x^2+8x} \right]$$

$$\frac{3(2x+5)}{x^2+8x} = \frac{A(x+8x) + B(8x) + C(x^2)}{x^2+8x}$$

**Example 2**

Before II

$$\frac{x^2+4}{x^2(3x+1)} = \frac{A}{x(x+1)} + \frac{B}{(3x+1)}$$

Students incorrectly break down the denominator of a partial fraction.

After I

$$\frac{3(2x+5)}{x^2+8x} = \frac{3(2x+5)}{x(x+8)} = \frac{A}{x} + \frac{B}{x+8}$$

$$= \frac{A}{x} \left[ \frac{(x)(x+8)}{(x)(x+8)} \right] + \frac{B}{x+8} \left[ \frac{(x)(x+8)}{(x)(x+8)} \right]$$

$$\frac{3(2x+5)}{x(x+8)} = \frac{A(x+8) + B(x)}{x(x+8)} \quad \text{equation 1}$$

$x+8=0 \quad x=0$   
 $x=-8$

After II

$$\frac{x^2+4}{x^2(3x+1)} = \frac{A}{x} + \frac{B}{x^2} + \frac{C}{3x+1}$$

Students have mastered the basic concept and manipulative skills for partial fractions where the breaking down of the process of partial fraction denominator was done accurately and correctly.

**Fig. 3.** Student mistake when breaking down a partial fraction

## 18. REFLECTION

Research results show the student's concept mastery level and manipulative skills have improved after using the e-exercise book. Besides that, reinforcement exercises must be done to reinforce mastery and understanding of basic partial fraction concepts. This is according to Salleh (2010) who states exercise is important in training students in the mathematics learning method. This method has a positive impact whereby when an exercise is repeated it reinforces persons learning of a skill.

## 19. CONCLUSION

In line with development in the education field, teachers are asked to give a high commitment to professional development in terms of knowledge, skill and teaching. by this, to overcome students' weaknesses in learning mathematics, it can't be ignored that lecturers self-reflection plays an important role in influencing Knowledge of Specific Contents (PIKK). It is because PIKK can encourage lecturers to organise effective teaching and learning session. Furthermore, according to Koponen, Asikainen, Viholainen & Hirvonen (2019), PIKK is a specific knowledge domain that is needed by lecturers for teaching. Research done by Alkharusi, Aldhafri, Al- Hosni, Al-Busaidi, Al-Kharusi, Ambusaidi, and Alrajhi, (2017) has proven only teachers who have high self-efficacy can achieve and sustain endeavour. This has motivated the researcher to create the e-exercise book for this research.

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## I-CReST 2023:055-077 - Research on the Usage of Pocket Score Woodball Application Version 1

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### ABSTRACT

This study aims to investigate the usage of the Pocket Score Woodball application during the first phase of its implementation. Woodball is a growing sport that requires precise scorekeeping, and the Pocket Score Woodball application was developed to provide a convenient and efficient solution to this need. The study collected data on the usage of the application including the effectiveness of the application, user satisfactions and user feedback. The results showed a positive response from users, with a high level of satisfaction with the application ease of use, accuracy, and convenience. The study also identified some areas for improvement, such as incorporating more features to enhance the user experience. The objectives are to assess the effectiveness of the application in improving scorekeeping accuracy and efficiency, to evaluate user satisfaction with the application ease of use and convenience, and to identify areas for improvement based on user feedback and usage data. The study aims to make recommendations for future development and implementation of the application. The Pocket Score Woodball application was developed to improve the scorekeeping process in Woodball competitions. Traditional paper-based methods can be time-consuming and prone to errors. The effectiveness and user satisfaction of the application during the first phase of its implementation are unclear. Further research is needed to evaluate the application impact on the Woodball community and identify areas for improvement. Overall, the Pocket Score Woodball application has shown enormous potential in terms of improving the scorekeeping process.

**Keywords:** User interface design; woodball; score system

### 1. INTRODUCTION

Woodball is a growing sport that requires precise scorekeeping. Traditional paper-based methods can be time-consuming and prone to errors. The Pocket Score Woodball application was developed to improve the scorekeeping process in Woodball competitions. The application allows users to easily and accurately keep score, and it also provides several other features, such as a live scoreboard, statistics, and a chat function.

The purpose of this study was to investigate the usage of the Pocket Score Woodball application during the first phase of its implementation [1]. The study collected data on the usage of the application including the effectiveness of the application, user satisfactions and user feedback. The results showed a positive response from users, with a high level of satisfaction with the application ease of use, accuracy, and convenience. The study also identified some areas for improvement, such as incorporating more features to enhance the user

experience. Overall, the Pocket Score Woodball application has shown great potential to improve the scorekeeping process in Woodball and enhance the overall experience for players, coaches, and spectators.

The study was conducted in two phases. The first phase involved collecting data on the usage of the application. The second phase involved collecting user feedback on the application. The data was collected using a survey and a focus group. The survey was conducted online, and the focus group was conducted in person. The results of the study showed that the Pocket Score Woodball application was well-received by users. Most users found the application to be easy to use, accurate, and convenient. The user's application also appreciated the application other features, such as the live scoreboard and the chat function. But the study also identified some areas for improvement. Some users suggested that the application could be improved by adding more features, such as a tournament mode and a ranking system. Other users suggested that the application could be improved by making it easier to share scores with others.

Overall, the Pocket Score Woodball application has shown enormous potential to improve the scorekeeping process in Woodball [2]. The application is easy to use, accurate, and convenient. It also provides several other features that are valuable to Woodball players and coaches. The study identified some areas for improvement, but the application has the potential to be a valuable tool for the Woodball community.

## **2. MATERIALS AND METHOD**

The Pocket Score Woodball Application is a mobile application that allows users to keep a score in woodball games. The application has several features that make it easy to use, including a simple interface, automatic scoring, and the ability to track player statistics. This study used quantitative methodology. According to [3], the use of the quantitative approach helps describe the trends in a population or describes the relationships among the study's variables. A survey questionnaire was used to gather the study's main sources of information.

The survey's items were evaluated using a Likert scale. The Likert scale is a popular tool for assessing the degree of agreement among respondents to the assertions contained in the questionnaire [4]. A 5-point Likert scale was employed for this investigation. The anchor points for the scale were (1) Strongly disagree, (2) Disagree, (3) Nature, (4) Agree, and (5) Strongly agree. The data from the questionnaire were statistically analyzed in order to achieve the study's goals of assessing application's effectiveness in improving scorekeeping accuracy, user satisfaction, and identifying areas for improvement based on feedback. The Stack Ranking Woodball event was used to collect data on the effectiveness of the Pocket Score Woodball Application. The event was a single player tournament with 80 respondents that used the application. Each player used the Pocket Score Woodball Application to keep score of their games.

The Technology Acceptance Model (TAM) was used to assess user satisfaction with the Pocket Score Woodball Application ease of use and convenience. TAM is a widely used model for understanding user acceptance of information technology [5]. The model theorizes that user acceptance is influenced by two factors: effectiveness of the application and user satisfaction with the application. The effectiveness is how much a user believes using a Pocket Score Woodball Application will improve respondent performance while playing. This study was

conducted to assess the application effectiveness in improving scorekeeping accuracy and efficiency.

The Pocket Score Woodball Application is a mobile application that lets users keep scores in woodball games. The application has several features that make it easy to use, including a simple interface, automatic scoring, and the ability to track player statistics. User satisfaction is the degree to which a user believes that using an application will be free of effort. In the case of the Pocket Score Woodball Application, user satisfaction is important because it can help to ensure that users continue to use the application and recommend it to others. A survey was conducted to assess user satisfaction with the Pocket Score Woodball Application. The survey asked users about their overall satisfaction with the application and their satisfaction with specific features, such as ease of use, convenience, and accuracy [6].

### 3. RESULT AND DISCUSSION

In this study, a research tool was created to determine whether users would be open use Pocket Score Woodball application in improve the score keeping process. The TAM model, which was the main theory employed in this study, contends that elements such as the effectiveness, user satisfaction, and user feedback to use technology are related to users' acceptance of the use of Pocket Score Woodball application [7].

#### 3.1 The Effectiveness of the Application

The Pocket Score Woodball Application use effectiveness reflects how users believe it has improved efficiency and accuracy in maintaining score. The four items that were created specifically for this study's setting and used to test the effectiveness of use construct are listed in the table below.

**Table 1.** Effectiveness of the application

Effectiveness of the Application	Average Mean Score
The application is easy to use	4.6
The application accurately tracks game sore	4.8
The application provides very helpful features	4.7
The application very recommends to other woodball player	4.9
Total Average Mean Score	4.8

Based on the mean score of the effectiveness of the application is 4.8 out of 5, the application is well-received by users and has a positive rating. The application is easy to use, visually application appealing, and provides accurate and up-to-date information. Users also find the application to be helpful, engaging, and valuable. The application is also reliable and secure.

#### 3.2 The Satisfaction of Using the Application

User satisfaction refers to a user's perception of whether using technology, in this case, the Pocket Score Woodball, could improve their performance. The satisfaction of using the application is influenced by other elements particularly the degree to which a user believes that

using an application will be free of effort. This is because the user will be inclined to choose tools that are easy to use and require minimal effort to solve a scorekeeping problem. For this study, user satisfaction was measured through three items. These items were developed to suit the context of this research. The responses for these three items are tabulated in the table below.

**Table 2.** Satisfaction of using the application

Satisfaction of Using the Application	Average
The application overall satisfies to use	4.8
The graphic user interface (GUI) overall very satisfies to us	4.7
The user navigation among pages is user friendly to use	4.9
Total Average Mean Score	4.8

Based on the mean score of user satisfaction with the application is 4.8 out of 5, the application is a valuable tool that users find helpful and enjoyable to use. Users find the application to be helpful, engaging, easy to use, visually application appealing, accurate, and up to date. They also feel that the application provides value to them and would recommend it to others. The analysis also pointed up some room for development. The Pocket Score Woodball might be made better by adding more features and content, making it simpler to use and navigate, improving the accuracy and timeliness of the information, and application linking it to new events, according to user feedback data.

#### 4. CONCEPTUAL FRAMEWORK

Multiple theoretical stances have been presented by academics in instructional technology to better understand how end users choose to use technologies. Regarding this, the most popular theories on the application of technology include the Theory of Planned Behavior (TPB) [8], the Technology Acceptance Model (TAM), the Innovation Diffusion Theory (IDT), and the Unified Theory of Acceptance and Use of Technology (UTAUT). These theories have been employed as techniques for determining whether technological applications are successful or unsuccessful.

The Technology Acceptance Model (TAM) is a model used to explain and predict user acceptance of information technology. It suggests that perceived usefulness and perceived ease of use are the two most important factors in determining user acceptance. Perceived usefulness relates to how much a user believes a system will improve their job performance, while perceived ease of use relates to how easy a user believes a system will be to use. The model has been widely tested and application lied, including in the adoption of mobile application.

The Technology Acceptance Model (TAM) has been used to explain and predict the adoption of various mobile applications, including Pocket Score Woodball [9]. A study by Chan et al. (2019) found that the effectiveness and user satisfaction were both significant predictors of user intention to use Pocket Score Woodball. The study also established that the effectiveness had a stronger influence on user intention to use than user satisfaction. Based on the conceptual framework of the TAM, the study identified the effectiveness, user satisfaction, user intention to use, and actual use as critical constructs in determining user acceptance of mobile application.

The findings of the study suggest that developers of mobile applications can improve user adoption of their applications by focusing on improving the effectiveness and user satisfaction of the application [10]. To achieve this, developers can ensure that their applications are easy to learn and use, demonstrate how the application can solve real-world problems, and get feedback from users to make improvements based on their feedback. By following these suggestions, developers can improve the effectiveness and user satisfaction of their mobile applications, leading to increased user adoption.

## 5. RECOMMENDATIONS FOR EXPERIMENTATION

The success of a system largely depends on its ability to function without limitations. In the case of a field game management system, it is essential to have a smooth flow of the system without the need for yearly maintenance [11]. To achieve this, the system should be designed to automatically update the field game without requiring the organizer to edit it. This will significantly reduce the amount of time needed to update the field back and ensure that the system runs smoothly over an extended period.

In addition to automatic updates, the system should also allow players to edit their profiles. This feature will help to avoid the redundancy of data stored in the database and lift the workload of the organizer. When players can edit their profiles, they can easily update their information, such as contact information, and skill level, without having to contact the organizer. This will save time and ensure that the database remains up to date, making it easier for the organizer to manage the game.

In conclusion, a field game management system should be designed to operate without limitations [12]. Automatic updates and the ability for players to edit their profiles are essential features that can help to achieve this goal. By implementing these features, the system can function smoothly over an extended period, reducing the need for yearly maintenance and lifting the workload of the organizer.

## 6. CONCLUSION

The extensive study provided in this paper examined the Pocket Score Woodball Application, a mechanism for scoring woodball games. The application's users have commended it for its accuracy, user-friendliness, and special features like the chat and live scoreboard. With an average rating of 4.8 out of 5, it demonstrated good efficiency and customer satisfaction as well as a strong helpful user response.

Although the request was well received, the study identified potential for improvement. The application's functionality should be increased to include a tournament mode and rating system, for example, as a result of user feedback that identified various areas for improvement. Users also proposed ways to make it simpler to share results. Future iterations of the application are guided by this user-centered feedback, making it more tailored to users' requirements and preferences.

The Technology Acceptance concept (TAM), a well-known theoretical concept, is used in the study to explain why users adopt technology equipment. According to the TAM, the Pocket Score Woodball application perceived usability and simplicity of use are what determine the acceptance of users. The great user acceptance that the application exhibits is supported and explained by this theoretical foundation.

There are some suggestions for the application ongoing development in the report's conclusion. The automation of playground updates to lessen manual editing and guarantee system stability is one of the most significant suggestions. This and other suggestions are meant to enhance Pocket Score Woodball's general effectiveness and user pleasure, leading to greater user adoption rates.

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## I-CReST 2023:060-033 - Comparison Analysis of SVM and Naïve Bayes for Sentiment Analysis on Public's Perception Towards Second-hand Smoke

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### ABSTRACT

Second-hand smoke (SHS) comes from a burning cigarette or other tobacco product, that is exhaled by smokers. Diseases such as lower respiratory illnesses, impaired lung functions and lung cancer could potentially harm human's health conditions due to the exposure of SHS. Public smoking has become a common factor that leads to people exposed to SHS and this occurs in various public places such as restaurants, workplaces, schools and at home. Smokers were less likely approached by someone else asking them to not smoke and non-smokers usually keep their opinions about inhaling the smokes to themselves. Due to this, the opinions, and perspectives of the society regarding the issue of SHS is unclear. In this study, a sentiment analysis was conducted to extract positive and negative sentiments of users' Twitter posts related to SHS. The sentiment extraction was done using sentiment classification with Valence Aware Dictionary and Sentiment Reasoner (VADER) model. The scent and smell of the cigarette smoke, ban on public smoking and health concerns are the topics that contributes to the negative sentiments. Freedom to smoke, equal rights for smokers and ignoring people affected by SHS exposure relates to the positive sentiments. Predictive models were constructed using Naïve-Bayes and Support Vector Machine (SVM) machine learning classifiers to predicts the sentiments from the dataset. The best predictive model is SVM with 70:30 split data ratio with an accuracy of 96.37%. In conclusion, SVM performed better than Naïve-Bayes for sentiment analysis on public perception towards secondhand smoke.

**Keywords:** Sentiment analysis; secondhand smoke; public smoking; Naïve-Bayes; support vector machine

### 1. INTRODUCTION

Second-hand smoke (SHS) is referred to the combination exhaled smoke by active smokers into the air which is called mainstream smoke (MS) and the smoke that comes from smoldering smoke produced by cigarettes which is called side stream smoke (SS) [1]. In other words, SHS smoke comes from a burning cigarette or other tobacco product, or that is exhaled by smokers. SHS is among the common factor of various diseases such as lower respiratory illnesses, impaired lung functions and lung cancer. These diseases or illness could potentially harm human's health conditions due to the exposure of SHS [2].

Public smoking has become a common factor that leads to people exposed to SHS because these places allow smoking activities. The common public places that have high potential in exposing oneself to SHS such as restaurants, public transportations, shopping centres, parks, workplaces, schools and at home [3]. SHS could affect anyone who is near smokers, but some groups of people are more prone to SHS exposure. [4] stated that restaurant servers who work in service industry, pregnant women, infants, and children are the category of people who has a greater risk of damage from SHS.

SHS exposure has been considered a major risk factor for impermanence especially among adults and children. Every year, SHS exposure has caused nearly half of the worldwide children and more than 166000 of the children die as early as 5 years old from the illnesses such as lower respiratory infections and asthma due to SHS exposure [5]. Moreover, subclinical cardiovascular disease markers in adulthood, for example carotid atherosclerotic plaques is also associated in childhood SHS. The SHS is usually exposed in public places, however, it is said to be having high in volume particularly in enclosed environments like vehicles and at home as it contains dangerous level of SHS contaminants for example, carbon monoxide, nicotine and fine particulate matter. Non-smokers who lived in the same house as smokers also has increase probability of exposing themselves in the home. Based on this, it is concluded that exposure to SHS is very harmful and there are no safe levels of the SHS effects [6].

In a common situation, smokers were less likely approached by someone else asking them to not smoke [7]. In reality, many smokers exhale the smoke to other people without considering their thoughts on having themselves caught in harmful smoke. Smokers continue to light up the cigarettes, blowing and puffing smokes in front of friends and families, and even worse, the children. Non-smokers usually keep their opinions about inhaling smokes that comes from the smokers to themselves. This is due to the society practice tolerance, and they are not encouraged to speak freely of their mind [8]. The society would be less likely to confront smokers to stop smoking to avoid arguments and misunderstanding among themselves. This makes the perception of the society regarding the issue of SHS is unclear.

One of the reasons adults exposed to SHS in public places especially in workplaces and homes is due to lack of awareness of the effects of SHS [9]. Some people do not take the issue of SHS seriously and unconsciously put themselves in a situation that could harm their health. The smokers usually acknowledge the consequences and how smoking can damage their health condition, but the fact that cigarettes smoke exhaled by them also has a significant negative impact on the health condition of non-smokers, this they may not be aware of.

This study aims to perform predictive models using Naïve-Bayes and Support Vector Machine classifiers onto the keywords used for second hand smoke in social media, especially in Twitter posts. This paper presents the related work done by other researchers, followed by the methodology. Then, the results and findings are explained in the sentiment classification and prediction models. And finally, it followed by the conclusion.

## 2. RELATED WORK

This section highlights the related work in sentiment analysis, which highlights several techniques such as BERT, Naïve Bayes, LSTM and SVM.

## 2.1 Sentiment Analysis

In 2021, Singh et.al [10] conducted a research to identify the effects of Covid-19 to the lifestyle of the public using sentiments analysis onto Twitters tweets related to Covid-19. The researchers performed feature extraction using minimum redundancy maximum relevancy (mRMR), and then applied BERT with pytorch for emotion classification. After that, BERT model was fine-tuned by defining the size of batch size to create tensors and iterators. Lastly, the study trains BERT model using the parameter. This study proved that this model has high potential in sentiment analysis, and it has achieved a high overall performance of accuracy using the proposed model which is approximately 94%.

Another research, Myslín et al. [11], has studied sentiment analysis implemented on the topic of tobacco. Although Twitter has become one of the key resources for applications of public health surveillance, but the level of awareness towards tobacco is not clear regarding the tobacco control challenges especially by e-cigarettes and hookah. This study has built a sentiment analysis with Twitter posts related to tobacco products mainly focusing on emerging products such as e-cigarettes and hookah using Naïve- Bayes and other classifiers so it can identify relevant posts and sentiment towards tobacco. A total number of 7362 tobacco-related posts using Twitter API was used in the study with the keywords of tobacco, cig\*, nicotine, hookah, smok\*, shisha, e-liquid, vape, vaping and waterpipe. The study was able to proof that Twitter insights for health surveillance related to tobacco is significant due to the high pervasiveness of positive sentiment. Besides that, classification tasks using machine displays an optimistic potential compared to approaches using keyword-based with the presence of improvement for signal-to-ratio in Twitter data.

Another study, related to smart city analytics refers to the process of tracking, clarifying, and classifying the sentiments and emotions shared through social media platforms[12]. A framework was constructed to facilitates the evolution of opinions' evaluation in real-time which are shared by public features and their followers.

The solution includes a deep learning-based LSTM model which is the Bi-directional LSTM classifier. This study focused on data from Twitter and the topic selected is "Climate Change". A total number of 278,264 Twitter posts related to climate change were retrieved. The relationship of words was analysed by using word embedding by implementing Word2Vec. The pre-trained Word2Vec model converted tweet words in a pre-defined vector space to real-valued vectors. LSTM model was trained with the vector representation to capture long-term dependencies of the words. The results of the accuracy for LSTM classifier obtained in emotion analysis were 89.66% for anger, 88.41% for discrimination, 87.52% for joy and 87.01% for inspiration. Meanwhile, the results of the accuracy for the proposed classifier obtained in sentiment analysis were 89.80% for strong support, 87.52% for strong opposition, 89.32% for support and 88.14% for opposition.

## 2.2 SVM in Classification

Along with sentiment analysis, SVM was used as the classifier for this study. SVM was selected because it was proven a prominent classification technique in many domains.

SVM was implemented in electrical signals classification [13]. The applied SVM to effectively classify EEG signals to detect abnormal signals. The main reason of developing the

method was to reduce experts' workload and potential human errors. The method was based on wavelet packet decomposition (WPD) which act as a decomposition mainly to generate bands at different levels and a chaotic one- dimensional local binary pattern (CLBP) which generates features from the EEG signals that are decomposed. For feature selection, the study used iterative minimum redundancy maximum relevancy (ImRMR) which will select features that are significant automatically. These selected features were passed to SVM classifier for classification process.

SVM was also used in an early warning system to prevent road accidents caused by drivers' distraction [14]. The objective of this research was to analyse the driver's face pose cues to detect a distraction. This study developed a driver database that consists of driving videos of drivers which the camera facing the driver to spot variation in face pose cues. SVM was developed with a clustered two-layer approach on Gabor features. Grayscale features which provide the intensity of information and Gabor features which provides orientation information were used for pose estimation. To obtain benchmark of data, a convolutional network with five layer and three fully connected layers was used.

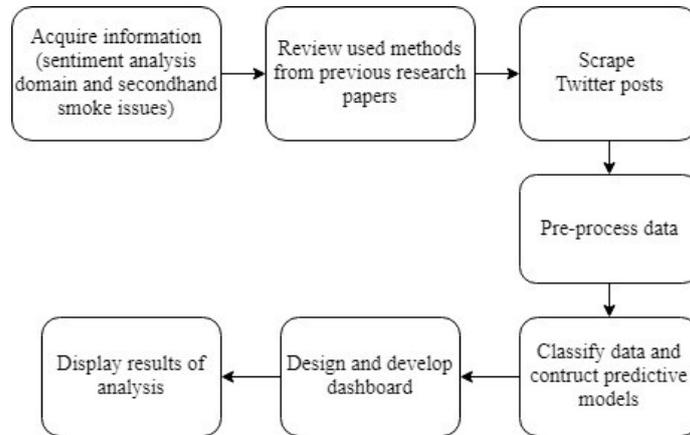
Besides, SVM was also applied in the research paper [15], to maintain the quality assurance and traceability of the lettuce production. The data collected was a total of 194 samples of lettuce and soil from two states in the south eastern and north eastern regions of Brazil which are São Paulo and Pernambuco farms. This study used SVM with the radial basis (RBF) kernel function. The kernel function enables SVM to project new dimensional space from the original data to search for linear decision boundary because it is impossible to linearly separate in original dimension space. Linear discriminant analysis (LDA) was also applied to compare the model's performances. After preparing the training dataset, SVM and LDA models were developed using the training data.

Hence, the related work has proven the efficiency of both techniques mentioned in sentiment analysis and classification. This has become the ground reason of the method selection in this paper.

### **3. RESEARCH METHODOLOGY**

This section highlights the framework of sentiment analysis using SVM and Naïve Bayes. Then, this section continues with the steps involved in sentiment analysis for second hand smoke, using SVM and Naïve Bayes method. It started with data collection, data pre-processing, sentiment extraction and data modelling.

### 3.1 Framework



**Fig. 1.** Research framework

Fig. 1 shows the overview of flow of the project. The project started with knowledge and information gathering of the domain and related works. Next, the research papers acquired are reviewed to study the techniques used in conducting their experiments and analysis by other researchers. After reviewing the research papers, the process continues with data collecting and pre-processing to use in further analysis. Before designing and developing a dashboard, the data has gone through cleaning and transformation and then classified into two categories which are positive and negative. Plus, a predictive models will be constructed using two machine learning classifiers which are Naïve Bayes and SVM. The final step is displaying and presenting the findings and results based on the evaluation made in the analysis process.

### 3.2 Data Collection

In this paper, the data required are secondhand smoke-related posts and the data are scraped and collected through Twitter. The list of keywords consists of the terms which often used by other researchers and associated to some popular phrase used by the society regarding SHS issues in order to scrape posts from Twitter. The retrieval of Twitter posts was done using Python using a built-in web scraping tool which is Twint. The data scraping process begins by importing the Twint library and insert inputs such as the keywords and the dates. The list of keywords is inserted alternatively for every range of dates. The retrieving process took about eleven months' worth of data which started from the first of January until the end of November 2021.

A total of 20,137 data was successfully collected and stored in an Excel file for further experiments. There are several attributes that were taken during the data scraping process including conversation ID, date and time, Tweet text, language, Twitter profile ID, username, post links and other attributes.

### 3.3 Data Pre-Processing

This project has selected two attributes from the data retrieved from scraping process which are date and tweet while the other attributes were removed as it has less value that could contribute to the analysis. The next step is to convert all text to lowercase letters in order to

standardize all texts to make analysis process easier. Other than that, HyperText Markup Language (HTML) references characters like ampersand and quotation marks were removed along with none-letter characters for example, punctuations, numbers, and symbols. Lastly, usernames in the form of '@username' were removed as it brings less meaning in sentiment analysis. Additionally, filtering tasks was taken to discard some non-related topic from text data as there were some texts which were not associated with the scope of the topic of this project's domain. A total of 10,004 number of data remained after pre-processing task.

The next tasks of data pre-processing were implemented using RapidMiner tool. The process begins with tokenization process. Then the tokens were filtered and removed based on the length of minimum and maximum characters in a word. After that, a list of stopwords were excluded. The next performed step was stemming. Lastly, vectorization process was applied using the calculation of TF-IDF (Term Frequency-Inverse Document Frequency). The Text Vectorization operator transforms one or several text columns into a vectorized format to identify words that are important in the dataset.

### **3.4 Sentiment Extraction**

Sentiment extraction refers to the process of obtaining the state of sentiment perspectives from any given text in a dataset. The sentiment extraction task begins with importing and reading the cleaned scraped dataset and converted into nominal data. For the sentiment extraction part, the Extract Sentiment operator with Valence Aware Dictionary and sEntiment Reasoner (VADER) model was used to score and label the sentiment of the tweet in the dataset. VADER uses lexicon and rule-based sentiment to do the scoring and it is specifically picked for producing sentiment expressed from social media.

### **3.5 Data Modelling**

As mentioned before, two machine learning techniques has been chosen as the sentiment classification method.

#### **3.5.1 Naïve-Bayes**

The data were split into two sets which are training and testing set using 70:30 ratio with automatic sampling which uses stratified sampling if the label is nominal and shuffled sampling for other types of labels. Next, the Text Vectorization operator was used for both training and testing sets and it transforms the text column into a vectorized format in order to identify words that are important in the dataset. After that, the Naïve-Bayes operator was selected in this model to see how well the classifier perform the predictions. The Performance operator was used for performance evaluation of the model, in this case is the accuracy performance of Naïve-Bayes model. These processes were repeated with other data split ratio which are 80:20.

#### **3.5.2 Support Vector Machine**

The prediction model for Support Vector Machine (SVM) classifier use the same operators as in Naïve-Bayes model however only the predictive model operator was changed to SVM operator instead of using Naïve-Bayes operator. SVM operator takes a list of input data and predicts the possible class which the input belongs to. There are several values were set in the

parameter for the SVM classifier. The dot kernel type was used and the kernel cache and max iterations were set to 200 and 100,000 respectively.

## 4. RESULTS & FINDINGS

This section highlights the results in the sentiment classification model, followed by the prediction model.

### 4.1 Sentiment Classification Model

Table 1 shows the total number of data categorized into positive and negative sentiment and the total percentage of each sentiment. The text data which falls into positive class has a total of 350 data while the text data which falls into negative class has a total of 9654 data. On the other hand, out of 10004 of tweet texts collected, only 3.50% were categorized as positive and 96.50% of the tweet texts were categorized as negative. Meanwhile, Table 2 shows the sentiment scores for the text data from the dataset. The maximum sentiment score is 3.28 while the minimum sentiment score is -10.13. The average sentiment score for the dataset is -1.29. According to the results obtained from the extraction process, the total number text data which labelled as negative is higher than the total number text data which labelled as positive. In this case, the results shows that most of the users who are using Twitter posts negative comments when discussing about the second-hand smoke (SHS) issue. Although the number difference of sentiment is large, however, there are a few percentages of people think that the SHS is not an issue. The average sentiment score indicates that the people mostly show a negative viewpoint regarding the issue. Overall, the sentiment extraction process concluded that the majority of the society has bad impressions and perceptions towards SHS problems.

**Table 1.** Total data and percentage of sentiments

Table Class	Total Number of Data	Total Percentage (%)
Positive	350	3.5
Negative	9654	96.5

**Table 2.** Maximum, minimum and average sentiment score

Maximum	Minimum	Average
3.28	-10.13	-1.29

Table 3 shows the sample of negative words derived from the extraction process of list of words. The word 'ban', 'crime' and 'safer' indicates that people who faces the SHS problem labelled the issue as a crime and the public smoking activities should be banned so non-smokers can be in a safer environment. One of the things that people especially non-smokers disagree with SHS issues is the scent and smell of the cigarette smoke. The word 'choke' and 'gross' further proved that the smoke itself is not welcoming to them. On the other hand, the people also describe their feelings about the issue for example the SHS is contagious thus, they express their worriedness in the Twitter posts. This can be seen with the use of words such as 'health' and 'lung' which indicate that the people are concern about their own health (lung) and other surrounding people especially pregnant from diseases associated to lungs. The word such as 'stop' and 'cigarette' shows that the society also wanted smokers to be considerate and stop smoking habit whether its tobacco or electronic cigarette.

**Table 3.** Sample of negative words

ban	choke	concern	health	stop
crime	gross	contagious	lung	cigarette
education	scent	hate	people	vape
safer	smell	worry	pregnant	smoke

Table 4 shows the sample of positive words acquired from the extraction process of list of words. From the word ‘defend’, ‘freedom’, and ‘choice’, some of the people especially the smokers believe they have the option to smoke wherever they want without having to leave and smoke outside of premises. Moreover, they expect to have same right as the public and treat smokers the same as anybody else. This is indicated by the use of the word such as ‘right’ and ‘equal’. Furthermore, the word ‘ignore’ and ‘love’ indicates that smokers take great pleasure in the behaviour of smoking and tend to neglect the comfort of people around them plus ignoring the possible effects of SHS towards passive smokers. Meanwhile, the word obtained from the dataset such as ‘good’, ‘option’ and ‘e-cigarette’ suggested that smokers assume there is better alternatives to replace cigarettes for example vapes which could reduce the staleness of the cigarette smoke’s scent.

**Table 4.** Sample of positive words

defend	ignore	choice	good
freedom	love	right	option
	equal	e-cigarette	

## 4.2 Prediction Model Comparison

As for this study, two machine learning classifiers were used to predict the sentiments based on the extracted sentiment dataset which include Naïve-Bayes and SVM. The performance of both classifiers will be evaluated based on its accuracy, misclassification rate, sensitivity, specificity and precision.

Table 5 shows the performance result for both Naïve-Bayes and Support Vector Machine (SVM) classifier predictive models. According to the results of the table, Naïve-Bayes 70:30 split ratio model has a score of 18.23% in misclassification rate. The negative class precision has a score of 96.75% while positive class precision has a score of 4.72%. The overall accuracy in predicting sentiments for Naïve-Bayes with 70:30 split ratio is 81.17%. For Naïve-Bayes 80:20 split ratio model, the misclassification rate has a score of 18.94% while the negative class precision has a score of 96.58% while positive class precision has a score of 3.88%. The overall accuracy in predicting sentiments for Naïve-Bayes with 80:20 split ratio is 81.06%.

**Table 5.** Performance result for both Naïve-Bayes and support vector machine (SVM)

Classifier	Split Ratio	Misclassification Rate (%)	Precision (%)		Accuracy (%)
			Negative	Positive	
Naïve Bayes	70:30	18.81	96.75	4.72	81.17
	80:20	18.94	96.58	3.88	81.06
SVM	70:30	3.63	96.50	0.00	96.37
	80:20	3.65	96.50	0.00	96.35

SVM 70:30 split ratio model has a score of 3.63% in misclassification rate. The negative class precision has a score of 96.50% while positive class precision has a score of 0.00%. The

overall accuracy in predicting sentiments for SVM with 70:30 split ratio is 96.37%. For SVM 80:20 split ratio model, the misclassification rate has a score of 3.65% while the negative class precision has a score of 96.50% while positive class precision has a score of 0.00%. The overall accuracy in predicting sentiments for SVM with 80:20 split ratio is 96.35%.

Based on the results, Naïve-Bayes with 70:30 split model has a slightly higher percentage compared to Naïve-Bayes 80:20 split ratio for the precision score. This indicates that Naïve-Bayes with 70:30 split ratio is better at finding both negative and positive sentiment than Naïve-Bayes with 80:20 split ratio. On the other hand, SVM with 70:30 split ratio model has the same percentage as compared to SVM 80:20 split ratio model. This shows that SVM model with 70:30 and 80:30 split ratio has similar performance in finding negative sentiment. With the precision percentage comparison with Naïve Bayes 70:30 split ratio, the model performed slightly better than both SVM models in searching for negative sentiment.

The misclassification rate for Naïve-Bayes with 70:30 split ratio is lower than the rate with 80:20 ratio model. For the accuracy score, Naïve-Bayes with 70:30 split ratio model has a higher percentage compared to Naïve-Bayes 80:20 split ratio. This indicates that Naïve-Bayes with 70:30 split ratio model is better at predicting sentiments than Naïve-Bayes with 80:20 split ratio model. Furthermore, the SVM with 70:30 split model has slightly lower misclassification rate than SVM model with 80:20 split ratio. Meanwhile, SVM with 70:30 split ratio model has a slight increase in percentage of the accuracy than SVM 80:20 split ratio model. This indicates that SVM model with 70:30 split ratio is better at predicting sentiments than SVM model with 80:20 split ratio. In comparing both Naïve-Bayes and SVM with 70:30 split ratio models, the SVM model performed better than Naïve-Bayes model in predicting sentiments due to higher accuracy percentage and lower misclassification rate.

## 5. CONCLUSION

This study was to determine the public's perception towards secondhand smoke (SHS) issue using sentiment analysis. In this paper, several stages of sentiment analysis processes were performed including data collection, data pre-processing and sentiment extraction. The data was scraped from Twitter and was pre-processed before extracting sentiments for each text data using Valence Aware Dictionary and sEntiment Reasoner (VADER) model. The scent and smell of the cigarette smoke, ban on public smoking and health concerns are the topics that relates to the negative sentiments while the freedom to smoke, equal rights for smokers and ignoring people affected by SHS exposure relates to the positive sentiments. A total of four predictive models were constructed using two machine learning classifiers which are Naïve-Bayes and SVM to test the accuracy performance for both classifiers and the predictive models' performance was evaluated and compared based on its misclassification rate, precision and accuracy. The best predictive model is SVM with 70:30 split data ratio with an accuracy of 96.37. In conclusion, most of the public had a negative impression towards SHS. These findings help the healthcare personnel to monitor the community's level of SHS exposure and assist law firms' authorities to implement stricter legislation to protect the society from the exposure of SHS.

## ACKNOWLEDGEMENT

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## I-CReST 2023:107-066 - An Educational Game Prototype to Cultivate Good Digital Habits

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### ABSTRACT

Digital devices are essential in youth's everyday lives and significantly impact their well-being. Indirect effects of continuous usage of digital devices could include stress, digital eye strain, sleep disturbance, and poor academic achievement. It may also lead to an addiction to screen time. Digital habits are healthy or unhealthy habits or behaviours related to digital technology, including digital devices and media. Even though there are several digital tools to monitor digital device usage, there is a lack of games focusing on educating good digital habits. Thus, this study develops an educational game prototype for awareness of good digital habits. A Rapid Application Development (RAD) approach is being used for this study, and it consists of four stages: requirement planning, user design, construction, and cutover. The study's outcome shows that this prototype is promising in cultivating awareness of good digital habits among youth.

**Keywords:** Digital technology; digital habits; educational game

### 1. INTRODUCTION

Recently, there has been a significant rise in the use of digital devices such as smartphones, gadgets, the internet, social networks, and other online activity devices. The digital world expands the students' world. They utilise technology for their studies since it has become crucial to their lives. The way that education is delivered has changed as a result of e-learning. Various digital learning platforms now assist students with their coursework and test preparation [1].

However, excessive screen time can harm our health as well as our level of productivity. Thus, our online and offline lives need to be in harmony with one another. To accomplish this, we must incorporate the so-called "Digital Detox" into our lifestyle. Therefore, there is a need to develop an educational game for good digital habits so that students can learn and adopt those good digital habits from the game.

Due to this problem, an urgent need is to develop an educational game that can promote good digital habits for students. The emergence of educational games in student life may open an opportunity to provide an effective way of promoting good digital habits through an interesting method, as almost all the students played the game during their leisure time. Hence, an educational game could serve as a helpful tool for fostering good digital habits among students. As a result, this article dominates the gap by exploring the possibility of educational games as a learning tool for students to instil good digital habits among themselves. This research aims to design and develop an educational game for good digital habits. The study helps to clarify the system requirements for such a system. The background and related study

are described in the next section—the following section details how the prototype was designed and developed. The evaluation of the prototype's usability is described in the following section. The study is concluded, and the paper's final section presents a list of future works.

## 2. RELATED STUDY

This section describes the background and related studies of digital habits. Later in this section, it discusses how information technology can help facilitate an educational game for good digital habits. Although digital devices have brought us a lot of convenience and entertainment, we must use them properly to avoid their harmful effects.

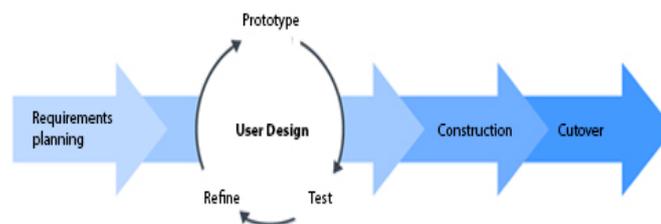
The usage of digital mediums such as smartphones, gadgets, the internet, social networks, and other online activities devices has increased. Despite the benefits of digital platforms and productivity enhancements from utilising digital devices, according to a growing body of research, many people use their digitally connected devices excessively and in ways that disrupt their daily lives [2]. This digital technology influences how individuals utilise technology to stay in relationships or break them up and how much time they spend engaging in virtual social interactions [3]. Thus, there are concerns that long engagement in these activities could cultivate bad habits and lead to societal problems once the crisis has subsided, especially for youth.

Researchers began investigating the potential of establishing digital wellness tools to positively impact user behaviours and attitudes towards digital devices since the technology may be part of the solution by utilising the same user data [4]. Through interactive data and dashboards, digital wellness applications mainly concentrate on giving users a better understanding of the proper amount of time spent on digital devices. Examples of these efforts include Google Digital Well-being [5], SPACE Break Phone Addiction [6], NUGU [7], Lock n'LoL [8] and Google's Interland [9]. However, most digital health applications were created to monitor and regulate screen time only.

Although many apps and systems are available in their market, most only focus on controlling or limiting screen time. The importance of screen time has been extensively acknowledged in consumer science studies over the past few decades. However, there has been little focus on how to foster those good digital habits through the game. There is a chance to enhance the entire process of fostering good digital habits through the educational game. Therefore, there is a need for research and development of an educational game to foster good digital habits among young people. The research described in this paper attempts to create and develop an educational game that might help users cultivate good digital habits.

## 3. METHODOLOGY

The study was carried out using the Rapid Application Development (RAD) methodology proposed by Martin [10]. An adaptive software development methodology, RAD, uses prototyping to gather system and app requirements. Despite the continuous changes in the software development process [11], RAD is still functional and widely used by software developers. It has four primary stages: requirements planning, user design, construction, and cutover. The flow of the phases is shown in Fig. 1.



**Fig. 1.** Rapid Application Development (RAD) model

The requirements planning phase involves determining the requirements for an educational game for good digital habits. Unified Modelling Language (UML) diagrams document and display the requirements, including the use case, sequence and class diagrams. The requirements of a system are typically presented in UML diagrams, as found in Adediran and Al-Bazi [12], Hussain et al. [13] and Yani and Zolkipli [14]. The user design and construction phases are carried out simultaneously when designing the game's user interface. Designing and developing an educational game for good digital habits involve users who always provide comments and feedback on improving the user interface and information flow. Finally, a usability review of the system is carried out during the cutover phase. The following sections provide a detailed explanation of the details for the implementation phases. The Design and Development section covers the phases of requirements planning, user design, and construction, while the Evaluation section explains the cutover phase.

#### 4. DESIGN AND DEVELOPMENT

This section describes the design and development of an educational game for good digital habits by following the first three phases of RAD. The section is divided into two sub-sections; (1) the requirements of the educational game for good digital habits and (2) the prototype development to illustrate the gathered requirements.

A requirement-gathering process was conducted using one method: (1) analysing materials and games from online resources relevant to digital habits. To search for documents, keywords were generally entered into the Google search engine such as "digital habits", "digital behaviours", "good digital habits", and "digital well-being". The documents were examined to determine the requirements for an educational game that could instil good digital habits among young people. The six most important criteria that came out of the requirements gathering process, along with their priority, are start game, view game instruction, view leader board and sound control, manage game feature and test game feature.

The requirements were converted into the functionalities of the computer system. The following step is visualising and modelling the system's requirements using the proper modelling methodology and tools. The requirements were represented and modelled using the Unified Modelling Language (UML). The models used for this work are three behavioural diagrams: use case and sequence diagrams and a class diagram, which illustrates the system's structural components. The diagrams were drawn using StarUML. The use case diagram and how the use cases interact with the actor for a proposed educational game are shown in **Fig. 2**. Six major use cases are start game, view instruction, view leader board, sound control, manage game feature and test game feature. The use case of Start Game allows users to perform

subfunctions, including "Move to Left or Right", "Answer Question," and "Submit Score". The Manage Game Feature allows the developer to "Add", "Delete", and "Update" the game.

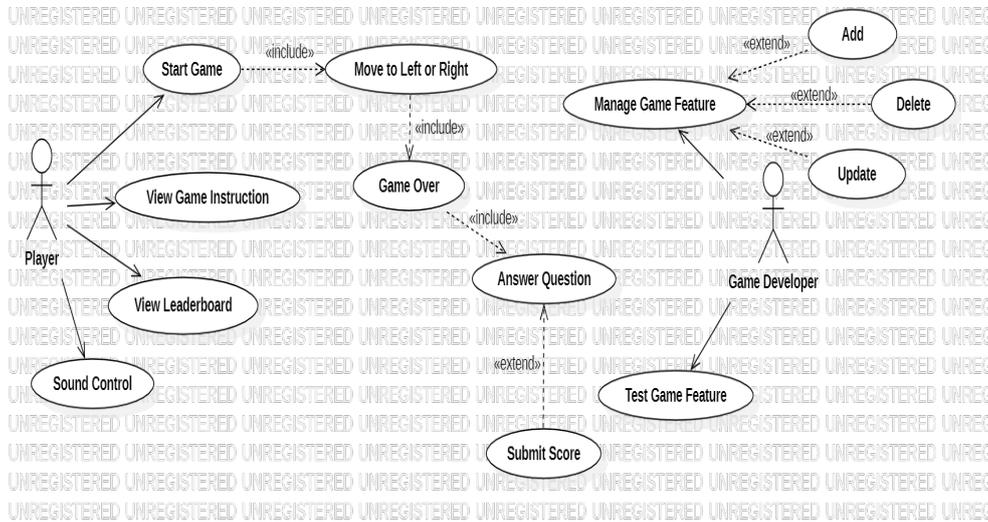


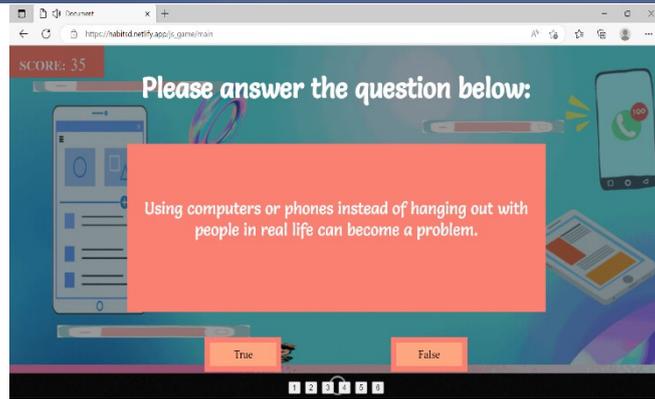
Fig. 2. The use case diagram of the prototype

## 5. THE PROTOTYPE DEVELOPMENT

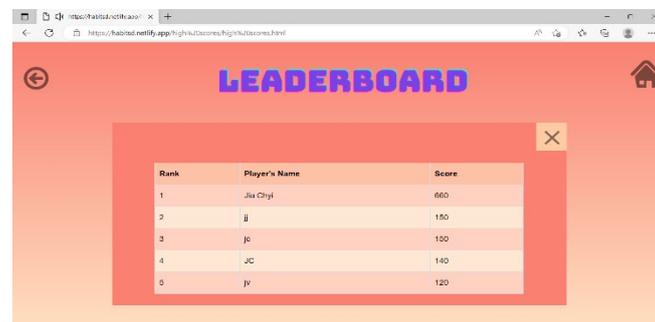
The prototype represents the specifications that were described in the previous subsection. A standard method of illustrating software requirements is through software prototyping, which allows users to provide further feedback and suggestions based on their interactions with the prototype. IntelliJ was used as the primary integrated development environment (IDE) tool. Additionally, the local storage was used as a database for storing data. Screenshots in Fig. 3, Fig. 4 and Fig. 5 illustrate the prototype interfaces.



Fig. 3. Interface for the instruction page



**Fig. 4.** Interface for the question page



**Fig. 5.** Interface for the leaderboard page

## 6. THE PROTOTYPE EVALUATION AND RESULTS

Thirty respondents were approached randomly and participated voluntarily in a usability evaluation, and they were students from a university in Malaysia. The respondents assessed the prototype features in a session. Then, they completed a post-task survey. The post-task questionnaire comprises five sections—section A about the respondents' demographic information, sections B, C, D and E inquired about the respondent's opinion about the prototype on a Likert scale with a maximum of five points, where one is for strongly disagreeing, and five is for strongly agreeing. The respondents followed the steps listed below to complete the evaluation: (1) reading and signing a consent form; (2) playing the educational game prototype as instructed by the experiment procedure; and (3) responding to the post-task questionnaire.

The respondents' demographic information analysis showed that 76.7% were female and 23.3% were male. The respondents also reported that 76.7% were in Semester 6, 13.3% were in Semester 4, and 10% were in Semester 2.

The responses provided by the respondents in Sections B, C, D, and E of the post-task questionnaire were examined. The section measures the respondents' perception towards the prototype's usefulness, design and functionality. It also measured the respondents' satisfaction towards the prototype. Table 1, Table 2, Table 3 and Table 4 reported the frequency and average of the responses. Most respondents rated agree and strongly agree with the four aspects of usability. None of the respondents rated strongly disagree or disagree—only a few rated neutral.



**Table 1.** The respondents' responses on the usefulness of the prototype

The post-task questionnaire items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Overall, the educational game meets the requirements.	0 (0.00)	0 (0.00)	0 (0.00)	8 (26.70)	22 (73.30)
Interaction between user and content is user-friendly.	0 (0.00)	0 (0.00)	0 (0.00)	1 (3.30)	29 (96.70)
I think that the education game is easy to use.	0 (0.00)	0 (0.00)	0 (0.00)	2 (6.70)	28 (93.30)
I find the system functioning smoothly and is well-integrated.	0 (0.00)	0 (0.00)	4 (13.30)	10 (33.30)	16 (53.30)
I can use the educational game without written instructions.	0 (0.00)	0 (0.00)	0 (0.00)	1 (3.30)	29 (96.70)
The information is well organised, and functions are easy to find.	0 (0.00)	0 (0.00)	0 (0.00)	2 (6.70)	28 (93.30)
I feel confident while using this system.	0 (0.00)	0 (0.00)	2 (6.70)	5 (16.70)	23 (76.70)

**Table 2.** The respondents' responses on the design of the prototype

The post-task questionnaire items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The font used is easy to read and view.	0 (0.00)	0 (0.00)	0 (0.00)	1 (3.30)	29 (96.70)
The operations, actions, and responses are consistent.	0 (0.00)	0 (0.00)	0 (0.00)	2 (6.70)	28 (93.30)
Buttons are reasonably easy to click on.	0 (0.00)	0 (0.00)	0 (0.00)	1 (3.30)	29 (96.70)
The game made good use of text, colours and graphics.	0 (0.00)	0 (0.00)	0 (0.00)	2 (6.70)	28 (93.30)
The layout is user-friendly.	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	30 (100.00)

**Table 3.** The respondents' responses on the functionality of the prototype

The post-task questionnaire items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Overall, the educational game is useful.	0 (0.00)	0 (0.00)	1 (3.30)	8 (26.70)	21 (70.00)
The educational game is attractive.	0 (0.00)	0 (0.00)	0 (0.00)	6 (20.00)	24 (80.00)
All the buttons are functional.	0 (0.00)	0 (0.00)	0 (0.00)	1 (3.30)	29 (96.70)



**Table 4.** The respondents' satisfaction with the prototype

The post-task questionnaire items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am satisfied with the educational game.	0 (0.00)	0 (0.00)	0 (0.00)	11 (36.70)	19 (63.30)
I would recommend the educational game to my friend.	0 (0.00)	0 (0.00)	1 (3.30)	8 (26.70)	21 (70.00)
The educational game is wonderful and pleasant to use.	0 (0.00)	0 (0.00)	0 (0.00)	10 (33.30)	20 (66.70)
I want to use the educational game in the future.	0 (0.00)	0 (0.00)	2 (6.70)	9 (30.0)	19 (63.30)

## 7. CONCLUSION

This paper outlines the development of an educational game prototype that encourages good digital habits. We intend to enhance the prototype's usefulness in the future by proposing assistance with good digital practices. An entertaining 3D game could be used to create a game that teaches players positive digital habits. The intricate aesthetics, the video game art, and the excellent design have influenced the popularity of 3D games. Players find these elements to be appealing. The sound effects will also be enhanced to improve the game's attraction.

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## **I-CReST 2023:127-141 - Improvement Designs of Jigs and Fixtures for Improve Working Postures and Eliminate Repetitive Movements**

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### **ABSTRACT**

The design of jig and fixtures is crucial in maximizing productivity and enhancing safety during production operations. It eliminates waste in production, such as movement, time, and space in the production area. This study conducted improvements at a television manufacturing company. The first step was to observe the current production method, followed by listing possible improvements. Finally, proposed designs for jigs and fixtures were suggested to improve operations at the company. Three improvements were suggested: proposing a design for round-shaped document storage, improving the part rack for the production line, and improving the jig for the source board grounding process at the assembly area. These improvements will enable employees to pick up parts in a more comfortable position, reduce the risk of musculoskeletal disorders (MSDs), improve working posture, and eliminate repetitive movements that can lead to injury and affect the body movement of the production worker. At the same time, the design of the jigs will help implement lean manufacturing, which will eliminate waste in the manufacturing operation.

**Keywords:** Ergonomics risk factors; continuous improvement; safety and health, jigs and fixtures

### **1. INTRODUCTION**

Ergonomics is critical because when the body is pressured by an awkward position, severe temperature, or repetitive movement while performing a task, the musculoskeletal system suffers. The body may begin to exhibit symptoms such as weariness, discomfort, and pain, all of which can be precursors to a musculoskeletal issue [1]. When considering the aetiology of musculoskeletal disorders in the workplace, it is important to include both physical and psychological ergonomic risk factors as independent variables, as they are often connected with one another. Musculoskeletal problems may be caused by a combination of psychological and physical exposures, as suggested by data from both based on empirical research [2]. According to OSHA recommendations, an effective control programme should include a systematic investigation of the work area to detect, classify, and eliminate ergonomic hazards.

According to Hui Wang & Hua Li, [3] a fixture is a mechanism used in manufacturing to hold a work piece, position it correctly with respect to a machine tool, and support it during machining. Regardless of what industry, jigs and fixtures are inseparable. They can be found in almost all industries for various objectives. Widely used in manufacturing, fixtures also have a direct impact upon product quality, productivity, and cost [3]. Generally, the cost associated with fixture design and manufacture can account for 10-20% of the total cost of manufacturing

system [4]. Fixture design work is also tedious and time-consuming. It often heavily relies on fixture design engineers' experience/knowledge and usually requires over 10 years manufacturing practice to design quality fixture [3]. Maximising production efficiency and productivity is a key concern for manufacturers. Jigs and fixtures are manufacturing aids used to increase the reliability, accuracy and quality of the manufacturing process whilst minimising production cycle times and improving worker safety [5].

The objective of this paper is to oobserved workers' work posture and work activities at assembly, inspection and packing areas at the production line, analyses all the working postures and recommend the improvement designs of jigs and fixtures for improve working postures and eliminate repetitive movements.

## 2. METHODOLOGY

Workers in the assembly, inspection, and packaging areas have been selected for investigation and analysis to enhance their health. The method was used in this study by following the flow diagram shown in the Table 1.

**Table 1.** Flowchart for methodology

Process flow	Activity/Tool usage
<div style="border: 1px solid black; padding: 5px; text-align: center;">Work postures observation</div>	Observed workers' work posture and work activities at assembly, inspection and packing areas at the production line
<div style="border: 1px solid black; padding: 5px; text-align: center;">Data Collection</div>	Record videos and images on the awkward work postures while doing the work activities at the production line
<div style="border: 1px solid black; padding: 5px; text-align: center;">Data Analysis</div>	Analyses all the working postures
<div style="border: 1px solid black; padding: 5px; text-align: center;">Improvement</div>	Design and propose improvement using engineering and administrative control

## 3. RESULTS AND DISCUSSION

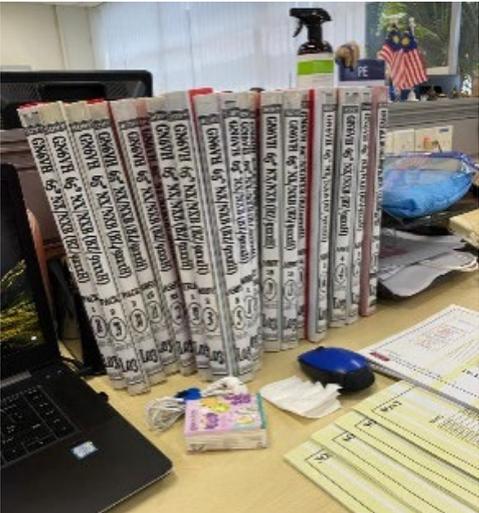
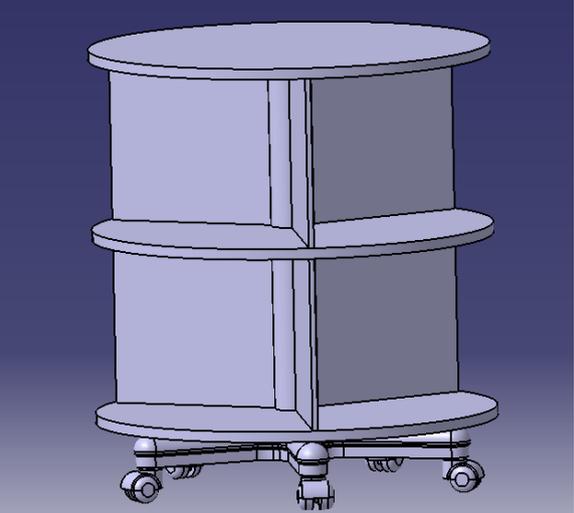
There are improvements were suggested in this study, proposing a design for round-shaped document storage, improving the part rack for the production line, and improving the jig for the source board grounding process at the assembly area.

### 3.1 Design for Round-shaped Files Storage at Production Line

The existing situation is the workers who is responsible in updating and editing the Standard Operating Procedure (SOP) document do not have a proper document files storage. The workers often placed the document file on the table and the files can fall easily since it does not have a good storage for the files. Moreover, there is insufficient space for files for each model of television that can be placed on the table if the files do not have a good storage management.

The suggested idea is by installing a round shaped document files storage that can be rotated. The rotating document files storage can facilitate engineers and technician to find the files that they need. Besides, the document files storage can be easily carried or moved anywhere due to the wheel at the bottom of the storage. Table 2. shows the current situation for document files storage and the suggestion for improvement activity.

**Table 2.** A design for round-shaped document storage at production line

Current Situation	Suggestion/ proposed
	

#### Project Description

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>✗ Files can fall easily.</li> <li>✗ Insufficient space for each model for each section</li> </ul> | <ul style="list-style-type: none"> <li>✓ Install round shape files storage that can fit many files and can be rotated as it is attached with wheel.</li> </ul> |
|--|--|

**Potential impacts:**

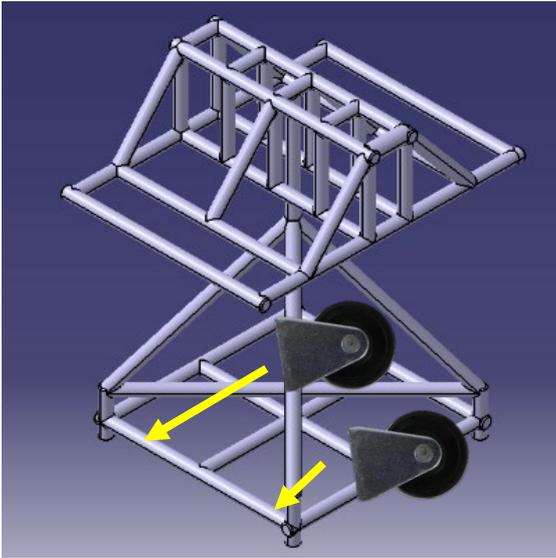
- Files will not fall and slip
- The staff can easily reach the files document within eye zone position

### 3.2 Design on Part Rack for Production Line

The current situation at the production line is it does not have any caster for the rack to be moved or rotate easily. The base of the rack might leave stain on the floor due to friction produced from the rack base and the floor, thus makes the floor look dirty and not cleaned. Besides, the rack or some other taller rack will be hard to move since they have no roller or caster to facilitate the movement between production line. Other than that, current part rack consumes more space if similar part rack has been placed next to each other.

The suggested idea for this issue or problem is by installing small sized plate caster on the side of the base of the rack so the rack can be moved easily to anywhere required. The purposed of mounting the caster on the side is to make sure the rack is not moving while the operator or worker is using the rack. The estimate cost for installing this caster is RM18.36 each. The improved part rack also designed to fit various sizes of assembly part boxes for two stations rather than using many small parts rack. Table 3. shows the current situation at production line and the proposed idea for improvement activity.

**Table 3.** Design on part rack for production line

Current Situation	Suggestion/ proposed
	

**Project Description**

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>✗ The current part rack is hard to move to another place.</li> <li>✗ One-sided part rack</li> <li>✗ Consume more space if another similar part rack is needed at next workstation.</li> <li>✗ Not many sizes of part boxes can fit the part rack</li> </ul> | <ul style="list-style-type: none"> <li>✓ The improved part rack was designed to allow part boxes for different station which is opposite to each other using only one part rack</li> <li>✓ Each part box is angled downward to allow employees to pick up parts in a more comfortable position</li> </ul> <p><b>Cost: RM18.36</b> – 1-1/2 in. Black Soft Rubber and Steel Rigid Plate Caster with 40 lb. Load Rating (Homedepot.com)</p> |
|--|--|

**Potential impacts:**

- Part rack can be carried to another place easily.
- Provide more space for worker to work and assemble part

**3.3 Design Jig for Source Board Grounding Process at Assembly Area**

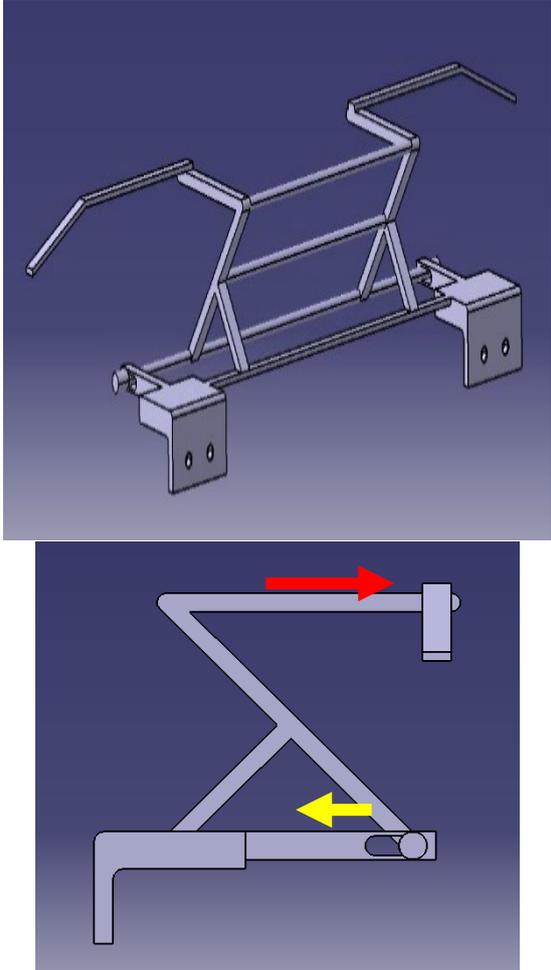
The current situation is the operator need to manually insert the two black block for grounding the source board and manually take them out for TV bezel installation. This process is continued for all sizes of TVs and the process is not efficient and time consuming.

The suggested idea is by installing a jig that using ‘Reverse Motion’ mechanism that can be pulled for TV’s source board grounding and pulled for TV bezel installation and returned to



original position. Table 4. shows the current situation for source board grounding process and the suggestion for improvement activity.

**Table 4.** Design on source board grounding jig at assembly area

Current Situation	Suggestion/ proposed
	
<b>Project Description</b>	
Manual insertion of two black block for grounding source board Extra job element Quality issue	Install a jig for holding the source board during grounding process that can be push and pull using 'Reverse Motion' mechanism.
<b>Potential impacts:</b> Reduce job element during grounding. Reduce quality issue	

#### 4. CONCLUSIONS

As a conclusion, the following are the results of the project completed at TV company: (1) The staff can easily reach the files document within eye zone position and files will not fall and slip if using new design for round-shaped files storage at production line; (2) The part rack can be carried to another place easily and provide more space for worker to work and assemble part if using improvement design on part rack for production line; and (3) Reduce job element during

grounding and reduce quality issue if using new design on source board grounding jig at assembly area

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## **I-CReST 2023:129-088 - Solar System Courseware for Dyslexic Children using Persuasive Technology**

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### **ABSTRACT**

The development of Solar System Courseware for Dyslexic Children is to assist children with reading disabilities. It is to help children who have phonological dyslexia learn how to read and write the names of stars and planets in our solar system. The theory used to develop this courseware applies the Fogg Behaviour model (FBM) persuasive technology. This theory encourages the children to act based on targeted behaviour, hoping to attract their attention during the learning session and allowing teachers to make the courseware one of their teaching materials. In this project, two objectives have been identified: i) to identify the current phonological characteristics of courseware for children with dyslexia and ii) to design and develop the courseware for children with dyslexia to learn about the solar system. The ADDIE model is used to develop this courseware with three factors in FBM: motivation, ability and trigger. This courseware may help children with phonological dyslexia to learn to read and write better and spark their interest in learning about our solar system.

**Keywords:** Dyslexia; courseware; persuasive technology, Fogg Behaviour Model

### **1. INTRODUCTION**

Reading and writing are essential skills that an individual needs to receive and use knowledge. Hence, reading and writing develop early in childhood because they become crucial. However, this is different for individuals who have dyslexia. Dyslexia is a particular learning disability that prompts certain troubles in the younger's learning procedures, especially in reading and writing (Nik Aziz et al., 2020). Dyslexia is not visible until the children enter pre-school, when the signs and symptoms of dyslexia become more visible. Reading and writing became a real struggle for children with dyslexia due to their neurological problems. However, it is essential to note that dyslexia does not affect their intelligence or survival skills. With the right tools, we could help them adapt to the problems.

Dyslexia is a form of learning difficulty, specifically in language, caused by neurological disorders. In addition to the inability to compose or read sentences in the correct order (reading in reverse), other cases of people with dyslexia also compose or read sentences from top to bottom, left and right, and they have difficulty in accepting commands that will be passed on to their memory in the brain. This leads most people to assume that people with dyslexia cannot focus and easily get distracted. (Eka Mariana et al., 2021). According to the Ministry of Health

Malaysia, around 4%-8% of school-going children have dyslexia, and most of the gender of children with dyslexia are boys.

The courseware has become one of the teaching and learning materials in all educational institutions. Educators in all institutions are encouraged to use courseware because it benefits both teachers and students. For instance, multimedia technology can turn a conventional classroom into an endless fictional environment (Faizal Amin Nur Yunus et al., 2020). Multimedia, a form of computer science, refers to the combination of two or more two media. The fact is that multimedia is a unity of media and proper coordination of media instead of a simple combination of a variety of media to show information and enhance people's understanding and memory of information (Guan et al., 2018).

Moreover, the courseware could change the way learning experience for dyslexia children. The content is based on the solar system for kindergarten in 6-year-old syllabus and will use Bahasa Melayu on all the courseware's contents. It consists basic introduction to planets and stars in our solar system and teaches dyslexia students how to read and write the planets and stars' names. The courseware also has a simple exercise for dyslexia students during their learning sessions.

Currently, we are lacking courseware in Bahasa Melayu. Most of the solar system content online uses English to communicate with the users. Although the language can give the students advantages, all students have different abilities to understand the language. This may cause dyslexic children unable to read or write the planets' and stars' names in Bahasa Melayu since most of the online content related to the solar system is in English. Hence, this problem highlights that there are lack of courseware in Bahasa Melayu created for dyslexic children.

Dyslexia students quickly lose interest or attention during classes due to their learning difficulties(Kannagara et al., 2018). This causes them to have difficulties understanding the topic and are unable to stay concentrated, making them feel drowsy or do other work when they learn about reading and writing the planets and stars' names. Thus, there should be courseware for the teachers to use for their teaching session and helps the teachers to gain dyslexia children's attention.

Teachers are faced with limited courseware for dyslexic children. (Nik Nor Azidah et al., 2020). It is found that there is solar system courseware for kids on the website that teachers can use as teaching materials for the children. However, the courseware is not created for teaching children with dyslexia.

This study seeks to develop multimedia courseware for kindergarten children who have dyslexia. The multimedia courseware is expected to help preschool children with dyslexia to read and write the name of our planets and stars. Also, this study identifies ways to attract the interest of dyslexic children in learning the basics of our solar system using our national language, Bahasa Melayu.

## **2. LITERATURE REVIEW**

### **2.1 Dyslexia**

Dyslexia is described as a learning difficulty that affects the ability of literacy and language-related skills. It will likely be present at birth and lifelong in its effects (Alsobhi and Alyoubi,

2020). Around 500,00 children in Malaysia were diagnosed with dyslexia in 2020, and this is expected to upsurge within 2021 (Nor, 2021). Despite conventional instruction, proper motivation, intact sense, normal intelligence, and freedom from a gross neurological deficit, dyslexia is a severe problem in learning to read with normal proficiency (Adubasim and Nganji, 2017).

Every individual with dyslexia experiences different learning difficulties. There are 5 common types of dyslexia that experts have categorised (Philipps, 2022), which are Phonological Dyslexia, Rapid Naming, Double Deficit, Surface, and Visual. Phonological dyslexia refers to children who have difficulties in matching sounds to symbols and breaking down the sounds of language. They struggle to decode or sound out the words. Rapid Naming is described as children struggle with the ability to rapidly name colours, numbers, and letters when presented with them. It also may link dyslexia to both reading speed and the processing speed for reading. They can utter the names of the colour, numbers, and letters. However, it often required them a much longer to turn up with the correct words. Children with double-deficit dyslexia struggle with two aspects of reading. The aspect often included naming speed and identifying the sounds in words. This type of dyslexia combines rapid naming and phonological, commonly found in dyslexic children. Children with surface dyslexia can pronounce new words easily but fail to recognize familiar words by sight may have surfaced dyslexia. In this case, experts believe that the brain fails to recognize what a word looks like to process the word quickly. Children who struggle to remember what they saw on a page may have visual dyslexia. It affects visual processing; thus, the brain doesn't get complete pictures of what the eyes see.

According to Philomena (2022), four main methods can be used for teaching reading to dyslexic children. The method are: 1) Look and say, 2) The phonic 3) The whole sentence, and 4) The 'Alphabetic Multi-sensory'.

In look and say method is an approach that trains the students by showing complete words or even complete phrases. The theory behind this approach is that frequent visual inspection will aid in the child's word memorization and reading.

Whereby the phonic method makes students learn the connection between letter names and sounds using this strategy. To interpret words that they are unfamiliar with, the pupils learn to pronounce each letter in the word.

The whole sentence method is also known as the Language Experience model. This method requires the students to read sentences, and the content of the reading is important. They are encouraged to use the sentence's meaning to help them make sense of or guess the individual work. However, the disadvantage of using this method is that students will be stumped if they meet an unfamiliar word.

The 'Alphabetic Multi-Sensory' method needs the teacher to deliver simultaneously "see, hear, and feel" the letters and sounds. For dyslexic students in particular, the key to mastering this approach of teaching reading is the ability to construct connections between the sound and its symbol.

## 2.2 Multimedia

To develop courseware for dyslexic children, it is important to identify the element in multimedia. Delivering the content to the target user and making them understand it is the most emphasised. The multimedia element that should be emphasized in this courseware is the text element.

Research conducted by Bachmann and Mengheri (2018) suggests using the font called EasyReading. Firstly, students read more easily with EasyReading, as demonstrated by improved reading fluency and accuracy. Secondly, teachers can facilitate reading for normal and dyslexic readers by simply changing fonts when preparing exams and texts for their students. The clinical improvement resulting from EasyReading is so consistent as to overtake the natural reading improvement in a year, thus proving that EasyReading makes reading easier. Another research suggests that Comic Sans MS font and 24-point size are suitable for the dyslexic reader through the experiments where an assessment of the students with learning disabilities on which font these students have shorter reading time and few reading mistakes (Rozita Ismail and Azizah Jaafar, 2018).

Rello and Bigham (2017) suggest warm colours such as peach, orange and yellow to be used for the background to increase the faster reading times and discourage the use of cool colours such as blue grey, blue and green, leading to longer reading times.

## 2.3 Persuasive Technology

Digital technologies have provided a new means of guiding human decisions and assurance to better or completely modify earlier modalities of persuasion. Persuasive technology is an interactive system designed to change and shape users' behaviours toward certain aims. (Fogg, 2003 as cited by Olivieri, 2021). According to the author of Persuasive Technology: Applications in education, Persuasive Technologies plays a role in education as a learning aid instruments. Persuasive Technology can also be found in Social Assistance, Health, Environment, Research and Development and many more (Devincenzi et al, 2018).

Persuasive technology is commonly used to motivate people to learn new knowledge or skills where it can be employed in school or outside of the educational environment. Persuasive Technology can be used on humans to start a given process of learning, tasks, review or to continue a particular activity. (Devincenzi et al, 2018).

Fogg Behavior Model (FBM) is being used for this study. Three factors have been identified and defined that control whether a behaviour is performed. The factors are motivation, ability, and triggers; each has its own subcomponents. The FBM states that for an individual to perform a target idea, one would need to:

1. Be sufficiently motivated
2. Can perform the behaviour
3. Be triggered to perform the behaviour

It must be noted that "persuasion" in the FBM model focuses not on people's attitudes but on their behaviour (Siamak, 2018).

### 3. METHODOLOGY

This courseware uses an Addie model, and the development process will be inferred from it. The model is divided into five major parts consisting of (1) Analyze, (2) Design, (3) Development, (4) Implementation, and (5) Evaluation. There are several advantages to choosing ADDIE model, which is interdependent, synergistic, dynamic, cybernetic, and systematic. Interdependent refers to each component in the model being interrelated.

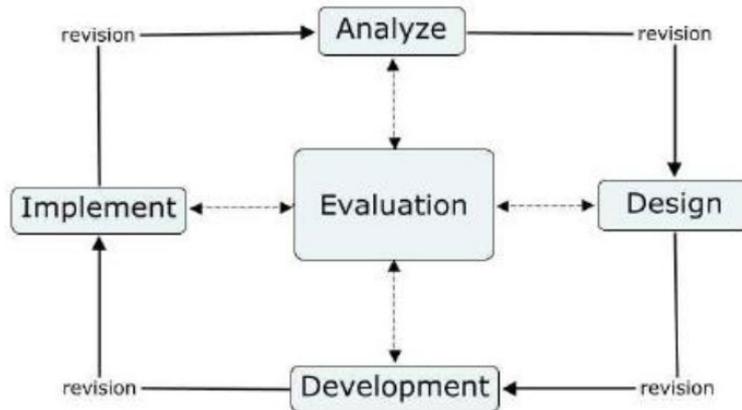


Fig. 1. ADDIE model

The analysis phase is the first phase of the Addie model that eases the beginning of the development of the proposed courseware. This phase will discuss the required content for the proposed courseware, interview questions, software specifications, and hardware specifications.

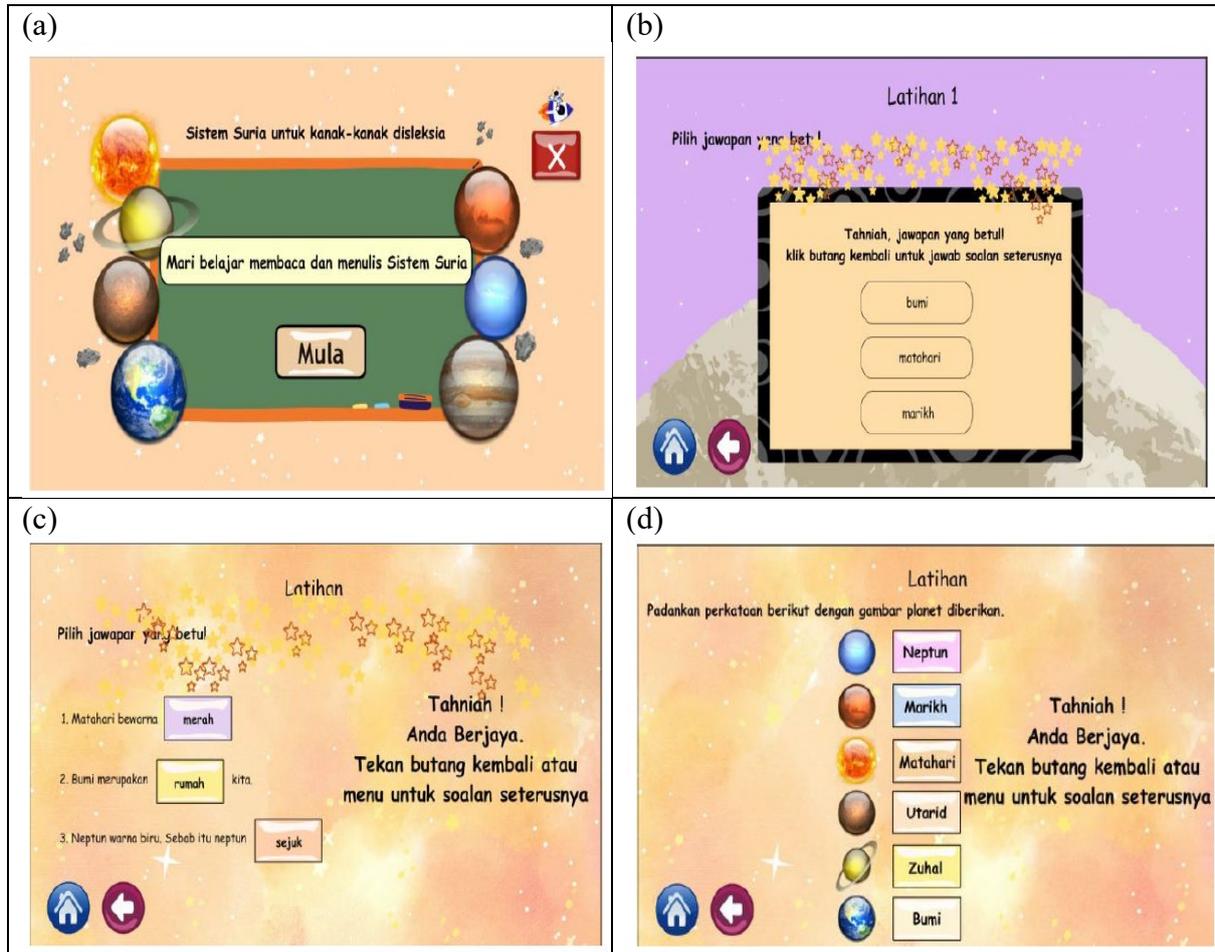
During the design phase, a prototype of a layout from the storyboard and navigation maps for the courseware is combined. A navigation map, storyboard, and interfaces is created in this phase before developing the courseware in the development phase. A navigation map identifies the flow and content, which helps ease the development process. On the other hand, a storyboard allows the developer to visualise the ideas of how it wants the courseware interface to be for the user.

Development is the third phase in the Addie model which the developer will start to develop the proposed courseware using all the information collected from earlier phases. All the multimedia elements such as audio, video, text, animation, and graphics are developed in this phase. Furthermore, the backgrounds and buttons inside the courseware will be developed and linked to the right page and flow. This phase requires the developer to check out the flow, spellings, grammar, or syntax during and after courseware's development to ensure the courseware is working efficiently.

After the development completed, the developer can proceed to the implementation phase. The courseware can be presented to the target user during the implementation phase.

As the final phase in the Addie model, the Evaluation phase is needed to determine whether the courseware is assessed and fully meets its objective. This phase allows users to comment on the courseware's effects on them and see whether improvements need to be made.

#### 4. RESULT



**Fig. 2.** (a) Starting page of the courseware apps (b) Multiple choice question exercise (c) Fill in the blank exercise (d) Matching exercise

Three main components in Fog Behavior Model are motivation, trigger and abilities. Based on Fogg(2009), three elements are under motivation: pleasure/pain, hope/fear and social acceptance/rejection. Meanwhile, the elements under abilities are time, money, physical effort, brain cycle, social deviance, and non-routine. The last component in FBM is trigger, which refers to something that tells people to perform a behaviour now. The factors are spark, facilitator and signal.

As shown in Fig. 2, all components in FBM were applied, such as motivation, abilities and triggers. It is to ensure that this courseware can persuade dyslexic children to learn about the solar system. In (a), the component used is a trigger. The “Mula” button will be a bit larger than its normal size when users hover their mouse to it. It indicates that the user can click the button to proceed to the main menu of the courseware. In order to persuade the user, a text instructions and an animated gif are made to ensure the user understands the next step after they were done their answering task. Also, this courseware used the facilitator as trigger theory, where a text instructs the user what to do. Thus, the icons and answer box will bounce slightly when the user hover to indicate this icon and the answer button is clickable.

The motivation element used in the correct answer interface is pleasure/pain. The result of when user click one of the answers is immediate and requires little anticipation from the user. It will make the user respond to what is happening at the moment. Also, when the user drags the answer object to the wrong answer box, it will go back to its previous place and requires the user to drag it again to the right question.

In order to respond to the question, the user needs to click on the answer button. This help to ease the dyslexic children to have control through one click and reduce frustration. In addition, when the user drags the answer object to the correct answer box, it will drop immediately and cannot be removed again once it is linked to the right answer box. The ability element used is time and brain deviance theory.

## 5. CONCLUSION

Dyslexic children can use this Solar System Courseware, as well as teachers who teach students with dyslexia or special needs, parents of dyslexia children, or any other party interested in using the courseware for teaching and learning purposes. The learning contents are implemented with multimedia elements for teachers to attract the attention of dyslexic children and make learning sessions more fun. In addition, this courseware can be used as teaching material for teachers who teach special needs students, to learn to read and write. Hence, the delivery of content implemented with multimedia elements such as graphics, animations, audio, videos, and text could help the teachers to gain the attention of dyslexia students, and dyslexia students could stay focused during teaching and learning. It also may help students in high school with reading disabilities to learn to read and write the names of stars and planets. Although the courseware development is finished, there are still some limitations, and several recommendations for further enhancement have been provided to allow Solar System Courseware for Dyslexia Children to become better.

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## I-CReST 2023:162-234 - Linear Codes Associated to the Jacobian Factors of Irreducible Curve Singularities

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### ABSTRACT

The linear error-correcting codes associated to higher dimensional projective varieties defined over a finite field have been studied intensively over the past four decades. In the present paper, we introduce a new linear error-correcting code related to the Jacobian factor of an irreducible curve singularity, which is referred to as Jacobian factor code (or JFC code, for short). We give the definition of the CJF for a given irreducible curve singularity as a projective system and study its properties. We also consider some explicit examples and calculate their fundamental parameters.

**Keywords:** Linear code; Jacobian factor; irreducible curve singularities

### 1. INTRODUCTION

The information Theory was established by Claude Elwood Shannon's paper [1] in 1948. A natural way of sending information is a stream of bits: 011100010100100011... Error-correcting codes are ways to send such information along a noisy channel so that the original message can be recovered with a high probability. The main goal of coding theory is to get a great deal of information across a noisy communication channel with short code words and a large distance.

While various types of error-correcting codes were studied, Goppa [2] started to study algebraic Geometry codes (AG codes) in 1981. Thanks to his work, the relation between coding theory and projective geometry was known and people got to study their connection. Many mathematicians (Hirschfeld, van Lint, van der Geer, Tafasman, Vladut, Nogin...) followed the initial study of Goppa for the past forty years. Codes associated to algebraic curves, Grassmannians, and Schubert Varieties are typical examples of AG codes. In this paper, we introduce new linear codes associated to the Jacobian factor of an irreducible curve singularity.

### 2. PRELIMINARIES

In this section, we briefly recall fundamental notions in coding theory and singularity theory required later, such as linear codes, projective systems, irreducible curve singularity, and their Jacobian factors. We also mention known results regarding Grassmannian codes and numerical datum related to curve singularities, semi-group structure on the local ring of the singularity, and its semi-modules.

## 2.1 Linear Codes and Projective Systems

Let  $\mathbb{F}_q$  denote the finite field with  $q$  elements and let  $n, k$  be integers with  $1 \leq k \leq n$ . A *linear*  $[n, k]_q$ -code  $C$  is, by definition, a  $k$ -dimensional subspace of  $\mathbb{F}_q^n$ . Since we only consider linear codes in this paper, we often will drop the adjective “linear”. The parameters  $n$  and  $k$  are referred to as the *length* and the *dimension* of the corresponding code respectively. We also call them *fundamental parameters* of the code.

An  $[n, k]_q$ -code is said to be *nondegenerate* if it is not contained in any coordinate hyperplane. If it is not nondegenerate, it is said to be *degenerate*. Two  $[n, k]_q$ -codes are said to be *equivalent* if one can be obtained from another by permuting coordinates and multiplying them by nonzero elements of  $\mathbb{F}_q$ . This equivalence relation gives a natural equivalence relation on the set of  $[n, k]_q$ -codes.

An alternative way to describe codes is via the language of projective systems introduced in [3]. A *projective*  $[n, k]_q$ -system is a finite unordered set  $X$  of  $n$  points in the projective space  $\mathbb{P}^{k-1}$  over  $\mathbb{F}_q$ . We call  $X$  *nondegenerate* if these  $n$  points are not contained in a hyperplane of  $\mathbb{P}^{k-1}$ . Otherwise, it is called *degenerate*. Two projective systems in  $\mathbb{P}^{k-1}$  are said to be equivalent if there is a projective automorphism of the ambient space  $\mathbb{P}^{k-1}$ . This equivalence relation gives a natural equivalence relation on the set of projective systems of  $n$  points in  $\mathbb{P}^{k-1}$ . It is known that the Grassmannian can be embedded into a suitable projective space by the Plucker embedding (see the subsection 2.3 below). In [3], the following theorem was proved:

**Theorem 1.** There is a natural one-to-one correspondence between the set of equivalence classes of nondegenerate projective  $[n, k]_q$ -systems and the set of equivalence classes of nondegenerate linear  $[n, k]_q$ -codes.

## 2.2 Grassmannian Codes

The Grassmannian  $G_{l,m} = G_l(V)$  of  $l$ -dimensional subspaces of an  $m$ -dimensional vector space  $V$  over  $\mathbb{F}_q$ . It is known that the Grassmannian  $G_{l,m}$  can be embedded into a suitable projective space by the Plucker embedding  $p$  (cf. [4] and [5]. See also the subsection 2.3 below). The image  $p(G_{l,m})$  is nondegenerate as a projective system. Considering the  $\mathbb{F}_q$ -rational points of  $G_{l,m}$  as a projective system, we obtain a  $q$ -ary linear code which is called the *Grassmannian code*. We denote by  $C(l,m)$  the Grassmannian code associated to  $G_{l,m}$ . The Grassmannian code is a typical example of a linear code corresponding to a projective algebraic variety. Grassmannian codes were first studied by Ryan [6-8] in the binary case and by Nogin [9] in the  $q$ -ary case. The length  $n$  and the dimension  $k$  of  $C(l,m)$  are given by

$$n = \binom{m}{l}_q := \frac{(q^m - 1)(q^m - q) \cdots (q^m - q^{l-1})}{(q^l - 1)(q^l - q) \cdots (q^l - q^{l-1})} \text{ and } k = \binom{m}{l}. \quad (1)$$

## 2.3 Jacobian Factors for Irreducible Curve Singularities

In this subsection, we recall the notions of Jacobian factor of a irreducible curve singularity and known results regarding it.



### 2.3.1 Irreducible Curve singularities and Their Jacobian factors

Here we recall the notion of Jacobian factors for curve singularities. [10] is our main reference. Let  $X$  be an irreducible singular curve over  $\mathbb{F}_q$  and  $o$  be its singular point. We refer to the pair  $(X, o)$  as a curve singularity. A *monomial curve singularity* is an irreducible curve singularity whose local ring  $O := O_{X,o}$  at the singularity  $o$  is isomorphic to  $\mathbb{F}_q[[t^{a_1}, \dots, t^{a_m}]]$  for some  $a_1, \dots, a_m \in \mathbb{N}_{>0}$ . Without loss of generality, we may assume that  $\gcd(a_1, \dots, a_m) = 1$ . In this paper, we only consider monomial curve singularities. Let  $O = \mathbb{F}_q[[t^{a_1}, \dots, t^{a_m}]]$  be the local ring of a monomial curve singularity. Its normalization  $\bar{O}$  is isomorphic to  $\mathbb{F}_q[[t]]$ . We call  $\Gamma := \{\text{ord}_t(f) : f \in O\}$  the *semi-group* of  $O$ . The *conductor*  $c$  of  $\Gamma$  is characterized by the following property: if any natural number  $n$  satisfies  $n \geq c$ , then  $n \in \Gamma$ . The positive integer  $\delta := \dim_{\mathbb{F}_q}(\bar{O}/O)$  is called the  $\delta$ -invariant of  $O$  (or  $X$ ). For a non-negative integer  $l$ , define

$$\mathcal{J}_l := \{I : I \text{ is an ideal of } O \text{ with } \dim_{\mathbb{F}_q} O/I = l\}.$$

Let  $G_{\delta,2\delta} = G_{\delta}(\bar{O}/(t^{2\delta}))$  be the Grassmannian which consists of  $\delta$ -dimensional linear subspaces of the  $2\delta$ -dimensional linear space  $\bar{O}/(t^{2\delta})$  over  $\mathbb{F}_q$ . For  $C \in G_{\delta,2\delta}$ , we define a multiplication with scalars by  $O \times C \ni (f, \bar{a}) \rightarrow \overline{f\bar{a}} \in C$ . Here we define the Jacobian factor of a given curve singularity  $(X,o)$  as follows:

**Definition 2** (Jacobian Factor). The set

$$J_X := \{C \in G_{\delta,2\delta} : C \text{ is an } O \text{ submodule with respect to the multiplication}\}$$

is called the *Jacobian factor* of the singularity  $(X,o)$ .

Here we use the Plucker embedding of the Grassmannian into a projective space with a suitable dimension. (cf. [4], [5]). Consider the following indexing set ordered lexicographically:

$$I(\delta, 2\delta) := \{C \in G_{\delta,2\delta} : \alpha = (\alpha_1, \dots, \alpha_\delta) \in \mathbb{Z}^\delta : 1 \leq \alpha_1 \leq \dots \leq \alpha_\delta \leq \delta\}$$

Given any  $\alpha \in I(\delta, 2\delta)$  and a  $\delta \times 2\delta$  matrix  $A = (a_{ij})$ , set

$$p_\alpha(A) := \alpha\text{th minor of the determinant } \det(a_{i\alpha_j})_{1 \leq i, j \leq \delta}.$$

For a formal power series  $f = \sum_{j=0}^{\infty} b_j t^j$  in  $\bar{O}$ , we denote its coset in  $\bar{O}/(t^{2\delta})$  by  $\bar{f} = \sum_{j=0}^{2\delta-1} b_j \tau^j$ . The notation  $\tau$  signifies the coset of  $t$  in  $\bar{O}$ . Define  $\text{ord}_t(\bar{f})$  by  $\text{ord}_t(f)$  (resp.  $\infty$ ) if by  $\text{ord}_t(f) \leq 2\delta - 1$  (resp.  $\text{ord}_t(f) \geq 2\delta$ ). In this paper, we use the notation  $\text{span}[v_1, \dots, v_\delta]_{\mathbb{F}_q}$  for a  $\mathbb{F}_q$ -vector space spanned by  $v_1, \dots, v_\delta$ . Let  $C = \text{span}[\bar{f}_1, \dots, \bar{f}_\delta]_{\mathbb{F}_q}$  be an element of  $J_X$  where by  $\bar{f} = \sum_{j=0}^{2\delta-1} a_{ij} \tau^j$ . We identify  $\bar{f}_i$  with the vector  $\mathbf{a}_i = (a_{i0}, \dots, a_{i2\delta-1})$  in  $\mathbb{F}_q^{2\delta}$ . Let  $A_C$  be the  $\delta \times 2\delta$  matrix whose  $i$ th row is  $\mathbf{a}_i$ . We call it the *representation matrix* of  $C$ . We may assume that  $A_C$  is represented by the reduced row echelon form. Identifying  $C$  with  $A_C$ , the Plucker embedding  $p$  is given by the *Plucker coordinates* as follows:

$$p(C) = (p_\alpha(A_C))_{\alpha \in I(\delta, 2\delta)} \in \mathbb{P}^{\binom{2\delta}{\delta}-1}.$$

We easily see that it depends only on  $C$ . Furthermore,  $p$  is injective (cf. [5] for details).

For any natural number  $l$ , Pfister and Steenbrink [10] defined a map  $\varphi_l: \mathcal{J}_l \rightarrow J_X$  by  $\varphi_l(I) = t^{-l}I/(t^{2\delta})$ .

**Proposition 3** ([10], Theorem 3). The map  $\varphi_l$  is injective for any  $l$ . Furthermore, it is bijective for  $l \geq c$ . The image  $(p \circ \varphi_l)(\mathcal{J}_l)$  is Zariski close in  $p(J_X)$ .

**Definition 4** (punctual Hilbert scheme). Let  $(X, o)$  be an irreducible curve singularity. The set  $\text{Hilb}^l(X, o) := \varphi_l(\mathcal{J}_l)$  is called the punctual Hilbert scheme of degree  $l$  for the singularity  $(X, o)$ .

Below we usually identify an element of  $G_{\delta, 2\delta}$  with its image by Plucker embedding  $p$  since  $p$  is injective. The following fact follows from Proposition 3.

**Corollary 5.** Any punctual Hilbert schemes  $\text{Hilb}^l(X, o)$  with  $l \geq c$  is isomorphic to the Jacobian factor  $J_X$ .

### 2.3.2 $\Gamma$ -Semi-Modules and A Cell Decomposition of Jacobian Factors

In this subsection, we consider a cell decomposition of punctual Hilbert schemes. Let  $O$  and  $\Gamma$  be the local ring of an irreducible curve singularity  $(X, o)$  and its semi-group respectively. A subset  $\Delta$  of  $\mathbb{Z}$  is called a  $\Gamma$ -semi-module if the set  $\Delta + \Gamma$  is contained in  $\Delta$ . Note that if  $\Delta$  is a  $\Gamma$ -semi-module, then a shift  $\Gamma - r$  for any integer  $r$  is also a  $\Gamma$ -semi-module. A  $\Gamma$ -semi-module  $\Delta$  is called  $0$ -normalized if  $\min\{\Delta\} = 0$ . For a  $\Gamma$ -semi-module  $\Delta$ , the  $\Gamma$ -semi-module  $\Delta^{(0)} := \Delta - \min\{\Delta\}$  is called the  $0$ -normalization of  $\Delta$ . We also mention that, for any ideal  $I$  in  $O$ , the order set  $\Gamma(I) := \{\text{ord}_t(f) : f \in I\}$  is a  $\Gamma$ -semi-module (This order set was also used in [11] and it was called ‘‘symbol’’ there). We write  $\Delta = \langle \alpha_1, \dots, \alpha_m \rangle_\Gamma$  for a  $\Gamma$ -semi-module  $\Delta$  which is minimally generated by  $\alpha_1, \dots, \alpha_\delta$ . We also denote by  $\mathcal{J}(\Delta)$  the set of all ideals of  $O$  whose order sets are a  $\Gamma$ -semi-module  $\Delta$ .

**Theorem 6** [12]. For a semi-group  $\Gamma$ , a  $p$ -basis of a  $0$ -normalized  $\Gamma$ -semi-modules  $\Delta$  is a unique  $p$ -tuple  $(a_0 = 0, a_1, \dots, a_{p-1})$  such that

$$\Delta = \bigcup_{i=0}^{p-1} (a_i + p) \text{ and } a_i \equiv iq \pmod{p}.$$

In particular, the set  $\{a_0, a_1, \dots, a_{p-1}\}$  generates  $\Delta$  as a  $\Gamma$ -semi-module.

**Remark 7.** In general, a  $p$ -basis is not a minimal set of generators for  $\Delta$ .

It is known that  $\mathcal{J}_l$  can be decomposed in terms of  $\Gamma$ -semi-modules.

**Proposition 8** [12]. There exists of a finite number of distinct  $\Gamma$ -semi-modules  $\Delta_{l_1}, \dots, \Delta_{l_n}$  such that

$$\mathcal{J}_l = \bigcup_{i=1}^{n_l} \mathcal{J}(\Delta_{li})$$

where  $\mathcal{J}(\Delta_{li}) \cap \mathcal{J}(\Delta_{lj}) = \emptyset$  for  $i \neq j$ . Proposition 8 yields the existence of cell decompositions of punctual Hilbert schemes.

**Corollary 9** [12]. A punctual Hilbert scheme  $\text{Hilb}^l(X, o)$  is decomposed as

$$\text{Hilb}^l(X, o) = \bigcup_{i=1}^{n_l} H(\Delta_{li})$$

where  $H(\Delta_{li}) = p(\mathcal{J}(\Delta_{li}))$ . By Corollary 5, for  $l \geq c$ , a punctual Hilbert scheme  $\text{Hilb}^l(X, o)$  is isomorphic to the Jacobian factor. So we obtain a cell decomposition of Jacobian factor as follows:

$$J_X = \bigcup_{i=1}^{n_c} H(\Delta_{ci}) \quad (2)$$

It is known that the cell decomposition (2) of Jacobian factor becomes an affine cell decomposition in special cases. Piontokowski [13] proved the following theorem:

**Theorem 10** [12]. Let  $(X, o)$  be a curve singularity with  $\Gamma = \langle p, q \rangle$  with  $\gcd\langle p, q \rangle = 1$ . Then the cell decomposition (2) of  $J_X$  is an affine cell decomposition. The dimension of the affine cell  $H(\Delta_{ci})$  is equal to

$$\sum_{i=0}^{p-1} |[a_i, a_i + q] \setminus \Delta^{(0)}|$$

Where  $\{a_0, \dots, a_{p-1}\}$  is the  $p$ -basis of  $\Delta^{(0)}$ .

### 3. JACOBIAN FACTOR CODES

Using the notions introduced in previous section, we give the definition of new error-correcting code, Jacobian codes. We also consider explicit examples based on fundamental singularities of types  $A_4$ ,  $A_6$ ,  $A_8$ ,  $E_6$  and  $E_8$  and compute their fundamental parameters. Finally, we give a general conjecture on the fundamental parameters of the Jacobian factor codes for the  $A_{2d}$ -singularities.

#### 3.1 Definition of Jacobian Factor Codes

Let  $p$  be the Plucker embedding. In general, the image  $p(J_X)$  of the Jacobian factor of  $(X, o)$  by  $p$  is degenerate as a projective system.

**Lemma 11.** If  $p(J_X)$  is degenerate, then  $p(G_{\delta, 2\delta} \setminus J_X)$  is nondegenerate as a projective system.

*Proof.* If  $p(G_{\delta,2\delta} \setminus J_X)$  is degenerate, then there exists a hyperplane  $H$  in  $\mathbb{P}^{\binom{2\delta}{\delta}-1}$  which contains  $p(G_{\delta,2\delta} \setminus J_X)$ . So we obtain the following decomposition of  $p(G_{\delta,2\delta})$ :

$$p(G_{\delta,2\delta}) = \{p(G_{\delta,2\delta}) \cap H\} \cup p(J_X)$$

Here  $p(G_{\delta,2\delta}) \cap H$  and  $p(J_X)$  are Zariski closed. However, this contradicts the irreducibility of the Grassmannian  $G_{\delta,2\delta}$ . Now we come to the following definition:

**Definition 12.** The linear code associated to the projective system  $p(G_{\delta,2\delta} \setminus J_X)$  is called the Jacobian factor code (JFC for short) of a curve singularity  $(X, o)$ .

We denote by  $C_X^{\text{JF}}$  the JFC of a curve singularity  $(X, o)$ . It follows from the definition and (1) that the length  $n$  and dimension  $k$  of  $C_X^{\text{JF}}$  is given by

$$n = |p(G_{\delta,2\delta})| - |p(J_X)| = \frac{(q^{2\delta}-1)(q^{2\delta}-q)\cdots(q^{2\delta}-q^{\delta-1})}{(q^{\delta}-1)(q^{\delta}-q)\cdots(q^{\delta}-q^{\delta-1})} - |p(J_X)| \text{ and } k = \binom{2\delta}{\delta}. \quad (3)$$

These fundamental parameters are determined by the delta invariant  $\delta$  of  $(X, o)$ .

### 3.2 Explicit Examples of Jacobian Factor Codes

In this subsection, we consider Jacobian codes associated to some simple singularities and compute their fundamental parameters.

#### 3.3 The $A_4$ , $A_6$ and $A_8$ -singularities

For the  $A_{2d}$ -singularity  $(X, o)$  (i.e. the curve singularity with the local ring  $O = \mathbb{F}_q[[t^2, t^{2d+1}]]$ ), we have  $\Gamma = \langle 2, 2d+1 \rangle$ ,  $\delta = d$  and  $c = 2d$ . If  $d=1$  (i.e.  $(X, o)$  is the  $A_2$ -singularity), the Jacobian factor is nondegenerate. So we consider following cases:

(Case where  $d=2$ ) If  $d=2$ , then  $\Gamma$ -semi-modules appear in the affine cell decomposition (2) of  $J_X$  are the followings:  $\Delta_{4,1} = \langle 6, 7 \rangle_{\Gamma}$ ,  $\Delta_{4,2} = \langle 5, 8 \rangle_{\Gamma}$ ,  $\Delta_{4,3} = \langle 4 \rangle_{\Gamma}$

By Theorem 10, we can compute the dimension of each affine cell in the affine cell decomposition (2) of  $J_X$ . Moreover, it follows from the dimensions of the affine cells that  $|p(J_X)| = q^2 + q + 1$ . Finally, by (3), the fundamental parameters of JFC for the  $A_4$ -singularity are determined as follows:

$$n = q^2(q^2 + q + 1) \text{ and } k=6.$$

(Case where  $d=3$ ) If  $d=3$ , then  $\Gamma$ -semi-modules appear in the affine cell decomposition (2) of  $J_X$  are the followings:  $\Delta_{6,1} = \langle 9, 10 \rangle_{\Gamma}$ ,  $\Delta_{6,2} = \langle 8, 11 \rangle_{\Gamma}$ ,  $\Delta_{6,3} = \langle 7, 12 \rangle_{\Gamma}$ ,  $\Delta_{6,4} = \langle 6 \rangle_{\Gamma}$

By Theorem 10, we can compute the dimension of each affine cell in the affine cell decomposition (2) of  $J_X$ . Moreover, it follows from the dimensions of the affine cells that  $|p(J_X)| = q^3 + q^2 + q + 1$ . Finally, by (3), the fundamental parameters of JFC for the  $A_6$ -singularity are determined as follows:

$$n = q^2(q^3 + q^2 + q + 1)(q^4 + q^2 + q + 1) \text{ and } k=20.$$

(Case where  $d=4$ ) If  $d=4$ , then  $\Gamma$ -semi-modules appear in the affine cell decomposition (2) of  $J_X$  are the followings:  $\Delta_{8,1} = \langle 12,13 \rangle_\Gamma$ ,  $\Delta_{8,2} = \langle 11,14 \rangle_\Gamma$ ,  $\Delta_{8,3} = \langle 10,115 \rangle_\Gamma$ ,  $\Delta_{8,4} = \langle 9,16 \rangle_\Gamma$ ,  $\Delta_{8,5} = \langle 8 \rangle_\Gamma$

By Theorem 10, we can compute the dimension of each affine cell in the affine cell decomposition (2) of  $J_X$ . Moreover, it follows from the dimensions of the affine cells that  $|p(J_X)| = q^4 + q^3 + q^2 + q + 1$ . Finally, by (3), the fundamental parameters of JFC for the  $A_6$ -singularity are determined as follows:

$$n = q^2(q^4 + q^3 + q^2 + q + 1)(q^{10} + q^8 + q^7 + 2q^6 + q^5 + 2q^4 + 2q^2 + q + 1),$$

$$k=70.$$

### 3.3.1 The $E_6$ -singularity

We consider the  $E_6$ -singularity (i.e. the singularity with the local ring  $\mathbb{F}_q[[t^3, t^4]]$ ). For this singularity, we have the datum  $\Gamma = \langle 3,4 \rangle$ ,  $\delta = 3$  and  $c = 6$ .

In [12],  $\Gamma$ -semi-modules appear in the affine cell decomposition (2) of  $J_X$  are determined as follows:  $\Delta_{6,1} = \langle 9,10,11 \rangle_\Gamma$ ,  $\Delta_{6,2} = \langle 8,10 \rangle_\Gamma$ ,  $\Delta_{6,3} = \langle 8,9 \rangle_\Gamma$ ,  $\Delta_{6,4} = \langle 7,12 \rangle_\Gamma$ ,  $\Delta_{6,5} = \langle 6 \rangle_\Gamma$ . By Theorem 10, we can compute the dimension of each affine cell in the affine cell decomposition (2) of  $J_X$ . Moreover, it follows from the dimensions of the affine cells that  $|p(J_X)| = 1 + q + 2q^2 + q^3$ . Finally, by (3), the fundamental parameters of JFC for the  $E_6$ -singularity are determined as follows:

$$n = q^3(q^6 + q^5 + 2q^4 + 3q^3 + 3q^2 + 3q + 2) \text{ and } k=20.$$

### 3.3.2 The $E_8$ -singularity

We consider the  $E_8$ -singularity  $X$  (i.e. the singularity with the local ring  $\mathcal{O} = \mathbb{F}_q[[t^3, t^5]]$ ). For this singularity, we have the datum  $\Gamma = \langle 3,5 \rangle$ ,  $\delta = 4$  and  $c = 8$ .

In [12],  $\Gamma$ -semi-modules appear in the affine cell decomposition (2) of  $J_X$  are determined as follows:  $\Delta_{8,1} = \langle 12,13,14 \rangle_\Gamma$ ,  $\Delta_{8,2} = \langle 11,13,15 \rangle_\Gamma$ ,  $\Delta_{8,3} = \langle 11,12 \rangle_\Gamma$ ,  $\Delta_{8,4} = \langle 10,14 \rangle_\Gamma$ ,  $\Delta_{8,5} = \langle 10,12 \rangle_\Gamma$ ,  $\Delta_{8,6} = \langle 9,16 \rangle_\Gamma$ ,  $\Delta_{8,7} = \langle 8 \rangle_\Gamma$

By Theorem 10, we can compute the dimension of each affine cell in the affine cell decomposition (2) of  $J_X$ . Moreover, it follows from the dimensions of the affine cells that  $|p(J_X)| = q^4 + 2q^3 + 2q^2 + q + 1$ . Finally, by (3), the fundamental parameters of JFC for the  $E_8$ -singularity are determined as follows:

$$n = q^3(q^{13} + q^{12} + 2q^{11} + 3q^{10} + 5q^9 + 5q^8 + 7q^7$$

$$+ 7q^6 + 8q^5 + 7q^4 + 7q^3 + 5q^2 + 4q + 1),$$

$$k=70.$$

### 3.4 A Conjecture for the Jacobian Factor Code Associated to the $A_{2d}$ -singularity

Through the examples Jacobian factor codes for the curve singularities of types  $A_4$ ,  $A_6$  and  $A_8$  in subsection 3,2,1, we expect the following conjecture holds for the  $A_{2d}$ -singularity:

**Conjecture.** Let  $X$  be the  $A_{2d}$ -singularity (i.e. the singularity with  $O = \mathbb{F}_q[[t^2, t^{2d+1}]]$ ). The length  $n$  of  $C_X^{\text{JF}}$  is given by

$$n = q^2 f(q) \sum_{i=0}^d q^i$$

where  $f(q)$  is a polynomial in  $\mathbb{F}_q[q]$ .

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## I-CReST 2023:166-130 - Diagonally Implicit Class of Block Backward Differentiation Formula with Off-Step Points for Stiff ODEs

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### ABSTRACT

In this paper, a diagonally implicit class of Block Backward Differentiation Formula (BBDF) with two off-step points was formulated for the solution of first order stiff ordinary differential equations (ODEs). The order and stability properties in terms of zero stability and convergence of the method are discussed. The stability analysis shows that the developed method is zero and  $A$ -stable. The numerical results indicate that the proposed method has improved in terms of its accuracy compared to the existing methods of a similar form in the literature.

**Keywords:** Block backward differentiation formula; diagonally implicit; stiff ODEs, stability analysis; off-step point

### 1. INTRODUCTION

In the realm of science and engineering, mathematical modelling plays a pivotal role in understanding complex physical systems. Among the countless mathematical constructs used, stiff initial value problems (IVPs) involving ordinary differential equations (ODEs) emerge as a recurring challenge.

In this context, the present work delves into the exploration and analysis of stiff IVPs to provide valuable insights into the complex physical systems represented by such equations in the form of

$$y'(x) = f(x, y), y(a) = y_0, x \in [a, b]. \quad (1)$$

The concept of stiffness pertains to the behaviour of these systems, wherein certain ODEs exhibit significant disparities in their characteristic time scales, leading to computational difficulties when attempting to simulate them accurately. Implicit methods have demonstrated superior efficiency when dealing with such problems and making their development a key area of interest in the study of stiff ODEs. Various authors have contributed to this field by proposing distinct approaches. Some classical methods focus on computing only one solution in each iteration, as evidenced by works in [1] – [3]. Conversely, other techniques have been designed to simultaneously compute multiple solutions, as considered by [4] – [10].



## 2. DERIVATION OF THE METHOD

In this article, the method in [8] has been extended by adding two off-step points,  $y_{n+\frac{1}{2}}$  and  $y_{n+\frac{3}{2}}$  for a constant step size,  $h$  and have the following form

$$\sum_{j=0}^{k+1} \alpha_{j-1,k} y_{n+j-1} = h\beta_{k,k} \left( f_{n+k} - \rho f_{n+k-\frac{1}{2}} \right), k = \frac{1}{2}, 1, \frac{3}{2}, 2 \quad (2)$$

where  $\alpha_{k,k} = 1$  and  $\beta_{k-1,k} = \rho\beta_{k,k}$  for  $k = \frac{1}{2}, 1, \frac{3}{2}, 2$  that represent the corrector formula for  $y_{n+\frac{1}{2}}, y_{n+1}, y_{n+\frac{3}{2}}$  and  $y_{n+2}$ , respectively. The linear difference operator,  $L$  associated with (2) is defined as follows

$$L[y(x), h] = \sum_{j=0}^{k+1} a_j y \left( x + j \frac{h}{2} \right) - h\beta_j y' \left( x + j \frac{h}{2} \right) = C_q y^q + O(h^{p+1}). \quad (3)$$

To obtain  $y_{n+\frac{1}{2}}, y_{n+1}, y_{n+\frac{3}{2}}$  and  $y_{n+2}$ ,  $k = i = \frac{1}{2}, 1, \frac{3}{2}, 2$  are substituted accordingly in (2). Each point will be indicated by letting  $\alpha_{k,k} = 1$  and considering  $\alpha_{0,1} = 0, \alpha_{0,2} = 0$  for  $y_{n+1}$  and  $y_{n+2}$ , respectively. The Taylor's series expansion of (3) is solved concurrently yield the corresponding formula for  $\rho$ -diagonally implicit block backward differentiation formulas with off-step points ( $\rho$ -DIBBDFO) for  $\rho = \frac{3}{4}$  and takes the following form

$$\begin{aligned} y_{n+\frac{1}{2}} &= -\frac{7}{20} y_{n-1} + \frac{27}{20} y_n + \frac{3}{5} h f_{n+\frac{1}{2}} - \frac{9}{20} h f_n \\ y_{n+1} &= -\frac{7}{33} y_{n-1} + \frac{40}{33} y_{n+\frac{1}{2}} + \frac{8}{11} h f_{n+1} - \frac{6}{11} h f_{n+\frac{1}{2}} \\ y_{n+\frac{3}{2}} &= -\frac{3}{88} y_{n-1} + \frac{13}{22} y_n - \frac{21}{11} y_{n+\frac{1}{2}} + \frac{207}{88} y_{n+1} + \frac{3}{11} h f_{n+\frac{3}{2}} - \frac{9}{44} h f_{n+1} \\ y_{n+2} &= -\frac{1}{86} y_{n-1} + \frac{21}{43} y_{n+\frac{1}{2}} - \frac{153}{86} y_{n+1} + \frac{99}{43} y_{n+\frac{3}{2}} + \frac{12}{43} h f_{n+2} - \frac{9}{43} h f_{n+\frac{3}{2}} \end{aligned} \quad (4)$$

Equation (4) can be written in matrix form as

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ -\frac{40}{33} & 1 & 0 & 0 \\ \frac{21}{11} & -\frac{207}{88} & 1 & 0 \\ -\frac{21}{43} & \frac{153}{86} & -\frac{99}{43} & 1 \end{bmatrix} \begin{bmatrix} y_{n+\frac{1}{2}} \\ y_{n+1} \\ y_{n+\frac{3}{2}} \\ y_{n+2} \end{bmatrix} = \begin{bmatrix} 0 & -\frac{7}{20} & 0 & \frac{27}{20} \\ 0 & -\frac{7}{33} & 0 & 0 \\ 0 & -\frac{3}{88} & 0 & \frac{13}{22} \\ 0 & -\frac{1}{86} & 0 & 0 \end{bmatrix} \begin{bmatrix} y_{n-\frac{3}{2}} \\ y_{n-1} \\ y_{n-\frac{1}{2}} \\ y_n \end{bmatrix} + h \begin{bmatrix} 0 & 0 & 0 & -\frac{9}{20} \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} f_{n-\frac{3}{2}} \\ f_{n-1} \\ f_{n-\frac{1}{2}} \\ f_n \end{bmatrix} + h \begin{bmatrix} \frac{3}{5} & 0 & 0 & 0 \\ -\frac{6}{11} & \frac{8}{11} & 0 & 0 \\ 0 & -\frac{9}{44} & \frac{3}{11} & 0 \\ 0 & 0 & -\frac{9}{43} & \frac{12}{43} \end{bmatrix} \begin{bmatrix} f_{n+\frac{1}{2}} \\ f_{n+1} \\ f_{n+\frac{3}{2}} \\ f_{n+2} \end{bmatrix}. \quad (5)$$

By applying the linear test problem  $H = h\lambda$  into (5) to obtain



$$\begin{bmatrix} 1 - \frac{3H}{5} & 0 & 0 & 0 \\ -\frac{40}{33} + \frac{6H}{11} & 1 - \frac{8H}{11} & 0 & 0 \\ \frac{21}{11} & -\frac{207}{88} + \frac{9H}{44} & 1 - \frac{3H}{11} & 0 \\ -\frac{21}{43} & \frac{153}{86} & -\frac{99}{43} + \frac{9H}{43} & 1 - \frac{12H}{43} \end{bmatrix} \begin{bmatrix} y_{2m+\frac{1}{2}} \\ y_{2m+1} \\ y_{2m+\frac{3}{2}} \\ y_{2m+2} \end{bmatrix} = \begin{bmatrix} 0 & -\frac{7}{20} & 0 & \frac{27}{20} - \frac{9H}{20} \\ 0 & -\frac{7}{33} & 0 & 0 \\ 0 & -\frac{3}{88} & 0 & \frac{13}{22} \\ 0 & -\frac{1}{86} & 0 & 0 \end{bmatrix} \begin{bmatrix} y_{2m-\frac{3}{2}} \\ y_{2m-1} \\ y_{2m-\frac{1}{2}} \\ y_{2m} \end{bmatrix} \quad (6)$$

which is equivalent to  $AY_m = BY_{m-1}$ .

The constant  $C_q$  in (3) is given by

$$C_q = \sum_{j=0}^k \frac{j^q \alpha_j}{q!} - \frac{j^{(q-1)} \beta_j}{(q-1)!}, q = 0, 1, 2, \dots, p + 1. \quad (7)$$

As stated in [11], the difference operator in (3) is deemed to be of order  $p$  if the coefficients  $C_0 = C_1 = \dots = C_p = 0, C_{p+1} \neq 0$ , where  $C_{p+1}$  is identified as the error constant. By plugging the

obtained values for  $a_j$  and  $b_j$  into (3), the result  $C_0 = C_1 = C_2 = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}, C_3 = \begin{bmatrix} -\frac{9}{10} \\ -\frac{50}{33} \\ 0 \\ 0 \end{bmatrix}$  is obtained.

The fact that  $C_3 \neq 0$  confirms that this formula  $\rho$ -DIBBDFO is of order 2.

### 3. STABILITY PROPERTIES OF THE METHOD

This section examines the stability of the proposed method, specifically focusing on its zero and  $A$ -stability, to ensure its appropriateness in solving stiff ODEs. First, we present the definitions of zero and  $A$ -stability as follows:

**Definition 1.** The method is said to be zero stable if there is no root of the first characteristic polynomial having modulus greater than one and if every root with modulus one is simple (see [11]).

**Definition 2.** A numerical method is  $A$  – stable if its region of absolute stability covers the entire of the negative half-plane  $Re(h\lambda) < 0$  (see [12]).

The stability polynomial of the method is determined by evaluating  $|At - B|$  in (6) yields



$$R = \frac{3789}{9460}t^2 - \frac{2187}{208120}H^4t^3 + \frac{864}{26015}t^4H^4 - \frac{404}{215}t^4H + \frac{6477}{5203}t^4H^2 + \frac{47781}{416240}t^3H^3 - \frac{8892}{26015}t^4H^3 - \frac{23373}{52030}t^3H^2 + \frac{312241}{416240}t^3H^2 - \frac{5829}{83248}t^2H + \frac{81}{3784}t^2H^2 - \frac{1053}{416240}t^2H^3 + t^4 - \frac{13249}{9460}t^3. \quad (8)$$

For zero stability, we set  $H = 0$  in (8) to obtain the first characteristic polynomial

$$R = \frac{3789}{9460}t^2 + t^4 - \frac{13249}{9460}t^3 = 0. \quad (9)$$

By solving (9) for  $t$ , gives  $t = 0, 0, 0.4005$  and  $t = 1$ . Since all  $t \leq 1$ , therefore by Definition 1 the method is zero stable.

Next, by setting  $t = e^{i\theta}$  in (9) and solving  $R$  for  $t$ , the boundary of the stability region for  $\rho = 3/4$  are determined. The stability region for  $\theta \in [0, 2\pi]$  where  $|t| < 1$  illustrated in Fig. 1.

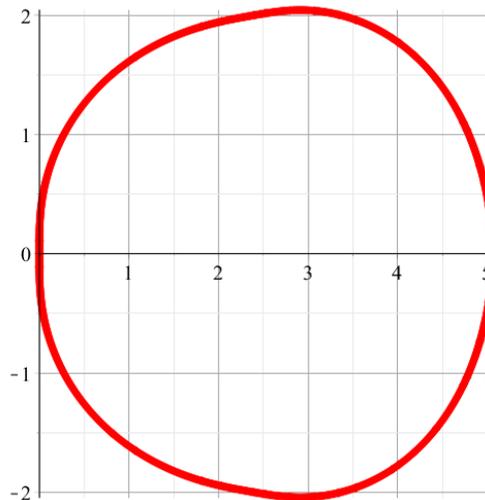


Fig. 1. Stability region for  $\rho$ -DIBBDFO of order 2 for  $\rho = 3/4$

By observing the stability region in Fig. 1 and thus by Definition 2,  $\rho$ -DIBBDFO is said to be  $A$ -stable.

#### 4. NUMERICAL RESULTS

This article conducts an efficiency assessment of the derived method by testing it on four test problems involving first order stiff ODEs provided in [5] as follows:

Test Problem 1:

$$y' = -100(y - x) + 1 \quad y(0) = 1 \quad 0 \leq x \leq 10$$

$$\text{Exact solution: } y(x) = e^{-100x} + x$$

Test Problem 2:

$$y' = -20y + 20 \sin x + \cos x \quad y(0) = 1 \quad 0 \leq x \leq 2$$

$$\text{Exact solution: } y(x) = \sin x + e^{-20x}$$

Test Problem 3:



$$\begin{aligned} y_1' &= -20y_1 - 19y_2 & y_1(0) &= 2 & 0 \leq x \leq 20 \\ y_2' &= -19y_1 - 20y_2 & y_2(0) &= 0 \\ \text{Exact solutions: } y_1(x) &= e^{-39x} + e^{-x}, y_2(x) = e^{-39x} - e^{-x} \end{aligned}$$

Test Problem 4:

$$\begin{aligned} y_1' &= 198y_1 + 199y_2 & y_1(0) &= 1 & 0 \leq x \leq 10 \\ y_2' &= -398y_1 - 399y_2 & y_2(0) &= -1 \\ \text{Exact solutions: } y_1(x) &= e^{-x}, y_2(x) = -e^{-x} \end{aligned}$$

As for the comparison methods, we selected two methods having same order as our derived method. In Tables 1–4, the notations used are described as follows:

H	Step Size
TS	Total Steps
MAXE	Maximum Error
TIME	Execution Times in Microsecond
$\rho$ -DIBBDFO	$\rho$ -Diagonally Implicit Block Backward Differentiation Formula with Off-Step Points ( $\rho = 3/4$ )
$\rho$ -DIBBDF	$\rho$ -Diagonally Implicit Block Backward Differentiation Formula in [8] ( $\rho = 3/4$ )
2OBBDFO	2-point Block Backward Differentiation Formula with two off-step points in [5]

**Table 1.** Numerical results for Test Problem 1

H	METHOD	TS	MAXE	TIME
$10^{-2}$	$\rho$ -DIBBDFO	500	2.62911e-2	4.40113e-5
	$\rho$ -DIBBDF	500	1.83156e-2	6.92059e-5
	2OBBDFO	500	1.95754e-2	2.37103e-3
$10^{-4}$	$\rho$ -DIBBDFO	50000	1.10669e-4	7.32453e-4
	$\rho$ -DIBBDF	50000	3.11091e-4	9.39725e-4
	2OBBDFO	50000	7.16455e-3	7.71449e-2
$10^{-6}$	$\rho$ -DIBBDFO	5000000	1.18120e-8	3.62770e-1
	$\rho$ -DIBBDF	5000000	3.34926e-8	7.21357e-1
	2OBBDFO	5000000	7.35564e-5	9.49209e+0

**Table 2.** Numerical results for Test Problem 2

H	METHOD	TS	MAXE	TIME
$10^{-2}$	$\rho$ -DIBBDFO	100	1.96455e-2	5.25955e-5
	$\rho$ -DIBBDF	100	4.77620e-2	5.65826e-5
	2OBBDFO	100	8.05923e-2	6.33001e-4
$10^{-4}$	$\rho$ -DIBBDFO	10000	4.65613e-6	6.86780e-4
	$\rho$ -DIBBDF	10000	1.31837e-5	8.08135e-4
	2OBBDFO	10000	1.46355e-3	1.90020e-2
$10^{-6}$	$\rho$ -DIBBDFO	1000000	4.72884e-10	1.31618e+0
	$\rho$ -DIBBDF	1000000	1.34084e-9	2.67920e+0
	2OBBDFO	1000000	1.47126e-5	3.43859e+0

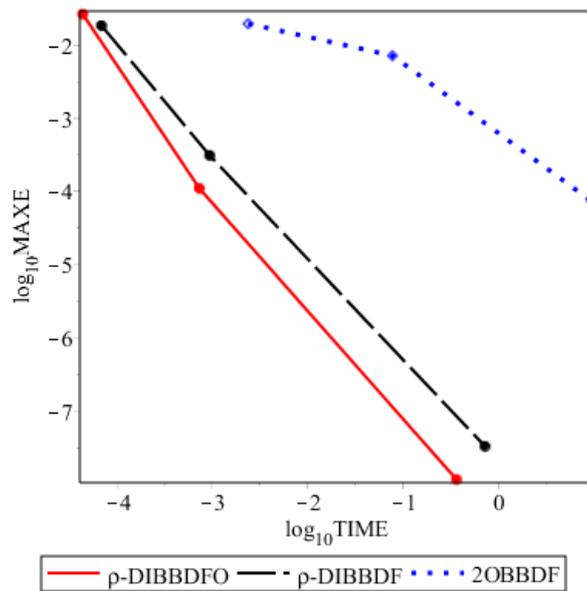
**Table 3.** Numerical results for Test Problem 3

H	METHOD	TS	MAXE	TIME
$10^{-2}$	$\rho$ -DIBBDFO	1000	3.84072e-2	3.98514e-5
	$\rho$ -DIBBDF	1000	8.22397e-2	6.36290e-5
	2OBBDF	1000	7.00088e-2	3.07107e-3
$10^{-4}$	$\rho$ -DIBBDFO	100000	1.74879e-5	2.97760e-3
	$\rho$ -DIBBDF	100000	4.94395e-5	5.45188e-3
	2OBBDF	100000	2.84492e-3	2.92691e-1
$10^{-6}$	$\rho$ -DIBBDFO	1000000	1.79891e-9	8.37102e-1
	$\rho$ -DIBBDF	1000000	5.10082e-9	9.49837e-1
	2OBBDF	1000000	2.87417e-5	5.30707e+1

**Table 4.** Numerical results for Test Problem 4

H	METHOD	TS	MAXE	TIME
$10^{-2}$	$\rho$ -DIBBDFO	500	1.10669e-4	7.56786e-5
	$\rho$ -DIBBDF	500	3.11091e-4	9.05335e-5
	2OBBDF	500	7.17251e-3	3.79395e-3
$10^{-4}$	$\rho$ -DIBBDFO	50000	1.18120e-8	1.66872e-3
	$\rho$ -DIBBDF	50000	3.34926e-8	2.61857e-3
	2OBBDF	50000	7.35564e-5	1.38798e-1
$10^{-6}$	$\rho$ -DIBBDFO	500000	3.49384e-10	1.20935e-1
	$\rho$ -DIBBDF	500000	5.64019e-10	2.18933e-1
	2OBBDF	500000	7.35775e-7	2.63500e+1

Fig. 2–5 depict the correlation between  $\log_{10} \text{MAXE}$  and  $\log_{10} \text{TIME}$ , providing insights into the efficiency of the methods concerning the accuracy of the approximate solution.



**Fig. 2.** Graph of  $\log_{10} \text{MAXE}$  against  $\log_{10} \text{TIME}$  for Test Problem 1

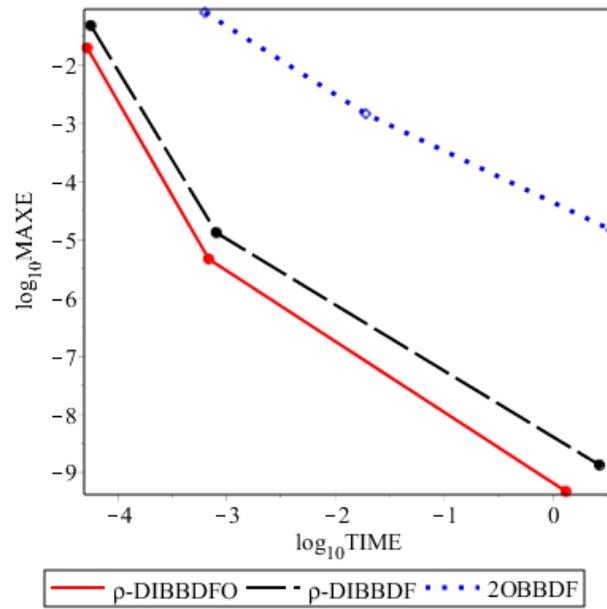


Fig. 3. Graph of  $\log_{10} \text{MAXE}$  against  $\log_{10} \text{TIME}$  for Test Problem 2

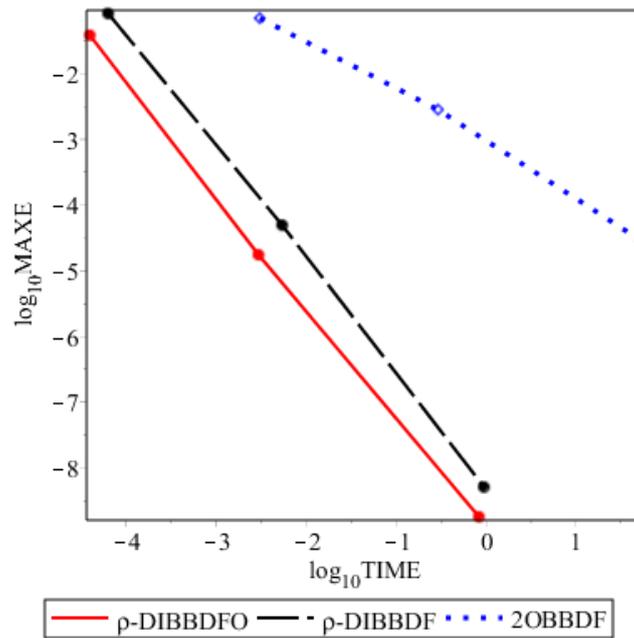


Fig. 4. Graph of  $\log_{10} \text{MAXE}$  against  $\log_{10} \text{TIME}$  for Test Problem 3

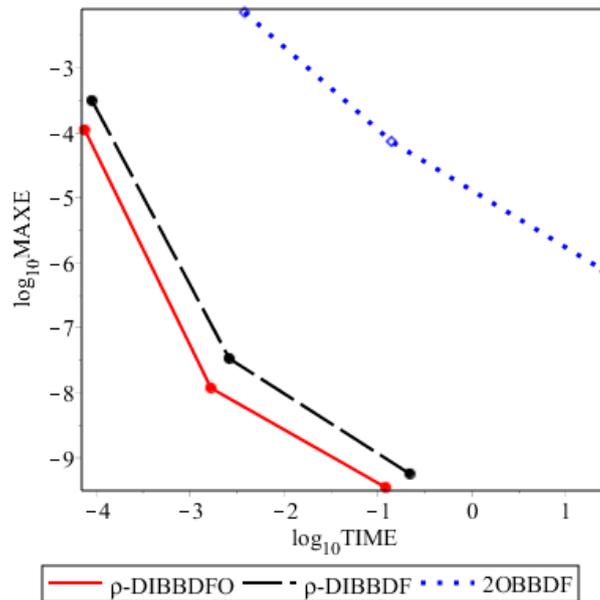


Fig. 5. Graph of  $\log_{10} \text{MAXE}$  against  $\log_{10} \text{TIME}$  for Test Problem 4

As a matter of fact, for a specific abscissa, the most effective values of the ordinates are the lowest among all. This observation is evident from the efficiency curves in Fig. 2–5, where the derived method outperforms both  $\rho$ -DIBBDF and 2OBBDF in terms of consuming less maximum error and computational time.

## 5. CONCLUSION

The analysis of stability properties for  $\rho$ -DIBBDFO reveals its effectiveness in solving stiff ODEs.  $\rho$ -DIBBDFO offers enhanced stability, improved accuracy, and flexibility in handling stiff systems with varying time scales. In all comparison attributes, which are the total steps, execution time and maximum error, the proposed method have proved to be efficient than the comparing methods. Future research may focus on optimizing the placement of off-step points and exploring adaptive strategies to further improve the efficiency and applicability of this method.

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## **I-CReST 2023:184-142 - Improve Working Posture using RULA Method to Reduce Risk of MSDs Among Production Workers**

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### **ABSTRACT**

Working postures, material handling, and repetitive movements are aspects of ergonomics that pose a danger to the health of workers and need to be improved. Poor working postures can lead to musculoskeletal disorders (MSDs), and these injuries can affect the worker's body movements. This work focuses on improving working postures using the Rapid Upper Limb Assessment (RULA) method on the Television (TV) Production line. The work involves analyzing working postures and proposing improvements to reduce the risk of MSDs in the workplace. To achieve the project's objective, information was gathered through observation of television production activities, including assembling parts for the TV back panel, carrying loads, inserting television accessories, and manually masking tape at the inspection area. The data obtained were recorded using the RULA employee assessment worksheet. The RULA scores from the observations were between 5-7, indicating a medium to high risk level. The proposed improvements include providing a stage platform for assembly activities, providing a stair-climbing trolley for carrying loads, providing back support belts for lifting, and installing a one-hand packaging tape dispenser. It is expected that the risk of MSDs among workers at the television production line will be reduced after implementing those countermeasures.

**Keywords:** Ergonomics risk factors; RULA; safety and health, production

### **1. INTRODUCTION**

Ergonomics is the study of fitting tasks to employees rather than attempting to fit the job to the worker. It is concerned with the design of workstations, tools, and work tasks to ensure their safety, efficiency, and comfort [1]. Ergonomics aims to reduce tiredness and injury while boosting comfort, productivity, job satisfaction, and safety, because work-related injuries are not unavoidable and a well-designed job should not cause harm [2]. Awkward postures are those that, when repeated or for an extended period of time, increase the risk of tiredness, pain, or injury [3,4]. Low back pain is a very frequent condition in the United States of America, affecting between 12% to 30% of the population at any given time [5]. Improper back postures, physical effort, especially manual labour involved with handling goods or people are all examples of workplace physical ergonomic exposures involved with this risk [6]. An effective control programme should include a systematic investigation of the work area to detect, classify, and eliminate ergonomic hazards.

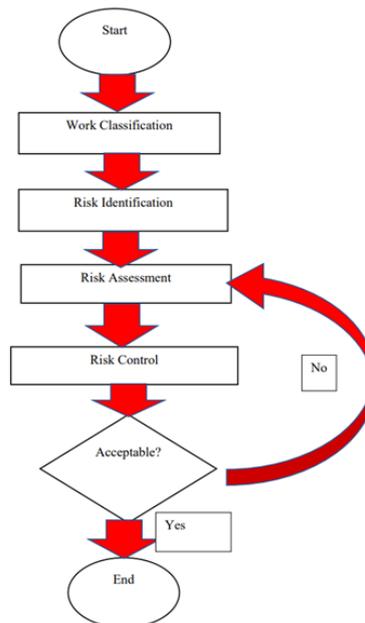
According to Department of Safety and Health Malaysia (DOSH), 5289 cases of Occupational Accident and Disease were reported in 2021 [7]. 201 out of 5289 are related to

Musculoskeletal Disorder (MSD). The manufacturing sector contribute the largest occupational disease with 3383 cases. From the data presented, if the employers are not taking action to improve the working condition and posture, the occupational disease specifically MSD will increase. This will lead to the workers not fit to perform the job and impact on the output and revenue of the company. The company will have to pay for the medical treatment of the workers and training of the new workers.

The aims of this study is to improve the working posture of workers at television (TV) assembly line in order to reduce the risk of MSD. The objective of this work are to determine the current working condition at the TV production assembly line. RULA method will be used to determine the risk level of the existing working condition. Then, proposed improvement will be made to the current system and evaluated using RULA technique. In terms of significance of study, the information obtained from this study can be used to prepare the Standard Operation Procedure (SOP), guideline or Industrial Code of Practice (ICOP) related to ergonomics at the workplace.

## 2. METHODOLOGY

Fig. 1 shows the flow chart of the work. First step is to classify the work. Observation was done to classify the work at the production line of the television. Four types of activities were identified. These activities are: carry heavy load on shoulder while climbing stairs, assemble part for TV back panel, inserting TV accessories at packing area and manual tape masking at the inspection area. The next step was to identify, assess and control the risk. This was done using RULA technique. A countermeasure was suggested for each of the activity to improve the working posture. The new working posture was assessed using RULA method. If the score is lower than the previous working posture, the new technique is accepted.



**Fig. 1.** Flow chart of the research

### 3. RESULTS AND DISCUSSIONS

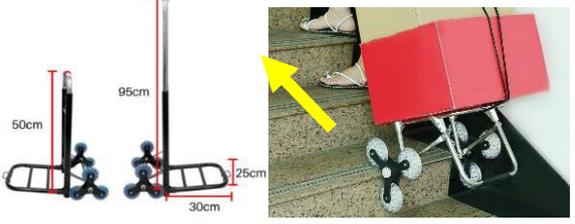
Table 1 shows the results of the current working posture for the work activity stated. The risk level for posture 1 and 3 is medium with RULA score of 5 and 6. Posture 2 and 4 have the highest risk with the RULA score of 7. Improvements are required to improve the working posture and reduce the possibility of MSD among production TV workers.

**Table 1.** RULA results of current working posture

Posture	Work Activity	RULA Score	Risk Level
1	Carry heavy load on shoulder while climbing stairs	5	Medium
2	Assemble part for TV back panel at assembly area	7	High
3	Inserting TV accessories at the packing area	6	Medium
4	Manual tape masking at inspection area	7	High

The work activity of carrying heavy load on shoulder while climbing stairs is shown on Table 2. The worker need to bend the body while carrying the load and walking up the stairs. This is a bad working posture because it can cause back pain. To overcome this problem, stair climbing trolley should be provided. This will reduce the strain and exhaustion on the arms, shoulders, low back and knees caused by bending to carry large item upstairs.

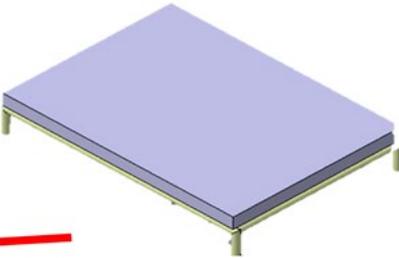
**Table 2.** Carrying heavy load while climbing stairs

Current Practice	Proposed Solution
	

Posture 2 is the assembly part for TV back panel as shown in the Table 3. The worker is doing the job in the standing position. The operator will raise and extend hand to pick the part. This is a bad working posture due to short height and shorthead length that can cause back and hand pain from the hand extension. An anti-slip stage platform was proposed to improve the working condition. The platform can increase the worker's height by 16 cm and allow the employee to work in a neutral and proper posture and minimizing repetitive motion reaching to pick up parts to be assembled on the TV back panel. The suggested platform will reduce the takt time and improve the productivity of the process.



**Table 3.** Assemble part for TV back panel

Current Practice	Proposed Solution
	

Posture 3 is inserting TV accessories at the packing area. As shown in the Table 4, the workers need to bend the body to reach low position of the TV accessories. This can cause back pain from the poor body posture. The employer need to provide Standard Operating Procedure (SOP) on the right technique of performing the job. In addition, the workers have to wear back support and knee pad to reduce the risk of back pain due to improper posture.

**Table 4.** Inserting TV accessories at the packing area

Current Practice	Proposed Solution
	

Table 5 shows the manual tape masking process at the inspection area. The worker need to bend in order to apply the tape to the TV. This can cause back injury and muscle pain. The problem can be overcome by using packaging tape dispenser. It will ease the process and reduce the risk of injury due to poor working posture and improve the productivity by reducing the job element in the process.

**Table 5.** Manual tape masking at the inspection area

Current Practice	Proposed Solution
	 <p>Tape masking from point 1 to 2</p>

Assessment is done to the improved working posture to evaluate the effectiveness. Table 6 shows the RULA results of the improved working posture. The risk level for all of the working posture have improved from medium or high to low risk level. This is a good indicator that the improvements have a positive impact at reducing the risk of MSD among productions workers at the TV production line. The proposed improved working posture also will help to eliminate unnecessary movement that will reduce the production time and increase the productivity.

**Table 6.** RULA results of improved working posture

Posture	Improvements	RULA score	Risk Level
1	Providing a stair-climbing trolley for carrying loads	3	Low
2	Providing a stage platform for assembly activities	1	Low
3	Providing back support belts for lifting	3	Low
4	Installing a one-hand packaging tape dispenser	3	Low

#### 4. CONCLUSIONS

This project aims to improve the working conditions of production workers. It utilizes RULA method to assess the risk level of current working condition and the proposed improvement. In this study, lifting and bending are two activities that has the highest risk that could cause MSD among production workers. Therefore, the employer must take action as suggested to reduce the possibility of injury or occupational disease among the workers. Through communication and education, the proposed improvement can be implemented that will benefit the employee and the company in the long term.

#### ACKNOWLEDGEMENT

The authors would like to thank School of Mechanical Engineering, College of Engineering, Universiti Teknologi MARA for encouraging this research.

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## I-CReST 2023:184-143 - Assessment of Noise Level at Assembly Production Line using Digital Sound Level Meter Smartphone Application

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### ABSTRACT

Noise is one of the issues that could impact the hearing of workers in industries. It is the employer's responsibility to ensure that the noise level is within the limit allowed by the authorities. This paper presents an assessment of the noise generated from television assembly operations. A digital sound level meter smartphone application was used to determine the noise level. The data were compared to the noise exposure limit from The Factories and Machinery (Noise Exposure) Regulations 1989, which states that no employee shall be subjected to sound levels greater than 90 dB (A) or greater than 115 dB (A) at any time. The noise levels were demonstrated visually through noise mapping in relation to the highest and minimum sound levels. The noise tests were performed in three areas: assembly, inspection, and packing. The results show that the noise level is within the DOSH exposure time standard of 90 dB for eight hours a day, therefore the workers are not exposed to excessive noise on the production line.

**Keywords:** Ergonomics risk factors; continuous improvement; safety and health, noise level

### 1. INTRODUCTION

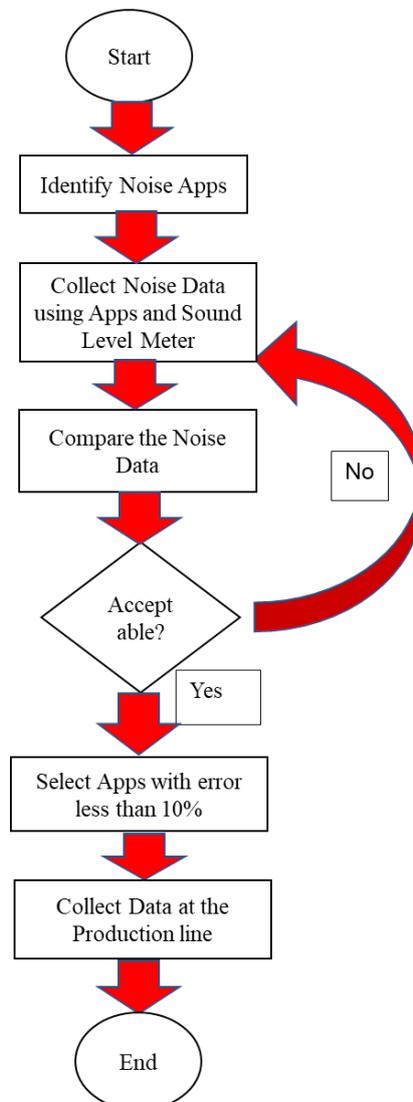
Noise, defined as any unwelcome sound, is the biggest occupational hazard in all industries worldwide. Noise's health consequences can range from auditory impairment to various non-auditory disorders, putting a country's social and economic infrastructure at risk [1,2]. Hazardous industrial noise continues to be a significant issue on a global scale [3]. In 2021, industrial noise-induced hearing disorders were the most frequently reported occupational illness in Malaysia, accounting for 3648 cases (74.5 percent) [4]. In terms of DOSH-administered regulation, complete safety of the workers against the harmful effects of noise at work began with the 1989 Factories act (Noise Exposure) Regulations. This regulation's principal purpose is to avoid workplace noise-induced hearing damage [5]. Employees shall not be subjected to noise levels greater than 90 dB(A) or greater than 115 dB(A) and a peaked level of noise of 140 dB at any time, according to the Malaysia Factories and Machinery Act [6]. Excessive exposure above the allowable limit should be avoided, and a noise risk management plan should be implemented.

This paper aims to assess the noise level at assembly production line using digital sound level meter smartphone application. The availability of digital sound level meter on the smartphone has made the data collection of noise easier. However, validity of the data from the app is questionable. Therefore, a systematic technique is introduced where the data from the app is validated with the data obtained from the sound level meter. If the percentage difference

between the reading of the Apps and sound level meter is less than 10%, it indicates the accuracy reading from the Apps is good. The selected Apps will be used for noise data collection at the Television production company.

## 2. METHODOLOGY

Fig. 1 shows the flow chart of the work. First, the user must identify the digital sound level meter smartphone application. In this project, four digital sound level meter smartphone application Apps were identified. These Apps were tested in the lab to ensure its accuracy of the noise data collected. The data obtained from the Apps were compared with the data obtained from the actual sound level meter (Castle GA6224/6). The Apps that has the smallest value of error was selected to be used for data collection at the production line of TV. Three areas have been identified for noise data collection at the TV manufacturing company: assembly, inspection and packing. The data collected will be analysed to ensure it comply with the regulation from the authority.



**Fig. 1.** Flowchart of the project

### 3. RESULTS AND DISCUSSION

The results of noise data for four Apps are shown in the Table 1. The table also include the data from the actual sound level meter. Three data were recorded that are: Leq (average noise), Lmax (maximum noise) and Lmin (minimum noise). The value of error reading for all of the Apps are also shown in the Table 1. From the results obtained, it is clearly shown that Apps A has the smallest value of error reading. Therefore, Apps A was selected to be used to obtained noise data at the production line of TV.

**Table 1.** Noise data of four Apps

	<b>Leq (dB)(Error(%))</b>	<b>Lmax(dB) (Error(%))</b>	<b>Lmin (db) (Error(%))</b>
Sound level Meter (actual)	72.5	86.5	48.9
Apps A	72.5 (0)	88.2 (3.12)	50.2 (2.66)
Apps B	64 (-11.72)	75.5 (-12.72)	47.3 (-3.27)
Apps C	60.4 (-16.69)	87.2 (0.81)	58.4 (19.43)
Apps D	70.1 (-3.31)	83.6 (-3.35)	46.6 (-4.70)

For this activity, noise tests are performed in the assembly, inspection, and packing areas to determine the sound levels produced by each of the activity. Following the completion of the noise level testing, the results of the maximum and average sound level based on its distance parameter for these three locations are summarized and analyzed in Table 2. It has been determined that the noise levels at the three locations, despite differing distances, do not exceed the DOSH standard of 90dB (A). As a result, the exposure time that the workers were given to execute their jobs at these three locations met the DOSH's exposure time standards of 90dB (A) for 8 hours a day. As a result, the noise mapping for the three separate locations was shown to determine the noise level that was produced in each area based on the readings. Table 3 illustrate the noise mapping for the selected areas.

**Table 2.** Noise level test for three different areas

<b>Location</b>	<b>Area</b>					
	<b>Assembly</b>		<b>Inspection</b>		<b>Packing</b>	
	<b>Lmax (dB)</b>	<b>Leq (dB)</b>	<b>Lmax (dB)</b>	<b>Leq (dB)</b>	<b>Lmax (dB)</b>	<b>Leq (dB)</b>
1	87.1	67.2	68.5	63.6	80.2	70.0
2	87.6	70.2	68.4	63.7	78.4	69.9
3	82.6	71.4	69.9	64.1	78.3	71.3
4	85.2	69.9	67.0	62.0	76.6	72.5
5	84.0	70.8	66.9	62.0	77.4	73.3
6	86.0	71.2	68.8	64.5	78.5	71.0
<b>AVERAGE</b>	<b>85.4</b>	<b>68.5</b>	<b>68.3</b>	<b>63.3</b>	<b>78.2</b>	<b>71.3</b>
<b>RESULT</b>	<b>Acceptable limit: 90 dB (A) for 8 hours per day</b>					
	<b>PASS</b>	<b>PASS</b>	<b>PASS</b>	<b>PASS</b>	<b>PASS</b>	<b>PASS</b>

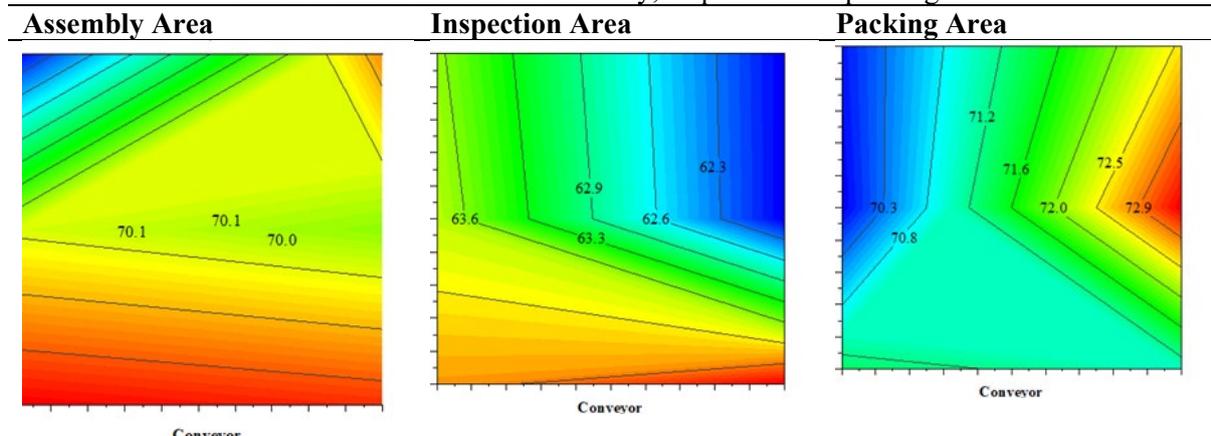
From the noise contour at assembly area, the red area which is around 70.6 to 71.4 dB (A) is closed to the conveyor due to assembly work area and noise coming from robot, machines, and conveyor itself. While the green and blue area at top is location at walking path between production line. To conclude the noise contour for assembly area, the noise test at assembly area is still within limit that DOSH set which is not to exceed 90 dB (A) on 8 hours working.

The highest noise recorded is 87.1 dB (A) which may be due to employees chatting or part rack need to be relocated or had been adjusted.

From the noise contour at inspection area, the red area which is around 64.2 to 64.5 dB (A) is closed to the conveyor due to inspection work and noise coming from the conveyor itself. While the green and blue area at top is location at walking path between production line. Inspection area does not produce much noise as assembly area that have many robots and machines to assemble the TV parts. To conclude the noise contour for inspection area, the noise test at inspection area is still within limit that DOSH set which is not to exceed 90 dB (A) on 8 hours working. The highest noise recorded is 69.9 dB(A) which is still acceptable and within limit.

From the noise contour at packing area, the red area which is around 72.9 to 73.3 dB (A) is closed to the logistic area due to lorry noises and loading carton into lorry for logistic purposes. While the green and blue area at the left side which is around 70.3 to 71.2 dB (A) is the location at last station at packing area for TV to be inserted into carton and shipped worldwide. Although packing area recorded the highest noise which is 71.3 dB (A) but it still acceptable. To conclude the noise contour for packing area, the noise test at packing area is still within limit that DOSH set which is not to exceed 90 dB (A) on 8 hours working. The highest noise recorded is 69.9 dB (A) which is still acceptable and within limit.

**Table 3.** Noise contour at assembly, inspection and packing area



#### 4. CONCLUSIONS

The evaluation of the noise at the TV production line was done successfully using digital sound level meter smart phone application. This technique can be used by the worker to monitor the noise at the production floor without the need of sound level meter equipment. It will speed up the data collection process. Based on the results presented, it can be concluded that the noise level at the TV production area is within the limit that has been set by DOSH. This noise level need to be maintained to avoid occupational disease related to noise related hearing disorder. This can be achieved through continuous monitoring of the noise and educate the workers on the danger of excessive noise to the hearing.

## ACKNOWLEDGEMENT

The authors would like to thank School of Mechanical Engineering, College of Engineering, Universiti Teknologi MARA for encouraging this research.

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## **I-CReST 2023:215-173 - Designing and Developing Web Based System for Managing Charity Coupon at Sultan Mizan Zainal Abidin Polytechnic**

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### **ABSTRACT**

E-charity wallet is a web-based system used at Sultan Mizan Zainal Abidin Polytechnic. The proposed review is meant to distinguish the necessity of an e-charity wallet, foster it on electronic stage and direct testing on the framework. It was used to store information about the charity coupon, like how many were given and who got them. Accessing information about the coupon recipient was difficult prior to the development of the system. During project development, the waterfall model was utilized. This project had three user roles, student (receiver), administrator (hep officer), and cafeteria or canteen. A web-based system is developed using the PHP language, code from Visual Studio, the Apache server, the MYSQL database, and Bootstrap software as the frontend of the web interface. This system has been subjected to white box and user acceptance testing. The outcome indicates that the testing was successful, and that the system works as expected. To be closed the framework assist a ton with making the foundation coupon efficient, prepared, and simple to utilize.

**Keywords:** Charity; coupon; web-based; inventory; system

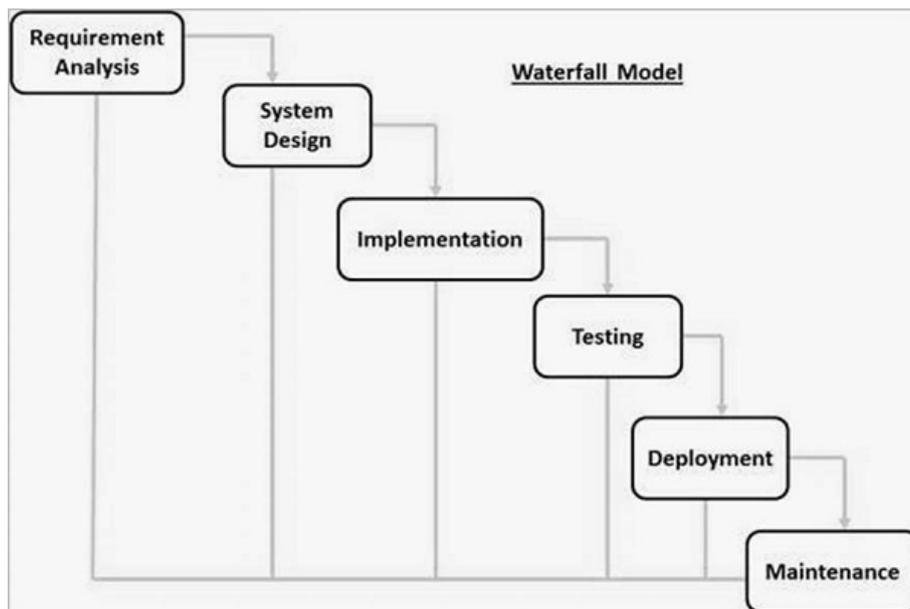
### **1. INTRODUCTION**

In the face of the increasingly rapid and challenging era of digitalization, we cannot run away from the development of technological facilities, they grow like mushrooms after the rain. The evolution of this technology takes place in every aspect of our lives and recently we are also introduced to the use of e-wallets where financial transactions can take place by just using a smartphone. E-wallet is the latest trend and is a fast-growing payment method in Malaysia. Its quick adoption over the years has significantly helped to facilitate electronic commerce in the global business environment, paralleling the internet's rapid global expansion (Fernandes, 2013). According to Roy and Sinha (2014), an electronic payment platform is any system used to accept payments for goods or services ordered online. The use of virtual currency, often known as cashless transactions, has increased significantly during the previous 12 months. Nowadays, practically every industry is adopting the cashless payment trend. With little to no use of actual money, cashless services are emerging as the future of transactional services. Sultan Mizan Zainal Abidin Polytechnic now uses a manual system to handle the polytechnic charity food process. The current system requires multiple paper forms and manual calculations. Therefore, we plan to develop a system to manage all transactions so that it can be transferred to a computer-based system because it can facilitate all users. The e-Charity Wallet project provides a digital coupon system that makes it easy for administrators to store and monitor student purchase data, so students don't need to carry coupon cards to make

purchases. The goal of e-charity wallet is, to provide a simple and easy system for administrators to carry data and students to use.

## 2. METHODOLOGY

The software development process frequently employs a variety of techniques (Mounir, 2018). Methodology refers to the methodological framework employed in a specific field of study or practice. It covers every step of the software development process (Sabbir et al., 2017). The waterfall model is employed in the system development cycle to produce a linear and sequential system. A waterfall is a model that transitions from one step to the next. This model is broken up into different phases, with the output from one step serving as the input for the next. Stages cannot overlap and must be finished before the subsequent stage may start. Because of the scalability and seamless phase transitions of our platform, the waterfall model was chosen as a strategy. The emphasis is on planning, timetables, objectives, budgets, and the concurrent implementation of the entire system. At the conclusion of the majority of phases before moving on to the next, tight control is intended to support project inventory through complete documentation, official investigation, customer approval or closure, and data innovation guidance.



**Fig. 1.** Waterfall model methodology

### 2.1 Requirement Analysis

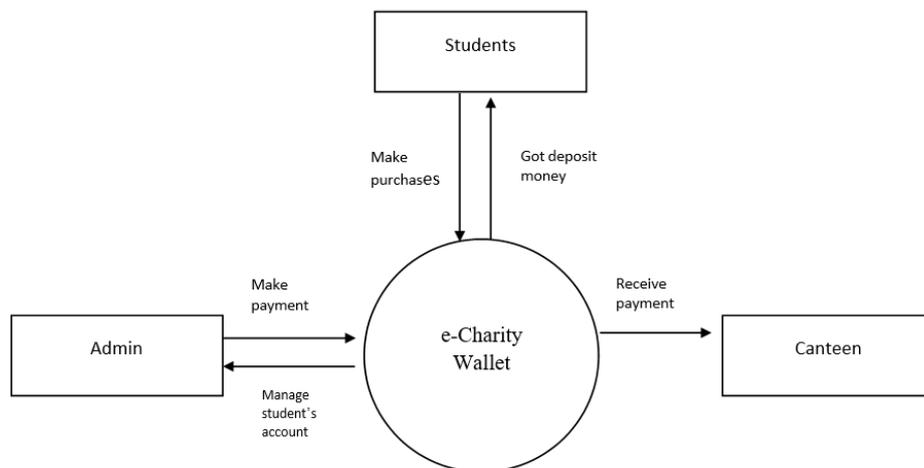
The main purpose of this step is to distinguish between problems or data needs. In this first research phase, the areas of system, limits and development strategies of the new IT systems are defined. An important activity in this phase is evaluating the possibilities. Also, we plan to develop the system using Gantt chart when creating this system. The purpose of the usage study is to determine where the problem lies while attempting to repair the system. This phase consists of dividing the system into different parts to examine what is happening, analyse the project goals, separate what needs to be done and try to engage customers so that clear needs can be identified.

## 2.2 System Design

The purpose of this step is to schedule a new secure frame using the default frame configuration programmed in the UI scheduling cycle for that frame. The required hardware, software, and data resource specifications that meet the requirements can be identified once the requirements have been specified. From system planning to analysis, every decision must be translated into an application. This is to ensure the competence and adequacy of the framework.

### 2.2.1 Logical Design

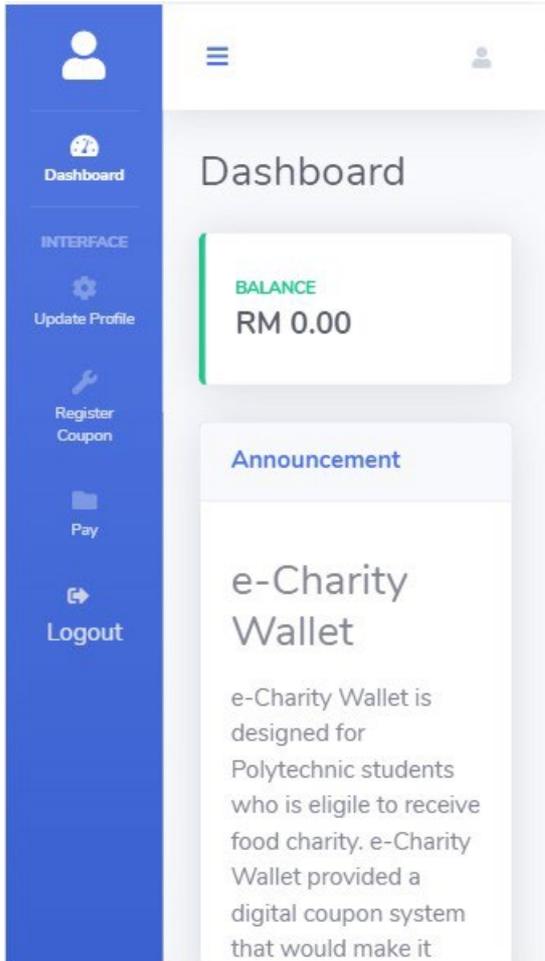
The context diagram of the e-charity wallet is shown in Fig. 2. The metric diagram is level 0 of the information flow overview and shows the overall planning picture. It also characterizes the degree and boundary between the frame and the outer substance. In addition, it shows information flows and information outflows to and from external structures and substances (Dahlan, 2015). In this context there are 3 main classes of clients or substances like doubles, hep employees, and container owners. The double deposit is exchange like customized upgrade, coupon refund and order exchange action. Official entries such as voucher measurement, voucher redemption and voucher requests. Voucher requests come from the owner of the canteen.



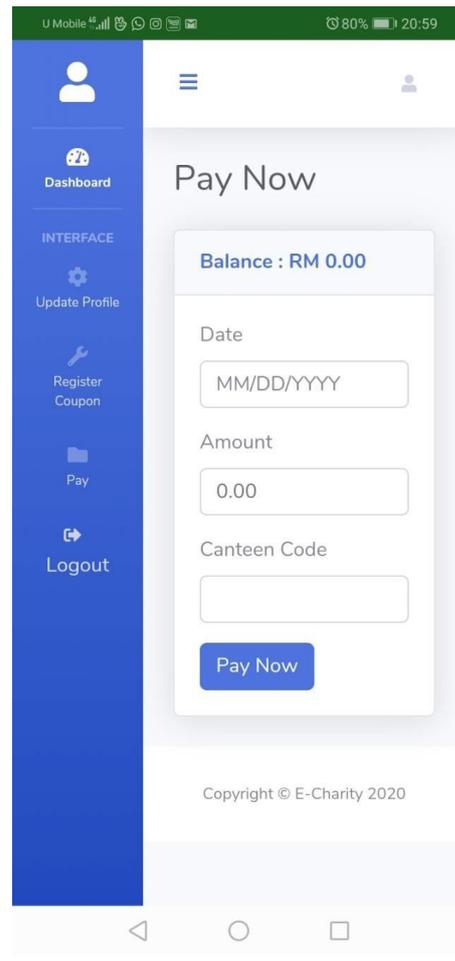
**Fig. 2.** Context diagrams of E-charity wallet

### 2.2.2 Physical Design

The physical architecture of the system affects its real input and output procedures. It focuses on how data is organized, verified, processed, and output shown. By establishing a design specification that precisely outlines how the potential system will operate, it addresses the current system. It deals with setting up the process plan, the information plan, and the user interface configuration. Figs 3 and 4 provide examples of an e-charity wallet's physical construction.



**Fig. 3.** Student main page



**Fig. 4.** Student pay now page

### 2.2.3 Hardware and Software Requirement

The technologies and tools used in this project are listed in Table 1 below.

**Table 1.** System requirement

Item	Function
Google Chrome	Internet browser that used to run application
Visual Studio Code	Code editor to write HTML, JavaScript, CSS, and PHP code
XAMPP	Local web server to test website during development phase
Php Myadmin	Tools to handle administration of My SQL database over web
MySQL	Database service used to store and retrieve data

### 2.3 Implementation

The necessary source code is written in this stage. With the aid of system design, the system is initially developed in units, which are brief programs that are included into the subsequent phase. Each component is developed and tested for functionality.

## 2.4 Testing

Functional and acceptance testing are parts of user acceptance testing, according to Putri (2015). This phase involves evaluating the framework's usefulness and interaction point. Each unit is tested before being added to a system along with all the other units developed during the implementation phase.

## 2.5 Deployment

The system is put to the test in a live environment (client's server) to see how well it performs after the functional and non-functional testing are finished.

## 2.6 Maintenance

There are a few issues in the client environment. To fix these problems, patches are published. To further improve the product, upgraded versions are also released. Maintenance is carried out in order to introduce these updates to the client environment.

## 3. RESULT AND DISCUSSION

Testing was completed following the completion of the product improvement in order to find any potential errors or discrepancies with the project. White box testing (unit testing) is done to determine the accuracy of the programming cycle developed and to certify that each unit of the product code functions as intended. Table 2 displays the findings of the examination of the units used. We can infer from the analysis that the e-charity wallet generally passed the tests.

**Table 2.** Analysis based on unit testing

Number	Features (User)	Pass (%)	Fail (%)
1	Sign Up (Student)	100	
2	Log in (Student)	100	
3	Update Profile (Student)	100	
4	Redeem Coupon (Student)	100	
5	Pay (Student)	100	
6	Payment History (Student)	100	
7	Student Information (Hep officer)	100	
8	Update coupon (Hep officer)	100	
9	Student Purchase Information (Hep officer)	100	
10	Student Balance Account (Hep officer)	100	
11	Canteen Information (Hep officer)	100	
12	Student Information (Hep officer)	100	
13	Generate Report (Hep Officer)	100	
14	Update Canteen (Canteen Owner)	100	
15	Canteen Claim (Canteen owner)	100	

User acceptance testing (UAT), usually referred to as end-user testing, also includes actual users including students using charity coupons, hep officers, and canteen owners. In order to determine if programming can be recognized or not, the practical, framework, and relapse testing are followed by this final test. This testing's main goal is to make sure the software complies with the demands of the industry. A series of questions was distributed following the conclusion of the UAT testing. The analyser evaluated four models, technical, user interface

(UI), data accuracy, and system functionality. Every criterion has five questions. The results of the analysis of the average mean score are shown in Table 3.

**Table 3.** Analysis based on unit acceptance testing

Criteria	Mean Score
Technical	4.39
User Interface	4.33
Data Accuracy	4.54
System functionality	4.60

#### 4. CONCLUSION AND RECOMMENDATION

The principal justification behind the improvement of the e-charity Wallet project is to make it simpler for the Hep official to record and store the information bought by student. The development system can basically store all of the store inventory information in a structured database system. Throughout its development, the system has a number of advantages and disadvantages that can be identified. Throughout the process of implementation, each benefit and drawback will serve as a guide for future system development. The upside of this framework will be investigated so framework designers can track down ways of improving and fulfil the client's requirements. Based on new ideas and improvements, the system's weaknesses will also be fixed to make the proposed system more effective.

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## **I-CReST 2023:218-171 - Controlling, Monitoring and Diagnosis Systems to Improve Gas and Energy Production from Biogas Power Plant**

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### **ABSTRACT**

With demand for green energy power generation, Biogas Power Plant currently is one of the most popular methods for generating energy from waste. To maximise the power generation, the efficiency while processing the waste is very important. To increase efficiency of gas and energy production from Biogas Power Plant, Supervisory Control and Data Acquisition system installed at biogas plant[1]. All data from process instrument are collected through Data Acquisition System and analysed automatically and displayed on large monitor for supervision. Critical parameter will be added with alarm features to make sure the process value is within the most efficient state. At the end of the process, efficiency parameter will be calculated and analysed and displayed for operator action. All pump and motor are supported to controlled remotely from SCADA workstation, operator does not need to waste time to reach the Motor Control Circuit Panel (MCC) for start and stop the equipment. All the process, calculation and analysis are on real time based so operator can do action immediately. Data processes are recorded on database for future analysis and support for storage data for more than 5 years. Experience shows that improvisation on process can be done easily by referring and analysis the recorded data.

**Keywords:** Programmable Logic Controller (PLC); SCADA; efficiency; automation; biogas plant

### **1. INTRODUCTION**

Conventional biogas power plant is controlled by plant operator where they must run the process by following the schedule and instruction from supervisor. As we know, when fully human based operated, some error will occur [2]. It can happen when operator a bit late from scheduled or over limit on some process. For example, the ideal palm oil mill effluent temperature to feed in the reactor are set to 28 to 35 degrees Celsius [3]. If the operator feed in while the effluent in high temperature, it will disturb the digestion process inside the reactor. Process measurement is one of the most important tasks in the whole control system [4]. To archive best result, we must integrate a closed loop system where the system able to supervise, control and collect data for analysis. The closed loop system are consist of supervision, control and data acquisition [5][6].

### **2. METHODOLOGY**

#### **2.1 Data Collection**

This paper use pre and post test result to significantly differentiate the improvement value between fully human based operated compared to system integration [7]. Data are collected

one month before implementation of controlling and monitoring system to the biogas scrubber section. The data recorded continuously after the implementation of the system to analysis the improvement.

In biogas scrubber section, gas production is recorded hourly by operator. Contamination on the gas produced are include H<sub>2</sub>S, CO<sub>2</sub>, Methane and Oxygen. Every hour, operator must adjust the air injection valve to maintain the value of gas contamination. From the data recorded, gas contamination is fluctuating and hard to maintain, where resulting the low-quality gas where the value of methane gas (CH<sub>4</sub>) is low.

Integration of the system resulting the improvement of the methane gas value. Value of CH<sub>4</sub> gas can be maintained and less fluctuate. System integrated are efficiently controlled the air injection into the scrubber to control the quality of gas production.

## 2.2 System Integration

SCADA systems are integrated on existing biogas power plant. The combination of Programmable Logic Controller, field instrument such as gas analyser, temperature sensor and flowmeter are constructed and installed at biogas scrubber section.

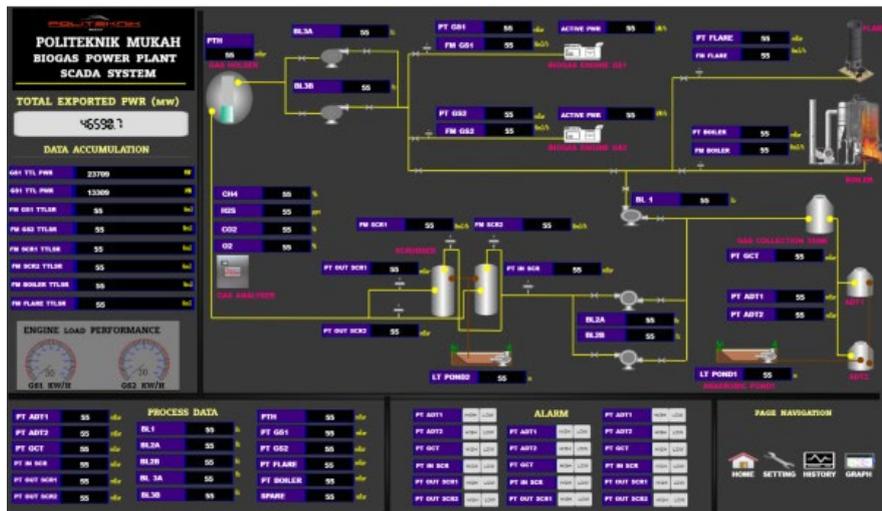


Fig. 1. SCADA system installed at biogas power plant

## 3. RESULT & DISCUSSION

Recorded data the transformed into graph. Duration of the data recorded are chopped into 14 days pre-installed system and 14 days after installation. The efficiency of gas and energy production increased. Any uncommon process data will be notified immediately through alarm section. Post-mortem on process can be done easily through plotting recorded real time data on the system.

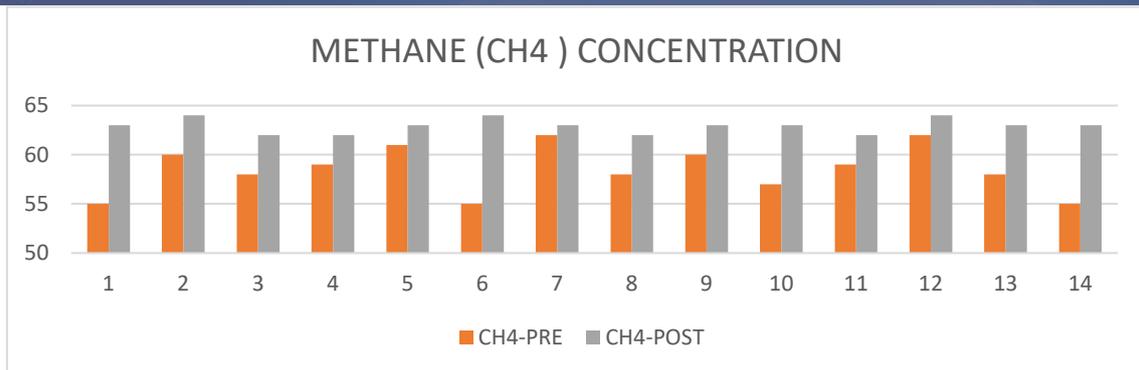


Fig. 2. Methane concentration on gas production

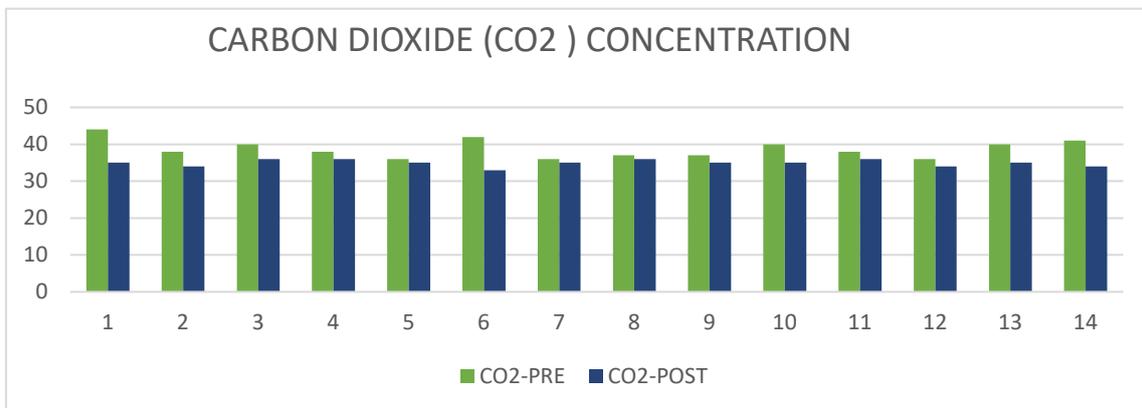


Fig. 3. CO<sub>2</sub> concentration on gas production

From the result above, data shown that CH<sub>4</sub> concentration are highly produced on every day's comparison. Value of CO<sub>2</sub> also decreased and maintained below 40%. In biogas plant gas production, methane is the most important gas concentration. Methane can be use for flaring system and for the biogas engine generator.

#### 4. CONCLUSION

As a conclusion, the improvement of gas production after implementation of controlling, monitoring and diagnosis system in biogas power plant was proven. Methane gas production can be maintained on average 60% from total gas concentration where resulting the high quality of gas produced. The gas quality is very important in biogas power plant. Lower quality of gas can cause the gas engine generator unable to run perfectly.

When concentration of H<sub>2</sub>S is high, it can cause the gas engine lifetime degradation. H<sub>2</sub>S is the gas that can harm the iron inside the gas engine generator. Carbon dioxide also need to be monitor and controlled. Higher concentration on carbon dioxide can cause inflammation and gas engine and flare unable to burn the methane. This project able to increase gas and energy production by controlling and analyse the process instrument and process data. This project can be implemented on various plant process such as Biomass Power Plant and Solar Power Plant

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## I-CReST 2023:222-182 - Moneyness Analysis of Hybrid Pricing Formula for Equity Warrants

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### ABSTRACT

A financial contract which gives the right, but not the responsibility to purchase or sell securities at a specific price before its expiration is known as warrants. Moneyness is one of the analyses conducted on warrants to discover their individual profitable status. Since the moneyness factor has been evaluated in the literature in a variety of ways, this paper investigates the moneyness of hybrid pricing formula for equity warrants under the Heston-CIR model using several moneyness definitions. The analysis performed on 32 equity warrants in Bursa Malaysia for year 2019 reveals that 93.75% of the warrants using the definition of the stock price divided by the strike price of warrants hold in-the-money status. Similar moneyness status is exhibited by all warrants when moneyness is calculated using the difference between the current stock price and the present value of the warrants' strike price divided by the warrants' present value. These findings verify the in-the-money status obtained from the original moneyness factor calculation using the comparison of the strike price and stock price of warrants, besides supporting the notion that the hybrid pricing formula provides warrant investors with profitable returns.

**Keywords:** Equity warrants; moneyness; stochastic interest rates; stochastic volatility, Heston-CIR model

### 1. INTRODUCTION

A warrant enables the holder to acquire a share at a specific cost given a specific timeline. Theoretically, call options and stock warrants are very similar because both derivatives ask for the holder to buy the assets at a specific price before they expire. Following is a general formula for equity warrants:

$$W(t) = 1/(N + Mk) [(kV(t) - NG)]^+ \quad (1)$$

where  $W$  is the warrant price for a company backed by  $N$  common stocks,  $M$  is the total number of outstanding equity warrants, and  $S$  is the asset's current value. The warrant holder will receive  $k$  shares at time  $T$  for each warrant when the payment of  $G$  is released.

Moneyness is one of the analyses conducted on warrants to discover their individual profitable status. The warrant may be in-the-money (ITM), in which case the investors profit; at-the-money (ATM), in which case the investors break-even; or out-of-the-money (OTM), in which case the warrant expires worthless. Since the moneyness factor has been evaluated in the literature in a variety of ways, this paper investigates the moneyness of hybrid pricing formula for equity warrants under the Heston-CIR model using several moneyness definitions. Specifically, we extend the work of [1] which involved Cauchy problem and heat equations using Heston-CIR hybrid model to derive the characteristic function of hybrid equity warrants. In [1], the moneyness factor calculation was performed using the comparison of the strike price and stock price of warrants. Our aim is to investigate the moneyness element of the same hybrid pricing formula using several moneyness definitions by [2] and [3], and further compare it with the original findings. Consequently, we aim to verify the status obtained from the original moneyness factor calculation, besides fulfilling the gaps in the literature in terms of moneyness analysis of hybrid pricing formula for equity warrants.

## 2. LITERATURE REVIEW

Moneyness is one of important items to be analysed as indicator for determination of warrant/option is profitable or vice versa. In the literature, a lot of researchers studied about it and a review is given in this section as follows.

[4] studied about delta-hedged call option and discovered a positive relation between delta-hedged call option returns and options moneyness, where delta-hedged call returns are negative and low moneyness OTM options have more negative returns. Meanwhile [5] analysed about impact on option moneyness status OTM, ATM and ITM, after controlling for other considerations of options trading, such as trade volume, market liquidity, and intraday time periods. The negative and significant coefficients on Moneyness indicate that the information content of trade duration is greater for the OTM options than for the ITM options, which is consistent with the finding of fast trading means informed trading in the OTM options and noisy trading in the ITM options.

Additionally, [2] investigated the impact of several variables such as moneyness on the warrant mispricing for four companies listed in Bursa Malaysia. They applied Black-Scholes Option Pricing Model (BSOPM) to determine the mispricing of warrant. From their analysis; moneyness, maturity, and volatility positively and significantly described the mispricing of warrant, while stock return does not give an impact towards warrant mispricing. The BSOPM consistently mispriced the warrants either ITM or OTM warrants. A further extension was made by [6] highlighted the moneyness in their investigation about the accuracy of the Black-Scholes (BS) model and the dilution-adjusted Black-Scholes (DABS) model to pricing some warrants traded in the Malaysian market.

In contradiction, [3] discussed about two possibilities of considering the moneyness categories and different time to maturities in testing the effectiveness of the most popular options pricing models, namely the Monte Carlo simulation method, the Binomial model, and the Black-Scholes model. They analysed those models on the European call options data under the Nifty50 index during the period of 25/07/2014 to 30/06/2016, with 463 contracts. They found all models overpriced in all Moneyness categories with a high level of volatility in ITM category. Second finding is that the Monte Carlo Simulation method is outperforming when

the volatility is lower, while the Black-Sholes model and the Binomial model are outperforming in the entire sample by ignoring moneyness.

[7] tested some binomial model on S&P500 Index option and carried out comparisons for many different business environments, including moneyness levels traded. They set up three Moneyness levels and analysed 4,017 different options based on moneyness level traded for 21 days. The outcomes are 1,065 options (27%) were OTM, 2,379 options (59%) were ATM, and 573 options (14%) were ITM. This result implies most investors in the market want to hedge themselves in ranges close to the current market price. They also found a connection of moneyness to Ask and Bid prices, where the lower the moneyness and the shorter the time to exercise, the greater the percentage difference between the Ask and Bid prices. One of their conclusions related to moneyness is neither the market trend nor the level of moneyness has a significant effect on the average tradability levels.

In the same year, [8] examined the link between option and equity markets by considering the informational content of the option trading volume with respect to moneyness and maturity when the trade direction is unobserved. In his study, the call option and put options contracts were classified into five moneyness ranges. The author used option data of all U.S.-listed equity call and put options and consists of end-of-day bid and ask quotes for each strike and expiration, implied volatility and option Greeks, and trading volume for sample period of January 1996 to December 2019. One of his findings is the publicly available and nondirectional option trading volume, of all maturity terms, DITM put options, and DOTM call options, significantly and negatively predicts cross-sectional stock returns.

In other perspective, [9] studied the effect of an asset's volatility on the expected returns of European options on the asset with 2 volatility types- systematic and idiosyncratic volatility. One of their outcomes, for example under calls, systematic volatility positively prices ITM and ATM but negatively sufficiently OTM calls. Conversely, idiosyncratic volatility unambiguously negatively prices call, with its effect however decreasing with moneyness.

### 3. METHODOLOGY

#### 3.1 The Model

The Heston-CIR model considered in this paper is adopted from [1] as follows

$$\begin{aligned}
 dS(t) &= rt)S(t)dt + \sqrt{v(t)}S(t)d\tilde{w}_1(t), \\
 dv(t) &= k^*(\theta^* - v(t))dt + \sigma\sqrt{v(t)}d\tilde{w}_2(t), \\
 dr(t) &= \alpha^*(\beta^* - r(t))dt + \eta\sqrt{r(t)}d\tilde{w}_3(t)
 \end{aligned} \tag{2}$$

The underlying price, volatility, and interest rate are denoted by the letters  $S(t)$ ,  $v(t)$  and  $r(t)$ , respectively. The asset's price,  $S(t)$  is determined by the drift  $r$ . Its volatility is represented by  $v(t)$ , while the mean-reversion process is represented by  $k^*$ . The long-term mean is represented by  $\theta^*$ , which  $\alpha^*$  also defines its mean-reversion speed and  $\sigma$  as its volatility. The interest rate volatility  $\eta$  is tracked by the symbol  $\beta^*$ , which reflects the interest rate's long-term mean. For this model, the correlation imposed are  $(d\tilde{w}_1(t), d\tilde{w}_2(t)) = \rho dt$ ,  $(d\tilde{w}_1(t), d\tilde{w}_3(t)) = 0$ , and  $(d\tilde{w}_2(t), d\tilde{w}_3(t)) = 0$ , with  $-1 < \rho < 1$  and  $0 \leq t \leq T$ . Note that  $2k^*\theta^* \geq \sigma^2$  and  $2\alpha^*\beta^* \geq \eta^2$  retain the constant positivity of the square roots.



### 3.2 Equity Warrants Hybrid Pricing Formula

Here, we present the equity warrants hybrid pricing formula from [1]. Let  $W(t)$  be the appraisal of the equity warrant. The appraisal of the equity warrant at time  $t \in [0, T]$  is

$$W(t)(S(t), T, t, G, \sigma, r, v, k, N, M) = \frac{1}{N+Mk} [kS(t)\phi(d_1) - NGe^{-r(T-t)}\phi(d_2)], \quad (3)$$

$$d_1 = \frac{\ln \frac{kS}{NG} - \ln P(r, t, T) + \frac{1}{2}L(T-t) + \frac{1}{2}Q}{\sqrt{L(T-t) + Q}},$$

$$Q = \eta^2 r \int_t^T \left( \frac{\sqrt{L(T-t) + Q}}{2((\alpha^*)^2 + 2\eta^2) + (e^R - 1)(C)} \right) ds,$$

$$R = (T-s)\sqrt{(\alpha^*)^2 + 2\eta^2},$$

$$C = \left( \alpha^* \sqrt{(\alpha^*)^2 + 2\eta^2} + (\alpha^*)^2 + 3\eta^2 + (e^R)((\alpha^*)^2 + \alpha^* \sqrt{(\alpha^*)^2 + 2\eta^2} + \eta^2) \right),$$

$$d_2 = d_1 - \sqrt{L(T-t) + \eta^2 r \int_t^T B^2(s, T) ds}, \text{ and } \Phi(\cdot) \text{ represents the cumulative Gaussian distribution function.}$$

### 3.3 Moneyness Evaluation

In this section, the moneyness element of the hybrid pricing formula in (3) is analysed using several moneyness definitions by [1], [2], and [3]. The analysis was performed on 32 equity warrants in Bursa Malaysia for year 2019, based on the following moneyness definitions.

#### 3.3.1 Roslan et al. (2021)

[1] determined moneyness by directly comparing the strike price,  $K$  against  $S(t)$  the stock price of warrants. For the final status of the warrants, the authors categorized warrants having the status of ATM if its strike price is equal to the stock price of the underlying asset, ITM if its strike price below the stock price, and OTM if its strike price is above the stock price. Based on their findings, 3.125% of the warrants for year 2019 are OTM and 96.875% of them are ITM.

#### 3.3.2 Sakti and Qoyum (2017)

According to [2], moneyness is first calculated as below

$$\text{Moneyness} = \frac{\text{Stock price} - \text{Exercise Price}^{-rT}}{\text{Exercise Price}^{-rT}} \quad (4)$$

followed by the scale for moneyness for determining the warrants' status as presented in Table 1.

**Table 1.** Moneyness scale

Moneyness, $M$	Status
$M < -0.5$	Deep OTM
$-0.5 < M < -0.05$	OTM
$-0.5 < M < 0.05$	ATM
$0.05 < M < 0.5$	ITM
$0.5 < M$	Deep ITM

### 3.3.3 Bendob and Bentouir (2019)

In the similar vein of [1], [3] also chose to compare the strike price,  $K$  against  $S(t)$  the stock price of warrants, but using the division operation

$$\text{Moneyness, } M = S(t) / K \quad (5)$$

Following this, moneyness is evaluated based on the range between the following intervals respectively.

$$1.2 \leq M < 1.9 \text{ ITM,}$$

$$0.9 \leq M < 1.2 \text{ ATM and}$$

$$0.8 \leq M < 0.9 \text{ OTM.}$$

## 4. RESULTS AND DISCUSSION

The results of the moneyness analysis performed on the hybrid pricing formula in (3) will be presented in this section. **Table 2** and **Table 3** display the moneyness status obtained based on the analysis performed using the definitions of [2] and [3] respectively.

According to the findings, all warrants exhibited the ITM status when evaluated under [2]'s moneyness definition, whereas 93.75% of the warrants using the definition of [3] hold the ITM status. These findings were in agreement with the result obtained in [1] where 96.875% of the warrants hold the ITM status. Additionally, this finding supports the notion that hybrid pricing formula in (3) of [1] provides warrant investors with profitable returns, since all three moneyness analysis produce more than 93% of ITM status for the warrants.

**Table 2.** Moneyness analysis based on Sakti and Qoyum (2017)

Warrants	Stock price, $S(t)$	Strike price, $G$	Moneyness value	Moneyness status
APPASIA-WA	0.0847	0.0880	1.6163	ITM
AZRB-WA	0.3052	0.1850	3.4844	ITM
BIMB-WA	4.1956	0.2280	49.0212	ITM
BTM-WB	0.1250	0.1180	1.8795	ITM
DIGISTA-WB	0.0371	0.0180	4.6027	ITM
DNONCE-WA	0.2533	0.1430	3.8150	ITM
DOMINAN-WA	1.2082	0.0350	92.8351	ITM
DPS-WB	0.0571	0.0380	3.0846	ITM
ECOWLD-WA	0.6694	0.2380	6.6455	ITM
EG-WC	0.3351	0.0730	11.4780	ITM
GPA-WA	0.0704	0.0380	4.0360	ITM
GUNUNG-WA	0.3924	0.1280	7.3332	ITM
INIX-WA	0.0455	0.0080	14.4602	ITM

JIANKUN-WA	0.2749	0.0680	9.9891	ITM
KIMLUN-WA	1.0579	0.2680	9.7301	ITM
LBS-WB	0.4471	0.0530	21.9310	ITM
LEWEKO-WB	0.1826	0.0380	12.0621	ITM
LUSTER-WB	0.0643	0.0330	4.2965	ITM
MAGNA-WB	0.7083	0.1480	12.0092	ITM
MBL-WA	0.8000	0.5750	2.7820	ITM
MCLEAN-WB	0.1292	0.0550	5.3855	ITM
OCK-WA	0.5224	0.0830	16.1088	ITM
PENSONI-WB	0.2932	0.0600	12.2833	ITM
POHUAT-WB	1.0134	0.5030	4.4766	ITM
REACH-WA	0.1576	0.0380	10.2737	ITM
SERSOL-WA	0.0777	0.0400	4.2803	ITM
SOLID-WA	0.1953	0.0730	6.2723	ITM
SRIDGE-WA	0.1832	0.1080	3.6110	ITM
SYMLIFE-WB	0.3876	0.0180	57.5337	ITM
THRIVEN-WB	0.1776	0.0180	25.8204	ITM
WCT-WE	0.8536	0.0380	60.0612	ITM
WZSATU-WA	0.1702	0.1030	3.4918	ITM

**Table 3.** Moneyness analysis based on Bendob and Bentour (2019)

Warrants	Stock price, S(t)	Strike price, G	Moneyness value	Moneyness status
APPASIA-WA	0.0847	0.0880	1.6163	ITM
AZRB-WA	0.3052	0.1850	3.4844	ITM
BIMB-WA	4.1956	0.2280	49.0212	ITM
BTM-WB	0.1250	0.1180	1.8795	ITM
DIGISTA-WB	0.0371	0.0180	4.6027	ITM
DNONCE-WA	0.2533	0.1430	3.8150	ITM
DOMINAN-WA	1.2082	0.0350	92.8351	ITM
DPS-WB	0.0571	0.0380	3.0846	ITM
ECOWLD-WA	0.6694	0.2380	6.6455	ITM
EG-WC	0.3351	0.0730	11.4780	ITM
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LBS-WB	0.4471	0.0530	21.9310	ITM
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LUSTER-WB	0.0643	0.0330	4.2965	ITM
MAGNA-WB	0.7083	0.1480	12.0092	ITM
MBL-WA	0.8000	0.5750	2.7820	ITM
MCLEAN-WB	0.1292	0.0550	5.3855	ITM
OCK-WA	0.5224	0.0830	16.1088	ITM
PENSONI-WB	0.2932	0.0600	12.2833	ITM
POHUAT-WB	1.0134	0.5030	4.4766	ITM
REACH-WA	0.1576	0.0380	10.2737	ITM
SERSOL-WA	0.0777	0.0400	4.2803	ITM
SOLID-WA	0.1953	0.0730	6.2723	ITM
SRIDGE-WA	0.1832	0.1080	3.6110	ITM
SYMLIFE-WB	0.3876	0.0180	57.5337	ITM
THRIVEN-WB	0.1776	0.0180	25.8204	ITM
WCT-WE	0.8536	0.0380	60.0612	ITM

## 5. CONCLUSION

This paper investigates the moneyness of hybrid pricing formula for equity warrants under the Heston-CIR model using several moneyness definitions. The analysis was performed on 32 equity warrants in Bursa Malaysia for year 2019 using several moneyness definitions by Roslan et al. (2022), Sakti and Qoyum (2017), and Bendob and Bentouir (2019). All three moneyness analysis produced results with more than 93% of warrants holding the ITM status. This verifies that the hybrid pricing formula under investigation provides warrant investors with profitable returns. Future research might include considering more datasets and more moneyness definitions to be included into the analysis.

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## **I-CReST 2023:241-202 - Exploration on The Integration Between Artificial Intelligence (AI) and Crisis Management in Malaysian Companies: A Review**

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### **ABSTRACT**

The advance technology and globalization that rapidly occurring across the globe had been a massive support to humankind in many aspects. The surge of Artificial Intelligence (AI) had act as game changer in many industries around the world as artificial intelligence approaches are useful in business, engineering even for medicine field under the scope of information-intensive and knowledge-critical domains. Therefore, with the presence of artificial intelligence in crisis context can help to manage crisis and achieve effectiveness in crisis management aside of being able to response and forecast potential crisis in the future. This is because, based on the current event of pandemic in the past years which shook the entire humanity with sudden plague and disturbed major business especially the corporate world and force major companies to dealt with loss and bankruptcy. This circumstance is not an exception to Malaysia as our countries had to suffer due to the sudden crisis (pandemic) that happened. Hence, this article purpose is to review the literature relating to artificial intelligence under the scope of crisis management in the field of Malaysian companies. In Malaysia, most of the companies with a good execution of crisis management are the Government Link Companies (GLSs) than the private companies and the AI ubiquitous influence can be seen Malaysia through the development and deployment of AI technologies in Malaysia. Thus, this act as an opportunity to studies the adaptation of AI in term of crisis management context in Malaysia companies.

**Keywords:** Artificial Intelligence (AI); crisis management; Malaysian companies

### **1. INTRODUCTION**

The need for research regarding AI under the context of organization is an act of desperate measure in order to shed light on this matter [1]. According to Nilson [2] artificial intelligence (AI) can be viewed as machines that come with the ability to conduct the cognitive function that is related to the human mind. For example, interaction, problem solving and learning. The application of AI in the management such as managerial assessment had shown that AI is more than a mere artifact and served as a tool within organization as stated by Floridi and Sanders [3]. This is because AI acts as the borderline of computational advancement that has the ability to deal with complicated decision-making issues [1]. AI come with the capacity to restructure and manage the innovation in the company in in systematic manner and with the constant evolution of technology as well the substitution of human organization in the management had led companies to diverse its attention towards the AI in term of innovation process for the organization as a whole [4]. On the other hand, AI has its intriguing side where AI comes with

better autonomy as the core of contemporary AI possesses the machine learning technology which offers detailed learning ability and is cryptic than “intelligent” IT as stated by Baird and Maruping [5]. The ascendancy of AI had overcome its downsides such as the increasing cost as companies realized its importance during the innovation process as this process forced companies to deal with technology competition, extreme volatile and inconstant environment [6] along with the epiphany of the organization on the availability of information as indicate the competitive stance on the information and the ability in term of problem solving among the companies [7]. Artificial Intelligence (AI) hints at the resurgence of the further stage of information technology in terms of management. For instance, handling AI including the coordination, communication and control on the partition of computational development that oriented the human intelligence when managing intricate decision-making problems [8].

Meanwhile, crisis can be seen as the unexpected circumstances that come with the potential to jeopardize the anticipation of stakeholders in the company on matters such as safety and economic issues that have a severe effect toward the organization’s performance and result in unwanted comments according to Coombs [9]. It also important to be aware in order to avoid confusion that risk management is part of crisis management due to circumstances where crisis bound to happen if risk is not been handle in the rightful manner, for example negligence of risk management in the tourism sector will positioning tourist in a risky spot [10] and the ability of risk itself in causing loss and harm [11]. There are various definitions for crisis management from multiple scholars. For instance, in the study conducted by Mikusova and Horvathova [12] had cited two scholars on their definition of crisis management such as Bundy had stated that crisis management is view as process on how organization faced with unsettling and unpredictable circumstances that poses threat on the companies including the stakeholder and society in general while Bernstein highlighted that crisis management does served as single activity and involve few activities such as prevention, planning, training , response and recovery. Hence, the integration of AI and crisis management can be beneficial to one and another as an amalgamation of two mechanisms can permit companies to get the best of both worlds.

## **2. THE ADAPTATION OF ARTIFICIAL INTELLIGENCE IN MALAYSIAN COMPANIES**

Artificial Intelligence (AI) is view as the pillar of investment under the scope of technology as the investment are poised in the technology industry (AI) as the effect of the AI is escalating due to its ability to reform the industries in Malaysia such as healthcare and logistic as the year of 2023 marked as the year for the AI to go big [13]. According to the survey conducted on the annual report pertaining to artificial intelligence, around 1% or less than 20 companies had stated about AI, machine learning and big data, as this term only been found in the Chairman’s statement and strategic business plan for the future. This indicates that the practice of AI in Malaysia Public Listed companies is at infancy stage or at awareness level [14]. Even though multiple efforts had been made to execute AI in the company’s operation aside from conducting research and making improvements on this matter. For example, be aware of the AI adoption in the company’s management as well in the operation. Organization is struggling to have suitable analysis on the method and plan for AI application for the future sake as stated by Omar and Ulfaz [14]. Moreover, a study by Lee and Tajudeen [16] had shown low execution of AI among Malaysian companies based on the survey conducted by Malaysian Institute of Accountants (MIA) in 2017. Where, the outcome of the survey reflects that the usage and the implementation of AI is low as compared to other well-known software such as Microsoft

application, fintech and data analytic tools but expected to have increment in term of usage in the of three years [15]. The study by Lee and Tajudeen [16] indicates that, the capabilities owned by the AI tend to be ignored in various industries in Malaysia and this is a very alarming situation as AI is viewed as one of the main components for Industry Revelation (IR) 4.0 in this fast development of the modern era.

Countries that participate in the Association of Southeast Asian Nations (ASEAN) had been taken part in effort to adopt AI innovation despite of one step behind but ASEAN countries are thriving in a fast pace and only 6% of major companies of ASEAN stated AI in the annual report in 2011 but in 2016, 1/3 of major companies of ASEAN had stated AI term in the annual report showing that the AI had been among of the technologies the companies had set as strategic priorities. Malaysia is at a slow pace in executing the AI innovation as compared to Singapore as Singapore is in the lead when it comes to AI experimentation in the various industries. Countries such as Malaysia, Vietnam and Thailand including Singapore are well are the competitive advantage carried by AI in term of revenue sources and within ASEAN countries, Brunei, Myanmar and Laos are at the low level of implementation of AI in the industries [14]. Still, Malaysian companies are aware about AI but facing issues on how to implement AI into the business, for example Malaysian private and public sectors are falling behind when it comes to accepting AI, yet realize there is potential distribution. For example, companies in Malaysia portray unenthusiastic manners when it comes to AI which act as the reason why it is difficult for the companies to progress the AI in the first place as stated by Afandi [17].

### **3. THE EXECUTION OF CRISIS MANAGEMENT IN MALAYSIAN COMPANIES**

Based on the survey conducted by Ipsos, Petronas have effective crisis management among other companies in Malaysia in 2020 followed by Maybank, Employees Provident Fund (EPF), McDonald and Perodua. The survey was carried out with 4,000 respondents and more than 100 companies in Malaysia. The survey showed that effective crisis management was not influenced by the sector and the survey focused on the main mechanisms in crisis management such as honesty in communication. In the midst of pandemic, companies need to adopt the “new normal” environment since the companies were bombarded with the unexpected crisis (pandemic) and need to response with the sudden crisis and most of the government-linked companies (GLCs) and government regulators have proper crisis management as compared to the private companies in Malaysia as society have high expectation toward the companies to contribute in the recovery of the pandemic [18]. Ipsos stated that, despite of the differences between public and private organizations in term of crisis management, both of the sector (public and private) had taken initiative in order to withstand the crisis and survive during the hurdle [18]. According to Othman & Yusoff [19], crisis management is seen as a new field in Malaysia that comes with a high demand for today's modern times.

Practitioners in Malaysia are prone to be aware of their behaviour when it comes to crisis response strategy but this act of cautious is the outcomes of the company's incompetence in handling crisis as the companies tend to delay any form of communication and action which led to speculation of rumours after the crisis occurred [20]. For example, Malaysia Airlines is heavily criticized due to its poor crisis communication as the company failed to deal with the crisis with the proper clarification and punctuality resulting in a lost control during the occurrence of the crisis [21]. Furthermore, companies of high-risk industries in Malaysia tend

to make external stakeholders as their main focus while aiming for the media and the society as well the government regulatory agencies as part their response towards the crisis which lead high risk industries in Malaysia to be external oriented and focus on the crisis communication aspect of crisis management [22]. Despite the obstacles of internal crisis communication in terms of producing the suitable practice for the internal crisis management, companies are now realizing the importance of internal crisis communication such as the factor that influences the internal crisis communication [23]. This indicates that companies in Malaysia, especially the high-risk industries are aware of the value presented within the crisis management. For example, the demand for the internal crisis management is align with the development of the high-risk risk industries in Malaysia such as oil and gas as the companies believe the influence of internal crisis communication can aid to enhance the corporate reputation of the company and included internal crisis communication as part of strategic growth as stated by Mohamad et al. [23].

#### **4. THE INTEGRATION OF ARTIFICIAL INTELLIGENCE (AI) AND CRISIS MANAGEMENT IN MALAYSIAN COMPANIES**

AI have the capacity to overthrown human in decision making process and offer assistance in innovation process by merging the barriers that need to be solved by the AI system and human as stated by Haefner et al. [4], as AI system can recognize and assess high level of information that can be applied to enhance ideas aside of identifying high number of problems, threat and opportunities to generate new ideas. This showed that the ability possessed by AI that is associated with threats and issues as well as assessing information can be helpful to achieve effectiveness in crisis management in the companies. For example, assessing information is important during the process of post-crisis as the companies need to evaluate the information gathered during the crisis and use it for the purpose of learning in the post crisis stage. While, identifying threats and problems by the AI system can assist companies to forecast crises and recognize potential risk for the future. Based on the analysis of past research on crisis management, the studies recommend AI for the decision support system for crisis management as AI has the ability to establish strong justification and AI technologies are convenient in the field of crisis management [24].

In addition, AI method served as useful gear for the purpose of advancement in crisis response and management systems as the technology can aid company to provide solution to the issue pertaining crisis response for example, the multi-agent systems structure and methodologies act as main fundamental of crisis response system which allow crisis management team or committee to manage coordination and interaction issue aside of acquiring planning potential through the AI [25]. It is important to be aware that, crisis management is seen as a well-rounded action that was executed with effectiveness to ensure targeting goal is obtained and consist of planning, decision-making process, guiding and controlling of the resources [26]. Thus, AI can be adopted during uncertain times as algorithms derived from the mathematical approaches can be used to find solutions towards the problems that usually occurred in crisis circumstances that are non-linear and dynamic. The values carried by the AI technology can help crisis management to run at its effective level, since AI able to examine, coordinate and process data at a fast rate which can help Malaysian companies in the high-risk industries in terms of internal crisis communication. This is because processing data is crucial during unexpected circumstances as quick decisions need to be made and required to be accurate to avoid the opposite effect to the one company intended, with bad or dangerous results.

## 5. METHODOLOGY

For the purpose of methodologies in this study, literature review had been applied where the literature search had been done through the Google Scholar from the 1971 until 2023. For example, all the discussion had been derived from the journals, websites, dissertation papers, books, published articles including the other relevant sources on artificial intelligence and crisis management that meet the requirements which act as the materials in order to meet the purpose of this study. In addition, enhancement from the literacy aspect as well as better access to artificial intelligence and crisis management can be achieved using literature review methods. This is because this approach can help the practitioner to develop the artificial intelligence practice through the evidence that is available [27]. For instance, the management of the crisis in Malaysia under the corporate sector can be improved with the presence of artificial intelligence.

## 6. CONCLUSION

Based on the studies carried by Wong [28] AI fits well with crisis management in order to achieve a successful detection process as AI influences the business operation in a desirable manner by offering innovation that can assist companies in the learning phase of crisis management as well pre-crisis period by having prevention approaches. Besides that, the joint approaches of human and AI in decision-making can lead to fascinating outcomes according to Ali and Wood-Harper [29]. This is because when it comes to the crisis management process, it involves complex data technology, thus it requires effort on information transfer and collection of active data in order to lower the rate of uncertainty along with assessing and handling the consequences aside of dealing with the resources with daily problems [30]. Adoption of AI is essential to escalate the awareness of the crisis. Management and AI can be viewed as the two sides of the same coin, even though these two items seem unrelated but it's actually two sides of the same part as management and AI work interdependent. Especially when embarking into uncertain future, AI can act as company safety net in the turn of unwanted event as during chaotic time nothing is assure but having tool that can provide assistance when need the most in the time of crisis will be a huge advantage to any company that embrace AI well and efficiently align the technology with the crisis management for the sake of sustainability of the company.

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## I-CReST 2023:250-220 - The Comparative Study of Fuzzy Logic and Artificial Neural Network Controllers of Dynamic Voltage Restorer for Voltage Sag Mitigation

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### ABSTRACT

In this paper, the performances of difference controller of Dynamic Voltage Restorer (DVR) for mitigation technique for voltage sag issues has been discussed. The study is focusing on the control unit operation and two types of non-linear controllers which are Fuzzy Logic (FL) controller and Artificial Neural Network (ANN). The effect of voltage sag in the system's voltage profile while applying the DVR device is investigated by using MATLAB Simulink application. The analysis has been conducted based on the Total Harmonic Distortion (THD) and the peak voltage surges. Single Line to Ground (SLG) fault has been chosen as the voltage sag sources due to the frequent occurrence it electrical system. Final result indicates that, both controller manages to restore the voltage with ANN based DVR controller demonstrate the better performance.

**Keywords:** Dynamic Voltage Restorer (DVR); voltage sag; comparative studies; Fuzzy Logic (FL) controller; Artificial Neural Network (ANN) controller

### 1. INTRODUCTION

Nowadays, the reliability of the electrical system could be affected by the sensitive equipment against various disturbances that could occur randomly. Voltage sag is one of disturbance that frequently occurred and encompasses almost 80% of the distribution system power quality problems [1]. It occur when there is reduction in RMS voltage by 10% - 90% of the nominal voltage and the duration of half a cycle to 1 minute [2]. These disturbances happened as the result of event such as the start-up of large power motors, switching off large loads, energizing of capacitor bank, short circuit occurrence and overloaded. As the result, there are adverse effect has been experienced by the electrical system lead financial losses.

There are a number of studies that have been done pertaining to the mitigation of voltage sag especially on Dynamic Voltage Restorer (DVR) and its control mechanism. Dynamic Voltage Restorer (DVR) is one of the modern Custom Power Device (CPD) that predominantly being deployed as the to mitigate the voltage sag due to its cost-effective [3]. Purushothama et al.[4] has presented the studies of mitigating the voltage sag using dynamic voltage restorer with PI controller with synchronous reference frame (SRFT) control method. The study shows that this control method is capable for compensating the voltage sag which associated to the

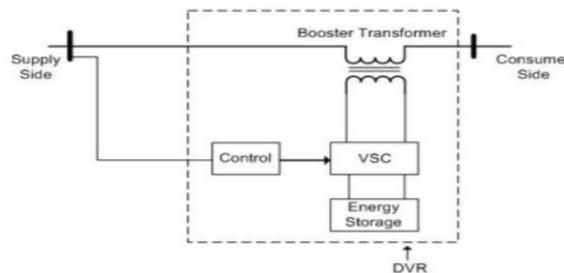
Shankar et al.[5] said that DVR requires proper controlling method to control the fluctuations in the operation of compensating devices by using the artificial intelligence . FL and AFL are said to be a very powerful AI techniques and some example of applications of fuzzy logic in power quality are in diagnosing PQ problems PQ disturbances [6]. Besides, Ansal [7] in his research also have highlighted the ANN controlled Dynamic Voltage Restorer by ALO optimization in improving the compensation of voltage sag. The proposed technique manage to compensate voltage sag more efficient as compare to PSO [8]. However, there is no comparative analysis with other controller to measure the impact from detecting the disturbances.

In this study, two control methods i.e. Fuzzy controller and ANN controller base DVR has been analyzed and compared based on the impact from mitigating the voltage sag. The simulation of voltage sag has been demonstrated from the single line to ground. Since both controller are able to perform comprehensively on injecting the voltage sag, the results has been observed based the spike magnitude and Total Harmonic Distortion (THD).

### 1.1 Dynamic Voltage Restorer (DVR)

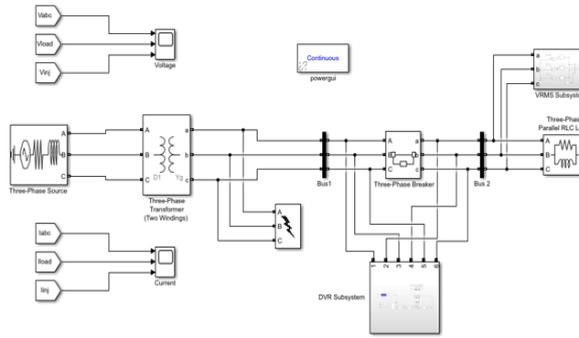
the DVR consists of several main components composed of injection transformer, filter, voltage source inverter, protection circuit, control circuit, and energy storage (Fig. 1). the DVR only operates when it detects any abnormal conditions and remains steady during normal condition. The device maintains the magnitude of the load voltage to its nominal value after the DVR injects a voltage ( $V_{inj}$ ) into the system via injection transformer. as stated in equation (1) :

$$S_L = P_L - jQ_L = (P_s - jQ_s) + (P_{inj} - jQ_{inj}) \tag{1}$$



**Fig. 1.** The main components diagram for DVR

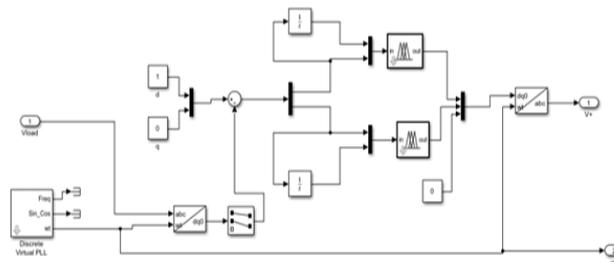
The DVR is connected to distribution system consists 11kV supply voltage, 50Hz frequency and step down to 415V as shown in Fig. 2. MATLAB Simulink is used to simulate performance of DVR to mitigate voltage sag . The processes of mitigating starting from selecting the operation mode, followed by detecting the voltage sag and lastly injecting the required amount of voltage.



**Fig. 2.** The Simulink model of distribution system with DVR

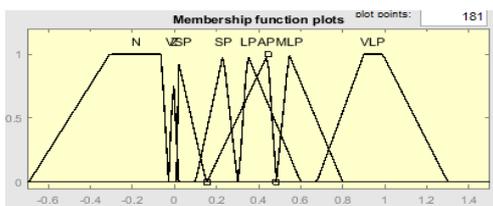
## 1.2 Fuzzy Controller Based DVR

Fuzzy Logic (FL) controller is one of the non-linear controller which can adapt and at the same time handling with varying parameters and abrupt changes in the error signal. Simulation model of Fuzzy Controller designed in MATLAB, Simulink is shown in Fig. 3.

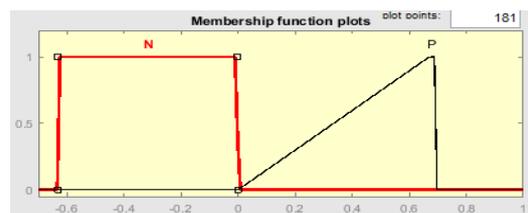


**Fig. 3.** Simulation model of Fuzzy Controller designed in MATLAB, Simulink

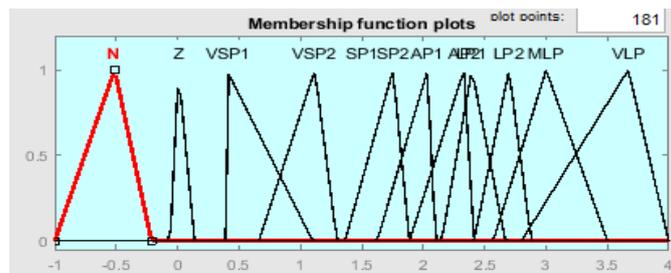
Fig. below shows the membership function of input  $s$  (error and change of error) and output of the controller are shown in Fig. 3,4 and 5, respectively.



**Fig. 4.** Membership function of error



**Fig. 5.** Membership function of change of error



**Fig. 6.** Membership function of output gain

### 1.3 Artificial Neural Network Controller Based DVR

Artificial Neural Network (ANN) is one of the computing systems designed which is used to simulate the way the human brain processes information and it is the foundation of Artificial Intelligence (AI) which is widely used nowadays. The simulation model of given ANN controller is shown in Fig. 7

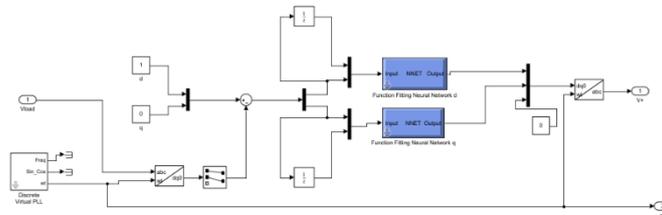


Fig. 7. Simulation model of ANN Controller designed in MATLAB, Simulink

As for the purpose of producing the efficient DVR performance, a multi-layer feed forward which consists of 2 input layer, 10 hidden layer and 1 output layer is applied as Fig. 8. The network has also been trained by using Lavenberg-Marquardt (LM) back propagation algorithm.

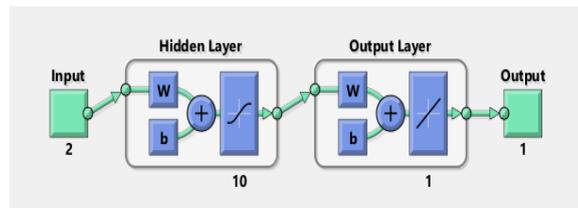


Fig. 8. A multi-layer feed forward with sigmoid hidden neurons and linear output neurons

From the Fig. 9, 10 iterations has been executed where it takes 2 seconds for the training time. It proved LM algorithm provide the fast-converging algorithm and able to perform with high accuracy and efficiency as the time spent for this algorithm is very short and quick. As stated in Fig. 9, the best validation performance is 0.14838 which is at epoch 4.

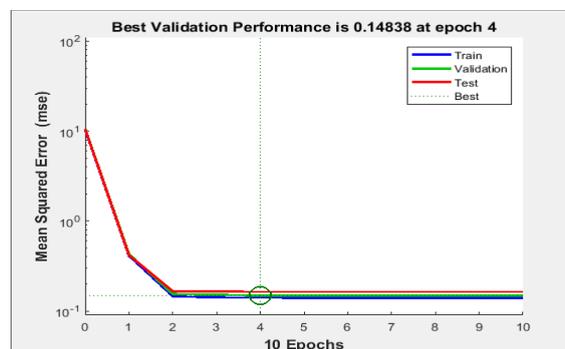
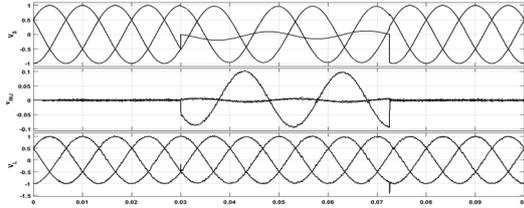


Fig. 9. Validation performance plot indicator

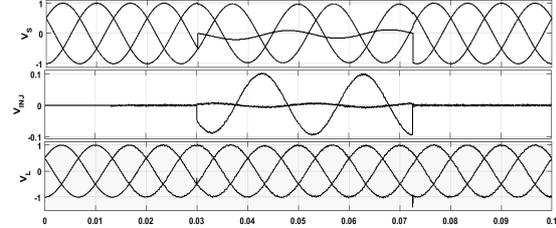
## 2. RESULT AND DISCUSSION

In this part, simulation result used to highlight the comparison of the controllers between FL and ANN controller. The value of Total Harmonic Distortion (THD) and length of surges has

been observed for comparison purpose. The results of both controllers are illustrated as in the Fig. 10 and Fig. 11. To evaluate the capability of the DVR operation in handling fault condition, single line to ground have been applied in the system. Firstly, for single line to ground fault which at phase A, occurs at the first feeder at the time interval from 0.03s to 0.07s. As soon as the DVR detects the fault, it rapidly injects the required voltage referring to the fault condition happened.

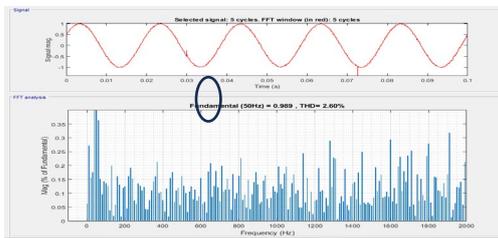


**Fig. 10.** Result from DVR based fuzzy controller

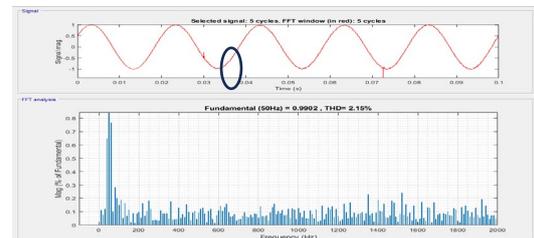


**Fig. 11.** Result from DVR based ANN controller

In order to quantify the level of harmonic distortion, Total Harmonic Distortion (THD) is the pivotal measure to be analyzed. By performing the Fast Fourier Transform (FFT) analysis. Fig. 13 and Fig. 14 show the measured THD of the voltage after compensation of voltage sag by using Fuzzy controller-based and ANN controller-based, respectively DVR. In addition, the peak of surge is observed based on the surge appear during the beginning of mitigation process as illustrated in circle in Fig. 13 and Fig. 14.



**Fig. 12.** FFT for Fuzzy controller-based DVR



**Fig. 13.** FFT for ANN controller-based DVR

Table 1 shows the comparative analysis of both controllers which are Fuzzy and ANN controller-based DVR. The comparison is done in term of the THD values and peak of voltage surges. For THD value, it can be seen after compensation of voltage sag occurred, ANN controller has lower THD value 2.15% compared to Fuzzy controller-based DVR which is 2.6%. However, both values are within the allowable range of harmonics referring to IEE 519. Moreover, the peak of voltage surges is much lower occurred when using ANN as the controller which is 1.427 pu as compare to Fuzzy as the controller which is 1.435 pu. The DVR device with ANN controller seems more efficient than fuzzy controller-based DVR.

**Table 1.** Compilation result of both Fuzzy and ANN controller-based DVR

Control unit	Total Harmonic Distortion (%)		Peak of Voltage Surge (pu)
	Before mitigation	After mitigation	
Fuzzy controller	62.79	2.60	1.435
ANN controller	62.78	2.15	1.427

### 3. CONCLUSION

As the conclusion, the performance of DVR in mitigating the voltage sag have been analyzed by modeling and simulating the distribution circuit with DVR implementation in the system by using MATLAB Simulink. The comparative analysis between Fuzzy controller and ANN controller-based DVR also have been done by comparing their efficiency in compensating the sag in term of its percentage of THD and the peak of voltage surges occurred. Both controllers able to compensate the voltage sag occurred in the system, but it has been proved that ANN controller provides a better solution in controlling the DVR device with compared to the Fuzzy controller.

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## I-CReST 2023:283-245 - Poisonous Mushroom Detection using Convolutional Neural Network: A Conceptual Paper

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### ABSTRACT

Research on poisonous mushrooms is a crucial area due to the high risk it poses to human health. Mushroom poisoning typically arises from the misidentification of edible and poisonous mushrooms, as they can share similar physical characteristics. This misidentification often occurs due to the resemblance in general morphology and coloration between poisonous mushrooms and their edible counterparts. Ingesting wild mushrooms can introduce various toxins, including muscimol and muscarine, which can induce symptoms such as vomiting, diarrhoea, confusion, visual impairments, excessive salivation, and hallucinations. This paper aims to address the misidentifying of mushrooms through a classification method by applying Convolutional Neural Network (CNN). This is important for ensuring that mushrooms are safely consumed and not mistaken for harmful species. This paper also contributes by providing suggestions for scholars, educators, and practitioners that aid in illustrating how CNN can be instrumental in solving misidentifying problems in support of a poisonous mushroom detection system.

**Keywords:** Poisonous; mushroom; convolutional neural network

### 1. INTRODUCTION

Mushroom is a type of fungus that typically consists of a stem and a cap, which is often referred to as the fruiting body of the fungus [1]. Mushrooms can be found growing in a variety of environments, including forests, fields, and even in homes. They are typically considered to be a type of edible or medicinal plant, although some species of mushrooms can be toxic if consumed [2]. Moreover, mushrooms are a high-nutritional-value food that contains minerals such as calcium, phosphorus, vitamins and proteins [3].

Mushroom poisoning is often the result of ingesting wild mushrooms after misidentifying a poisonous mushroom as an edible species. The most common reason for this misidentification is the general morphological and colour similarity of the poisonous mushrooms to the edible species [4]. The report by World Health Organization (WHO) says that wild mushrooms may contain several toxins, such as muscimol and muscarine, which can cause vomiting, diarrhoea, confusion, visual disturbances, salivation, and hallucinations. Onset of symptoms occurs between 6 to 24 hours or more after ingesting mushrooms [5]. The further report from WHO says that fatal poisoning is often associated with late onset of very severe symptoms, toxicity

to the liver, kidneys and nervous system. Cooking or peeling does not inactivate the poison. Any wild mushrooms should be avoided unless they are determined to be non-toxic [5].

Thus, detection and analysis of poisonous mushroom can reduce the risk of people acquiring more serious health issues. According to a study by Ribeiro et al. [6], mushroom poisoning is a worldwide public health concern that has been reported in many countries. The study reported that the incidence of mushroom poisoning is increasing, which highlights the need for proper identification and management of poisonous mushrooms. The study by Yee et al. [7] reported that there are over 2,000 species of mushrooms in Malaysia, with about 300 of them being edible. However, among the edible species, there are several poisonous species that can cause severe symptoms and even death. The study further highlighted the fact that mushroom poisoning is often under-reported, and the actual incidence rate may be much higher. Therefore, it is essential to educate the public about the dangers of consuming poisonous mushrooms and the importance of seeking medical attention in case of poisoning.

## 2. RELATED WORKS

Ketwongsa et al. [8] explores the development of a deep learning model for the classification of poisonous and edible mushrooms. They propose an improved AlexNet convolutional neural network model that is trained on a large dataset of mushroom images. Zahan et al. [9] proposes a deep learning-based approach for the classification of edible, inedible, and poisonous mushrooms. The study was conducted using a large dataset of mushroom images and a deep neural network was trained to accurately classify the mushrooms. In [1], Preechasuk et al. explores the use of convolutional neural networks for the classification of mushroom types. The authors used a dataset of mushroom images and trained a CNN to accurately classify the mushrooms into different types. This researches show the results that the proposed model were effective in classifying mushrooms as either poisonous or edible with high accuracy and outperformed traditional computer vision techniques. The authors conclude that the new deep learning model for the classification of mushrooms has great potential for use in the food industry and has the potential to improve food safety by accurately identifying poisonous mushrooms.

Cengil and Çinar [10] focuses on the use of the YOLOV5 algorithm for detecting poisonous mushrooms. The authors aim to provide a solution to the problem of accurately identifying poisonous mushrooms in the wild, which can be dangerous for foragers who collect mushrooms for food. The YOLOV5 algorithm, which is a deep learning approach, is trained on a dataset of mushroom images and then used to classify the images into either poisonous or edible categories. The results of the study show that the YOLOV5 algorithm provides an effective method for identifying poisonous mushrooms and has the potential to be used in practical applications. The authors hope that their research will help to improve the safety of mushroom collection and consumption.

Chitayae & Sunyoto [11] compares the performance of two different methods for mushroom types of classification, the K-Nearest neighbor method and the decision tree method. The study was conducted using a dataset of mushroom images and the results showed that the decision tree method had a higher accuracy rate in comparison to the K-Nearest neighbor method. The authors suggest that the decision tree method is a suitable method for mushroom classification tasks. This study contributes to the field by providing insight into the performance of different classification methods for mushroom identification.

### 3. CONVOLUTIONAL NEURAL NETWORK

Poisonous mushroom detection is a system using deep learning approach along with computer vision. Deep learning is a subset of machine learning in artificial intelligence that mimic the human brain to behave similarly while processing data and model production [9]. It involves the implementation of multiple layers of neural networks, allowing complex processing, and is more accurate than human classifiers because they are trained by large datasets [8]. This study classify mushrooms type through Convolutional Neural Network (CNN). According to Zahan et al. [9], CNN is considered the most powerful visualisation model in computer vision to enable precise segmentation by creating feature hierarchies. CNN also known to estimate relatively faster than different algorithm while maintaining reasonable performance.

CNN algorithm is a widely used deep learning technique for image and video analysis, known for its simplicity and effectiveness. A CNN consists of one or more convolutional layers, which make use of convolutional and pooling operations to learn and extract features from input data. The final prediction is made through a fully connected layer. Each layer applies a filter or kernel to the image, which produces an output that becomes increasingly detailed and specific. The filters in the early layers start as simple features and become more complex as the network progresses, with each layer learning to identify different aspects of the image. The output of each layer serves as the input for the next, until the final fully connected (FC) layer recognizes the complete object represented by the image. The input image passes through multiple filters, with each layer activating specific features and contributing to the overall recognition of the object. This process is repeated multiple times, resulting in a complete recognition of the image [12]. Fig. 1 shows the architecture of CNN.

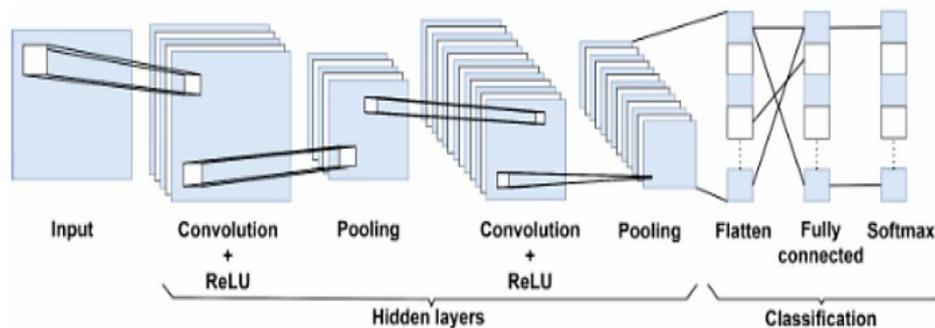
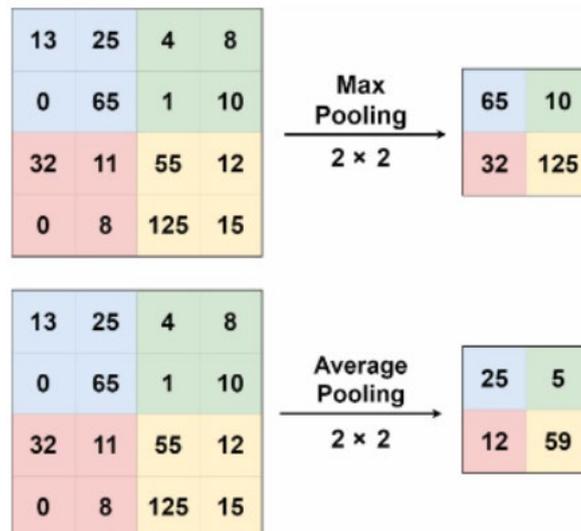


Fig. 1. Architecture of CNN

Based on Fig. 1, the convolution operation is the initial step in extracting meaningful features from an image in a CNN. It involves the use of filters in a convolution layer to identify specific features in the image. The filters are smaller than the image, and they move across the image to detect features [8]. The convolution layer performs a combination of linear and nonlinear operations, and is the core building block of a CNN, performing most of the computational work [13]. After the first convolution layer, a second layer can be added. The process of convolution uses a kernel or filter to scan the image's receptive fields, checking for the presence of features. After multiple iterations, the kernel covers the entire image and a dot product is calculated between the input pixels and the filter for each iteration. The output from the series of dot products is known as a feature map or convolved feature. This layer converts

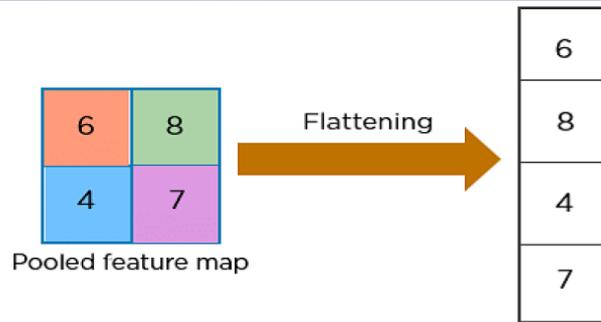
the image into numerical values, allowing the CNN to interpret and extract relevant patterns from the image [14].

The pooling layer serves to simplify the output and reduce the amount of computing resources needed by reducing the number of parameters and complexity through dimensionality reduction. By utilizing a specified pool size, it also helps to extract key features that are insensitive to rotation and position, thus enhancing the efficiency of model training [15]. According to Saha [16], there are two forms of pooling: Max Pooling and Average Pooling. Max Pooling returns the highest value from the area of the image encompassed by the Kernel, while Average Pooling returns the average of all values within that same area. Max Pooling has the added benefit of acting as a noise suppressant by eliminating noisy activations and reducing noise in addition to reducing dimensionality. In contrast, Average Pooling only serves as a dimensionality reduction mechanism, lacking the noise suppression capabilities of Max Pooling. Therefore, Max Pooling is considered to perform much better than Average Pooling. Fig. 2 shows the example pooling layer.



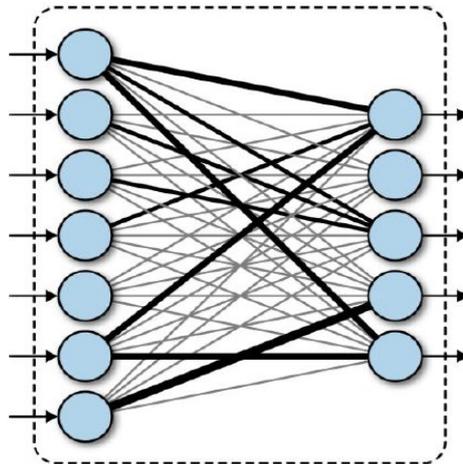
**Fig. 2.** Pooling layer

The flattened layer is used to prepare the data for the final fully connected layer, which makes the final classification decisions. The fully connected layer is designed to work with 1D data and therefore, the data must be flattened into a 1D vector before being fed into it. The flattened layer simply flattens the multi-dimensional arrays into a single long vector, which is then fed into the fully connected layer for the final classification [17]. Fig. 3 shows the flattened layer.



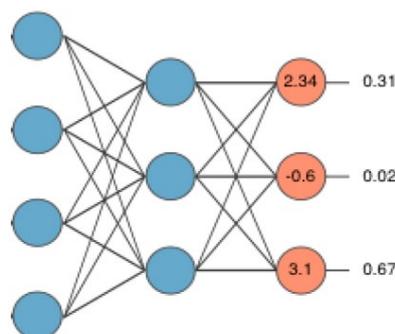
**Fig. 3.** Flattening layer

In a CNN, the final image classification takes place in the Fully Connected (FC) layer, where the features obtained from the previous layers are utilized to make predictions. The FC layer is referred to as "fully connected" because all neurons in one layer are connected to every activation unit in the next layer, effectively combining all the properties extracted from the previous layer for use in classifying the next [18]. Fig. 4 shows the fully connected layer.



**Fig. 4.** Fully connected layer

The softmax layer takes in the output from the final fully connected layer and applies the softmax activation function. The softmax function maps the input values to a probability distribution, where the sum of all the values is equal to 1. This allows the model to predict a probability for each class and select the class with the highest probability as the final prediction [8]. Fig. 5 shows the softmax layer.



**Fig. 5.** Softmax layer

CNN has its strength and weaknesses. One of the key strengths of CNNs is their ability to work well with image data. The architecture of CNNs is specifically designed to extract features from images and use these features to make predictions. This makes them highly effective for image recognition tasks, where the goal is to identify objects in an image. Another strength of CNNs is their ability to extract relevant features from the input image. The convolutional layers in a CNN process the input image and extract features that are important for making predictions. This makes it easier for the model to learn relevant features and improve performance. Although deep learning models can be computationally expensive, CNNs are designed to be computationally efficient, making them a good choice for real time applications and large-scale image processing.

Despite their strengths, CNNs typically require a large amount of labelled data to train effectively. This makes them less suitable for small datasets or tasks with limited labelled data. Another weakness of CNNs is that they are prone to overfitting. Due to their complex architecture, CNNs can easily fit the training data too well, which can lead to poor performance on new, unseen data. Finally, although CNNs are designed to be computationally efficient, they can still be computationally expensive, especially for large images or datasets.

#### 4. CONCLUSION

Convolutional neural networks have been effective in classifying mushrooms as edible, inedible, or poisonous. CNN-based systems may be able to detect mushrooms that have not been previously identified as poisonous, making them useful for identifying new toxins. Poisonous mushroom detection system using CNN makes an important contribution for users, where the system would enable them to identify toxic mushrooms accurately and avoid consuming them, reducing the risk of severe health complications, including death. The system would also provide users with a sense of confidence when identifying mushrooms, especially for those who are not experts in mushroom identification. In education, a detection system would be an essential tool in teaching individuals how to differentiate between edible and poisonous mushrooms. It would provide a practical and hands-on approach to learning, making it easier for individuals to understand and apply the knowledge in real-life situations. The system could also be used to create awareness about the dangers of consuming poisonous mushrooms and educate individuals on the proper techniques for identifying and managing them. Overall, the use CNNs for poisonous mushroom detection has the potential to improve food safety and reduce the risk of mushroom poisoning.

#### ACKNOWLEDGEMENT

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## I-CReST 2023:313-281 - Developing of Student Project Report Inventory System at JTMK, PSMZA with PHP Language Programming and MySQL Database

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### ABSTRACT

Today, Malaysian society is living in an era of globalization that is science and technology-oriented. The use of information technology is essential in delivering information and has become a necessity in efforts to develop and enhance the field of education. In line with this, the Student Final Project Management System was developed to provide facilities for storing records of Student Project Reports and Student Project Reports (Softcopy) for the Department of Information Technology & Communication (JTMK) at Politeknik Sultan Mizan Zainal Abidin (PSMZA). Additionally, this system is used to update and delete Student Project Reports (softcopy) as well as information on Student Project Reports, Students, and Staff. The system can be used by students to search for reference sources that can guide them in carrying out their final projects. The Waterfall Model is the methodology used as a guideline in developing this system. The programming languages used are PHP, HTML5, CSS, Javascript, JQuery, and SQL. Furthermore, the Codeigniter and Bootstrap frameworks are also employed in the development of this system. As for the database, the developers chose to use MySQL. Therefore, it is hoped that this system can assist students and staff in obtaining information related to Student Project Reports and ultimately improve the quality of teaching and learning at PSMZA.

**Keywords:** Student final project report management system; PSMZA; JTMK

### 1. INTRODUCTION

Advancements in science and technology are not unfamiliar in today's world. Developments in information and communication technology have had a significant impact on global society. Information and communication technology is not just a tool for daily work but also a medium of interaction and communication in this century. In the era of globalization, the use of computers and the internet in data management and organization is essential to ensure that information can be distributed and improved over time. [18], state that the emergence of information and communication technology allows the general public to access information through the internet. Although knowledge can now be obtained at the touch of a finger, the importance of reference books remains relevant.

The Final Student Project Report is one of the assessments in the Programming Project course. This course is part of the specialization category for sixth-semester students in the Diploma in Digital Technology program. The preparation of the Final Student Project Report is a routine task carried out by all students in polytechnics and other institutions. It can be considered as one of the mandatory criteria that students must fulfill in completing their final projects. Assessing students' ability to present their work in written form can be measured through the preparation of their final project reports.

The use of online systems is synonymous with modern human life [1]. Therefore, the development of the Student Final Project Report Management System at JTMK, PSMZA is highly suitable as it can facilitate users in obtaining information related to the Final Student Project Reports, thereby further enhancing the quality of teaching and learning at PSMZA.

### **1.1 Problem Statement**

Several problems arise among lecturers and students in obtaining information regarding the Student Project Reports. One of these problems is the irregular recording and difficulty in searching for the list of Student Project Reports because they are stored separately by semester in Microsoft Excel files. According to [16] and [19], traditional file-based systems lack a centralized method or approach to manage data. This inefficient recording process leads to numerous issues, especially when staff changes occur. Additionally, the Student Project Reports can only be referenced at the Resource Center and cannot be borrowed by students. The list of Student Project Reports available at the Resource Center is in hardcopy format. As a result, students face challenges in searching for the required reports and need to be present at the Resource Center constantly for reference purposes. These problems faced by lecturers and students not only hinder their access to relevant information but also have an impact on the teaching and learning process.

### **1.2 Research Objectives**

To achieve the research goal, the following objectives have been established:

- i. To develop an online Student Final Project Report Management System.
- ii. To make up improvements in recording, updating, and retrieving information related to the list of Student Project Reports.
- iii. To compile records of borrow and return information for Student Project Reports in the database.

### **1.3 Significance of the Study**

The Student Final Project Report Management System holds importance for students, lecturers, and the JTMK Project Unit, PSMZA. The following is the significance of the study for i) Students, ii) Lecturers and iii) Project units.

#### **1.3.1 Students**

The Student Final Project Report Management System is essential for students as it allows easy access to previous project reports for reference. By maintaining a repository of project documents, students can review and learn from past works, gaining insights into successful

approaches and avoiding mistakes. This quick access to valuable information streamlines the learning process and encourages continuous improvement.

### **1.3.2 Lecturers**

The Student Final Project Report Management System provides convenience for lecturers in accessing the list of Student Project Reports more quickly and easily compared to the manual system. This is because all information related to the Student Project Reports is stored in one centralized location, which is the system's database. As a result, information regarding the list of Student Project Reports can be accessed anytime if needed, especially in assisting students in executing their final projects.

### **1.3.3 Project Unit**

The Student Final Project Report Management System is of utmost importance to the JTMK Project Unit at PSMZA. This is because it serves as a crucial reference source for obtaining information on the list of projects executed by JTMK students. Improvements in recording and updating the information related to the list of Student Project Reports can be enhanced as well. Additionally, this system assists the Project Unit in conducting faster, easier, and more efficient reviews of borrowing records for Student Project Reports.

## **1.4 Research Scope**

The Student Final Project Report Management System is developed for the JTMK Project Unit. The main information contained in the system includes the list of Student Project Reports, along with supervisor, student, study session, location, and borrowing records. The scope for the users is as follows:

### **1.4.1 System Administrator**

- a. Has comprehensive access to the system.
- b. Enters username and password to access the system (login).
- c. Adds, updates, and deletes the list of Student Project Reports (project title, student information, supervisor, session, and location), borrower information, and system utilities.
- d. Performs searches for the list of Student Project Reports and borrowers.

### **1.4.2 Lecturers and Students**

- a. Performs searches for the list of Student Project Reports.

## **2. LITERATURE REVIEW**

The study was conducted based on several equivalent systems to analyze and compare them with manual systems and existing automated systems. Some of the studied systems include the Facilitator Filing System [2], SMS-Based Book Search and Ordering System in Edusarana Online Bookstore [5], and E-Journal System at UPSI [6]. The Facilitator Filing System is a system that stores information and borrowing records for Student Project Reports. The main

software used in system development are Visual Basic and Microsoft Access [10]. The SMS-Based Book Search and Ordering System in [5] Online Bookstore is a system that assists users in book search and ordering. The technology used is Short Message Service (SMS), and the programming language used is PHP [4]. On the other hand, the E-Journal System [6] at UPSI is a system that stores working papers produced by the institution's members. The database used is MySQL, and the programming language used is PHP [5].

### 3. METHODOLOGY

The methodology used in the development of the Student Final Project Report Management System is based on the Waterfall Model, also known as the Waterfall Model. The model consists of five phases: Planning Phase, Analysis Phase, Design Phase, Implementation Phase, and Support Phase, as shown in Fig. 1. This model was chosen because it is suitable for the studied problems, including [17]:

- i. Each phase has a clear structure and format at the beginning and end, which facilitates software development management.
- ii. Detailed analysis of requirements can be performed.
- iii. Each phase is completed before moving on to the next phase. This meets the characteristics of a dynamic model, where relevant phases are reiterated if there are any changes, corrections, or errors.

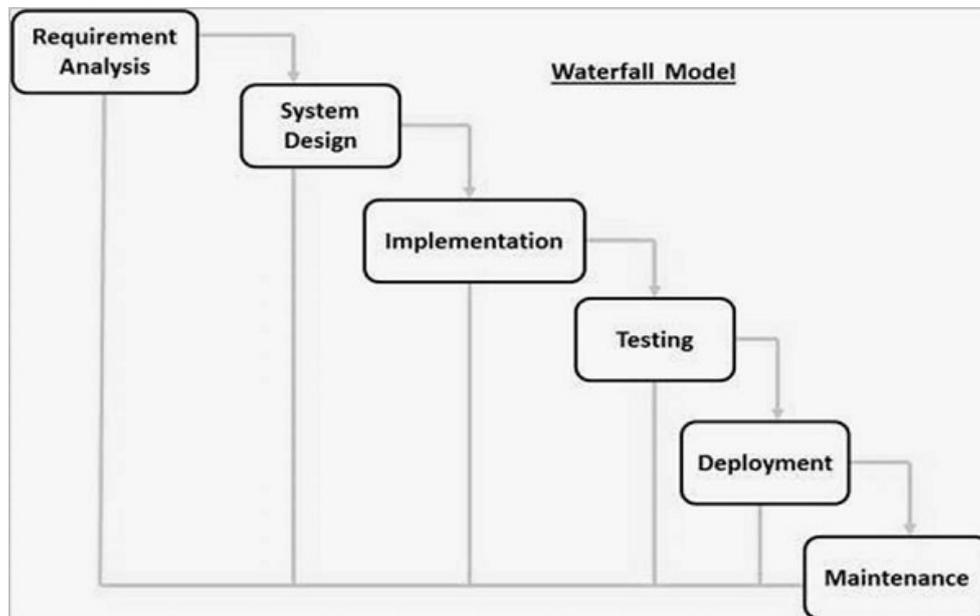


Fig. 1. Waterfall model

#### 3.1 Planning Phase

The planning phase is the first phase in the Waterfall Model. This phase is carried out to gather the necessary resources during the system development process to meet the established objectives and scope. Initial planning is conducted to determine the scope and objectives of the system to be developed. Additionally, a Gantt chart is created to indicate the progress being made and the required time frame to complete the project.

### **3.2 Analysis Phase**

The system analysis phase is a method used to identify problems in the existing system and also to identify the requirements specifications for the system to be developed. Discussions with the Project Unit Committee and lecturers teaching the Programming Project course were conducted to identify the system requirements and review the requirements for developing the system. Problem analysis was also collected and recorded through observation methods, and the next step involved distributing questionnaires to students. Questionnaires were among the main research instruments used and were developed by the researcher. According to [20], the use of questionnaires can improve the accuracy and reliability of feedback provided by respondents as it is not influenced by the researcher's behavior. Data from respondents can be obtained in a short period of time, and the obtained answers are more consistent [15]. In this study, the sampling design was random. According to [6], random sampling is the sampling of individuals from a study population where each individual in the population has an equal chance of being selected. The target population consists of sixth-semester students in the Diploma in Digital Technology program, JTMK PSMZA. The instrument used by the researcher involves the use of Likert scale measurement. The Likert scale is used because of its high reliability level of 85% [21]. Questions in the form of nominal scale are also used to obtain respondents' agreement regarding online system development.

### **3.3 Design Phase**

This phase describes the basic design of the system to be developed. All system requirements obtained from the previous phase are used as a guide in designing the system. This phase involves two types of design: logical design and physical design. Logical design includes designing the system processes, system input-output, overall system flow, database design, coding process, and program preparation. On the other hand, physical design involves preparing the system interface.

#### **3.3.1 Logical Design**

Activities carried out in this phase include designing the database, which involves depicting the data in Entity Relationship Diagram and the system (Context Diagram). Additionally, source codes for system functions are prepared to ensure the system functions properly. The created source codes will be implemented in the physical design phase as appropriate.

#### **3.3.2 Physical Design**

Activities in this phase involve the process of designing the system interface. User interface is one of the important element in developing a system. User Interface (UI) Design centers around anticipating users' potential actions and ensuring that the interface incorporates easily accessible, comprehensible, and user-friendly elements to facilitate the execution of those actions [1]. All the functions and coding implemented in the logical design phase will be used in this phase.

### **3.4 Implementation Phase**

Bootstrap and CodeIgniter are the frameworks used in the development of this system. PHP, HTML5, JavaScript, jQuery, and SQL are among the programming languages used, while

MySQL is chosen as the database by the developers. Sublime Text 3 and Adobe Photoshop are additional software used in the development of this system. In this phase, the formulated source codes will be integrated into the program's codebase. After running the program, any detected errors will be fixed to ensure the system can run smoothly. Once all the source codes are incorporated into the system, system testing will be conducted to ensure that each function operates correctly and is free from errors.

### 3.5 Support Phase

This is the final phase of system development. In this phase, comprehensive testing of the system will be carried out to ensure its proper functioning and compliance with user requirements. During this phase, the system will also be tested by the system administrator, who serves as the main user of the system. System testing questionnaires will be distributed to the users during the testing session. Improvements can be implemented based on user feedback to enhance the system's performance and user-friendliness. Additionally, the survey questionnaires will be redistributed to the students to evaluate the effectiveness of the developed system. Once the users and management are satisfied with the overall system, the Student Final Project Report Management System will be fully operational at JTMK, PSMZA. However, it should be noted that the developed system is still in the trial phase and will be fully operational when there are no complaints or issues raised by users or management.

## 4. STUDY FINDINGS

### 4.1 User Requirements Analysis

The user requirements study was conducted to gather insights into the current problems and suggested system improvements from the users' perspective[3]. Following the guidelines of Krejcie and [7], the minimum sample size required is 48 individuals for a population of 55. However, considering the views of [2] and [22] stating that a larger sample size is more reliable and convincing, questionnaires were distributed to 50 respondents. The survey results were summarized in tabular form (Table 1) as follows:

**Table 1.** Results of data analysis for the study of user needs

No.	Student Final Project Report Management System	Percentage			
		Strongly Disagree	Disagree	Agree	Strongly Agree
1.	The list of student project final reports for the last session is difficult to refer to	0%	8%	70%	22%
2.	It is difficult to search for student project final reports by project title in the library	0%	22%	54%	24%
3.	The search process of the Final student project report in the library takes time.	0%	22%	50%	28%
4.	The final report of the student project is more suitable to be placed in the department rather than the library.	2%	2%	36%	60%
5.	Allowing the final report of the student project to be borrowed by the student instead of only being referred to in the library	0%	6%	28%	66%

Overall, the table provides insights into how the respondents perceive various aspects of the Student Final Project Report Management System. It suggests that there are concerns about the accessibility and usability of the system, and a significant portion of respondents believe that the final project reports are better suited for departmental placement rather than being kept in the library. Additionally, there is strong support for allowing students to borrow the final project reports instead of just referring to them within the library.

## 4.2 System Usability Study Analysis

The Student Final Project Report Management System was developed with the aim of facilitating users in conducting searches and borrowing processes for Student Project Final Reports at JTMK. System testing was conducted through the distribution of system testing questionnaires to the Project Unit Committee at JTMK to test and validate the automation process of this system. Survey questionnaires were also distributed, initially to 20 respondents consisting of 6th-semester students from the Diploma in Digital Technology program, to assess the usability of the system. The survey results distributed to the students can be summarized in tabular form (Table 2) as follows:

**Table 2.** Data analysis results for usability

No.	Student Final Project Report Management System	Percentage			
		Strongly Disagree	Disagree	Agree	Strongly Agree
1.	The list of previous Student Project Final Reports can be easily referenced.	0	0	30	70
2.	The search process for Student Project Final Reports by project titles is easier compared to the manual system.	0	0	30	70
3.	The search process for Student Project Final Reports takes a short time.	0	0	25	75
4.	The borrowing process for Student Project Final Reports can be carried out easily and quickly.	0	0	30	70
5.	The status of Student Project Final Reports, whether 'Available' or 'Not Available,' is easily obtained.	0	0	25	75

The analysis in Table 2 clearly indicates that this system can assist users in conducting searches and borrowing processes for Student Project Final Reports at JTMK. Items 3 and 5 have the highest percentage of Strongly Agree, which is 75%, while items 1, 2, and 4 have a lower percentage of Strongly Agree, which is 70%. Through the yes-or-no agreement questions, 100% of the students also agreed that the Online Student Final Project Report Management System is highly effective in assisting users in conducting searches and borrowing processes for Student Project Final Reports at JTMK. Additionally, the Project Unit Committee members provided positive responses during the system testing, agreeing that this system should be implemented for the convenience of students and has achieved the established objectives.

## 5. CONCLUSION

The Student Final Project Report Management System was developed to replace the existing file-based system with a more database-oriented system. The developed system utilizes database technology, ensuring more accurate data storage by reducing data redundancy. Additionally, the stored data can be shared among all users of the system. The system also introduces enhancements by providing convenience for students to borrow the final reports.

The Student Final Project Report Management System brings numerous benefits to JTMK, particularly to the Project Unit, students, and lecturers. With the existence of this system, the list of Student Project Final Reports can be accessed faster compared to the existing records, thus saving time in accessing relevant information. The quality of teaching and learning at PSMZA can be improved as the relevant information regarding Student Project Final Reports can be easily accessed and utilized by students in completing their final projects. The system also contributes to environmental friendliness as it reduces the use of paper and ink in storing information and records related to the borrowing of Student Project Final Reports.

## 6. RECOMMENDATIONS

The researchers propose expanding the scope of the study by adding information on the achievement or category of Student Project Final Reports, whether unsatisfactory, moderate, or good, into the system. The record of students who have previously borrowed each report can also be included in the administrative scope of the system. Furthermore, the researchers hope that this system can be implemented in all academic departments at PSMZA and eventually be accessible through mobile devices. The system is also highly suitable for application and has the potential to be marketed as it can be utilized by academic departments in all polytechnics or other educational institutions for the purpose of storing Student Project Final Report information.

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## I-CReST 2023:321-289 - Development of IoT Starter Learning Kit for Educational Purpose

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### ABSTRACT

The Internet of Things (IoT) is a technology that enables physical devices to interact with their environment over the internet. Considering the present growth of industrial revolution 4.0 and demand of IoT in Technical and Vocational Education and Training (TVET), the usage of IoT devices in educational activities can improve the teaching and learning process to motivate students in much quicker and more efficient methods. There are many kits available in the market, but the cost of the kits is pricey and less ideal for usage to discover the fundamental of IoT. Furthermore, some IoT devices may not be compatible and do not function because of improper installation. Indeed, compatibility issues between IoT devices can present significant challenges during troubleshooting. The purpose of the paper is to demonstrate the development of the IoT starter learning kit which provide users with hands-on experience and practical knowledge in building IoT systems. This kit consists of Printed Circuit Board (PCB) board along with ESP8266, input port for sensor, light emitting diodes (LEDs), organic light-emitting diode (OLED) and relays. The structure of the kit is simple to understand, and it is well constructed. Overall, it can empower both students and lecturers with practical skills, foster creativity and prepare them for the exciting opportunities in the IoT technology.

**Keywords:** Internet of things; teaching and learning kit; educational kit

### 1. INTRODUCTION

In the era of Industry 4.0 and digital transformation, there is a growing imperative to enhance the understanding, mindset, and competencies of both educators and learners when it comes to microcontrollers and the Internet of Things (IoT). These rapidly emerging technologies giving a big challenge for both students and educators. Polytechnics one of higher education recognize a need to teach students digital skills and basic programming due to new trends and capabilities demanded by the industry. The study of microcontroller concepts is integrated into the curriculum of institutions ranging from universities and polytechnics to course centres and vocational high schools (VHS), with a special emphasis on the domain of electrical engineering education. Many educational institutions are continuously exploring new opportunities and seeking new technologies towards industry 4.0 to enhance learning and teaching process. Besides, they have discovered a remedy in the use of less expensive hardware, such as microcontroller platforms, sensors, and actuators, as well as software that can be used to program the hardware and is free for educational purposes [1], which can undoubtedly help students approach programming industrial machinery and equipment. Some of educators develop their own training kits to make the technical and practical learning easier for students.

The Internet of things is a simple concept which means taking all the things in the world and connecting them to the internet. For example, the smart home where user can remotely operate the things in that hub via a smartphone app or website since there are internet-connected smart TVs, lights, air conditioners, doorbells and security alarms that create a connected hub where data is shared across physical devices. An IoT prototype consists of a user interface, connectivity, and hardware components like sensors, actuators, and processors. An interface could be a web front end or a mobile application. A physical phenomenon may be measured by a sensor, which then converts the data into an electric signal. An actuator converts electrical input into physical movement. The microcontroller (MCU), which processes data and run software stacks interfaced to a wireless device for communication, serves as the IoT systems processor unit.

The MCU or development board is a prototyping tool with low-power processors that support a range of programming environments, collect sensor data using firmware, and transmit it to a local or cloud-based server. The NodeMCU that is an Arduino like device, is a platform that operates under an open-source firmware, offering the flexibility to modify, edit or construct its hardware design. The NodeMCU development kit comes with ESP8266 Wi-Fi chip. This ESP8266 is the ideal module for the IoT due to its low cost and powerful features [2].

The research problem addressed in the development of IoT trainer kits covers several key aspects. Firstly, the cost of the existing kits in the market is pricey. This financial constrain inhibit the accessibility of these kits to a broader range of students and institution. Secondly, a notable challenge arises in the troubleshooting process of IoT trainer kits. Th complexity of IoT systems often leads to intricate issues that students must resolve during their learning journey. This troubleshooting difficulty can hinder the smooth progression of practical learning experiences, potentially dampening the effectiveness of IoT education. Furthermore, a prevailing issue is the limited practical engagement available to students using current IoT trainer kits. This limitation impedes student's capacity to gain a comprehensive understanding of IoT concepts by restricting their hands-on interaction with real-world scenarios. Consequently, students may struggle to fully grasp the intricacies of IoT technology and its applications. Addressing this concern through innovative approaches and solutions in the development of IoT trainer kits is vital to enhance the affordability, troubleshooting ease, and practical engagement opportunities for students, ultimately enriching their learning experience and mastery of IoT concepts.

The objective of the paper is to demonstrate the development of the all-in-one package IoT starter learning kit tailored for educational purposes which provide users with hands-on experience and practical knowledge in building IoT systems. This paper describes the developed system, which could help the user understand the fundamentals of IoT applications, such as monitoring, data logging and controlling. It has been implemented on a Telecommunication Network course.

## 2. LITERATURE REVIEW

The integration of IoT trainer kits into educational settings has garnered significant attention to enhance learning experiences and prepare students for the digital age. These kits, designed specifically for educational purposes, offer hands-on engagement with IoT concept, enabling students to construct, program and interact with IoT devices. Literature underscores the benefits of IoT kits, including fostering practical skills, promoting critical thinking,

encouraging interdisciplinary collaboration, and aligning with curriculum standard. IoT has been successfully incorporated into variety of educational instruction modes, including face-to-face, remote, and hybrid, according to findings. IoT tools can enhance educational practices and support better teaching and learning [3-7]. However, challenges such as technical complexity, resource constrains, and effective assessment methods are also acknowledged. Research highlights the transformative potential of IoT kits in bringing the gap between theoretical knowledge and practical application, contributing to a more proficient and technologically literate generation poised to navigate the complexities of the IoT landscape.

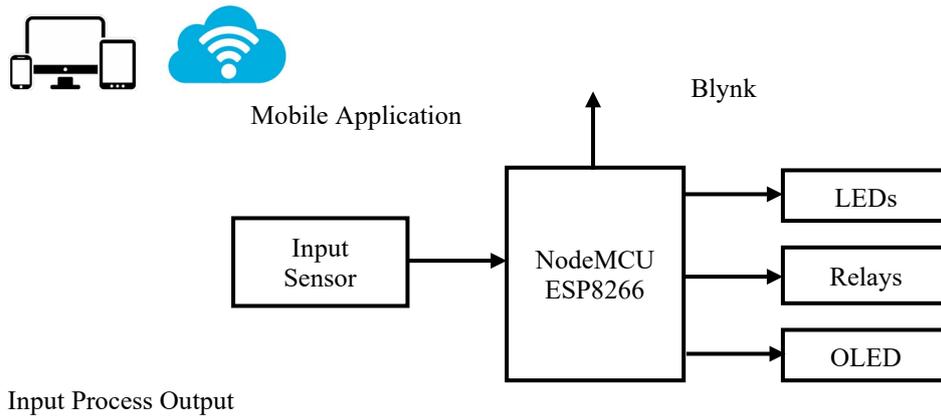
Numerous research investigations have been carried out to enhance comprehension within the realm of Electrical Engineering. Based on others researcher finding, Hamid et al. [8], Fong et al., [9] and Khaing et al. [10] do research and innovation about the development of training kits for education purpose. While Somantri et al. [11], Lyzhin et al., [12] and Kusmin et al., [13] studied the development and the implementation of IoT training. Furthermore, according to Zeeshan et al., [14] the IoT plays a crucial role in enhancing the efficiency of educational environments by optimizing their requirements. Given the numerous benefits and potentials of IoT technology research in the form of a learning trainer, the researcher takes the initiative to create one of the learning media resources in the design of an IoT learning trainer module with a prototype using NodeMCU, which is expected to provide changes for students in understanding and utilising computers and microcontrollers in a broader application.

### 3. METHODOLOGY

The IoT Starter Learning Kit was developed by 4 phases which are analysis, design, implementation and testing. The analysis phase involves investigating the surrounding environment to identify prevailing issues and discern the essential requirement for developing educational prototype kits. Then, the design phase takes place after understanding the essential requirement, enabling the creation of both the trainer kits hardware and the software for its utilization. Next, the implementation phase involves putting together all the components from the design stage to produce the IoT trainer kit. Once the trainer kit is complete, and it is deployed in the testing environment. During this phase, the kit is also tested to the targeted users for make it function properly accordance with the needs analysis.

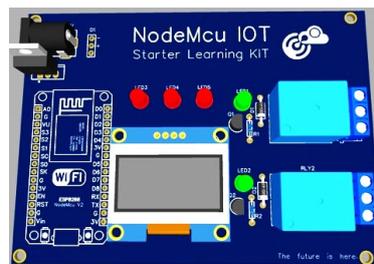
#### 3.1 Hardware Development

The trainer kit is an all-in-one prototyping platform for the internet of things that includes open-source development boards for microcontrollers and processors. The hardware development process is divided into three main parts process which are designing a schematic, producing Printed Circuit Board (PCB) layout and fabricating a PCB. During the circuit design process, the choice of the microcontroller circuit board holds significant importance to ensure seamless integration of every chosen component with both the main circuit board and other components that have been previously address. Based on the initial requirement analysis, the trainer kit is developed by using NodeMCU ESP8266 for its microcontroller and it consist of one input sensor, and two actuators; relay and LED as a basic trainer kit for students to understand the concept of IoT. Furthermore, this kit also includes one sensor input and OLED display. The block diagram of the IoT Starter Learning Kit is shown in Fig. 1.



**Fig. 1.** Block diagram of an IoT Starter Learning Kit

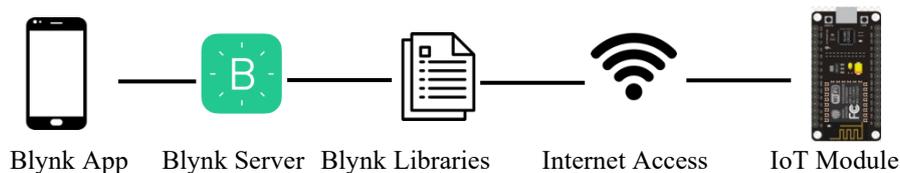
The schematic and PCB layout were designed using EasyEDA Online Software and were made by PCBWay Assembly Service. Fig. 2 shows the hardware board with the components mounted on the PCB.



**Fig. 2.** Hardware board with the components mounted on the PCB

### 3.2 Software Development

The next step involves enhancing the components capability to establish an internet connection. The program code for this trainer kit is implemented using the Blynk application. Blynk is an Internet of Things platform that works with variety of microcontrollers, including NodeMCU, ESP32, ESP8266, Arduino, Raspberry Pi, Particle and supports both iOS and Android. This application is used to generate a graphical interface or human-machine interface (HMI) by assembling and configuring the appropriate addresses within the accessible widgets. The Blynk's architecture as shown in Fig. 3 consists of three main components; Blynk application which controls an embedded system and uses widgets to display data, Blynk server that allows all cloud-based connectivity between mobile devices and embedded system, and Blynk libraries which are made up of numerous widgets for performing out various control, display and time management tasks.



**Fig. 3.** Blynk's architecture



At testing phase, the trainer kit is tested by running a generated program through each component and sending several data to the OLED for display. The test results are shown in Table 1.

**Table 1.** Component testing result

No.	Component	Expected Output	Remarks
1	LEDs	The LEDs light up upon the execution of the program code	Succeeded
2	Relays	The relays are activated upon the execution of the program code	Succeeded
3	Input Sensor	The DHT11 sensor detects the temperature and humidity of the room	Succeeded
4	OLED	The OLED display the data upon the execution of the program code	Succeeded

Besides that, this trainer kit has been evaluated by Diploma in Electronic Engineering (Communication) third-semester students and a group of lectures who are also final-year project supervisors.

#### 4. RESULT AND DISCUSSION

Based on hardware design, software, input-output testing, and remote testing experiments, the trainer is working properly to support the practical work related IoT topics. The development of IoT Starter Learning kit is shown in Fig. 4. It satisfied the design specification that users could use this trainer as a learning platform to understand IoT applications. In a survey of 40 students, 98% said they were happy with the trainer's appearance and usability. While in a survey of 11 lecturers, 100% were satisfied with this kit. The goal of this development trainer kit is accomplished by this outcome.



**Fig. 4.** The development of IoT Starter Learning kit

#### 5. CONCLUSION

The growing adoption of IoT devices has captured the interest of various industries, among them the field of education. The demand for inventive pedagogical approaches is pressing due to the multifaceted nature of IoT. Employing educational kits expedites the learning journey and unlocks the full potential of IoT. This research has succeeded in developing IoT trainer kit tailored for educational purpose. According to the test results, the designed instructional kit can operate effectively in line with the needs analysis. The kit is well-built and has an easily comprehensible structure. Overall, it may provide practical skills to both students and

professors, encourage innovation, and get them ready for the exciting opportunities in IoT technology. It has been implemented for Telecommunication Network course. For future work, one of the aspects that should be improved in the study and development kit was the supplied material. The content must adapt as technology does to keep up with these changes.

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## SOCIAL SCIENCES

## **I-CReST 2023:009-176 - The Application of Serious Game in Donation Crowdfunding Platform: Mediating Role of Trust in Platform**

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### **ABSTRACT**

The inception of technology in the financial world has spawned many innovative financial activities, including crowdfunding. Ever since its inception, crowdfunding has fostered a thriving environment for fundraising initiatives, facilitating the realization of countless innovative projects and enterprises. Nevertheless, sustaining a consistent stream of donations poses a significant hurdle for crowdfunding platforms. Most crowdfunding platforms lose half of their donors after their first donation. Therefore, this study proposes the use of gamification to increase and maintain individuals' donations on a crowdfunding platform. In addition, this study also examines the role of user experience and trust in platform as a mediating variable between gamification and donor intention on the crowdfunding platform. Data for this research were collected through a survey, then analysed using structural equation model using partial least squares method (SEM-PLS). The hypothesis testing revealed that gamification positively influences user experience, but not donation intention on a crowdfunding platform. Meanwhile, user experience and trust successfully play a mediating role. Thus, the results lead to a discussion on the justification of using gamification and suggestions for future research.

**Keywords:** Crowdfunding; donation; gamification; trust; intention

### **1. INTRODUCTION**

Advancements in technology have revolutionized fundraising methods in recent decades. In the past, people relied on religious centers or traditional organizations for donations. However, the emergence of the Internet introduced a new approach through crowdfunding platforms. These platforms act as intermediaries, connecting those seeking funds with potential contributors. By posting their projects on these online platforms, individuals and organizations can reach out to a global audience, breaking geographical barriers and facilitating faster fundraising compared to conventional methods.

Crowdfunding platforms have revolutionized fundraising by accommodating diverse project types, including civic crowdfunding and not just emergency cases [1]. This online system has facilitated global donations, allowing millions of people worldwide to contribute to various projects with greater efficiency compared to conventional methods [2]. Technology has ushered in a new era of fundraising, broadening the scope of support and amplifying the impact of charitable efforts worldwide.

Even though the introduction of a crowdfunding platform to ease donation activities, local crowdfunding platforms are struggling to attract donors. Researchers found that more than 50% of crowdfunding projects are failed to reach their funding target [4], [5]. The phenomenon implies the imbalance ecosystem of donation-based crowdfunding activities when people seeking funding are more than people contributing to the projects. If this trend continues, donation based crowdfunding activities will collapse and just be a mere trend. Worst, the failure to successfully fund crowdfunding projects will hinder the potential of crowdfunding as the vehicle for alternative funding.

Prior research found that the usage of crowdfunding platforms is to initiate an exchange of resources between fund seekers and donors [5]–[7]. Contributors have forgone their financial portion to pledge to a crowdfunding project to receive returns [8]. Some of them are looking for social reputation [9] and community recognition [10]. In other words, they feel the same obligation to do the project that they are funding to be a success [11].

In addition, trust has been the recurring issue when involving financial contributions either for economic benefits or benevolent action [12], [13]. In charitable perspectives, donors have limited information and connection towards the beneficiaries thus they rely on their mental short cut to trust the intermediaries in managing their contribution with integrity [14]. Therefore, the objective of this study is two-fold, first, this study intended to examine the usage of serious gamification to attract donors to donate using crowdfunding platform and second, the role of trust as mediating factors between gamification and intention to donate.

## **2. LITERATURE REVIEW**

### **2.1 Donation Crowdfunding**

The contextual based definition of crowdfunding was built on two perspectives which are the goals of the contributors and the nature of the relationship between the fund seeker and the crowd. As such, it is divided into two main categories which are investment-based crowdfunding and charity-based crowdfunding [15]–[17]. The first category is for investors who look for monetary exchange for their investment while the second category implements a modus operandi that provides nonfinancial returns. Focusing on donation crowdfunding, Paschen (2017) grouped donors based on their expectations to receive rewards into two groups, the pure donors who financially support crowdfunding projects without the intention to seek any return and those who are involved in crowdfunding projects to collect non-tangible rewards such as recognition or tokens.

Donation-based crowdfunding, also known as charitable crowdfunding [19], involves contributors providing financial support to a project without expecting anything in return from the project owner [20]. This type of crowdfunding operates solely on the spirit of goodwill. In terms of volume, donation crowdfunding ranks as the second-largest form of crowdfunding globally (Massolution 2015). Significant contributions to this achievement have been made by platforms like Global Giving and Go Fund Me. Among them, Global Giving, established in 2002, has played a pivotal role in collecting donations from crowds worldwide and distributing them to those in need across the globe. These donations have been utilized for various social projects and charitable causes, with a particular focus on providing relief funds in the aftermath of natural disasters [21].

## 2.2 Gamification

Gamification is a concept that combines elements of game design with a reward structure to motivate and engage individuals in non-game contexts. The goal is to make tasks or activities more enjoyable, encouraging participation and promoting desired behaviors. In a gamified reward system, various features typically found in games are employed, such as points, levels, badges, leaderboards, challenges, and other forms of virtual rewards. When the fun and enjoyable element from game activities embedded in a non-game context, it is known as serious game.

Due to its proven effectiveness in increasing students' motivation and participation, gamification has found wide application in the education field, leading many websites to incorporate such systems into their platforms. Specifically, researchers had conducted research pertaining to gamification in crowdfunding activities [22][23] and these researchers confirmed that gamification could ensure the contributors' participation in crowdfunding activities. Nevertheless, the topic remained sparse, and this research intends to enhance the understanding of gamification in crowdfunding perspectives. Empirically, gamification has emerged as a popular trend in web services due to its ability to influence customer behavior and enhance their motivation for task performance [22][23]. In crowdfunding context, gamification found to have positive correlation with users' intention to utilize a crowdfunding platform [23].

Meanwhile, the connection between gamification and trust has its constraints as incorporating game elements primarily aims to offer a fun and enjoyable experience, which may lead to a perception of reduced seriousness and trustworthiness in certain activities. Nevertheless, some studies, such as [24] have discovered that the use of a progress bar can serve as a positive signal to potential contributors, indicating that a project is worthy of funding. In this sense, when contributors perceive a project as deserving of their financial support, the presence of gamified elements can actually enhance their trust in the endeavour. Based on this observation, the following hypothesis is formulated;

H1: Gamification has a positive influence on intention to donate using crowdfunding platform

H2: Gamification has positive influence on trust in platform

## 2.3 Trust in Platform

Researchers from various academic fields such as sociology, social psychology, economics, organizational behavior, and marketing have extensively studied the concept of trust. Recently, there has been a growing focus on understanding trust in the context of online perspectives arising from e-commerce activities [25]. [26] define trust in the online environment as an outcome of prolonged interactions between parties involved in a transaction. They propose a model that considers disposition to trust, institution-based trust, and trusting belief as factors influencing trusting intention.

In the realm of the Web, trust can encompass various aspects, including trust in the website itself, trust in the Web vendor, or trust in the Internet in general [27]. In transactions conducted on virtual platforms like websites, trust towards the website plays a particularly critical role (Oh et al., 2012). Additionally, it becomes essential to consider trust in the website when dealing with activities operating as two-sided market mechanisms such crowdfunding platform

since the website serves as the medium connecting the other two key players and facilitates communication between them [28].

Trust plays a pivotal role in potentially mediating the relationship between website features and behavioral intention. Studies have demonstrated that trust fosters various forms of philanthropic activity, such as charitable giving and voluntary work [29], civic engagement [30], and monetary donations [31]. Therefore, trust is widely recognized as a critical factor in facilitating online transaction activities. Hence, the following hypothesis is formulated;

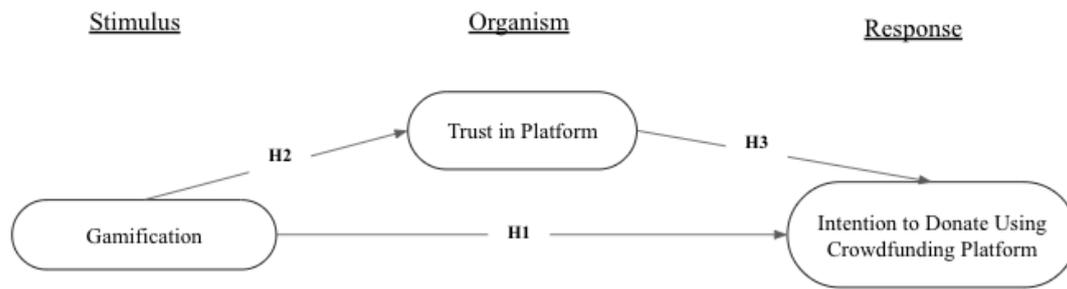
H3: Trust in platform has a positive influence on intention to donate using crowdfunding platform

H4: Trust in platform as mediating variable will strengthen the relationship of gamification and intention to donate using crowdfunding platform

#### **2.4 Stimulus-Organism-Response (S-O-R)**

The Stimulus-Organism-Response (S-O-R) model, proposed by Mehrabian and Russell in 1974, presents a conceptual framework that explores the interconnectedness of external stimuli, internal processes within the organism, and the resulting responses of the organism. According to this model, the impact of external stimuli on an individual's behaviour is influenced by their personal cognitive and emotional states [32]. In essence, the stimulus refers to an external element capable of influencing a person's cognitive and emotional state, while the organism represents the internal processes that generate a reaction (Vieira, 2013). The response, on the other hand, corresponds to the approach-avoidance behaviour, which is determined by the organism.

Therefore, the S-O-R model aims to highlight the mediating role of the organism in understanding human behaviour. In this study, based on the S-O-R model, we argue that gamification is likely to have a positive effect on trust in platform. Mehrabian and Russell (1974) proposed the S-O-R model as a way to explain a process that a stimulus transmits to a response via organism. In other words, the model indicates that stimuli cause individual cognitive and affective reactions, which, in turn, leads to behavioural outcomes. Fig. 1 shows the theoretical framework of this research.



**Mediating effects:**

**H4:** Gamification - Trust in Platform- Intention to Donate Using Crowdfunding Platform

**Fig. 1.** Research framework

### 3. METHODOLOGY

This study aimed to gather data from individuals with a basic understanding of crowdfunding and familiarity with crowdfunding platforms. Due to the nascent crowdfunding landscape in Malaysia, the researchers adopted a virtual snowball sampling approach to identify suitable respondents. The process involved scouring Facebook and Twitter pages related to crowdfunding. Identified individuals were then sent a survey link, which they completed. Additionally, participants were given the opportunity to recommend acquaintances for potential inclusion in the study. This data collection method resulted in 176 respondents who met the study's criteria. The findings revealed that over half of the respondents were female (58.8%), the majority aged between 18 and 25 years (68.8%), and most were students (55.7%).

### 4. FINDING

Data were analysed using SmartPLS to test the direct effect of gamification and trust in platform on intention to donate. Meanwhile, the mediating effect were accessed based on the result form indirect hypothesis testing analysis. Based on the table below, all hypothesis are supported.

**Table 1.** Direct hypothesis testing

Relationship	Std Beta	Std Error	t - value	P Values	Decision
Gamification -> Intention (H1)	0.211	0.059	3.551	0.000	Supported
Gamification -> Trust in Platform(H2)	0.590	0.047	12.472	0.000	Supported
Trust in Platform -> Intention (H3)	0.632	0.056	11.387	0.000	Supported

**Table 2.** Indirect hypothesis testing

Relationship	Std. Beta	Std. Error	t- value	LL	UL	Decision
Gamification – Trust in Platform – Intention (H4)	0.373	0.046	8.176	0.302	0.453	Supported

## 5. DISCUSSION AND CONCLUSION

Persuasive technology, exemplified by gamified websites, plays a crucial role in enhancing website credibility and fostering users' trust, as noted by Fogg in 2003. Additionally, the implementation of an almost accomplished progress bar on crowdfunding platforms serves as a powerful indicator of the project's popularity and success, as it reflects numerous contributions from individuals. This display of substantial financial support significantly influences potential contributors, instilling trust in the platform and encouraging them to participate in the project with confidence. By leveraging such persuasive elements, websites and crowdfunding platforms can effectively build trust and credibility, thereby attracting a more engaged and supportive user base.

Furthermore, gamification has emerged as a powerful tool for fostering trust in various domains. By altering the behavior of voluntary participants, it effectively encourages engagement in civic activities, promoting a sense of trust and collaboration. Additionally, gamification offers a technology-driven approach to establishing trust relationships with users, enticing them to accomplish the objectives of their interactions with a platform. As highlighted by [33] this innovative approach has shown promising results in cultivating trust and enhancing user experiences.

In conclusion, the study provides valuable insights into the impact of serious games, also known as gamification, on crowdfunding platform users. According to the research, serious games play a significant role in enhancing trust among users of such platforms. Moreover, the study highlights that trust in the platform serves as a mediator variable, linking the influence of gamification to users' donation intentions. These findings hold significant implications for crowdfunding platform operators, as they suggest that incorporating serious games should not be met with reluctance. On the contrary, doing so can foster a positive environment that not only boosts contributors' trust but also encourages their willingness to donate through the crowdfunding platform.

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## **I-CReST 2023:032-011 - A Correlational Study on Servant Leadership and Employee Engagement in TVET Educational Institutions**

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### **ABSTRACT**

This study aims to examine whether there is a significant and positive relationship between servant leadership and employee engagement, especially among educators in TVET educational institutions. The researcher sees the need to carry out this study since educators in Malaysia nowadays are increasingly experiencing burnout, job dissatisfaction, work involvement and turnover intentions. In this regard, the researcher detected the potential of servant leadership as effective leadership and a solution to the bad situation faced by directors in TVET educational institutions. Quantitative, descriptive and Pearson Correlation Coefficient methods were used in this research. Data was collected through a questionnaire using Google Forms from TVET educators in Kuching, Sarawak. Data were analysed using SPSS version 25 to find the relationship between servant leadership and employee engagement. The findings of the study have shown that servant leadership has a positive and significant relationship with employee engagement. Specifically, the analysis showed two of the characteristics of servant leaders, namely, emotional healing and behaving ethically were found to be related to employee engagement. Servant leadership shows its relevance in involving educators in their work. Through this research, educators are looking for caring leaders who act with integrity. The implication of the study is to reveal servant leadership to directors, continuous training, and provide professional development through courses designed to improve the director's skills and knowledge of the theory of the concept of servant leadership.

**Keywords:** Servant leadership; employee engagement; TVET educational institutions

### **1. INTRODUCTION**

The practice of servant leadership has shown its partial relationship with employee engagement. In quantitative research at one of the Malaysian Private Universities among the support staff, the finding showed that two dimensions of servant leadership namely communication and empowerment had a significant relationship with employee engagement while healing, integrity, service, and trust harmed employee engagement [7]. In addition, the researchers found that among working adults in various organizations, servant leadership was partially significant to affective commitment as only two out of eight dimensions of servant leadership showed positive affect towards affective commitment.

Numerous types of research had been conducted on the relationship between servant leadership and self-efficacy in the corporate world and service industries. For instance, the mentor and mentee's self-efficacy may be affected by servant leadership, servant leadership may enhance the effectiveness of mentoring relationship, and transformation in the mentor and mentee may occur, resulting in personal and professional development for the mentor and mentee. Chen, Zhu, and Zhou [8] found that servant leadership brought a beneficial effect on employees' self-efficacy in a salon. In the same vein, Tian, Hu, and Cheng [32] articulated that servant leadership had a positive impact on employees' self-efficacy in government agencies and state-owned enterprises with the result of encouraging the employees to express their opinions, views, and concerns regarding working issues.

In addition to this, Qiu, Dooley, and Xie (2019) predicted a moderate relationship between servant leadership and self-efficacy. According to Qiu et al. (2019), hospitality employees with low self-efficacy appreciated servant leader better than those with high self-efficacy as servant leaders provided support and encouragement, emotional healing, and commitment to developing their potential to the fullest. To reciprocate, the employees gave their best service to their customers. Therefore, through these past studies, it appeared that there is a need for the researcher to conduct a study on the investigation towards the significant influence of servant leadership on employee engagement and self-efficacy in the educational field in Malaysia.

## **2. LITERATURE REVIEW**

### **2.1 Servant Leadership and Employee Engagement**

Servant leadership is verified as effective leadership in various sectors. According to Spears [29], servant leadership has been widely practised in business organizations, non-profit organizations, educational institutions, medical management, religious organization, and foundations. An effective leader promotes professional relationships and brings school improvement, reformation, and success to the school. Inspired by their servant leader, followers emulate their leader's behaviour, perform well, and are committed to their tasks by serving their students effectively. Allensworth and Hart [3] asserted that by being supportive of the teachers, teachers feel motivated and invest their energy, effort, and focus in their work which enhanced students' learning and achievements. In the arena of sports, Lee [19] postulated that servant leadership was associated with emotional intelligence and the development of students' goals. These achievements were obtained because servant leader was committed to the growth and success of the follower, placed subordinates' interests and needs above their own's interests [20]; ensured the personal and professional development of the followers, became their mentors, gave words of encouragement and affirmation [16]; playing their role as a steward of the organization and respond to the society [33]; and demonstrate honesty, fairness, and openness [20].

The attributes of servant leadership and employee engagement implied the possibility of a positive relationship between servant leadership and employee engagement. Functioning as empowering teachers for school improvement, transformation, and effectiveness, servant principals served the needs of the followers first and behaved ethically. Follower educators who are empowered by the servant principal exhibit loyalty, are attached to their work and work diligently for the success of the students and the institution. In addition to this, educators demonstrated their ability, served the students, and desired to continue to serve in the institution. Thus, the quality service of the educators increased and enhancement of the

commitment to the institution. Al Hila and Al Shobaki [2] clearly stated that servant leadership is significant to the excellent performance of educators in technical colleges.

Visionary, trustworthy, and reliable servant leaders influenced the followers to dedicate themselves cognitively, emotionally, and physically to their work. Coetzer, Bussin, and Geldenhuys [9] stated that servant leadership mediated by job resources is positively associated with work engagement in a construction company. Gaining support from the servant leader through obtaining job resources [31], yielded a high level of work engagement. In addition to this, when the servant leader helped the employees to grow and succeed in their work, the employees reciprocated by being fully concentrated and absorbed in their work.

Setyaningrum, Setiawan, and Surachman [28] argued that servant leader elements such as empowering and developing, caring, meeting the needs of employees, and valuing their opinions involve them in their dedication and commitment without being selfish. Employees feel valued and invested in their energy (strength), dedication, and absorption (absorption) in the organization. When servant leaders listen to their employees' ideas, employees identify themselves with the organization and see themselves as part of the organization, and success and failure are their responsibility as well [32]. Previous studies have also found that servant leadership has a positive influence on academic engagement in higher education institutions [22]. In addition, mediated by intrinsic motivation, psychological ownership, and individual fit with the job, servant leadership has positively influenced academic engagement to a higher degree.

A servant leader who exhibits conceptual skills (competence, capability, organizational knowledge) builds trust among employees and wins their engagement. However, there is also evidence showing that servant leadership partially influences employee engagement [6]. Brown [6] states that servant leadership has a positive effect on meaningfulness and psychological safety but not availability. On the other hand, Mohammed, Khalid, and Mohammed [23] reported that servant leadership was not associated with work engagement in educational institutions. Therefore, it is hypothesized that:

Ho: There is no significant and positive relationship between servant leadership and employee engagement among the TVET educators in Kuching, Sarawak.

Ha: There is a significant and positive leadership between servant leadership and employee engagement among the TVET educators in Kuching, Sarawak.

### 3. RESEARCH METHODOLOGY

This study was conducted quantitatively where data was collected using a Google form in the form of a Likert scale (1 strongly disagree - 6 strongly agree). The collected data was analyzed using SPSS version 25 to find the correlation. Accordingly, this study uses a simple random sampling method. The questionnaire was distributed to 60 TVET educators at one of the TVET educational institutions in Kuching. However, a response rate of 80 percent involving 48 respondents participated in this study. This number is sufficient based on the Krejcie and Morgan (1970) Sample Size Determination Table.

This study uses a quantitative research approach because the data is more accurate, and can be replicated, allowing the researcher to gain a greater understanding and knowledge about the population being studied [34]. This approach also saves time and research resources.

Distributing questionnaires to respondents allows researchers to collect extensive data at one time, faster, and easily (Queiros, Faria, & Almeida, 2017). Collected data is analyzed immediately using statistics and as a result, researchers invest less time and energy to generate results [11].

In this research, female respondents outnumbered male respondents where 72.9% were female and the percentage for males was 27.1%. The primary contributors to this research aged 45 and above represented 25 (52.1%) and the lowest was 6 respondents (12.5%) from the 41-45 age group. With regards to working experiences, the highest was 20 years and above with a percentage of 50% (24 respondents) and the lowest was 10.4% (6 respondents) with working experiences less than 10 years. The level of education was dominated by a bachelor's degree with 50% (24 respondents).

The questionnaire used contains three parts with a total of forty items that have been adapted. Part A is a demographic profile of respondents constructed by the researcher that contains four items. To measure servant leadership, twenty-eight items were adopted and adapted from Liden, Wayne, Zhao, and Henderson [20]. Sample scales include, "I will seek help from my manager if I have a personal problem," "My manager cares about my well-being," and "My manager values honesty more than profit." Conversely, Section C measures employee engagement and consists of eight questions adopted and adapted from May, Gilson, and Harter [21]. Examples of scales include, "Performing my task is so interesting that I forget everything else," and "I am rarely distracted when performing my work."

#### 4. FINDINGS AND DISCUSSIONS

The findings of the study have shown emotional healing ( $r = .446, p = .009$ ) and behaving ethically ( $r = .479, p = .005$ ) were found related to employee engagement. Therefore, the null hypotheses were rejected. On the other hand, H2 was not rejected because the result showed  $r = .352, p = .045$  as the significant level was .01. This was followed by H3 where the result was  $r = .252, p = .156$ . The value for H4 was  $r = .313, p = .077$ . Thus, the null hypothesis was not rejected. H5 was not rejected as the result indicated at  $r = .306, p = .083$ . Finally,  $r = .394, p = .023$  was the result for H6 and the hypothesis was not rejected. In conclusion, two of the null hypotheses were rejected while five of the null hypotheses were not rejected. The present research aimed to examine the significant and positive relationship between servant leadership with employee engagement among TVET educators in Kuching. As predicted, the analysis revealed a significant and positive relationship between servant leadership with employee engagement whereby two of the servant leadership's dimensions, which are, emotional healing and behaving ethically were found to be associated with employee engagement. This result agrees with those obtained by Coetzer et al. [9]; Kaur [13]; Mohammed, Khalid, and Mohammed [22] where servant leadership were proven to engage the employees in their workplace.

Teaching is not an easy thing to do. Previous research findings have shown that the level of depression, stress, and anxiety faced by educators is very high [26]. In addition, educators from preschool to higher education levels are reported to experience fatigue [26]; high job demand and low job resources cause job dissatisfaction, job alienation and turnover intentions [1]. Furthermore, students' attitudes towards learning and their low performance, the conditions of the learning environment [24]; abusive words, vandalism, challenging students [27]; not

being appreciated [30]; and multitasking between online classes and households [26] increases the level of fatigue, exhaustion, and stress.

Analysis of the data collected shows that leaders care about their well-being and spend time communicating with them. The gesture of listening serves to ease the emotional turmoil of educators where educators can be freed from the burden because the root cause has been identified. Expressing care and concern for educators helps create a caring climate and as a result, it reduces stress and emotional turmoil for educators. When the atmosphere is positive, educators can carry out their duties with enthusiasm for the benefit of students. This is in line with the views of Ravender, Sharma, and Mona (2017) who have emphasized the characteristics of servant leaders, namely, empathy, compassion for employees, acting selflessly and listening to employees to ease their emotional turmoil, restoring the broken spirit and bring balance to their emotional state. Based on the leader-member exchange theory, the relationship between the leader and the subordinates in the context of this research can be said to be at the highest level because the director shows care and concern, stabilizes emotions, and restores their health. Feeling indebted to the leader, the subordinates responded by involving themselves in the task physically, emotionally, and cognitively.

The findings of the study also explain that educators consider their leaders to always practice high standards of ethics and integrity and are shown to be at an above-average level. Undoubtedly, leaders who work and act with integrity gain trust and influence educators to imitate and emulate their behavior. Educators feel safe and see the leader as trustworthy and responsible. In addition, ethical values such as justice, equality, honesty, responsibility, and respect are attractive qualities and interest educators to continue their work. The leader who serves and respects subordinates is open and honest in communication, implements equality, fairness, and equity in treating all members of the educational institution and takes responsibility for the decisions that have been made to inspire them to be involved in the educational institution.

The leader's credibility creates a positive atmosphere and increases their trust in their leader. A high level of integrity, concern, reliability, and efficiency in the workplace increases trust between educators and directors [4]. A positive climate is very important in educational institutions because it makes educators feel fun, free, and excited in carrying out their duties. Moreover, when leaders are respectful, honest, and fair in the management of institutions, the result is more committed and involved educators.

Trust is an essential element in relationships without which the relationship between leaders and employees will remain at a basic level. Kshirsagar and Ramgade [15] stated that honesty and integrity are the keys to successful leadership. This is also explained by the Leader-Member exchange theory when the relationship is at a basic level, less attention will be given, and fewer resources and support will be given to them. Conversely, when the relationship is at a high level, more attention and resources will be given to them. Radstaak and Hennes [25] improve high-quality relationships between leaders and employees and contribute to employee engagement. This follows receiving attention and resources from the leader which causes employees to feel indebted and reciprocated with positive attitudes and high involvement.

## 5. SUGGESTIONS AND CONCLUSION

Servant leadership has proven to be an effective leadership style in engaging TVET educators in their work. Servant leaders place importance on the well-being of their followers and care about their well-being as well. This leadership style also focuses on aspects of providing healing, motivation and aspiration, servant leaders acknowledge the needs of their followers and offer psychological support and a sense of belonging to reduce challenges in the contemporary workplace [10]. Under this leadership, the servant leader acts altruistically for the good and the good of the followers that is to develop the potential and talents of the followers to the fullest and obtain success in their work and life.

Undoubtedly, emotional health is as important as physical health and should not be neglected as it affects daily life and work performance. Employees with healthy emotional well-being can engage productively in performing their duties by remaining resilient despite life's challenges and difficulties. The World Health Organization has declared October 10 every year as World Mental Health Day with the aim of raising awareness about mental health, providing support to those in need, emphasizing all stakeholders to address mental health issues and further actions that can be taken to help people who are suffering emotionally [35]. Therefore, attention should be taken to managing the emotional state of employees for the sake of employee well-being and the sustainability of their work performance.

Behaving ethically also increases employee engagement in physical, emotional, and cognitive terms. Leaders who act honestly and fairly are individuals who can be trusted and will win the trust of employees, inspire and lead employees to act ethically. It is a personal trait in which employees voluntarily invest their energy, time, and talents in performing the tasks assigned to them. In any organization, trust is an essential element for effective relationships and essential for leadership for its sustainability and survival. Blanchard, Olmstead, and Lawrence [5] suggested the ABCD strategy of creating the trust that is possible, reliable, connected, and trustworthy. As a leader, he can demonstrate competence and skill; can be trusted by showing honesty, sincerity, humility, fairness, and respect; relate to each employee by showing attention, and concern and listening to them; and can be trusted with consistency, order, and continuity with school improvement planning. Therefore, employees perceive their leaders as ethical leaders to whom they dedicate their energy, time, and talent to work hard and immerse themselves in their work.

In retaining capable and knowledgeable educators, effective leadership is necessary. Furthermore, educational institutions have struggled to retain capable educators who seek higher prospects in other organizations. Without educators, student performance and success will be difficult. Educational institutions need educators who are ready to work, put their whole selves into the task and contribute cognitively, emotionally, and physically. This finding suggests the relevance of servant leadership theory to leaders and educators of educational institutions. In addition, it provides valuable information to the Ministry of Education, directors and educators about the importance, effectiveness, and practicality of servant leadership in involving educators in institutions. Employee performance increases when the level of employee engagement increases. Therefore, it benefits students because servant leaders can influence students and have a positive effect on their learning outcomes and engagement.

In theory, this study provides an additional reference to researchers regarding the relationship between servant leadership and employee engagement in TVET educational

institutions. The findings of this study have shown a positive and significant relationship between staff leadership and employee engagement. Therefore, the results of this study can be used to fill gaps in research and improve servant leadership literature. These findings provide the following insights for future research: Researchers can use a mixed-mode approach to obtain a diversity of views from participants and gain deeper insights and explanations for their preferred leadership types, regarding leadership issues and their relevance to their involvement. In addition, researchers can revise the conceptual framework and theoretical framework as a guide for future research by adding mediators or moderators to make the research more interesting, and to examine the relationship between the independent variable and the dependent variable. Furthermore, the sample of this study is small (forty-eight participants) and involves one of the educational institutions in Kuching. Therefore, the sampling population and sample can be expanded by adding samples in various sectors in Sarawak such as in public schools, private schools, agencies, or other related parties that provide educational services in generalizing.

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## **I-CReST 2023:043-262 - Light Pollution: A Brief Review on International Legal Framework and Malaysia**

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### **ABSTRACT**

This paper reviews the issue of light pollution, a pervasive and prevalent environmental issue with implications for human health, biodiversity, astronomical observations and ecological balance. This doctrinal study consists of a comprehensive analysis of background and legal perspectives and international legal perspectives from developed countries, including common law cases and international treaties and Malaysia's legislations. Given the absence of binding measures in the Malaysian legal framework, this study also explores the efforts and measures taken by other countries to tackle light pollution. In the context of Malaysia, the Parliament has enacted the Environmental Quality Act 1974 [Act 127], however, the Act lacks a clear and precise definition as well as enforcement measures specifically addressing light pollution. Therefore, this research paper presents a comprehensive analysis of the factors and impacts of light pollution and evaluates the effectiveness and alignment of the Malaysian legal framework with international standards. It identifies regulatory gaps and offers recommendations, emphasising the absence of binding solutions or legislation. Drawing insights from these examples, specific recommendations are proposed for the Malaysian government to enhance its legal framework, reduce light pollution, protect public health and ecosystems and promote sustainable practices. It also offers tailored recommendations for Malaysia by empowering policymakers, environmental agencies and stakeholders to mitigate light pollution and preserve natural darkness. Hence, Malaysia needs to urgently implement these solutions to have sustainable lighting practices and that we need to ensure a harmonious coexistence between human activities and the nocturnal environment for the sake of our future as per the United Nations Sustainable Development Goals (SDG), particularly SDG 3 and SDG 15.

**Keywords:** Light pollution; international law; Malaysian law; sustainable development goal

### **1. INTRODUCTION**

Light pollution has emerged as a significant environmental issue in recent years, drawing attention to the detrimental effects of excessive artificial lighting on the natural world and human well-being. As urbanisation and industrialisation continue to expand, the night skies that were once filled with stars have given way to a pervasive glow that obscures our view of the cosmos. This phenomenon has profound implications for various aspects of life, including ecosystems, human health, astronomical research, and energy consumption.

The term, light pollution, refers to the excessive or misdirected artificial light that spills beyond its intended area, resulting in the brightening of the night sky and the illumination of

the surrounding environment. It arises from a variety of sources, including streetlights, commercial and residential buildings, sports facilities, and advertising signs. Instead of serving its intended purpose, light pollution spills over into the atmosphere, creating a diffuse glow that obscures celestial objects, hinders astronomical observations, and impacts the natural behaviour of organisms.

Statistics reveal the pervasive nature of light pollution and its widespread impact on different regions around the world. According to recent studies, it is estimated that over 80% of the world's population lives under light-polluted skies. Dense urban areas and industrial regions are particularly affected with high levels of artificial illumination that drown out the visibility of stars and celestial bodies. In many cities, the night sky is now up to a thousand times brighter than it was just a few decades ago, greatly diminishing the ability to observe stars and other astronomical phenomena. Urban centres and densely populated areas often experience severe light pollution, with excessive brightness that extends well beyond the immediate vicinity of the light sources. These statistics demonstrate the extent to which our nights have been transformed by the ever-present glow of artificial lighting.

The impact of light pollution extends beyond its interference with stargazing and astronomical research. It also affects the natural behaviour and ecological processes of wildlife, disrupts human sleep patterns, and contributes to unnecessary energy consumption and carbon emissions. Hence, in understanding the magnitude of light pollution and its widespread occurrence, there is an urgency in addressing the issue of light pollution and taking proactive steps to mitigate its adverse effects.

## **2. INTERNATIONAL LEGISLATION**

In recent years, the issue of light pollution has gained significant attention around the world due to its negative impact on human health, wildlife, the environment, and the night sky. As a result, there has been an increasing demand for international regulations to manage and control light pollution. While there is no universal law which governs light pollution globally, many countries have implemented their own legislation to mitigate the effects of excessive outdoor lighting. This includes regulations on the use of outdoor lighting fixtures, the types of bulbs used, and the amount of light emitted. Thus, there are various countries internationally which have their legislations which help to regulate light pollution.

### **2.1 United Kingdom**

In the United Kingdom, light pollution is addressed through a combination of regulations and statutes. The Clean Neighbourhoods and Environment Act 2005 is the first statute that directly addresses light pollution. This can be seen in Section 102(2) of the Act, which deals with statutory nuisance for lighting, amends Section 79(1)(fb) of the Environmental Protection Act 1990. It introduces provisions that declare artificial lights capable of jeopardising health or causing nuisance as statutory nuisances. The Clean Neighbourhoods and Environment Act 2005 also includes Section 102(5B), which excludes certain lights emitted for transportation systems such as airports, harbour premises, railway premises, tramway premises, bus stations, lighthouses, and prisons. This exclusion is necessary for safety reasons due to the nature of these facilities. However, the Act does not specifically address lights emitted for advertising purposes.

Nevertheless, the use of light for advertising is regulated by British laws, particularly through the Town and Country Planning (Control of Advertisements) (England) Regulations 2007. These regulations empower local authorities to regulate illuminated advertisements, including laser beams or high-powered lights directed towards the sky to attract public attention. The motive behind the use of light for advertising purposes is vital as the Act focuses solely on lights used for advertising and grants discretionary power to the Secretary of State for the Environment in Wales and England. The combination of the Clean Neighbourhoods and Environment Act 2005 and the Town and Country Planning (Control of Advertisements) (England) Regulations 2007 reflects the United Kingdom's approach to addressing light pollution at the national level. These regulations aim to strike a balance between managing artificial lighting to minimise negative impacts on the environment, including the night sky, while allowing for necessary lighting for transportation and carefully regulated advertising.

## 2.2 Australia

Australia has recognised the importance of managing light pollution and preserving dark skies through national legislation. The Australian Environment Protection Act 1997 serves as the primary federal legislation regulating environmental matters across the country. This Act requires all states to comply with its provisions while also allowing individual states to have their own legislation related to environmental issues. Within the Australian Environment Protection Act 1997, the term 'light' is specifically included in the definition of 'pollutants' and 'environmental nuisance' as outlined in Section 3(d) of the Act. The inclusion of 'light' as a pollutant signifies Australia's commitment to addressing light pollution on a federal level. The Act recognises that light, along with energy, heat, noise, and radioactivity, can have detrimental effects on the environment.

By incorporating 'light' within the definition of pollutants, Australia demonstrates its legal initiatives to mitigate light pollution. This recognition acknowledges the negative impact of artificial lighting on the natural environment, particularly in relation to the visibility of the night sky. By including 'light' as a pollutant, Australia highlights the need to regulate and manage artificial lighting to minimise its adverse effects. The inclusion of 'light' within the Australian Environment Protection Act 1997 emphasises the country's commitment to mitigating light pollution at a domestic level. This legislative approach sets the foundation for managing artificial lighting and highlights the importance of reducing light pollution's impact on the environment and the visibility of the night sky. Through its legislative framework, Australia aims to address light pollution and promote responsible lighting practices.

## 2.3 Spain

Spain has taken significant steps to address light pollution through the implementation of national legislation. One key legislation is the Royal Decree 347/2011, which regulates maritime fishing for recreational and professional purposes in Spanish waters. While the main objective of this decree is to govern fishing activities, it also includes provisions related to the use of artificial light in fishing practices. To further elaborate, Article 12(d) of the Royal Decree explicitly prohibits the use of lights as a means of attraction or artificial concentration of species during recreational fishing. This provision aims to prevent the negative impact of artificial lights on marine ecosystems and the sustainable management of aquatic resources. Nevertheless, exceptions are made for hand lanterns, but other forms of artificial lighting are strictly forbidden.

Furthermore, Article 16(b) of the Royal Decree prohibits the use of capture instruments with electrical or electronic explosive tips, as well as light bulbs, except for hand lanterns, during recreational sea fishing. These regulations help to reduce light pollution associated with fishing activities, promoting responsible practices that minimise environmental impact. The Royal Decree also establishes reporting requirements for holders of commercial vessels authorised for the capture of differentiated species of protection. These individuals must submit a monthly report on catches and the release of protected species to the Ministry of the Environment, and the Rural and Marine Environment. This reporting mechanism helps monitor and regulate fishing activities to ensure compliance with conservation measures. To enforce compliance with the regulations set forth in the Royal Decree, penalties are stipulated under Article 23. In addition, violations of the decree's provisions are subjected to sanctions in accordance with the relevant sections of Law 3/2001. The precise coordination mechanisms that guarantee the exercise of the sanctioning powers lie within the framework of Article 7, ensuring effective enforcement by the General Administration of the State.

### 2.3 Common Law Cases

Light pollution has become a subject of legal consideration within the framework of common law, specifically through the concept of nuisance. The common law of nuisance has been utilised as a course of action to address the issue of light pollution and impose conditions of development consent. For instance, the Australian Environmental Protection Act 1997 allows the imposition of conditions to mitigate light pollution on an ad hoc basis. In the case of *Lot 11 Neil Street Pty. Ltd. v. Cumberland Council* [2021] NSWLEC 1037, a condition of the development consent was imposed to address light pollution. The condition required that any lighting on the site should be designed in a way that does not cause a nuisance to neighbouring residences or motorists on nearby roads. The aim was to ensure that light overspill does not have an adverse impact on the amenity of the surrounding area.

In another case of *Raciti v Hughes* [1995] 7 BPR 14,837, the Supreme Court of New South Wales addressed the issue of light pollution and surveillance. The defendant had installed floodlights and cameras aimed at recording activities in the plaintiff's backyard. The plaintiff experienced distress and could not use their yard normally due to the presence of these lights and cameras. The court considered two separate nuisances: the impact of the lights and the recording of activities. The court ruled that the illumination and surveillance of the plaintiff's land could constitute an actionable nuisance. Therefore, an injunction was granted, requiring the defendant to cease using such lights and recording equipment. The court also held that the lights would be considered a nuisance if they materially interfered with the ordinary comfort of human existence. Moreover, evidence was presented showing that the plaintiff's health was being negatively affected by the continued illumination of their land. The surveillance and recording of activities in the plaintiff's backyard were deemed to be sufficiently intrusive, resembling "watching and besetting," which constituted an actionable nuisance.

This case illustrates the court's recognition of the adverse effects of light pollution and surveillance on individuals' well-being and the importance of balancing the rights of individuals with respect to their use and enjoyment of their property. These cases demonstrate that common law principles, such as nuisance, can provide a legal avenue to address light pollution and its adverse effects. By recognising the impact of light pollution on individuals and their surroundings, courts have taken steps to protect the rights and well-being of affected parties. These legal precedents serve as a means to regulate and mitigate light pollution,

ensuring a balance between the use of artificial lighting and the preservation of natural darkness.

### 3. MALAYSIA LEGAL FRAMEWORK

#### 3.1 Legislations

Although international legislations have been put in place to combat light pollution globally, Malaysia lacks specific national legislation addressing this issue. Malaysia does have an Act on the regulation of the environment, particularly the Environmental Quality Act 1974 [Act 127], specifically covers atmosphere pollution (Section 22), noise pollution (Section 23), soil pollution (Section 24), water pollution (Section 25), oil discharge in Malaysian waters (Section 27) and waste discharge in Malaysian waters (Section 29). However, light pollution is not explicitly defined and enforced under the Act.

#### 3.2 Hybrid Bill

In 2016, the ANGKASA proposed the Light Pollution Bill as a hybrid bill aimed at tackling light pollution in Malaysia (Astro Awani, 2016). The Parliament of Malaysia defines the Hybrid Bill as:

*“A Bill that affects both private and public matters. In other words, there is both a widespread public, possibly national interests, but also a specific effect on particular individuals and organisations who may be adversely affected.”*

According to Izzah and Jannah (2021):

*“Hybrid Bills relate to issues that involve matters of both public and private interests; for example, those with widespread public ramifications yet jointly cause a specific impact on a particular group of people.”*

This proposal was prompted by an incident in Kuala Lumpur where polluted skies disrupted the operations of the National Planetarium’s observatory.

In 2016, Astro Awani conducted an interview session with Noordin Ahmad, the former Director-General of ANGKASA. He stated that ANGKASA collaborated with the relevant authorities, which is the Ampang Jaya Municipal Council (MPAJ), Kuala Lumpur City Hall (DBKL), and Public Works Department (JKR) to develop guidelines addressing light spillover from urban development because lights in building and streetlights are under their supervision. He expressed that ANGKASA certainly needed this Act due to the establishment of the Langkawi National Observatory (ONL) in 2006 which was prompted by the inadequate functionality of the National Planetarium, the former national observatory center. Thus, without appropriate controls in the form of an Act, ordinance, or guidelines, the ONL would also be adversely affected (Noordin, 2016 as cited in Astro Awani, 2016). Unfortunately, no significant process has been made on this bill since its proposal.

In 2019, the University Malaya Law Review conducted an interview session with Mohd Zamri Shah, the Deputy Director of the Education Section of the National Planetarium, in order to gain additional insights on the proposed bill. According to him, the implementation of the Act’s framework would primarily benefit astronomical research conducted in urban areas.

However, this alone is insufficient to outweigh the interest of profitable commercial entities. Legislations, such as the Exclusive Economic Zone Act 1984 [Act 311] and Custom Duties (Amendment) Order 1989, would require amendments if this proposal were to be enforced (Zamri, 2019 as cited in Hanis, Sahira, Akmal, and Farah, 2019).

### 3.3 Subsidiary Legislation

In the absence of a specific legislation, a subsidiary legislation has been implemented to regulate the brightness of LED digital advertisements on major roadsides in Malaysia. The *Tatacara Permohonan Mendirikan Struktur Paparan Iklan di dalam Rizab Jalab Persekutuan/Lebuhraya Tahun 2020*, that was put into effect under Section 84(1) of the Road Transport Act 1987 [Act 333] specifies the maximum brightness levels for these advertisements during the day and night as well as authorizes Minister of Works and appropriate authorities to enforce these regulations against any person who fails to comply with the requirements. However, this regulation primarily addresses the issues of brightness levels and does not comprehensively tackle light pollution.

On top of that, Malaysia has subsidiary legislation that empowers the Department of Environment to conduct Environmental Impact Assessment (EIA) through the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 2015, which is enforced under Section 34A(2) of the Act 127. The purpose of the EIA is stated as follows:

*“Any person intending to carry out any of the prescribed activities shall, before any approval for the carrying out of such activity is granted by the relevant approving authority, submit a report to the Director General. The report shall be in accordance with the guidelines prescribed by the Director General and shall contain an assessment of the impact such activity will have or is likely to have on the environment and the proposed measures that shall be undertaken to prevent, reduce or control the adverse impact on the environment.”*

Section 3(1) of the Order defines prescribed activities as:

*”The activities specified in the First Schedule and the Second Schedule are prescribed activities.”*

According to Section 34A(4) of the Act 127:

*“If the Director General, on examining the report and after making such inquiries as he considers necessary, is of the opinion that the report does not satisfy the requirements of subsection (2) or that the measures to be undertaken to prevent, reduce, or control the adverse impact on the environment are inadequate, he shall not approve the report and shall give his reasons therefor and shall inform the person intending to carry out the prescribed activity and the relevant approving authorities accordingly: Provided that where such report is not approved it shall not preclude such person from revising and resubmitting the revised report to the Director General for his approval.”*

While Section 34A(5) of the Act 127 affirmed that:

*“Any person intending to carry out a prescribed activity shall not carry out such activity until the report required under this section to be submitted to him for his approval.”*

Based on Sections 34A(4) and (5) of Act 127, it can be understood that the Director General, responsible for Environmental Quality, cannot approve an EIA report unless it satisfies the specified requirements. The Director General must then provide reasons if the EIA report is deemed unsatisfactory and allow the applicant to revise and resubmit the report for approval. During the period awaiting new approval, the applicant is prohibited from conducting the prescribed activities.

However, the concern arises because the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 2015 does not include "artificial lighting" as a prescribed activity in either the First or Second Schedule of Section 3(10) of the Order. This omission allows industries to freely use excessive artificial lighting, leading to light pollution, which is not adequately addressed as a mandatory factor in the Malaysian legislation.

### **3.4 Parliamentary Hansard**

The Parliamentary Hansard on November 27, 2018, highlighted concerns regarding light pollution caused by excessive LED lights used by squid-catching boats. This practice has a long-term impact on other fishermen and disturbs the endocrine system of fish and marine life. Azman Ismail, the former Member of Parliament for Kuala Kedah emphasised the need for immediate control measures and inter-ministerial discussions to prevent extreme harm and negative consequences from light pollution.

## **4. RECOMMENDATIONS AND IMPROVEMENTS**

The Government of Malaysia should consider amending the Environmental Quality Act 1974 [Act 127] to include a specific provision for "light pollution." This amendment would grant the authorities the power to enforce penalties against individuals or entities contributing to light pollution. A comprehensive review of existing laws and regulations related to urban planning and fisheries should also be undertaken to ensure their effectiveness and relevance. Clear definitions, explanations, illustrations, and appropriate penalties for violators should too be included in the amendment. These measures will enhance environmental management and ensure effective control and management of light pollution, which poses a significant threat to public health, wildlife, and ecosystems.

The Government of Malaysia should consider gazetting several dark sky areas in the country through the Ministry-in-charge for Environment and Natural Resources. These areas should be located far from sources of excessive light and free from human and industrial activities that could interfere with astronomical observation. Therefore, the gazetting process should involve clear legal provisions to prevent exploitation in the future. Gazetted dark sky areas will allow for scientific research on astronomy, attracting both local and international researchers interested in conducting astronomical-oriented studies in Malaysia. This step will contribute to the nation's economic development by promoting stargazing tourism and collaborations with international researchers.

Moreover, the Ministry-in-charge for Industry should authorise the Department of Environment to conduct Environmental Impact Assessments (EIAs) for industrial companies

using significant amounts of lighting during the night. EIAs help to identify potential negative impacts on wildlife, humans, and the environment, as well as prevent, control and reduce environmental pollution through effective monitoring and enforcement activities. The EIA reports should also provide professional evaluations with appropriate mitigation measures such as the use of energy-efficient lighting technologies and responsible lighting practices. Guidelines and regulations on responsible lighting practices for industrial companies should be developed, specifying appropriate lighting levels, types of lighting technology, and time frames for lighting usage. These measures will promote sustainable lighting practices, reduce energy consumption and protect the environment from the adverse effects of excessive lighting. By implementing responsible lighting practices, industrial companies can contribute to environmental protection while reducing their energy costs and demonstrating corporate social responsibilities.

To sum up, in effectuating these recommendations, Malaysia can address light pollution comprehensively. Amendments to the Environmental Quality Act will enhance enforcement measures, gazetting dark sky areas will protect natural darkness for astronomy research and tourism, and authorising EIAs and establishing guidelines for responsible lighting practices will consequentially promote sustainable development and protect the environment. These measures will enable Malaysia to position itself as a leader in implementing sustainable lighting practices on the international plane and contribute to the preservation of natural beauty, human well-being, and biodiversity.

## 5. CONCLUSION

In conclusion, light pollution is a pressing environmental issue that demands attention and action. The excessive and misdirected artificial illumination that fills the night skies has profound consequences for ecosystems, human health, astronomical research and energy consumption.

Collaboration between stakeholders including governments, urban planners, experts in light pollution and the general public, is crucial for achieving meaningful change as they can strive to strike a balance between the benefits of artificial lighting and the preservation of natural darkness. Ultimately, the goal is to reclaim the dark skies, protect the biodiversity, enhance human well-being, advance scientific knowledge and reduce energy waste and through collective efforts and a commitment to responsible lighting practices, a future can be created where the night sky is once again a source of wonder and inspiration and where the harmony between artificial light and the natural environment is achieved. All in all, it is within the power of every individual to make a positive difference and pave the way for a brighter, yet darker, future.

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## I-CReST 2023:072-068 - Challenges and Solutions: The Experiences of Out-of-Field Lecturers

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### ABSTRACT

Quality and effectiveness of teaching and learning will be achieved through the mastery of lecturers in the field of teaching taught. However, the Out-of-Field (OOF) phenomenon that requires lecturers to teach subjects that are out of their field and expertise has given an impact on the quality of teaching and learning. In fact, there are non-accounting lecturers who need to teach topics related to accounting or finance, particularly in an entrepreneurship subject. This brings challenges to the lecturers involved. Thus, this study attempts to explore the challenges faced by OOF lecturers in the teaching process and how they address these challenges. Hence, this qualitative study gathered data through observation, interview, and content analysis involving seven (7) participants from different academic backgrounds, using both inductive and deductive analytic methods. Subsequently, the study found that OOF lecturers experienced difficulties and challenges during the teaching and learning process. Moreover, the study also found that five (5) major themes emerged as to the lecturers' experiences with OOF teaching: travails, adjustment issues with the subject's academic content, hard-to-answer students' questions, tough in building trust, and challenges in using effective teaching methods. Lack of resources and content knowledge were identified as common challenges faced by OOF lecturers. However, the lecturers employed various coping strategies, such as thoughtful preparation, using different teaching methods, pursuing professional development, peer coaching, and measuring learning outcomes. In addition, the participants suggested several solutions to address the problem of OOF teaching, exclusively developing related educational applications. It is hoped that this study can benefit policymakers, educators, and institutions in developing appropriate policies, strategies, and programs to support OOF lecturers and improve the quality of education in entrepreneurship and related fields. Ultimately, future researchers may also conduct a study about the underlying causes of OOF teaching and the possible solutions to this issue.

**Keywords:** Challenges; out-of-field (OOF) lecturers; financial topic; entrepreneurship course; solutions

### 1. INTRODUCTION

Lecturers are individuals who play the most important role in producing excellent and high-quality students in higher education institutions. As lecturers, there is a need for mastering the content of the subject or syllabus, diversifying teaching strategies and teaching resources also skilled in technology. However, there are requirements that necessitate lecturers to instruct the content that is out of their expertise field. For instance, a non-accounting lecturer needs to explain an accounting part of a particular subject. In polytechnics, entrepreneurship, and

business plan subject are requiring a business lecturer to guide students to produce a business plan document that contains the financial section. In fact, to complete the financial section, accounting literacy is needed to ensure the success of planning and managing financial matters involving cash flow, cost of production, asset, and liabilities [1]. Moreover, accounting is perceived as a complicated process due to its technical difficulties. However, the issue of out-of-field (OOF) lecturers has created various challenges for the lecturers involved to achieve an effective teaching and learning activity.

OOF teaching occurs due to systematic lecturer shortages or unequal distribution of lecturers in certain higher education institutions like polytechnics. Unsuitable assigned lecturers in a particular subject seemingly become an immediate solution to the lecturer shortage issue for particular courses. In fact, these lecturers have the responsibility to provide students with effective and quality teaching based on curriculum fixed. Accordingly, this study attempts to explore the challenges OOF lecturers (OOFLs) face in the teaching process and how they address these challenges. Despite many literatures discussing the issue of challenges faced by OOF educators [2] [3], there was a minimal study that covers the adaptive solution that can be practiced by the lecturer to ensure they were able to survive in teaching non-field subjects in technical and vocational education and training (TVET) institution, particularly in polytechnic.

The present study focuses on the lecturer's stories about remarkable episodes of their teaching career especially when given the task to teach subjects outside their expertise. Based on the foregoing, this study deems it necessary to determine the challenges to the effective teaching of accounting or financial topics among OOFLs. This study is also able to provide additional insight into strategies for OOFLs to survive and enjoy their teaching careers.

## **2. LITERATURE REVIEW**

### **2.1 Out-of-Field Teaching (OOF) and In-the-field (ITF) Teaching**

OOF and ITF teaching describes different instructional contexts based on the subject expertise and experience of the lecturers in an educational institution. OOF teaching occurs when lecturers teach subjects outside their area of expertise without adequate training or educational background in that field [2], [4] – [6]. In the context of accounting, OOF teaching happens when lecturers without a strong accounting or financial background are assigned to teach accounting topics [7]. In contrast, ITF teaching refers to lecturers with significant subject knowledge, expertise, and practical experience in the field they are teaching, particularly in accounting [8]. These lecturers can provide real-life experiences, industry best practices, and mentorship to students, bridging the gap between academic knowledge and practical application [9], [10]. Ugwu et al. [11] categorized accounting education lecturers into experienced (with 10 years and above of working experience) and less experienced (with below 10 years of experience). Experienced lecturers are well-trained in applying accounting knowledge, skills, and attitudes to students. On the other hand, OOFLs, compared to experienced ones, face challenges with content knowledge and context-specific skills [12]. This limitation can negatively impact the quality of teaching and learning, leading to lower confidence levels in teaching accounting topics and potentially affecting the effectiveness of their role as lecturers [12], [13].

## 2.2 Challenges of OOF Teaching in the Accounting Field

OOFLs face multiple challenges in teaching subjects outside their area of expertise, particularly in accounting education. These challenges include difficulty fitting the curriculum and practices, determining appropriate teaching methods, and providing relevant teaching materials. OOFLs lack formal education or training in accounting, making it challenging for them to grasp complex accounting principles and theories as required by the curriculum [14]. The limited time available for covering a wide range of topics in accounting also poses challenges in providing in-depth knowledge or incorporating specialized areas. Balancing theoretical knowledge with practical application is also a struggle for OOFLs in accounting education [17], [18]. Moreover, OOFLs find it difficult to effectively convey complex accounting topics to students due to their limited subject knowledge [19]. Identifying key content areas and teaching advanced topics also prove challenging [20]. Additionally, keeping pace with industry trends and incorporating up-to-date content into teaching is a struggle for OOFLs who are not in the accounting field [21].

Besides that OOFLs have limited access to relevant accounting resources, which hinders their ability to develop comprehensive teaching materials [22]. The lack of background in accounting makes it difficult for them to identify appropriate resources that align with the curriculum and learning objectives [2], [23]. Moreover, the time constraint for acquiring accounting knowledge may hinder them from creating or adapting materials that effectively meet students' learning needs [24]. Integrating real-world relevance into teaching materials is also a challenge due to their limited knowledge of current accounting practices and industry trends. These challenges faced by OOFLs in accounting education can potentially impact the quality of teaching and learning, as well as the overall learning effectiveness of the students.

## 3. METHODOLOGY

Seven non-accounting lecturers from various study programs teaching entrepreneurship course at Politeknik Muadzam Shah were selected for this qualitative study. Data was collected through face-to-face interviews using a semi-structured interview guide, lesson observations, and analysis of lesson plans. The major challenges encountered by these lecturers in teaching accounting or financial topics were identified and analyzed. Creswell [25] described a qualitative study as one that takes place in a natural setting and the researcher goes to the site to conduct the research enabling to get detailed information about the problem.

All the interviews were audio recorded and notes were taken to complete the recordings. The lesson observation schedule was semi-structured in the sense that it not only contained the teaching and learning methods intended to be observed but also made provision for the collection of other data (field notes) that illuminated the teaching methods/activities predetermined in a far less systematic manner [26]. The guidelines for making the OOFLs's observation protocol were based on the goals of the integrated entrepreneurship syllabus focus on accounting and financial topics. It consisted of activities to engage students. The purpose of this instrument was to collect data on the pedagogical skills of the OOFLs. The lesson plans of the OOFLs were also analyzed to find the teaching methods they had been using. The spreadsheet was used to code and analyze the interview transcripts. Classroom observation data were coded manually and then categorized. Coding helps in effectively labeling and retrieving data [27]. The coding was done based on the themes that emerged and those that were predetermined. The inductive and deductive methods were used to create the themes. Then, the

codes were connected to form categories for each case. The acronym of OOFL in the findings is refer to Out-of-Field Lecturers involve in this study.

## 4. RESULT AND DISCUSSION

### 4.1 Challenges/experiences OOF Teaching Financial Topics in Entrepreneurship Subject

The analysis of data revealed that all the OOFLs faced some form of challenge in teaching accounting and financial topics in entrepreneurship course.

#### 4.1.1 Travails

The difficulties occur in terms of preparing the materials for teaching activities due to the new teaching scope. There is a need for lecturers to find new teaching materials, do a lot of research, and read about accounting fields. This effort requires a lot of time instead they have a limited time allocation to finish the syllabus. OOFL5 disclosed,

*“I am a degree holder in the entrepreneurship field but I am not an expert in finance/accounts. The theory part such as 4P’s (place, promotion, price, and product) are all ok for me. But, on the financial part, a bit less mastered.”* OOFL6 divulged the struggles faced, *“It is difficult to teach a subject that is outside my field. A lot of time is needed for preparation. You have to understand the content of the syllabus to avoid mistakes. I always feel nervous and unconfident to teach accounting topics. In fact, I never like this subject before but now I need to teach the subject. Besides that, there are a lot of references needed to understand and find material. Normally, I will take a long time to understand, use, and deliver all things to students, but, the time allocated is limited. There are many other topics to cover. Sometimes I feel so stressed, sad, and disappointed.”*

*“It’s a bit challenging to teach a subject that is not our major. The main challenge is in terms of to fulfill the requirements of the syllabus and time constraints to prepare teaching aids because lack of understanding of the topics to be taught. There also have a problem to find references. Sometimes, we doubt the correctness of the source found, whether it is correct or not. I become depressed because of it. Indeed, without proper understanding, we will feel uncomfortable and unconfident. I also feel sorry for the students because we are unable to give a comprehensive explanation as stated in the syllabus,”*

complained OOFL7.

#### 4.1.2 Adjustment Issues with the Subject's Academic Content

*“It is difficult to teach a subject that is out of the field, especially accounting or finance. I perceive that I’m not interested in this anymore due to being out of my field. But if you have to teach this subject, you also have to master it. Actually, it’s hard to master because the account is technical. It takes a lot of time to study and understand a lot of things,”* elucidated OOFL4. *“When it comes to the financial part, we only use limited information to deliver to students. The financial part involves technical understanding and cannot be*

*understood in a short period of time. If there is a requirement to make a review on the financial part, we leave it to an expert lecturer to review it,”*

defended OOFL3.

The challenges occur when there is difficulty for the lecturer to understand the requirements of the syllabus. This issue adds to the difficulty for the lecturer to master the content of the subject and triggers them to study more.

#### **4.1.3 Hard-to-Answer Students' Questions**

Due to limited knowledge of the accounting field, some lecturers face difficulties in dealing with inquiries from students in an attempt to cope with this situation, sufficient preparation in terms of reference materials, and technical and practical knowledge is necessary. OOFL cried,

*“We are not always able to answer student questions, particularly for high-level technical questions. If possible to answer, we are not really sure of the level of correctness of the answer. Sometimes, we feel nervous if students ask the question. This is because accounting involved the practical task such as preparing an account. Sometimes I feel frustrated because I can't answer the questions asked.”*

#### **4.1.4 Tough in Building Trust**

Lecturers encounter an issue to acquire students' trust. The trust lessens since the lecturer is seemingly unconfidence and incompetent while teaching in the accounting part. This has influenced their respect and confidence toward lecturers. Eventually, there are difficulties for OOF lecturers to handle their students.

*“When students know that we are incompetent, they don't pay much attention or they also might be not understood what is being delivered. Besides lecturers, students are also not interested in calculation specifically accounting. Most worsen, their respect for lecturers become lessened,”*

claimed OOFL4.

#### **4.1.5 Challenges in Using Effective Teaching Methods**

Lecturers are also facing difficulty in applying an effective teaching approach. Apart from the OOF issue, issues related to pedagogy and andragogy have also caused the failure to convey knowledge effectively.

*“I still lack exposure to teach and meet the needs of students parallel with syllabus requirements, especially in the practical part as I'm not in this field,”*

argued OOFL6.

Common difficulties experienced by OOFLs included a lack of resources and a lack of subject-matter expertise. For content knowledge, they all had some problems as the lesson observation and interview revealed. That is not surprising because they were assigned for

teaching entrepreneurship course without an accounting or financial background. Their problem with accounting or financial topics was to be expected because it was never taught even though it was in the addendum to the syllabus. Content analysis of the OOFLs' lesson plans and the observation of their lessons showed that they used mainly brainstorming, demonstration, and lecture on financial plan topics. The demonstrations were generally with provided accounting or financial templates for a limited period. Because of that, the process skills dependent on teaching and learning materials were hardly attained as the interviews revealed.

OOFLs face challenges teaching financial topics due to the new teaching scope and limited expertise in finance or accounts. This matter has caused stress and a lack of confidence. Additionally, OOFLs require extensive research to prepare teaching materials, leading to difficulties in conveying comprehensive explanations to students. Moreover, OOFLs struggle with the subject's academic content due to difficulty in understanding syllabus requirements and the technical complexity of accounting and finance. Limited time allocation and lack of expertise lead them to use limited information, highlighting the need for expert assistance to ensure accuracy. Besides that, they encounter challenges in answering students' questions due to their limited knowledge of accounting, particularly in addressing high-level technical inquiries. Despite their efforts to prepare with reference materials and practical knowledge, their lack of expertise in the field may lead them to direct students to seek additional information from other sources, causing feelings of frustration and inadequacy in fully addressing students' inquiries. The challenges in building trust with students are due to perceived incompetence and lack of confidence in the subject. This results in disengagement, disinterest in accounting and, eventually, lessen in respect and confidence towards the OOFLs. Such a situation poses difficulties for the OOFLs in handling their students during the accounting part of the course effectively. In addition, OOFLs encounter difficulties in using effective teaching methods because of their limited expertise in the subject, inadequate exposure to finance and accounting, and challenges in handling adult learners. The combination of these factors hinders their ability to deliver comprehensive financial topics, meet student needs, and fulfill syllabus requirements, particularly in practical aspects of the subject.

#### **4.2 Solutions of OOF Teaching Financial Topics in Entrepreneurship Subject**

The OOFLs survived by attempting to provide their own solutions to the challenges they face in teaching accounting or financial topics in entrepreneurship course in terms of 1) thoughtful preparation, 2) using different teaching methods, 3) pursuing professional development, 4) peer coaching, and 5) measuring learning outcomes.

As revealed by OOFL1 that the lecturers have syllabi and need to prepare a course outline that will be the basis of their activities inside the classroom. Lecturers carefully plan the lesson and read ahead of time through the syllabus. Moreover, as explained by OOFL5 the lecturers used seminar workshops in which students have to perform and utilize a variety of strategies like reciprocal teaching. Lecturers use other forms of strategies and approaches that best suit the students and employ a participatory approach. Furthermore, the lecturers suggest not settling for mediocrity. They should aim for higher education and engage in advanced reading and research including conducting research about the subject they are teaching.

*“So, use another method such as reading existing journals, looking for reading material, etc,”*

said OOFL7.

Besides, OOFL6 claimed that OOFLs consult their colleagues who have taught the subject for many years and seek other lecturers' help for support and believed that they can also learn from others. Finally, the lecturers evaluate the learners and whether the strategies employed are effective. Lecturers assess them during lectures based on what they have in mind by distributing rubrics ahead of time while practical. OOFL4 confirmed that *"We will evaluate using the rubric. There is also a presentation for students' understanding"*.

The solutions employed by OOFLs in teaching accounting/financial topics in entrepreneurship courses demonstrate a thoughtful and proactive approach to addressing the challenges they face. Thoughtful preparation involves utilizing the syllabus and course outline to carefully plan lessons, but they acknowledge the need for further understanding. Using different teaching methods, such as seminar workshops and participatory approaches, allows them to create engaging learning experiences with real-life examples. Pursuing professional development, despite limited opportunities, highlights their dedication to enhancing their knowledge and skills. Peer coaching and seeking support from experienced colleagues emphasize their willingness to learn from other's expertise. Measuring learning outcomes showcases their commitment to evaluating student understanding and adjusting teaching strategies accordingly. These solutions reflect a growth mindset, where OOF lecturers continuously seek improvement, adapt to the subject, and prioritize students' learning experiences. Their resilience and determination contribute to fostering effective learning environments despite the challenges they encounter in teaching accounting and financial topics.

Exclusively, all the informants in this study propose developing educational applications as the best solution to address the problem of OOF teaching accounting or financial topics in entrepreneurship courses. As promoted by OOFL7 on the advantage of related educational app development for financial topics that focus on cost and price calculation, cash flow, and financial statement preparation,

*"My student has to do business for this entrepreneurship subject. If there are suitable apps, it's great. Students can use it directly for practical purposes in their business."*

Using specific apps would solve times constraint for teaching the financial topic. The apps could use easily in the classroom and could cover the financial topic in the entrepreneurship course. Apps are relevant for teaching and learning nowadays for students. Also shouted by OOFL1,

*"It is very helpful if there are related apps."*

Their views are supported by OOFL2,

*"It is also possible if there are apps. Even students are easy to use. The lecturer is easy to teach."*

OOFL3 that problematic with existing accounting software or template agree with them,

*"It's ok if there are apps. Can only be used on mobile phones. I now use a template in Excel. It is quite tough for me to exploit it. Students also difficult and slow to understand"*

*and apply it". OOFL4 had the same viewpoint as well: "If there are more apps, it's good. Easy to use. Students now love to use technology. Even the lecturers are confused about how to teach finance".*

From the voice of OOFL5,

*"It would be great if there were apps."*

It is similar to OOFL6's scrutiny,

*"Save more time if using apps. Can be a teaching aid. There is not much time to teach this financial topic. Students can only use mobile phone apps in class to determine prices, costs and prepare cash flow."*

The idea that educational applications should be created as a way to deal with the difficulties of OOF teaching financial or accounting topics in entrepreneurship courses is well-founded and is backed by the study's informants. Utilizing specialized tools for cost and price calculation, cash flow recording, and financial statement preparation can help OOFLs fill in knowledge gaps and improve student learning. These apps provide useful and applicable applications, which makes it simpler for OOFLs to teach financial concepts. Apps also fit nicely with the current trend in education, where technology is vital for empowering and involving students in their learning. The apps not only reduce teaching time but also enable students to provide rapid feedback and actively participate in class.

## 5. CONCLUSION

The OOFLs faced the following challenges in teaching and learning accounting or financial topics in entrepreneurship courses: (a) travails, (b) adjustment issues with the subject's academic content, (c) hard-to-answer students' questions, (d) tough in building trust, and (e) challenges in using effective teaching methods. However, a lack of resources and content knowledge were identified as common challenges. They have solutions for the problems. Additionally, the informants offered a number of approaches to deal with the issue of OOF teaching, concentrating only on creating associated educational applications. In order to promote OOF lecturers and raise the standard of education in entrepreneurship and related subjects, it is envisaged that this study would be useful to policymakers, educators, and institutions in formulating suitable policies, strategies, and programs. Finally, a study regarding the root causes of OOF teaching and potential fixes might also be conducted by future academics.

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## **I-CReST 2023:084-076 - Application of Project-based Learning in the Matriculation Engineering Program to Develop Future Ready Graduates**

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### **ABSTRACT**

The Mechanical Engineering Program at the Matriculation Engineering College has been using the Project-Based Learning (PBL) method in the second semester of the academic year since 2011. The PBL method has been continuously learned and then integrated into the application of the project. Some challenges still exist, such as: (a) improving peer evaluation; (ii) expanding the project coordination team and (iii) refining data collection and analysis tools. How well prepare our future graduates are depends on how higher education institutions best prepare them for the challenges of the future workplace and society at large. A questionnaire was used to collect data. Fifty-two second semester students in the 2022/2023 academic year of the mechanical engineering programme participated in this study. The findings of the study show that the role of lecture and the students in the implementation of PBL is significant. Based on the results, some suggestions and recommendations were made that could help lecturers and decision makers in implementing PBL.

**Keywords:** Project based learning; mechanical engineering programme; matriculation engineering college

### **1. INTRODUCTION**

The Mechanical Engineering program at the Matriculation Engineering College has been using the Project-Based Learning (PBL) method in the second semester of the academic year since 2010. PBL is used when students design projects semester 2 where this design is part of the continuous assessment of students for the second semester. However, until this article was written, no research has been done at the College of Engineering Matriculation on the level of PBL implemented in terms of the role of lecturers and students in implementing PBL.

Therefore, the researchers want to know the extent to which the level of PBL is carried out at Kedah Engineering Matriculation College (KMKK) in terms of the role of lecturers and students in implementing PBL. The results of the study can show the level of implementation of PBL in Matriculation College Kedah Engineering (KMKK) is related to the role of lecturers and students in the implementation of PBL where this study can serve as a guide for the Matriculation Division, Ministry of Education Malaysia to create a curriculum in accordance with the present will. This study only involves KMKK mechanical engineering students 2022/23 totaling only fifty-two students only.

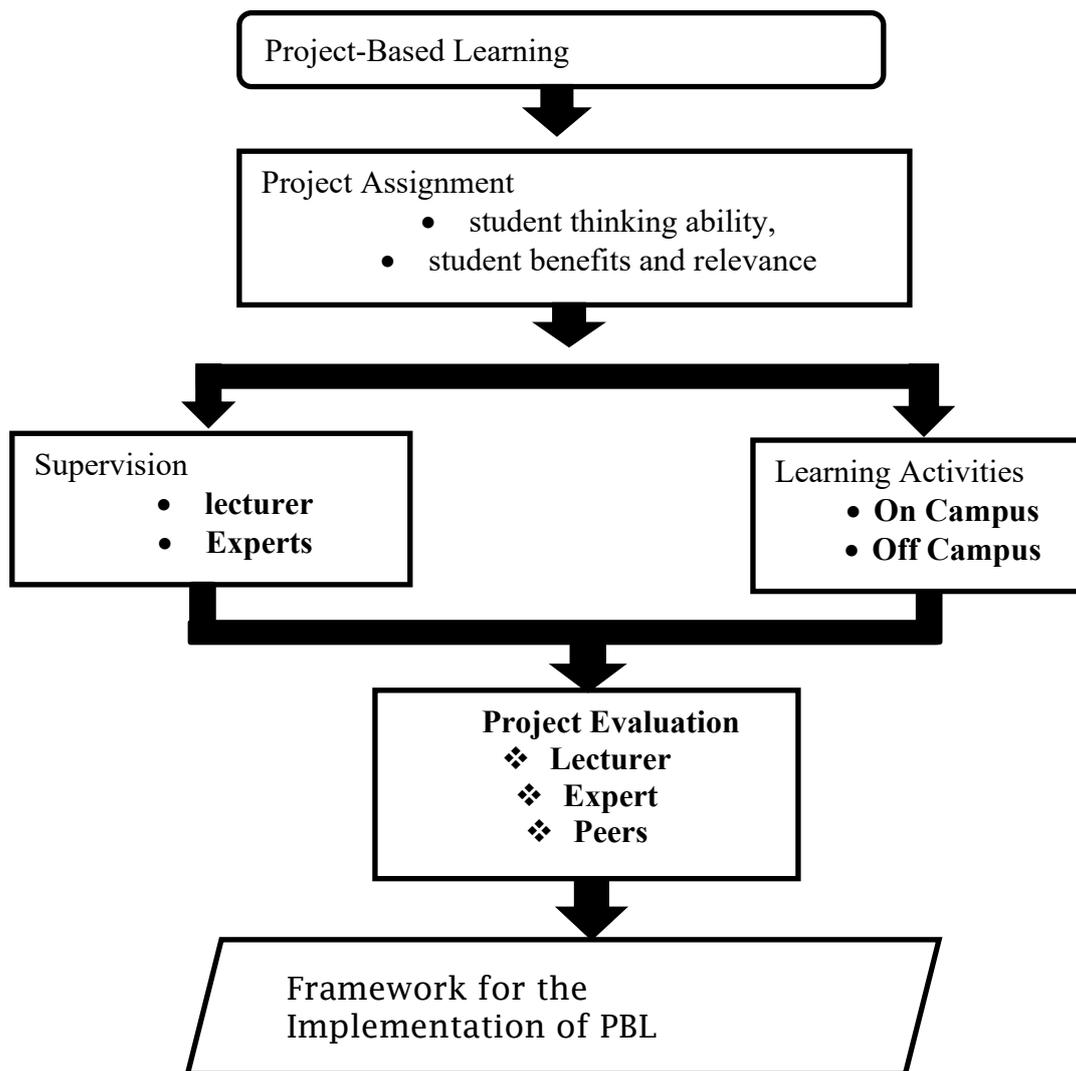
Project-Based Learning is a student-centered teaching method based on the theory of constructivism developed by Gergen (1995); Piaget and Inhelder (1969); Vygotsky (1978). The

literature review shows that PBL has been tried and adopted in variety of educational around the world (Pereira, et al, 2017). PBL is student-centered learning where student have control over final product of the project task. In addition, students must be accountable for every decision and outcome. PBL is used to train students to be active students (Mohd Noramdzan Mohd Yusof, 2021). PBL is not limited to providing students with content knowledge, but also develop skills their psychomotor and social skills, such as searching for information from various sources, critical thinking, problem solving, self-assessment, summarizing and presentating which are highly recommended for lifelong learning (Aldabbus, S. 2018).

## 2. LITERATURE REVIEW

This section discusses the framework for the Implementing Internal PBL teaching elements in engineering students (Mohd Noramdzan Mohd Yusof, 2021) shown in Fig. 1.0. The framework below consists of four main elements: project assignments that incorporate students level of thinking ability, student benefits and relevance; guidance and supervision from external lecturers and experts; on and off-campus learning activities; and continuous assessment by lecturers, peers and external experts. Project assignments consist of tasks that are useful and relevant to students based on the student's educational level and assignments can challenge students and promote critical thinking. The experience of an outside expert can expose students to the thinking more mature outside expert, and this interaction matures students. Lecturers should work with students to ideas ideas for project assignments, envision problems and challenges students will face in completing the assignments and work with students to set the goals of student project assignments by formulating guiding questions for students and to encouraging students to dare to develop ideas that go outside the box.

Project evaluation is one of the element that provide thr framework for implementating PBL instruction for engineering students. Project evaluation consists of three elements, namely lecturers, external experts and students. This assessment is formative. Lecturer evaluation includes regular or periodic evaluation and final evaluation. Involving external evaluator to assess student work can help students develop project assignments that meet real-world standards. Peer assessment takes the form of reflection, where students ask fellow students in the group to collectively assess the student's project assignments. It is expected that communication will be encouraged and discussions will be held that can improve other students' thinking and metacognitive critical thinking skills at some level.



**Fig. 1.** Framework for the implementation of PBL teaching elements among engineering students (Mohd Noramdzan Mohd Yusof, 2021)

### 3. METHODOLOGY

The research design used in this study is a descriptive survey using quantitative methods. Descriptive studies explain phenomena through the analysis of descriptive data collected with questionnaires. Descriptive survey research is a study of what is happening. In this situation data are collected, interpretations (evaluations) are made, comparisons are made and generalizations are formulated.

The sample of the study consists of 52 mechanical engineering students from the KMKK class of 2022/2023. The 52 students surveyed are sufficient because they follow the sample size determination of Krejcie and Morgan (1970) who listed the sample size that corresponds to the size of the study population (see Table 1). According to Merriem (1998), the sample from the population should be truly representative of the population. Sampling must also be able to reduce sampling errors that may occur in any study conducted. Therefore, purposive sampling is used in this study is because the identity of the respondents is known in advance

and sampling can provide accurate information to answer the research questions. The questionnaire is built in the form of a Microsoft Form and respondents received given a link to answer the questionnaire through social media i.e. KMKK telegram group for mechanical engineering studentS. The process of collecting research results done by Microsoft Form.

**Table 1.** Krejcie and Morgan (1970) sample size determination table

<i>Table for Determining Sample Size of a Known Population</i>									
N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	346
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	354
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	370
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	226	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
85	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	75000	382
95	76	270	159	750	254	2600	335	1000000	384

*Note: N is Population Size; S is Sample Size* *Source: Krejcie & Morgan, 1970*

The research instrument used in this study is a questionnaire in Malay language, which includes only one part. Researchers use questionnaires because they are more appropriate and practical, effective and efficient as well as and they also save costs. The questionnaire used uses employ 5-point Likert scale with the value 1 = Strongly Disagree (STS), 2 = Disagree (TS), 3 = Less Agree (KS), 4 = Agree (S) and 5 = Strongly Agree (SS). The distribution of items and reference sources for items construction by section is shown in Table 2.

**Table 2.** Questionnaire test determination schedule

Question	Item	Source
Lecture Role	1-11	Mohd Noramdzan Mohd Yusof (2021)
Student Role	12-19	

The data obtained from Microsoft Form is converted to Microsoft Excel format to obtain the mean and standard deviation, and this analysis is used to answer the research questions. The ranking of the level of lecturers and students in implementing PBL is shown in Table 3.

**Table 3.** Ranking for the level of the role of lecturers and students in implementing PBL

Level of Role of Lecturers and Students in Implementing PBL	Mean Value
Low	1.00 hingga 2.33
Moderate	2.34 hingga 3.66
High	3.67 hingga 5.00

#### 4. RESULTS AND FINDING

Based on the responses of the research sample, table 4 below shoes information about the distribution of the mean and standard deviation of the lecturer's role in implementing PBL. Item three for role of students received the highest mean score compared to the other items, which was high a mean of 4.77 and a standard deviation of 0.54 . Item eight scored the lowest at medium level with a mean of 3.44 and a standard deviation of 1.62. The other items in the lecturer's role are at high level with a mean of 4.58.

**Table 4.** Distribution of mean and standard deviation of lecturer's role in implementing PBL

No	Lecture Role	Mean	SD	Level
1	Lecturers help student's complete student projects	4.73	0.56	High
2	Lecturers help students get external information to complete student projects such as from the internet	4.62	0.59	High
3	The lecturer discusses with the students to complete the project	4.77	0.54	High
4	The lecturer instructs the students to complete the student project	4.69	0.61	High
5	Lecturers help students prepare report papers	4.67	0.54	High
6	Lecturers act as facilitators in completing student projects	4.67	0.58	High
7	The lecturer helps students to choose a project	4.69	0.57	High
8	The lecturer encourages the students to complete the project	3.44	1.62	High
9	Lecturers use the technical expertise they have to help students complete projects.	4.67	0.54	High
10	Lecturers monitor the development of student projects	4.63	0.59	High
11	Lecturer evaluates the student project well	4.73	0.48	High
	Mean Average	4.58		High

Table 5 provides information on the distribution of mean and standard deviation of students role in implementing PBL. Items 14,15, and 16 received the highest mean score compared to the other items, 4.71 with a standard deviation of 0.49. Item 13 received the lowest score with a mean of 4.60 and a standard deviation of 0.63. All items related to student role received mean of 4.11, which is at a high level.

**Table 5.** Distribution of mean and standard deviation of student's role in implementing PBL

No	Student Role	Mean	SD	Level
12	Students discuss with the lecturer to complete the project	4.69	0.54	High
13	Students are responsible for choosing the title of the student project	4.60	0.63	High
14	Students look for information in the process of completing a student project	4.71	0.49	High
15	Students make a written report of the student project	4.71	0.49	High
16	Students do workshop work such as welding while completing student projects	4.71	0.53	High
17	Students collaborate with experts when implementing projects	4.69	0.50	High
18	Students meet lecturers throughout the completion of the project	4.67	0.51	High
19	Students make a presentation of student project results to the assessor	4.65	0.51	High

#### 5. DISCUSSION

Overall, the results of the study revealed that the level of implementation of PBL based on the role of lecturers and students at Kedah Engineering Matriculation College (KMCK) is at a high level where the level of implementation of PBL based on the role of lecturers is 4.58 and the level of implementation of PBL based on the role of students is 4.11. (see to table 6)

**Table 6.** Level of PBL implementation

<b>PBL Implementation</b>	<b>Mean</b>	<b>Level</b>
Lecturer Role	4.58	High
Student Role	4.11	High
Mean Average PBL Implementation	4.35	High

The level of PBL implementation is based on the role of lecturers and students at a higher level than the role of students. This shows that lecturers can implement PBL perfectly compared to a study conducted by Aldabbus, S. (2018) in an elementary school in Bahrain which found that lecturers cannot apply PBL because lecturers cannot easily decide which topic or unit in the textbook should be taught PBL because the curriculum is not designed for PBL teaching.

According to Mohd Noramdzan (2021), in the traditional learning method, the lecturer plays an important role in ensuring that students understand each lesson taught by the lecturer, but the PBL method has changed the role of the lecturer from the usual norm to a kind of coach or facilitator. Lecturers are referred to as facilitators and are responsible for mediating student learning in solving problems and promoting thinking skills (Krsmanovic, M. 2021). Lecturers must set timelines for the various phases of project assignments so that students can meet project work objectives and also ensure that students receive accurate feedback on their project work. Lecturers are also responsible for ensuring that students are always motivated to learn in a PBL environment (Fitzsimons, 2013).

The level of PBL implementation based on the role of students at a high level, a score of 4.1, indicates that the role of KMKK mechanical engineering students in implementing PBL in the second semester design project is perfect. However, Aldabbus, S. (2018) found in his study that students could not play the role in PBL effectively because students in PBL groups could not cooperate with each other due to different in thinking levels because PBL required students to work in a group to complete assignments projects with real real project elements. PBL can develop technical skills and students can gain new experiences through inquiry activities in PBL (Mohd Noramdzan Mohd Yusof, 2021).

## 6. CONCLUSION

In summary, based on a successfully conducted study the KMKK Mechanical Engineering Unit implemented PBL for the second semester design project. The study found that the mechanical engineering lecturers and students were successful in this study and played a role in making PBL successful. The results of this study clearly show that the mechanical engineering curriculum designed by the Matriculation Division, Ministry of Education Malaysia is suitable for the implementation of PBL. The four main elements of PBL, namely project assignments, guidance and supervision, learning activities and continuous assessment (Mohd Noramdzan Mohd Yusof, 2021) should be emphasized in implementation of PBL. The application of PBL to matriculation college students needs to be further improved through the curriculum in order to develop future-ready graduates.



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## I-CReST 2023:090-050 - Performance of Family Takaful Operators and Life Insurance Companies: A Comparative Analysis in Malaysia

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### ABSTRACT

An important element in the financial services sector such as takaful and insurance industry is performance. It is important indicator to evaluate the effectiveness of the industry, how does the industry counter to the challenges and which companies are going to survive their businesses. The purpose of this study is to analyse the performance of 11 family takaful operators and 13 life insurance companies in Malaysia from 2013 to 2018. There are five operational specific factors (OSF) tested in this study which are size, capital, premium growth, underwriting risk and expense ratio. This study uses panel data analysis to analyse the data obtained from family takaful and insurance companies' financial statements. The findings show the performance of insurance companies is better than family takaful in generating profitability (ROA). The findings also concluded that the profitability was affected by four OSFs which are size, capital, underwriting risk and expense ratio while premium growth was found have no impact to the profitability for both takaful operators and insurance companies. From these results, it is recommended that both takaful operators and insurance companies should control and manage properly their OSFs in order to increase companies' profitability and stabilize their financial system.

**Keywords:** Performance; Takaful operators; insurance companies; panel data; operator's specific factor

### 1. INTRODUCTION

Malaysian financial system's landscape has experienced major structural changes through the era of globalization with numerous liberalism measures popularized over the last century. Such conditions are likely to affect the insurance industry's performance. In Malaysia, the insurance industry is unique because its' operation was split into a dual system that includes conventional insurance and takaful industry. This has created strong competition related to product development and operating performance that contribute to sales.

According to Mwangi and Iraya (2014), performance is an indicator of an institution's income, and profitability as proofed by the growth in the organization's share value. The performance is used to measure the efficiency of an assets used by entities to generate profits. It will give the indication of the management level in managing the assets. High level performance is important to company because would increase confident level of an investors to make investments that would generate the company's profit (Heikal, Khaddafi and Ummah 2014).

In Malaysia, Takaful industry has been regulated under the Islamic Financial Services Act 2013 (IFSA 2013) while insurance industry has been regulated under the Financial Services Act 2013 (FSA 2013). These Act had replaced the previous law regulating the takaful and insurance industries namely Takaful Act 1984 and Insurance Act 1996. An important change brought for takaful and insurance industry by enacted of IFSA and FSA are the split licenses of insurance and takaful entities for their life/family and general businesses in order to improve the administration of general and family/life business operations in Malaysia.

According to Bank Negara Malaysia (BNM), IFSA 2013 and FSA 2013 is an initiative to streamline the laws governing the conduct and oversight of financial institutions in Malaysia to make sure that these laws tend to be significant and efficient in maintaining the performance of industry, encourage sustainable growth of industry and provide sufficient insured's protection (Thajudeen, 2015). For Takaful industry specifically, the reason for the decoupling is to push them into a new level of maturity, and at the same time, the takaful operators can participate in strategic alliances and partnerships to meet the higher capital requirements stated in this new Act. With a single license, the takaful business can concentrate all the resources on improving Performance of a specific line of business. It can also provide opportunity for new takaful industry players to be more competitive to their counterpart conventional insurance industry (Thajudeen, 2015).

Therefore, the performance of the takaful and insurance industry in Malaysia needs to be analysed especially after new Act of IFSA 2013 and FSA 2013 has been enacted in year 2013 to investigate whether the enforcement of this new Act would give impact and improving the performance of takaful and insurance industry in Malaysia and at the same time to determine the relationship between operational specific factors (OSF) and profitability of family takaful operator and life insurance companies in Malaysia. In addition, it is important to conduct this comparison performance study because there was limited literature available on comparing Takaful and insurance's performance in Malaysia. Besides that, there is lacking studies that choose family takaful operators and life insurance companies as samples in their study. Thus, this study is looking to relatively fill up the research gap by providing a comprehensive latest data of companies from year 2013 until 2018.

## **2. LITERATURE REVIEW**

### **2.1 CAMEL Framework Model**

Financial Soundness Indicators (FSI) is used for insurance industry are known as CAMELS. CAMELS are stands for Capital adequacy, Asset quality, Reinsurance, Adequacy of claims and actuarial, Management soundness, Earnings and profitability, Liquidity and Sensitivity to market risk. This framework was commonly used in insurance industry and has displayed an excellent outcome in the assessment of insurance industry's financial soundness. (Smajla, 2014).

This framework has been designed in IMF-Background paper by Das, Davies and Podpiera, (2003) and the paper also proposes CAMELS framework as a set of crucial factors that to be used for monitoring the insurance companies' financial soundness and the insurance.

**Table 1.** The variable used related to CARAMELS framework model

Type of Financial Sound indicator (FSI)	CARAMEL Framework Indicator	Variable used in this study
Financial Performance	Capital Adequacy	Capital
	Asset Quality	Size
	Management Soundness	Underwriting risk Expense ratio
	Earnings /Profitability	Premium growth

According to Abduh, Omar and Tarmizi (2012) there are various ways to evaluate the performance of Takaful operators. One of the most used is to look at company profits. Generally, the performance of insurance industry can be estimated by measuring their profitability, which is an indicator of business' successful, and it represent the financial performance (Mazviona, Dube, & Sakahuhwa, 2017).

Capital is referred as a good indicator of financial robustness of insurance company. An adequate capitalisation is important to preserve policyholder and encourage the robustness and effectiveness of financial system Wani and Dar (2015). It implies whether the insurer has enough capital to digest the losses resulting from the claims. Capital is most used by the researcher as among the factors that influenced the insurer's profitability as it shows the financial strength of the insurer. A positive correlation between the capital and insurers' profitability is intended, since a better equity's flow could lead to better financial stability and create opportunity to expand the businesses.

The company's size can be represented by several parameters including volume of workers, how many branches established or total assets. Size of firm is deemed to be important variable as it indicates that bigger firm are running well in the industry, operating at an economical scale then enjoying higher profit (Flamini, McDonald, & Schumacher, 2015).

According to Lire and Tegegn (2016), premium growth is a proxy to imply the market potential's rate. This means that insurance companies have a better chance of being competitive over the years. This occurs if they earn revenue from the premium received if undue advertising attention is given to increasing premiums with a proportionate allocation of resources to control their investment portfolios.

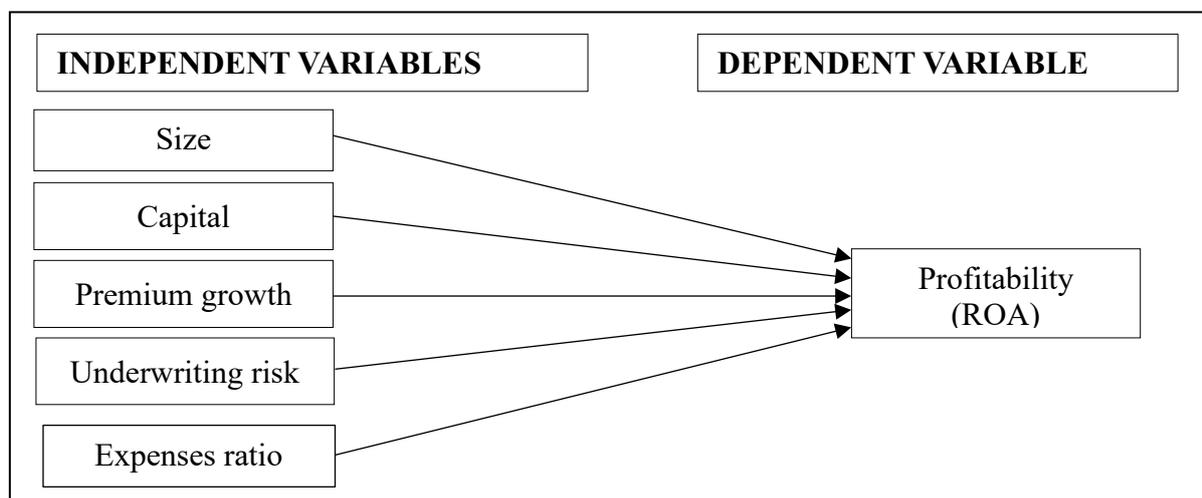
Underwriting risk highlights the efficacy of the underwriters and represents the adequacy of the underwriting quality of the insurers (Adams and Buckle 2003). Clear underwriting guidelines are essential to the financial performance of insurers. The risk of underwriting depends on the life insurers ' risk appetite (Wani & Dar 2015). Besides that, Santomero and Babble (1997) described that clear guidelines of underwriting are essential to the success of an insurance company including optimal reliable risk estimation and appropriate exposure pricing. Most of companies should seek the acceptance at standard rates of a large majority of risks, but always implement adjusted premiums that considered of loss experience and other risk factors that do not follow uniform requirements.

Kramaric, Miletic and Pavic (2017) claims that expense ratio measures the amount of earned premium rate to be charged by an insurance company to cover the costs generated in the business. The goal of each insurance company is to increase premiums while at the same

time decreasing expenses. Higher operating cost have a significant effect on the income of insurance companies, therefore negative influence of this variable is expected.

### 3. METHODOLOGY

#### 3.1 Theoretical Framework



**Fig. 1.** Theoretical framework of study

The research framework shows in Fig. 1 would give a clear picture of the variables used in this study that related to performance of family takaful operators in Malaysia. Performance in this study is proxy by profitability and was used as the dependent variable. Five independent variables are used in this study that representing operational specific factor (OSF) which are size, capital, premium growth, underwriting risk and expense ratio.

#### 3.2 Research Design

This study is categorized as quantitative research involving secondary data used. The population of this study consist of 11 Family takaful and 13 Life insurance companies in Malaysia from year 2013 to 2018. This study used panel data analysis and the researcher chooses to use EViews 10 as statistical software to analyse the panel data.

### 4. RESULTS AND DISCUSSION

#### 4.1 Descriptive Statistics

**Table 2.** Descriptive statistics of the variables for Family Takaful operators

Variable	Obs	Mean	Std. Dev.	Min	Max
ROA	66	0.399	3.008	-10.820	7.940
Size	66	14.712	1.761	12.000	19.00
Capital	66	0.159	0.100	0.074	0.658
Premium Growth	66	2.205	16.268	-0.318	132.314
Underwriting risk	66	2.259	1.702	0.490	8.870
Expense ratio	66	0.435	0.115	0.207	0.753

Table 2 above shows the descriptive statistics of six variables which are ROA, Size, Premium growth, expense ratio, capital and underwriting risk of 11 Family Takaful operators in Malaysia for six years. Thus, there are 66 observations for this study. As we can see the result above, the

mean value of ROA is 0.399 and the standard deviation is 3.0078. The maximum value of ROA is 7.940, while the minimum value is -10.820. This shows that the profitability of Family Takaful operators can be either generated or degenerated from their assets.

The mean value of Family takaful operator size (lnTA) is 14.712 and the standard deviation is 1.761 whereas the maximum value of takaful operator Size is 19 while the minimum value is 12. Besides that, the mean value for Family takaful operator's capital is 0.159 and the standard deviation is 0.100. Capital has a maximum value of 0.658 and minimum value of 0.074. For Family takaful operator Premium growth the mean value is 2.205 and the standard deviation is 16.268 whereas the maximum value of Family takaful operator premium growth is 132.314 while the minimum value is -0.318. Otherwise, the mean value of Family takaful operator's underwriting risk 2.259 and the standard deviation is 1.702. The maximum and minimum value for underwriting risk is 8.870 and 0.490 respectively. Lastly, the mean of expense ratio is 0.435 while the standard deviation is 0.115. The maximum and minimum value of expense ratio are 0.753 and 0.207 respectively.

**Table 3.** Descriptive statistics of the variables for Life insurance companies

Variable	Obs	Mean	Std. Dev.	Min	Max
Roa	78	1.571	1.799	-2.11	6.96
Size	78	15.8718	1.2099	14	18
Capital	78	0.1229	0.0674	0.0225	0.3063
Premium Growth	78	0.0704	0.14104	-0.4149	0.4175
Underwriting risk	78	1.7484	1.0258	0.4635	4.4578
Expense ratio	78	0.299	0.083	0.1974	0.5479

Table 3 above shows the descriptive statistical for Life insurance companies regards on 78 observations for this study shows that, the mean value of ROA is 1.571 and the standard deviation is 1.799. The maximum value of ROA is 6.96, while the minimum value is -2.11. This also shows that the profitability of Life insurance companies can be either generated or degenerated from their assets.

For OSF, the mean value of Life insurance companies' size (lnTA) is 15.8718 and the standard deviation is 1.2099 whereas the maximum value for size is 18 while the minimum value is 14. Besides that, the mean value of Life insurance companies' capital is 0.1229 and the standard deviation is 0.0674. Capital has a maximum value of 0.3063 and minimum value of 0.0225. For Life insurance companies' premium growth, the mean value is 0.0704 and the standard deviation is 0.14104 whereas the maximum value of Life insurance companies' premium growth is 0.4175 while the minimum value is -0.4149. Otherwise, the mean value of Life insurance companies' underwriting risk is 1.7484 and the standard deviation is 1.0258. The maximum and minimum value for underwriting risk is 4.4578 and 0.4635 respectively. Lastly, the mean of expense ratio is 0.299 while the standard deviation is 0.083. The maximum and minimum value of expense ratio are 0.5479 and 0.1974 respectively.



## 4.2 Regression Analysis

**Table 4.** Regression Analysis for Family Takaful operators

	<b>Coefficient</b>	<b>Std. Error</b>	<b>p-value</b>
<b>Size</b>	-0.621**	(0.188)	0.002
<b>Capital</b>	-9.764*	(4.405)	0.034
<b>Premium Growth</b>	-0.003	(0.025)	0.898
<b>Underwriting risk</b>	-0.357*	(0.201)	0.080
<b>Expense ratio</b>	-7.870*	(2.771)	0.006
<b>Intercept (baseline)</b>	15.329***	(3.198)	0.000
<b>R-squared = 0.4012</b>			
<b>Adjusted R-squared = 0.3513</b>			
<b>F-statistic = 8.04</b>			
<b>N = 66</b>			

Table 4 shows the family takaful operators' regression analysis of ROA by using Fixed Effect (FE) model. The table shows the ROA as the dependent variables and family takaful operator's size, premium growth, expense ratio, capital and underwriting risk as independent variable. This model has the high good of fitness among the variables with R-squared 0.4012 which means the proportion of ROA is explained by the independent variables at 40.12%.

Based on the result provided, there are four independent variables that have significant relationship with dependent variable which are size, capital, underwriting risk and expense ratio. Size has negative coefficient which is -0.621 at 0.002 significant level with standard error of 0.188. The capital also shows the negative coefficient of -9.764 at 0.03 significant level with standard error of 4.405. Same result shows by underwriting risk variable with negative coefficient of -0.357 at 0.80 significant level with standard error of 0.201. Expense ratio also has negative coefficient which is -7.870 at 0.006 significant level with standard error 2.771.

There is one independent variable that show insignificant relationship and has a negative coefficient with ROA which is premium growth and. Thus, the researcher develops the multiple linear regression equation as below to interpret the model.

**Table 5.** Regression analysis for Life Insurance companies

	<b>Coefficient</b>	<b>Std. Error</b>	<b>p-value</b>
<b>Size</b>	<b>0.627**</b>	<b>(0.190)</b>	<b>0.002</b>
<b>Capital</b>	28.092***	(4.132)	0.000
<b>Premium Growth</b>	-1.250	(1.263)	0.326
<b>Underwriting risk</b>	0.566**	(0.244)	0.023
<b>Expense ratio</b>	-8.195***	(2.602)	0.002
<b>Intercept (baseline)</b>	-10.282***	(3.403)	0.004
<b>R-squared = 0.4365</b>			
<b>Adjusted R-squared = 0.3974</b>			
<b>F-statistic = 11.1558</b>			
<b>N = 78</b>			

Table 5 shows the life insurance companies regression analysis of ROA by using Pooled OLS model. The table shows the ROA as the dependent variables and family takaful operator's size, premium growth, expense ratio, capital and underwriting risk as independent variable.

This model has the high good of fitness among the variables with R-squared 0.4365 which means the proportion of ROA is explained by the independent variables at 43.65%.

From the result, there are four independent variables that have significant relationship with dependent variables which are size, capital, underwriting risk and expense ratio. Size has a positive coefficient which is 0.627 at 0.002 significant level with standard error of 0.190. Same goes to the coefficient of capital shows positive of 28.092 at 0.000 significant level with standard error of 4.132. The underwriting risk also shows a positive coefficient of 0.566 at 0.023 significant level with standard error of 0.053. However, the expense ratio shows a negative coefficient which is -8.195 at 0.002 significant level with standard error 2.602. There is only one independent variable that show insignificant relationship with ROA which is premium growth with a negative coefficient.

## 5. CONCLUSION

This study presented the evidential investigation on the performance of 11 family takaful operators and 13 life insurance companies conducted using a panel data set over the period of 2013 to 2018. There are two mains of objective in this research which are, firstly to analysis the performance of family takaful operators and life insurance companies in Malaysia and the second objective is to determine the relationship between operational specific factors (OSF) and profitability of family takaful operator and life insurance companies in Malaysia.

Based on descriptive analysis shows that the life insurance companies performed better than family takaful operators in generating profits. Based on results of Fixed Effect Model regression analysis revealed that companies' size, capital, underwriting risk and expense ratio were statistically significant to profitability of family takaful operators, while premium growth and were negatively related to performance (ROA). For life insurance companies, the operator specific factors (OSF) that shows significant relationship toward profitability were size, capital, underwriting risk and expense ratio factor, while premium growth the only factors that shows insignificant relationship.

### 5.1 Limitation and Recommendations of Study

Based on the above findings, we can see that the performance of family takaful operator is still left behind the life insurance companies in generating profit. Family takaful operators need to improve their overall factor productivity, focusing mainly on the technical component, such as improving or enhancing information technology and providing human resource training to increase the productivity and efficiency of operators. The high performance of family takaful operators in Malaysia is important in order to achieve Malaysia government ambitions to become a regional hub of Islamic finance in the world. These findings will help takaful operator in improving their performance by manage their related OSF that give impact to their profitability in order to achieve a competitive advantage over their conventional competitors.

Besides that, both Family takaful operators and life insurance companies should be concerned about their operational specific factors (OSF) that tested and had significant relationship towards profitability in this study such as size, expense ratio and underwriting risk. Both entities need to measure, manage and control such factors that have an impact on profitability in order to maintain and increase their profitability as well as their performance.

As a recommendation for future research, the future researcher is advised to increase the time period of study to more than six years. Besides that, they maybe can try to do comparative research among the general takaful operators and general insurance company to test on general takaful/insurance businesses. Future researcher may also do a comparison analysis towards local and foreign takaful operators and insurance companies in Malaysia. Other than that, the researcher also recommends adding more variables in future studies regarding the operator's specific factors (OSF) that will balance the whole management of the takaful and insurance industry such as the liquidity, investment yield, and leverage and so on. At the same time maybe, the determinant factor could be included the macroeconomics factors such as Gross Domestic Product (GDP), inflation rate, Price Index (CPI) and so on.

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## **I-CReST 2023:106-064 - The Necessity and Significance of Book Clubs: An Auto-Ethnographic Perspective**

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### **ABSTRACT**

There are definitely many and various readers the world over. So, have reading and books and the need to discuss books given rise to ‘bookclubs’? The authors have undertaken to study the need as well as the significance of such clubs in Malaysia and specifically in the Klang Valley region. They have looked at various book reading circles and tried to determine what makes such clubs work. Is it the readership, the educational qualifications, interest, availability of the proposed reading material or any other significant cause that contribute to the establishment of such clubs? The researchers explored this phenomenon by adopting the autoethnographic approach, focussing on the Paperback Book club which was established in 2011. There are other book clubs associated with this club which will also be examined in terms of reading lists, frequency of meets, etcetera. One interesting factor to note is the creativity of sustaining these reading circles, no matter what the circumstances. The first author’s direct involvement in establishing and running book clubs will be the basis for the auto-ethnographic justification of the methodology employed. Having been a member since April 2013, the researcher has seen significant changes in the workings of the club, which boasts of both local and international members from various occupations.

**Keywords:** Paperback book club; reading circles; book lists; auto-ethnographic approach

### **1. INTRODUCTION**

All over the globe, book clubs are known to sustain readers who love a good discussion of books read, whether the books are liked or not. So how did this book club phenomenon come about? There is no definite answer but a quick search online claims that a certain Anne Hutchinson organized a women's book group for looking into weekly sermons, as far back as in the year 1634 [1].

The authors will use the auto-ethnographic way of rendering the information about the book clubs, particularly that of the Paperback Book Club, drawing comments and responses from various members of the book clubs about how significant (or not significant book clubs are today. A point to note is book clubs are interchangeably used to mean reading clubs or

reading circles, although to use 'literature circles' is highly specific and inclusive. Here in this paper, the authors prefer the term 'book club' to best meet the research objectives.

So how would one describe a book club? According to the Collins English Dictionary [2], a book club is

1. an organization that offers books at reduced prices to its members.
2. a group of people who meet to talk about a book or books that they have all read.

Taking the above definition into consideration, one objective was to determine who attends book clubs and why. Interestingly, despite book clubs such as the Paperback Book Club being primarily a club that discusses fiction, the members come from diverse professions – engineering, accounting, medical related professions, education and so on. This is why the responses were elicited from the members.

This paper will review literature on the methodology applied, certain book club related articles, then go on to the way this research was conducted followed by a discussion which will cover the first author's observations of book club sessions and the experiences from them, followed by some takes by book club members of a few book clubs but mainly from the Paperback Book Club.

For the past year and even earlier, the local newspapers have been replete with news about reading for all levels and there are often news items on books and writers. This clearly shows that reading is important and hence the establishment of book clubs is just one of the ways to encourage reading.

The conclusion will look at how necessary book clubs are and whether they will continue to exist in the future as per the opinions of the several people contacted as well as the personal views of the researchers.

## 2. REVIEW OF LITERATURE

Book clubs are indeed an interesting concept. The existence of book clubs goes to show that people actually do read and like to discuss what they read. There are various types of book clubs in existence and some are named after the authors discussed while there are other generic ones like 'Children's Book Club', 'Young Adult Book Club', 'Fiction Book Club' and so on.

Burger [3] mentions how a photographer went about trying to establish a book club and she really did not know how but finally in getting a reading group together, it had been running for almost 26 years. She emphasized the popularity of book clubs among women specifically in America and what women gain from them and how they adapt themselves into the history of literary culture. A few points she discovered were women's education, self-culture, 19<sup>th</sup> century women's culture, self-help and in modern times, is mentioned the 'Oprahfication of Literacy' thanks to the establishment of the 'Oprah's Book Club'. According to Oprah Winfrey, popular media personality in the United States of America (USA), literature is a way of learning about oneself and that the act of reading can transform the reader.

Petrich [4] looked at conversations that came about from reading engagements which accounted for social-emotional learning. Here young learners select their own materials to read, work at their own pace using the reading skills learnt and this becomes highly motivational and further inspires as well as empowers the diverse young learners through the sharing of vocabulary. The fifth graders in an American mid-west school began to learn from different opinions of the ethnically diverse classmates when engaged in book club sessions, which were held once a week during the school day and lasting for less than an hour. Feedback was provided through Google forms and many of the students mentioned how they initially struggled with the reading but began to see it as a fun experience after listening to different perspectives. The teacher happily concluded that collaborative learning within the book club was far better than initially expected.

Sedo [5] in her PhD thesis back in 1992 studied the then established women's book clubs where she delved into an interdisciplinary approach where she made use of various theories to explain the social relations five Canadian reading groups, in terms of the motivations for reading. Her research questions covered social practices of these reading communities as well as the concept of interpretive communities. She looked at theories of cyber communities, reading and reading reception for the holistic portrayal of book clubs. As a participant observer, Sedo participated in all groups and adopted the micro ethnography method while looking at intersubjectivity factors such as genre choices, seat arrangements, space allocation and so on. She made extensive use of tables and curated some of the verbal exchanges among the readers, making her thesis one of the most interesting peeks into the world of book clubs.

Mendez Lopez [6] detailed the autoethnography method and the specific features associated with it. In her qualitative study, she examined the way students reacted emotionally in classrooms and how these emotions helped in studying their motivations towards language learning as well as other external incidents. She mentioned a few advantages of using this method, the most important being one of self-reflection. She does go on to discuss the disadvantages and the ethical considerations but concludes by saying that "it is an instrument through which researchers can explore and portray the culture where a phenomenon is being experienced" (p285).

Jocius and Shealy [7] tried to come up with ways to design book clubs that support students to develop their skills in a way to empower them to read and write to critique their environments and the world they see themselves in so that they are equipped to advocate for social change. The authors explain a four-phase model for scaffolding critical book clubs, and come up with instructional to help the students understand the texts they read.

### **3. METHODOLOGY**

A qualitative approach was best suited for this study, allowing the researchers to make observations while conducting and partaking in several book club sessions as well as interviewing 30 regular members about what reasons they had for joining the book club as well as the take-aways from the various sessions that they had attended. For auto-ethnographers, the work must evoke in readers a feeling that the experience described is lifelike, believable, and possible, a feeling that what has been represented could be true. Basically, it connects readers to writers and provides continuity in their lives.

The researchers looked at the demographics, popular genres, profession, interests, and in the conducting of the sessions, could also observe body language through posture, facial expressions, gestures and so on. Some of the responses were asked for the following questions:

1. Demographic details – Gender, Occupation, Nationality
2. Whether one preferred reading fiction or non-fiction and the reason for their preference
3. If they felt book clubs were necessary
4. Whether book clubs will continue to exist/thrive
5. What they enjoyed most from the book club sessions

The interviews were recorded and further checked for authenticity. Certain members were reached via texts on mobile app groups (in this case, WhatsApp) as interviewing them was not conducive due to time, work schedules and other issues.

#### 4. DISCUSSION

This paper will discuss the various observations made by the authors while attending the book club sessions and address some valid queries about the impact of book clubs. There are several book groups in Malaysia, many of them known only via social media posts. Some of the known ones are as follows:

**Book Sharing** 4,093 Members | Kuala Lumpur, Malaysia  
**The Paperback Book Club** 1,472 Readers | Kuala Lumpur, Malaysia  
**Light Portal** 194 Members | Kuala Lumpur, Malaysia  
**In Between the Lines (Book Club)** 40 readers | Kuala Lumpur, Malaysia  
**Johor Bahru Book Club Group** 7 Members | Johor Bahru, Malaysia  
**KLBAC (KL Book Appreciation Club)** Kuala Lumpur  
**Classics Challengers** Kuala Lumpur

##### 4.1 Observer Insights

###### 4.1.1 The Paperback Book Club

The first author has been a member of the Paperback Book Club since April 2013 and became a co-organizer (along with 2 others) of the same club since January 2015. Some information about the Paperback Book Club as in on public display is as given below.

*A book club for lovers of the written word to come together over pots of afternoon tea (and coffee) for relaxed discussion, dissection and deconstruction of their favourite readings. This group aims to help all of us get that much more out of each reading experience.*

*Open to humans above 18.*

*You can also find us on Facebook at <http://www.facebook.com/PaperbackBookClub>.*

*Click here (<https://www.meetup.com/paperback/messages/boards/thread/29740272>) to check out our current reading list*

Further information at the meetup website is as follows:



### ***How does a book club work?***

*A book club generally takes the following format:*

*Members are all given a certain amount of time to read one chosen book - say, a month. After that, we get together to discuss the book - for instance, its themes, characters, plot, style, etc. - and what we may have each gotten out of reading it.*

*The process is to help develop a deeper understanding and appreciation of the novel being discussed. Generally, these discussions are meant to be enjoyable and stimulating!*

*Rinse and repeat :)*

### ***How is the Paperback Book Club different from other book clubs?***

*We'd like our discussions to be relaxed and accessible to all - not necessarily only those with English Literature degrees! Understanding and appreciation of the written word should be for everyone.*

*We have (or plan to have) our meetings over lovely afternoon tea spreads. This way, we can combine two of life's fundamental pleasures - books and tea!*

*For the PBC's FAQs, click here*

*(<https://www.meetup.com/paperback/messages/boards/thread/17337012>).*

*If you're interested in joining us, just RSVP for the next scheduled meetup and we'll see you there!*

Although the number of members is many, the few who turn up for the regular physical meets are about 8-20 people. Usually the meet is held at a café in the centre of Kuala Lumpur, preferably accessible by the LRT and MRT train stations.

#### **4.1.2 General Observations Made in the Circle**

As one of the organizers of the paperback Book Club, the first author's profile on the website is as follows:

- *Co-organizer*
- *Joined Apr 22, 2013 - Visited group today*
- *Good day! I am Roy and I am an educator interested in books, plays, films, book club circles, graphic novels in education, movie adaptations of books & all related fields :).*  
*I have been in the education field for over 30 years.*

Each member's profile will mention the date of joining as well as a short description of the individual.

Demographically, the members are from various professions. Interestingly, there are a number of accountants and engineers. A few are from medical-related professions. We have quite a few local and foreign writers as well. We have Malaysians, ex-pats, foreigners working here, and so on. There are educators, tertiary students and researchers, among other professions. This being a 'fiction' book club, it is interesting to note that people actually read for the love of reading. Many friendships are cultivated through this love of reading and discussion. People just want to be heard. The different takes on the novel give a lot of food for thought. Since the

Paperback Book Club caters to fiction material, it is interesting how those not inclined towards fiction have actually picked up the interest to read further fiction.

There are sessions in which parents have brought in their young children and while the parents partook in the discussion, the off-springs generally sat quietly and listened. To make the members feel that they belong to a community, monthly birthdays are celebrated with a simple cake cutting ceremony. It is observed that although some members are clearly embarrassed, most of them take to cutting the cake happily.

Certain festivals are celebrated by having food laid out and a dressing theme adhered to. For the week before Christmas for example, the members are encouraged to dressed in Christmassy attire (the Santa hat included) or colours and while the discussion takes place, goodies such as sweet savoury snacks are passed around. This too adds to the sense of community that is embraced by the book club members.

Book launches and author meets also get the members to go in a group to these events, including non-book related events, such as attending drama, recitals, music and dance performances as well as movies. Once again, this goes into fostering a sense of community.

#### 4.2 Preferences – Fiction or Non-Fiction

The Paperback Book Club is unapologetically a FICTION book club. Many members initially join it thinking we discuss NON-FICTION. Due to this and to make way for those who go for non-fiction, an off-shoot club called LITERALLY VIRTUAL, which was established during the COVID 19 pandemic and this caters to both types. As for the members' answers to their preferences, these responses and reasons were gathered.

Fiction. I believe fiction explores human condition in more imaginative ways. No doubt there are many useful and readable biographies or memoirs or fact-based books. But the art and skill of a good literary novel is unbeatable.
Find fiction fascinating, interesting. A way to escape in different worlds and realities
Non-fiction. I read to expand my knowledge.
I write fiction; so learning the craft by reading other works is both entertaining and a learning experience. But, when the non-fiction work is good, I enjoy it, too.
Right now, I prefer NON-FICTION, but when I have the time I love fiction. My line of work takes me more into the non fiction for research and guidance.
I love the different genres, both fiction and non-fiction
Both, maybe slightly leaning towards non fiction
The subject matter is more important than fiction or nonfiction - I am not a fan of traditional narrative lines and prefer radically different perspectives.
I prefer fiction. Fiction allows me to appreciate the variety that characterizes the human condition. I find that deeply satisfying.
Fiction. I read to escape and have fun and usually fiction books are more fun and let me have that escape.
I am a mood reader. I love reading books about mental health. Both fiction and non-fiction. So I guess, both? I love psychological thrillers and historical fiction.
Non-fiction. I love History, and since I couldn't be an archaeologist or historian, I invest my time in history non-fiction.



I like to keep a 3:1 Fiction to Non-fiction ratio. I like reading essays/critiques/theories now and then so I read some non-fiction.

Fiction. For pleasure.

Non-fiction. I like reading about history to understand the past and I like reading about current political circumstances to understand why the world is where it is today.

Fiction. To get involved in another world/narrative

### 4.3 The Necessity for Book Clubs and the ‘Oomph’ Factors

The table below are the responses from some of the members of the book club.

Members' profession/ Nationality	Are book clubs necessary? Why so?	Any defining moments or general take-aways from the sessions
Chemical engineer Indian	Very. Book clubs set the pace for you, especially during readers' block. They also point us to new books or genres we may not be aware of.	I enjoy book club sessions if they are not frequent. Say once a month. More than that does not work for me. I specially enjoy sharing opinion on a good book, or just listening in to people who just finished a book they loved. This cross pollination of ideas is very enjoyable. I would like to relate an incident where another member and I were invited to a school, because they saw us as people encouraging reading. We had a fun time talking to younger readers on which books move us and why.
Retired accountant Indian	It is not necessary to have book clubs but it is highly desirable as Book Clubs help nurture a conversation about social issues and help to broaden one's mind by providing diverse perspectives to the participants	
Student American	Children in schools read and discuss books and that goes away after they graduate. Book clubs are a way to learn while reading (because you naturally do so) but coming together to discuss the book is not only fun and builds friendship, community and communication skills, but it also helps you learn more from one another. Not only about the book itself but about other people.	I really enjoy book club sessions. Major takeaways especially is the one I am in now, are that people come from all different kinds of backgrounds and places and we all view the same things differently, including books. One book that comes to mind is 'The Accidental Malay'. Everyone at the book club come from different places but we were all living in Malaysia and I learned a lot about the book and the culture of Malaysia from people who had lived in



		Malaysia a long time and also from people who have been born here. It was so insightful.
Pensioner and Housewife Malaysian	Yes, indeed! I love the discussions since there are no two people reading the book the same way. I get to know what others think about the book which is good because I might miss some interesting points. I also get extra information regarding the book, like its history.	The history behind the stories. Getting to know other bookworms Everyone is very open minded and respect one another.
Academic Indian	Very few things are strictly necessary but having book clubs is definitely a positive. So that one can meet people with different perspectives and experiences whose understanding and takeaway from the same books can be very different from each other. Learning about them adds to one's own understanding.	Yes, because I get exposed to new perspectives and ideas. Any completely different take can be a fun moment.
Educator & Entrepreneur	Obviously not a necessity, but certainly a good idea. Some people love the act of reading and having their imagination ignited, others love to read to talk about what they are reading, and seek to know more about what they are reading. Book clubs open these doors for people. Plus, they are a really good way to meet people who are like-minded. Also book clubs are a great way to discuss greater issues related to the book.	Yes, I do love the book club sessions. It's just interesting to get other people's perspectives on what you have read. I do think however the venue makes a difference, as being able to hear what people are saying is an important thing. If the venue is too big and the group is too big, it can be difficult. But if it is a small group in a cosy location, it's great.
Marketing Executive Malaysian	Yes. – as a support group -a great way to build fantastic friendships that goes beyond books and of course discover other great books through members' recommendations, without which I would not read.	Love them. Just discussing books is ecstasy for me.
Radiologist Malaysian	YES! Opportunity to read books you'd not pick up. A meeting of great minds.	Yes I do. Understanding new concepts. Seeing others' perspectives. Great camaraderie among members. Differences are celebrated.
IT security audits Malaysian	Yes. It fosters a community amongst those with the same interest.	Yes I do. It is a chance to meet people from across the globe and talk about something u both read but might interpret very differently. Its inspirational to have something in common with someone who is so different from you
Teacher	Obviously not a necessity, but certainly a good idea.	Yes, I do love the book club sessions. It's just interesting to get other people's perspectives



	<p>Some people love the act of reading and having their imagination ignited, others love to read to talk about what they are reading, and seek to know more about what they are reading. Book clubs open these doors for people. Plus, they are a really good way to meet people who are like-minded. Also book clubs are a great way to discuss greater issues related to the book.</p>	<p>on what you have read. I do think however the venue makes a difference, as being able to hear what people are saying is an important thing. If the venue is too big and the group is too big, it can be difficult. But if it is a small group in a cosy location, it's great.</p>
<p>Retired</p>	<p>Very few things are strictly necessary but having book clubs is definitely a positive. So that one can meet people with different perspectives and experiences whose understanding and takeaway from the same books can be very different from each other. Learning about them adds to one's own understanding.</p>	<p>Yes, because I get exposed to new perspectives and ideas. Any completely different take can be a fun moment.</p>
<p>Writer</p>	<p>They aren't necessary but they facilitate alternative ways of understanding and interpretation which enhances the reading experience. They also establish very real human connections and relationships which go far beyond the books being read and discussed.</p>	<p>My most surprising moments have been at my romance bookclub sessions mostly because romance novels are considered trashy/ not high quality/ easy reading.</p> <p>I am often surprised by the honesty and acceptance of the very accepting and liberal views about sex, gender equality, feminism etc expressed by women who may seem outwardly quite conservative. I always come away energised and more empowered from these sessions.</p> <p>We have a saying "what happens in book club stays in book club" so in a way this creates a 'safe space' for people to say what they think without fear of being judged or put down. It's very powerful.</p> <p>We have one member who delights in introducing us to the most bizarre romance books featuring dinosaurs/ aliens/ the most absurd shape shifter romances / time travel etc. which leave us highly amused and in stitches of laughter.</p>



Retired Educator	Yes. Book clubs are a way for people to share their love of books, and for socializing.	They are good social events with like-minded people. I also get introduced to books I'd never otherwise read.
Consultant	Yes, book clubs are useful. Books clubs bring together persons who share a common love for books. Also, we learn different perspectives, or insights from each other, and this significantly improves the enjoyment of the books discussed.	As friends, we share and support each other emotionally, and this enriches life. A book club does not need to have large membership, even just a couple or so is enough for rich, engaging and rewarding sessions. Book club members, at least some, would also branch out to other activities like common hobbies, cultural events and travel.
Banker	Yes. Exchange of view; intellectual stimulation	Listening to other views, networking and enjoying snacks and special occasions.

#### 4.4 The Staying Power of Book Clubs

When asked if book clubs were here to stay or become defunct, the responses received were interesting. Of course, there was a clear thumbs-up given to book clubs' continuing existence by most of the members. These were some responses;

Participants' professions	Responses
Engineer	I think book clubs will always be around. Besides readers, it also builds a social circle we can dip into.  Yes I think it will continue.
Previously lawyer, now Writer	They'll never die. Just like water finds its own level, readers will always search for other readers. I am the reader in my family. None of my cousins are avid readers. So, I look for others who read and I'm very lucky that PBC members read the kind of books I like to read.
Educator, Entrepreneur, Writer	I really don't think book clubs will ever die. They have been around for as long as I can remember, and no matter what has happened in the changes in the world, the book clubs still seem to be thriving...
Retired accountant	Yes, book clubs will always continue as it is also an informal social circle. As friends, we share and support each other emotionally, and this enriches life. A book club does not need to have large membership, even just a couple or so is enough for rich, engaging and rewarding sessions.
Educator	They will continue to be around. Because there are dedicated people who still run them and can pass to the next people
Writer/Poet/Playwright	Bookclubs were my sanity during the Covid lockdown. Technology makes it possible to exchange views with people thousands of miles away. It's exciting. Book clubs are going to be around for as long as there are readers.
Retired accountant	I think Book Clubs would always be around as the need to discuss and share one's thoughts is a human trait

Student	I think reading is growing with the rise in book and other social media places and so I think as the younger generation starts to read more, that will increase the number of book clubs
Housewife	They will be around. In social media platforms like Instagram & TikTok, there are a lot of Generation Y, Z and Millennials discussing on the books that they have read. But sometimes it can be toxic when people start attacking them due to different opinions. Nevertheless, I see bookclubs being around for a long time. I would join a small group discussion in Instagram. We would form a buddy reading group. This is a bookclub in a new platform. Not to mention Zoom sessions. These two platforms make it easier for us because some of us can't make it to book discussions at certain place because they live far.
Retired Academic	I think they will be around as books are an important medium, especially for older material when other media were non-existent or very limited. It is still the best medium for long discussions of deep thought.
Entrepreneur	I really don't think book clubs will ever die. They have been around for as long as I can remember, and no matter what has happened in the changes in the world, the book clubs still seem to be thriving...
Health care personnel	Continue and flourish! Readers read and need a place to talk about things they explore through reading.
IT personnel	I suspect they might die as more seek connection over social media rather than real life.
Corporate Communications Officer	Nope. Book clubs won't die out as from the experience of the book club I am a part of, the members are fanatical about books.
Teacher	I really don't think book clubs will ever die. They have been around for as long as I can remember, and no matter what changes take place in the world, the book clubs still seem to be thriving.

#### 4.5 Reasons for Reading

People read for various reasons. Some interesting takes from members are as follows:

Reading is an interest.
It depends on the person. I believe reading is an inherent part of human growth and understanding.
Reading is a choice.
Reading depends on past, present and future interest in addition to knowledge.
For leisure and for a respite away from the hard realities of the grind of daily life.
In general, people don't think it is important to read.
I think many people find it hard to find the time as there are so many distractions.
People read because of interest and also because it is important.
I think reading is very important and nurtures sensibility.
Reading is vital for mind development.
As an interest, Or for work, study, curiosity.
I think reading is a habit, like brushing your teeth, you cannot do without it. It's impossible not to read.
Reading is important. Everyone reads, it's a question of what they read. If anything, technology has overwhelmed us with the written word.
I think people read as an interest but probably less than in the past due to more varied content formats that are now available.
I think there is a very significant group of people in society who absolutely love reading for pleasure, for them it is impossible to consider a day without some reading. Others read for their work, and



others read but don't realise they are reading....either through articles online, or social media links etc. I'd say a lot of people say they don't read because they associate reading only with 'novel' reading. Also, they wouldn't call themselves an avid reader because they may not buy books, but they are constantly reading other material, like on their favourite topics or current events.

I enjoy understanding the nuances that some of the great writers can express through the written word. It is an artform, and helps people to understand human behaviour and cultural aspects too....Reading a great story is a very powerful experience that will never die.

## 5. CONCLUSION

Having navigated through the various observations made by the first author, it is seen that in the final analysis, book clubs are deemed not only necessary but also important for the general well-being of a society. The various responses to the questions asked also show that despite some differing opinions, most of the book club members advocated the establishment of book clubs for the general good of the citizenry. Whether book clubs would survive and continue to be present elicited positive responses from most members, including the authors although a few were afraid that with the advance of technology, book clubs may not prevail. Different members had different preferences as in fiction and non-fiction; although the genres were not asked about in this research, from the first author's observations of the book discussions, the members enjoyed a wide range from fantasy, adventure, historical fiction, science fiction, classics, biographies, graphic novels and so on.

On a final note, to reiterate the importance of establishing book clubs, as mentioned by some members, they are a good way of encouraging the younger generation to read; it is highly recommended that one joins a book club; it is where one meets like-minded and interesting people. To end with what one member so encouragingly said can sum up the essence of a book club: "Running / managing / organizing a book club is hard work. It's not easy to choose the books, find the people, secure a location and ensure that everyone behaves in a civil manner. Quite simply, a book club needs stamina and is nothing but a labour of love."

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## I-CReST 2023:121-085 - Italy's Thrusting Gender Theory, Its Teaching in Public Schools, and Its Effects on Younger Students

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### ABSTRACT

Recently in Italy, the concept known as gender theory has permeated various aspects of public life, spanning across TV, radio, newspapers, media, the Internet, schools, universities, science, and political parties. Its prevalence has steadily increased over the years, becoming more widespread and evident. Gender theory, also referred to as progressive-liberal ideology, posits that there are no inherent biological differences between men and women; rather, such differences are considered cultural or social constructs. The theory suggests that individuals identify as male or female based on societal education, and they have the freedom to not only choose their own sexuality but also to change it as desired. Gender theory is closely intertwined with the concept of gender identity: this term refers to the intimate self-perception that some people might feel about their own sexuality. This topic is now being taught to Italian students attending public elementary and high schools, as these institutions aim to cultivate an inclusive environment where the rights of non-binary, transgender, LGBTQIA+, gender fluid, and queer individuals must not only be respected but also given the utmost consideration. Public schools are encouraged to adopt the so-called “free gender registers” which allow students to select their own sexual identity. The primary objective of this qualitative research is to investigate whether this gender theory is based on scientific evidence or if it is purely ideological, as well as to examine its impact on teachers, students, and their parents. The research draws mainly from current Italian newspaper articles (2017-2023), which seek to provide an accurate portrayal of life in Italian schools and the implications for students, their parents, and the educational system.

**Keywords:** Italy; ideology; public schools; gender theory; LGBTQIA+

### 1. INTRODUCTION

Gender is an English term that encompasses personal identity and sexual orientation. Throughout history, the term “sex” has traditionally been used to denote the distinctions between men and women. However, starting in the 1950s, primarily in the United States and Europe, scholars such as Claude Lévi-Strauss, a French anthropologist and philosopher (1908-2009), and Michel Foucault, a professor of Human Science (1926-1984), began to differentiate between “sex” and “gender”. Sex came to refer to an individual’s genetic and biological attributes, while “gender” became associated with complex mechanisms linked to the relationship between men and women. Gender theory seeks to challenge the traditional notion

of the family as the union between a man and a woman, which has long been considered the fundamental unit of society, as well as the established rules of nature.

Over the years, numerous gender theories have emerged across various fields (Elle, 2017) and, as a result, there is no single unified gender theory. This research will specifically focus on the theory related to gender identity, which differs from sexual orientation. Gender identity is one of the earliest factors influencing self-identification in children, typically emerging between the ages of three and four. It is unrelated to one's sexuality. Gender identity refers to how individuals perceive and define themselves as male, female, a combination of both, or neither. It is not always immutable but it can be subject to change based on personal experiences (Battaglia, 2022). On the other hand, sexual orientation pertains to one's sexual attraction to others. Only during puberty do individuals begin to experience feelings of sexual attraction, which may be directed towards the same gender, the opposite one, both, or none of them. Therefore, adolescence marks the period when individuals begin to comprehend their sexual orientation and, in this context, we can discuss sexuality. It is a common misconception that gender identity and sexuality are inherently linked. This confusion partly arises from the Italian language, which employs the same word - "sex" - to refer to both gender identity and sexuality (Caputo, 2019). Gender theory rejects the binary division between males and females and posits that there are numerous gender identities that may not align with biological sex. Sexual orientation does not adhere to rigid frameworks but allows for the possibility of shifting attractions throughout one's life, influenced by various factors such as time, circumstance, and individuals involved. Everyone has the right to feel attraction towards any or all genders, irrespective of their self-declared sexual orientation. Sexual fluidity does not equate to being gay, lesbian, or bisexual. In fact, the strength of this definition lies in not categorizing oneself. Sexuality is not fixed but can be shaped by social, cultural, and situational factors. Young people are increasingly rejecting labels when it comes to their sexuality. This is reflected in the expansion of the original acronym for the LGBT community (which stood for Lesbian, Gay, Bisexual, and Transgender) to LGBTQIA+, the "+" sign encompassing all other gender identities or sexual orientations beyond the previously mentioned categories. The clear distinction between heterosexuality, bisexuality, and homosexuality is no longer prevalent. One can fall in love with a girl today and feel attracted to a man tomorrow. Each individual's choice is unique and cannot be confined to predefined boxes (Giudice, 2023). The expression "sexual identity", which relates to the psychobiological dimension of the human being, should be replaced by "gender identity" which pertains to the sociocultural dimension (Di Iorio, 2022). Every individual possesses sexual variability and self-reference, free from environmental, religious, and sociocultural influences, and is capable of changing multiple times throughout the course of life, based on personal and transient impulses. Therefore, sexuality transcends the limitations of any singular hegemony and gives rise to a sexual pluralism that allows for diverse identities and alternative sexual experiences. The complex realm of gender theory can be divided into two major aspects: political and theoretical elaboration. The former employs gender theory as an ideology for political battles, while the latter involves discourse on sexuality and new experiences that challenge nature's rules and the dichotomy between masculinity and femininity. It is evident that gender theory is driven, on one side, by a meticulous commercial and marketing strategy and, on the other side, by its political influence in education, legal frameworks, and cultural perspectives (Avvenire, 2015).

New terms have emerged in recent years to define different gender identities (Saia, 2022). "*Cisessuale*" (Cisgender) is used to describe cases where an individual's biological sex aligns with their gender identity. "*Persone androgine*" (Androgynous) refers to individuals who

exhibit elements of both femininity and masculinity in their appearance. “*Binari*” (Bigender) identify themselves with both sexes and can assume male or female roles. “*Non binari*” (Nonbinary) is a term that encompasses individuals who do not exclusively identify as male or female but instead define their gender identity and experiences outside of these binary terms. “*Persone di genere fluido*” (Gender fluid) are those individuals who do not feel exclusively male or female and do not wish to fit into any specific sexual orientation category, be it heterosexual, bisexual, or transgender, as their gender and sexual identity are fluid and constantly evolving. “*Stravaganti*” (Genderqueer) is a term that describes individuals whose gender identity does not always align with their sexual identity. Genderqueer individuals typically reject the notion of fixed gender categories and embrace fluidity in both gender identity and, often but not always, sexual orientation. Those who identify as “genderqueer” may see themselves as both male and female, neither male nor female, or as existing completely outside of these categories. *Novosessuali* (Abrosexuals) are individuals who experience fluid and rapidly changing sexualities that fluctuate between different orientations. “*Persone senza genere*” (Agenders) are individuals who do not identify with any gender. “*Aessuati*” (Asexuals) are individuals who do not experience sexual attraction, and asexuality should not be confused with celibacy or sexual abstinence, as it is an inherent orientation. “*Persone bisessuali*” (Bisexuals) experience attraction - sexually, romantically, or emotionally - to individuals of both the same and different genders or gender identities as themselves. “*Demisessuali*” (Demisexuals) are similar to asexual individuals as they do not experience initial sexual attraction but may develop it once they form a strong (typically romantic) bond with someone. “*Poligenere e pangenero*” (Polygender and pangender) are people who identify themselves with multiple genders. “*Genere onnicomprensivo*” (Omnigender) refers to a person who identifies as and encompasses all genders. “*Persone intersessuali*” (Intergender) individuals possess various genetic/chromosomal, gonadal/hormonal, and/or anatomical sex characteristics that do not align with the typical binary notions of male or female bodies. Finally, the term LGBTQIA+ collectively refers to individuals who identify as lesbian, gay, bisexual, transgender, queer, intersex, or asexual. The “Q” can also represent “questioning”, encompassing those who are still exploring their sexuality and/or gender. Gender theory seeks to challenge the world we have known thus far, which has been composed solely of males and females (Cassi, 2022). Today, it is crucial to acknowledge the diverse nuances of gender identity, which open the doors to a more inclusive and complete world. The outdated binary perspective is counterbalanced by a multitude of individuals belonging to the aforementioned categories (Damiani, 2022).

According to gender theory, contemporary society must learn to appreciate and acknowledge the complex world of gender identities, their diverse aspects, and the broad spectrum that extends beyond a simple binary division of men and women. Gender is not synonymous with biological sex, as evidenced by the numerous identities that individuals can possess. Being born with male or female genitalia does not automatically determine a specific gender identity. One thing is biological sex, while another is the gender someone feels to belong to. While some individuals’ gender identities may remain fixed, others may evolve and change over time. Gender theory strives for greater inclusiveness by shedding light on the many facets that constitute the subject of gender. Our world is in constant flux and growth, with the emergence of new terms that enable an increasing number of people to discover and embrace their own identities (Carosi, 2022).

## 2. LITERARY REVIEW

There is copious literature on gender theory, mostly advocating for this ideology. There are few authors who dare to oppose gender theory and they are often accused of being modern fascists and homophobes. After all, like any ideology worthy of this name, gender theory does not tolerate a different thought and those who profess it are labeled as enemies of progress and societal advancement.

In her book “Gender Trouble: Feminism and the Subversion of Identity”, American philosopher Judith Butler presents a groundbreaking perspective on gender, sexuality, the body, and language. She is widely recognized as a pioneer of gender theory, which has gained popularity not only in Italy but also in other Western European countries. “Gender Trouble” (Butler, 1990) offers a compelling critique of heteronormativity and the role of gender in the modern world. It has become a seminal work in contemporary gender theory and is essential for anyone interested in studying gender, queer theory, or the politics of sexuality. Butler draws on French Theory, particularly the ideas of Michel Foucault, Jacques Lacan, Julia Kristeva, Claude Levi-Strauss, Simone de Beauvoir, Luce Irigaray, and Monique Wittig. Her thesis challenges the notion that sex is an inherent characteristic and argues that it is a product of historical processes in which various identities emerge. Butler dismantles the binary construction of man/woman and asserts that gender is socially constructed (Nucci, 2014). She raises fundamental questions such as: “What does it mean to belong to a specific gender?” And: “Is it possible to assign identity solely based on biological sex?” Butler answers these questions negatively, emphasizing that there are not only two genders but numerous possibilities that encompass those deemed anomalous and/or deviating from imposed social norms. Individual identities are fluid and cannot be reduced to stereotypical models. This perspective presents a challenge that ensures access to rights and fosters the quality of democratic practices.

*God Save the Queer. Catechismo femminista* (God Save the Queer: Feminist Catechism) by Michela Murgia (2022) explores the relationship between the Catholic religion and LGBTQIA+ individuals. The author ponders the question of how to reconcile Catholic faith and feminism. This dilemma also applies to LGBTQIA+ believers and others who find themselves compromising between their conscience and doctrinal precepts, particularly regarding topics such as abortion, euthanasia, and assisted fertilization. Murgia argues that it is indeed possible to believe in God and be a good Catholic while embracing a queer, transsexual, gay, or lesbian lifestyle. Certain teachings of the Gospel need to be reevaluated in the context of a modern society that has undergone significant changes. Murgia suggests that even God, as perceived by Christians, embodies contradictions: divine yet human, singular yet Trinitarian, omnipotent yet sacrificed on the cross. Therefore, human contradictions do not hinder a complete and conscious Christian faith. The author aligns with Michel Foucault’s theory that sexuality is not solely a biological sphere but rather a construct of a patriarchal and closed society. Gender theory emerged precisely to challenge the dominance of heterosexuality (Iannicello, 2022).

Murgia considers Jesus as a “queer” Messiah, as Christ did not categorize or judge people based on their sexual orientation. Consequently, supporting gender theory becomes an act that challenges Christianity. In recent years, Christians have faced various forms of attack across different sectors of society, ranging from issues related to the family, ethics, and respect for traditions to the delegitimization of Christian symbols (Giubilei, 2022). These attempts aim to

undermine the Christian religion at multiple levels and with varying degrees of intensity, from growing instances of Christianophobia to efforts to erase Europe's Christian roots.

*Il sogno del padre* (The Father's Dream), a book written by Massimiliano Fiorin in 2022, recounts the story of a man who returns to his hometown in search of an ideal father Fig.. This father Fig., not necessarily his biological father, could impart important life lessons for mental and physical growth. During his journey, Fiorin encounters numerous individuals, both men and women, who are constantly at odds with each other. The book alludes to Friedrich Nietzsche's prediction of an imminent and ruthless war between the sexes that would engulf European society. It is undeniable that, one hundred and forty years later, such a war has indeed erupted and has become fully manifested, even bloody, throughout the Western world. Its consequences include evident phenomena such as family and social disintegration, widespread psychological distress, collective impoverishment, and, regrettably, physical violence (Fiorin, 2022). This ongoing and violent war between the sexes has given rise to a petty world populated by lobbyists and unscrupulous individuals who prioritize their own self-interests. The disintegration of the societal fabric is a result of an alarming ethical void present in too many people, particularly in those who, by societal role, should serve as guides (Sari, 2023).

Samuele Briatore, the author of "*Il nuovo galateo di genere*" (The New Gender Etiquette), published in 2022, examines real-life situations and highlights the challenges faced by individuals who have come out with their gender identities. Briatore asserts that many people encounter difficulties and prejudices from friends and family members when revealing their gender identity. The book aims to promote the avoidance of stereotypes and non-inclusive behaviors towards LGBTQIA+ individuals (Mazza, 2022). Coming out and disclosing one's sexual orientation or gender identity is never easy. Sometimes, even friends may struggle to react appropriately, turning what should be a joyful and proud moment into an awkward and complicated one. After enduring a journey often marked by stigma, fears of rejection, and discrimination, one's identity is finally affirmed. In a society that is constantly evolving with new realities and social sensitivities influenced by gender theory, it becomes crucial to know how to behave in the most appropriate way. The New Gender Etiquette not only seeks to dismantle outdated male chauvinist norms and notions of gallantry, but also promotes inclusivity by providing practical examples and everyday scenarios. The book introduces a new and more inclusive language, offering guidance on what to say and what to avoid when engaging with individuals who are sharing their sexual identity. The following expressions should be avoided in front of someone who is coming out: 1) "I knew it already", which undermines the significance of the moment and makes the person feel like his/her sexuality or gender identity is insignificant. 2) "Are you sure?" implies doubt about the individual's gender identity, suggesting it may not be accepted wholeheartedly. 3) "Your parents will feel really terrible". 4) "Have you experienced any trauma?" 5) "I will pray for you". These expressions are offensive, and those who use them appear outdated and regressive. It is important for everyone to be aware of the appropriate language to use when interacting with LGBTQIA+ individuals (Zuccari, 2022).

Another book that supports gender theory is *Intersex. Antologia Multidisciplinare* (Intersex. Multidisciplinary Anthology) by Michela Balocchi, published in 2019. The anthology explores the concept of intersexuality and questions the socially recognized sex categories of female and male as being just two among the many sexualities that exist within human beings. Balocchi delves into why intersex people undergo surgical and medical interventions when there are no health issues present and without obtaining full informed

consent. The book also examines the existence of human rights for intersex individuals. “Intersex” (Balocchi, 2019) compiles and analyzes numerous research studies conducted by various authors across different disciplines who have made groundbreaking contributions to the field. Balocchi acknowledges the crisis faced by the binary model of sex in contemporary biology and genetics, which has given rise to the intersex movement. The book examines the changes in the understanding of human sex by comparing biological data with social realities. Additionally, Balocchi offers reflections on the legal aspects pertaining to the rights of intersex individuals.

In *Padri e Figli* (Fathers and Sons) by Mariolina Migliarese, published in 2023, the author explains the importance of the father Fig. in a child’s upbringing using scientific and sociological elements. Migliarese argues that the absence of a father Fig. negatively impacts the psycho-physical development of a child. This perspective challenges gender theory, which asserts that children can be raised happily and grow up normally even with same-sex parents. The cognitive development of children requires the presence of a male adult who can guide them, impart the ability to understand and balance different perspectives throughout life, and serve as a role model. Children observe their father’s behavior, both positive and negative qualities such as honesty or dishonesty, fidelity or infidelity, and tenacity or discouragement. They also observe how their father interacts with them, their mother, and others, how he speaks about his work, and whether he has interests in literature or sports. They notice whether he contributes to domestic chores or prioritizes his own needs. Furthermore, children observe their father’s friendships, how he interacts with others, and how he speaks about them at home. Children absorb and retain these experiences, which serve as references for their own behavior and choices as they grow older (Migliarese, 2023).

Fernando Savater, a prominent Spanish intellectual and former philosophy professor with over thirty years of experience in the Basque region and Madrid, authored the bestselling book “*Etica per un figlio*” (Ethic for a son), which was published in 2023 (Savater, 2023). Despite being associated with the liberal, left-progressive political sphere that advocates for gender theory to become the dominant ideology in Europe, Savater argues that Western countries frequently pass new laws that aim to change the lifestyle of the majority of citizens. While respect for minorities is crucial in a liberal democracy, it should not come at the expense of undermining the established rights of the majority. Savater affirms that gender theory is influenced by economic interests and seeks to disrupt society as it currently is. Individuals who undergo sex reassignment treatments become lifelong customers of pharmaceutical companies, and children are subjected to relentless advertising campaigns on social media that present sex change as an appealing and fashionable choice (Vivaldelli, 2023). Savater strongly criticizes the fervor of LGBTQIA+ associations, who now regard Spain as a “model” for the entire Western world following the passage of the “trans law” by the Spanish Parliament in 2023. This law grants the right to “gender self-determination” to individuals over the age of 16. Spain stands out as one of the few Western countries that allow gender changes on legal documents solely based on self-identification, without requiring the opinion of doctors or parents (Nesi, 2023).

In Nicola Carone’s book “*Le famiglie omogenitoriali*” (Same-sex Parenthood), published in September 2021 (Carone, 2021), the author explores the legal challenges faced by families with same-sex parents in Italy. Currently, Italy lacks a law regulating the registration of children born to same-sex couples. As a result, “rainbow families” have resorted to legal action to have their parental rights recognized or have sought the intervention of mayors to officially

record the names of both parents and their children, particularly when the children were born abroad through surrogacy (Fiechter, 2023). Surrogacy and same-sex couples are important aspects related to gender theory that will be examined in an upcoming research paper. They are often exploited as political tools by the radical left to try to discredit the current Italian government, using tactics such as spreading fake news. For instance, The New York Times falsely reported that “Italian Prime Minister Giorgia Meloni has instructed municipalities to cease certifying foreign birth certificates for same-sex couples who used surrogacy, leaving some babies in legal limbo” (Horowitz, 2023). This claim is entirely untrue, as both parents of the same sex can be legally recognized as such, as confirmed by the Court of Rome - Section XVIII, which handles personal rights, in a decision made on September 9, 2022 (De Santis, 2023). It is concerning that an internationally renowned US newspaper publishes news about the Italian legal system without conducting proper fact-checking.

### 3. METHODOLOGY

This qualitative research is primarily based on an analysis of current Italian newspaper articles from 2019 to 2023, highlighting the pervasive influence of gender theory in Italian schools. The teaching of gender theory is widespread and incorporated into various aspects of education, including books, films, cultural events, and extracurricular activities. The research employs the following methodology, consisting of five distinct sections: The abstract provides a concise summary that allows readers to understand the essence of gender theory and the purpose of this research. The introduction explains the origins of gender theory and introduces new terminology used to describe individuals with specific gender identities. It emphasizes that modern Western societies no longer adhere to the outdated male/female binary concept.

The literature review examines eight different books, including the 1990’s “Gender Trouble: Feminism and the Subversion of Identity”, which played a pivotal role in introducing gender theory to Italy and other European countries. While the selection is limited to eight books, it offers a balanced representation of different perspectives on gender theory. However, it is acknowledged that numerous other interesting and insightful publications have emerged in recent years. Nevertheless, the majority of publications and TV programs are pro-gender theory, even if there are few people who see, interpret, and judge it as a dangerous ideology that brings negative consequences to Western societies.

The results and discussion section demonstrates that gender theory is predominantly a political ideology rather than a science based on empirical evidence. It examines how it can have negative implications for primary and high school students. Nonetheless, for the sake of presenting a comprehensive overview, opposing viewpoints will also be cited. The scope of this research is limited to the consequences of gender theory on Italian students and the educational system, but future studies could explore its effects in social, cultural, economic, political, and legal contexts.

The conclusion will express the researchers’ perspective, highlighting the alignment of European political institutions (Parliament, Commission, and Council) with this ideology.

## 4. RESULTS AND DISCUSSION

### 4.1 Gender Theory is Just a Political Ideology and Cannot be Considered a Science

Gender theory, or gender ideology, directly challenges scientific principles. By distinguishing between the terms “sex” and “gender”, it is uncontroversial to assert that there are only two sexes, as evidenced by worldwide biological studies and exemplified by German biologist Marie-Luise Vollbrecht (Ercolani, 2022). Conversely, gender theory posits that there could be numerous genders, possibly in the tens or hundreds, identified through subjective, arbitrary, and undefined criteria. Its objective is to supplant biology and other related sciences, as acknowledged by Adriana Cavarero, a professor at the University of Verona, Italy (Redazione, 2022). Proponents of gender theory try to use the science of anthropology, philosophy, and psychiatry to affirm that there are more than two sexes, identified as a synonym of gender. They differentiate between the sex assigned at birth and the gender chosen during one’s lifetime. According to this perspective, the distinction between men and women, or males and females, is not an objective and scientifically determined fact, but rather a result of cultural and social construction. Consequently, one’s sexual identity is not determined by nature but is solely based on subjective perception. Individuals should have the freedom to assign themselves a gender that aligns with their perceived identity, directing their sexuality based on personal instincts and fluctuating impulses, allowing for the adoption of various genders over time. Sexual identity would then be determined by gender, rendering the notions of males and females obsolete in relation to certain physical attributes, and instead reliant on self-identification. Hence, there would no longer be males or females but only individuals who are free to choose the gender that best suits them (Ruggiano, 2021).

This theory argues that the natural categories of male-female, and the dichotomy of man-woman, should be abandoned because they are substantially unsuitable to represent modern social complexity. Consequently, it is necessary to deconstruct the notion of nature in an attempt to overcome a thought system considered outdated and irrelevant. While this ideology has sociological and legislative implications, it lacks scientific validity. However, expressing this viewpoint is often deemed politically incorrect, and scientists are frequently prevented from presenting their theses in public due to violent protests by organized and politically influential minority groups (Vietti, 2022). In an effort to establish scientific credibility for gender theory, the University of Rome “La Sapienza” has introduced a degree program in gender studies, culture, and politics for media communication, aiming to explore the structure of the new socio-economic society (Tomassi, 2022). The purpose of this degree program is to educate students about the intricate aspects of gender in contemporary society, with a focus on law, philosophy, and sociology. One must question whether this program fosters cultural formation or merely reinforces mainstream thinking (Cannone, 2022).

Gender theory is essentially a political ideology, akin to other ideologies such as Marxism-Leninism, white supremacy, American wokism, anti-militarism, anti-feminism, pacifism, Nazi-fascism, Europeanism, illegal mass immigration, and Greta Thunberg’s environmental movement, as it exhibits the following characteristics: 1) it does not tolerate dialectical discourse with opposing viewpoints; 2) it seeks to mobilize the masses and transform the *status quo* of society; 3) it is exclusively supported by the radical left and not by other political factions at the national and EU levels; 4) it exhibits violence and anti-democratic tendencies by suppressing dissenting opinions; 5) it exacerbates existing divisions, leading to social resentment and mistrust (Ideologia, 2023). Supporters of gender theory claim to protect LGBTQIA+ individuals, but only if they align with ideological frameworks and belong to left-

wing political parties. The case of Peter Thiel, the founder of PayPal and a supporter of former US President Donald Trump, is noteworthy, as he has been labeled as “a man who has sex with other men but not an activist gay” due to his conservative political beliefs (Robiati, 2020). Consequently, he has been ostracized from LGBTQIA+ left-wing political organizations. It is important to recognize that not all LGBTQIA+ individuals endorse gender ideology. In Italy, for instance, renowned drag queen Platinette has criticized gender theory, stating that “homosexuality has become a business” and that “gay people are being commodified” (Oliverio, 2023).

#### 4.2 Schools’ Gender Theory; Its Effects on Students, Their Parents, and the Educational System

In 2015, the Italian Ministry of Education introduced guidelines mandating the teaching of gender theory in all schools, from elementary to high school. These guidelines outlined several objectives: A) raising awareness among students, teachers, and parents regarding sexuality, sexual orientation, and gender identity; B) fostering acceptance and embracing diversity through the development of specific projects; C) discouraging the use of improper and offensive expressions; D) assisting students in the process of self-identity formation; E) identifying and eliminating ethnic, social, and cultural stereotypes and prejudices prevalent in mass media, researches, and textbooks; F) promoting education, combating all forms of discrimination, and fostering respect for individual differences. These values are further reinforced by the European Union’s Fundamental Rights Charter, the European Convention on Human Rights, and the Council of Europe Convention on Preventing and combating discrimination (Ministero, 2015). Despite the explicit statement in these guidelines that gender ideology should not be taught, the reality has unfolded differently, as evidenced by factual observations. In the town of Piacenza since 2015, a school not only adopted textbooks that promote same-sex couples and ridicule traditional mother figures who care for the household and children, but also introduced mandatory courses on “education, sexuality, and affectivity”. These courses did not provide information on how to prevent venereal diseases or unwanted pregnancies, but instead focused on topics such as gender identities, discrimination, and masturbation, utilizing explicit materials. Some parents of students expressed a desire to exempt their children from these courses, but the school headmaster denied their requests, citing that the curriculum had been approved by the Ministry, thereby allowing schools to provide an education that may not align entirely with the parents’ convictions (Massini, 2015). Subsequent guidelines issued by the same Ministry, following the year 2015, displayed even greater explicitness regarding gender theory, resulting in the dominance of this ideology (Frullone, 2017). The promotion of gender theory has become increasingly pervasive, leading to a demand for teachers to undergo specific training on how to incorporate this theory into their teaching. Not only are teachers expected to refrain from insulting or excluding gay students, but they are also required to avoid portraying situations solely from a heteronormative perspective, which assumes heterosexuality as the norm. In addition, teachers are instructed to utilize specific textbooks that teach how to identify and combat homophobia, while portraying homosexuality on an equal footing with heterosexuality or bisexuality. Extracurricular activities are encouraged to be inclusive and “gay-friendly”, offering games where heterosexual students can explore and empathize with the experiences of LGBTQ+ individuals, and selected TV series should feature same-sex couples. Consequently, some argue that students are subjected to what they perceive as a form of indoctrination (Curridori, 2017).



Another initiative aimed at promoting gender theory in public schools is the program implemented by the Virgilio Institute of Empoli, known as “LGBTQIA+ dance”; male students are required to dress as females, and vice versa, in the name of gender inclusivity. This course is compulsory for all students, including minors, and serves as one of the final assessments at the end of the school year (Leonardi, 2022). Even in kindergartens, educational cartoons are centered on gender themes. One example is “Peppa Pig”, where a young girl is depicted as having two lesbian mothers, a “special family” that brings her happiness (De Vico, 2022). Young children should learn about the existence of diverse family structures, such as rainbow families, and understand that these should not be disregarded (Alberti, 2022). However, when some parents expressed their concerns by signing a petition for the removal of this cartoon (Petition, 2022), their plea went unanswered, and they were accused of having a medieval obscurantist mindset. In reality, these parents’ protests appear to be well-founded, as it is not appropriate to influence and confuse young children’s minds by leading them to believe that it is natural to have two mothers, which is biologically impossible. The only way for two women to have a child is through sperm donation from a third party or through artificial insemination. Such practices involve the commodification of human gametes and infringe upon a child’s fundamental right to have a father. School textbooks must not include terms deemed “politically incorrect” and should not discriminate based on gender (Peluso, 2022). Inclusive language must always be used, and it is prohibited to perpetuate certain gender stereotypes. Additionally, many proverbs with a long-standing cultural tradition should be abandoned. When the Saint Louis School in Milan decided to introduce LGBTQIA+ topics to students over the age of eleven and discussions on gender identity to students over the age of fourteen, some school principals refused to comply with these guidelines because they believed that education should not be limited by students’ age (Bernacchia, 2023). Even private schools, which have independent control over their curriculum, are not free to design their own educational programs. The Marconi School in Florence, for example, adopted so-called “cultural programs”, organized and promoted by the “Queer Community Self-Managed Center” association, where boys are assigned female roles and vice versa. Some parents at this school argued that these “sexually sensitive” projects inflict unbearable psychological harm on children as young as eight years old (Baldi, 2020). Introducing gender-related topics to eight-year-olds in a school setting is considered highly inappropriate. Discussions on such subjects should be left to the families, who can address them when the time is deemed appropriate. Glossaries designed for nine-year-olds contain questions and answers regarding gender identity and sex education. They aim to explain the meanings of specific terms like cisgender, non-binary, genderqueer, transgender, gender fluid, and gender neutral. However, these glossaries also include ideological phrases such as “you do not have to feel male or female now, you will choose once you have grown up, without being influenced by society’s stereotypes” (Barlozzari, 2022). This presents a significant issue as these glossaries for underage students promote and spread unscientific theories, which can have dangerous effects worldwide. In numerous schools, 14-year-old students are required to read openly gay-themed books. For example, John Boyne’s “My Brother's Name is Jessica” portrays a minor undergoing sex change surgery, and Melania Mazzucco’s “You Are as you are” revolves around a homosexual relationship between two soccer players. Through these means, young children are exposed to topics of sexuality and different forms of love (Perrotta, 2022). Unfortunately, in such cases, the opinions of parents who disagreed with these initiatives were disregarded. At Monza’s “Zucchi” high school, some male students, advocating for gender equality and gender fluidity, attended school wearing skirts. Surprisingly, the teachers and headmaster praised this initiative (Corlazzoli, 2021). The situation at Zucchi high school was not an isolated case, but rather exemplified a fundamental concept of gender theory: the belief that sexes do not exist, and that

sex is an individual's autonomous and fluid construct (Franza, 2021). On November 5, 2021, eighty male students from Milan's "Bottoni" high school attended classes dressed as females, as gender theory promotes the freedom to choose one's attire. Nowadays, skirts are considered "unisex", and it is common to see men wearing them and other gender-neutral garments during prestigious fashion shows by brands like Armani, Gucci, and Jean Paul Gaultier. However, on that occasion, a history teacher sent the boys back home after observing their attire, deeming it indecent. Unfortunately, the poor fellow faced suspension for going against the teachings of gender theory. This serves as an example of a school that claims to be democratic and respectful but punishes a teacher for seeking decorum and decency (Parise, 2021). Many schools have chosen to cancel the celebration of Father's Day, traditionally observed on March 19, due to concerns that it may be disrespectful to students who have two mothers or two fathers as parents. In one of Viareggio's kindergartens, Father's Day was labeled as "discriminatory" because traditional families (consisting of one father and one mother) are no longer the only structure (Leardi, 2023). Today, there are rainbow families that must be "respected and protected" (Palumbo, 2023). Many parents did not appreciate or agree with this decision, as they saw it as an attempt to erase a centuries-old culture in favor of a concerning "left-progressive" gender ideology (Garau, 2023).

The concept of gender theory has allowed schools to implement "gender-free registers" or career alias, which enable students to register with the name and gender of their choice, disregarding their biological sex (Imperiali, 2022). Advocates for the rights of transgender individuals argue that gender-free registers are crucial for respecting and promoting personal gender identity. Supporters of gender theory cite legal backing for career aliases in the Student Statute of June 24, 1998, the UN Convention on the Rights of the Child, the European Parliament Resolution on Human Rights, Sexual Orientation and Gender Identity of September 28, 2011, and the Council of Europe's deliberation on the promotion and protection of LGBTQIA+ rights on June 24, 2013 (Buscaglia, 2023). Currently, over two hundred schools, forty-five universities, and numerous businesses have adopted gender-free registers as an important tool to safeguard and support young transgender individuals (Veli, 2023). In certain Italian schools, the ideology of gender neutrality has led to the introduction of so-called "neutral" or "genderless" bathrooms. These restrooms are not labeled for males or females, allowing all students to use them without distinction. Italian schools align with the prevailing belief that eliminating gender is necessary to prevent discrimination. They strive to be inclusive and embrace all forms of diversity, acknowledging that some individuals may not identify with the gender assigned to them at birth based on biological sex (Mariani, 2023). Currently, there are numerous gender theory projects in Italian schools, often financially supported by government funds or LGBTQIA+ associations. To obtain information about the extent, locations, participating schools, and offerings of these projects, please visit the following website: <https://www.provitaefamiglia.it/blog/progetti-gender-nelle-scuole-ecco-il-dossier> (updated March 2023). Gender theory has become prevalent in all schools, ranging from primary to high school. It is crucial to investigate the effects on students who are constantly exposed to these messages. How can children under the age of ten comprehend complex concepts like gender identity, sex change, and hormonal disorders? What traumas might they experience as a result of a program that celebrates events like "*La giornata dei calzini spaiati*" (Unmatched Socks Day) every first of February, aimed at promoting diversity and inclusion? This event was initially introduced in a primary school in Friuli Venezia Giulia in 2010 and is now observed in many schools across the country (Scognamiglio, 2023). Young children are encouraged to wear two socks of different colors, patterns, and fabrics, creating the impression that rules do not exist and that everything is allowed. Schools should serve as centers for

cultural development and open discussions, rather than places where young students in their formative stages are indoctrinated. Discussions about sexuality should be approached from a scientific perspective, free from ideological biases. Additionally, school programs should involve and consider the opinions of students' families, in accordance with the following legal principles:

- art. 26, third paragraph, of the Universal Declaration of Human Rights: "Parents have the right to choose the kind of education to be given to their children";
- art. 2 of the European Convention on the Universal Declaration of Human Rights: "The State must respect the right of parents to choose, for their children, the best education, according to their religious and philosophical convictions";
- art. 30 of the Italian Constitution: "It is the duty and right of parents to maintain and educate their children".
- 2010's Council of Europe Ministers' Recommendation, which explicitly urges Member States to "take into account the right of parents to take care of their children's education".

Unfortunately, these norms are often disregarded, as parents are unable to voice their opinions or influence decisions made by school administrators. On the other hand, influential and politically strong LGBTQIA+ lobbies seek to propagate their ideology in public schools, aiming to "re-educate" the younger generations. Those who oppose these lobbies often hesitate to voice their concerns, fearing being labeled as retrogressive or bigoted individuals or facing potential sanctions. Those who attempt to challenge these lobbies often refrain from doing so to avoid being labeled as backward or intolerant, or out of fear of facing repercussions. Several high school teachers have faced suspension, dismissal, or even worse, for opposing gender ideology. In 2022, a high school teacher was arrested because he refused to use a name for one of his students that did not correspond to his biological sex (Di Vito, 2022). In 2023, an elementary school teacher was suspended for twenty days after granting permission to some Catholic children in her class to recite the Ave Maria and the Pater Noster the day before Christmas (Zoccheddu, 2023). She did not engage in religious proselytism or coerce any children, yet she faced what seemed like persecution for allowing her pupils to pray in the classroom. We live in a world where drugs are accepted, same-sex marriages are legal, and children can have same-sex parents, yet it is forbidden for Catholic children to say a prayer in a public school (Sgarbi, 2023). Piergiorgio Dellagiulia, a high school teacher in Bra (Cuneo), was fired after sixteen years of teaching for expressing his personal opinion about the rights of homosexuals on Facebook (Guzzo, 2021). It is not coincidental that an increasing number of teachers wish to leave their profession because it is truly demeaning to carry out their educational duties under the constant threat of severe sanctions if they do not conform to the dictates of gender ideology (Intravaia, 2023). It poses a risk to the psycho-physical development of every child and adolescent. At the age of six or fourteen, the human mind is not yet equipped to comprehend the complexities of gender identity, sex reassignment, sexual desires, and similar concepts. During adolescence, mental and/or physical disturbances may arise, but they often dissipate with age. Neuro-psychiatry science teaches us that each individual has his/her own unique growth path, which should be allowed to develop freely and naturally, without external indoctrination. Young people have a nucleus accumbens that is twice as developed as that of adults, and they lack inhibitory signals because the cortex of their brains is not yet fully developed. Gender theory can have significant effects on adolescents such as altering their brain structures, the thickness of their prefrontal cortex, and influencing the development of their neurons, which can impact their personality. Children and adolescents are highly susceptible to influence from their school environment, which can shape their

thoughts, emotions, and behaviors. Although they may have their own opinions, they are easily swayed by external pressures (Montemurro, 2022). Often, in order to conform to school trends, they may adopt dangerous and self-destructive behaviors, such as self-inflicted “French scars” (Delfino, 2023), taking antihistamines without medical supervision to achieve a thin physique and slim waistline (Damiata, 2023), or engaging in perilous challenges like the “planking challenge” (Fiorentino, 2022). The Italian school system, heavily influenced by gender theory, fails to provide students with a well-rounded education because it restricts open debates. It is influenced by certain left-wing political parties that seek to proselytize. The educational system should not be monopolized by ideology; instead, it should prioritize educators rather than activists. It should foster discussions on a wide range of topics, including homosexuality, discrimination, violence, respect for others, and integration. However, it is unacceptable for these discussions to be solely focused on:

- A) meetings with prominent figures from the LGBTQIA+ community
- B) reading works by LGBTQIA+ authors (e.g., novels, fairy tales, and cartoons)
- C) exclusively featuring same-sex marriages and rainbow families
- D) organizing “gender swap” days, dedicated to role reversals
- E) promoting methods of changing one’s sex

## 5. CONCLUSION

Gender theory is widely regarded as lacking scientific validity, being highly ideological, and potentially harmful. It promotes the idea that gender is solely a social construct and suggests that individuals should determine their own gender identity based on personal feelings and perceptions. Advocates of Gender theory often refuse to engage in discussions with those who hold different viewpoints and label anyone who challenges their ideas as homophobic. This moral and social imposition can have a significant impact on children and young people who are still developing their critical thinking abilities. The most extreme manifestations of this theory involve administering drugs to prepubescent children to delay their growth until they can choose their own gender. Gender theory has permeated various aspects of Western culture, including fashion, television programs, political debates, the entertainment industry, art, and journalism. Gender Theory epitomizes what is referred to as the “dictatorship of the minority”. While a liberal democracy recognizes and protects the rights of minorities, it does not grant them the authority to disrupt the balance and security of society. As Sallusti (2023) argues, this “dictatorship of the minority” asserts rights solely in its own interest and imposes its principles on a society that does not share the same values. Consequently, the “dictatorship of the minority” is more disdainful than the lack of respect shown towards minorities. Contemporary Western society demands that everything be regulated according to the interests of minorities, from sexual behavior to literary preferences, communication styles, clothing choices, writing styles, dietary habits, and even child-rearing practices. The collective interests of the majority are supplanted by the ideological fanaticism of a few individuals seeking to impose their dogmas on everyone else. Despite the overwhelming and disproportionate media attention given to Gender theory, a recent census, conducted in 2021 on the entire population aged 16 and above, revealed that individuals who identify as “transgender”, “queer”, “nonbinary” or “gender fluid” constitute a very small minority (Vivaldelli, 2023). Regarding sexual orientation, respondents were asked two questions, with the following results (census findings in parentheses):

1) Which of the following best describes your sexual orientation?

- A) Straight/Heterosexual (89.4%)
- B) Gay or Lesbian (3.2%)
- C) Bisexual (1.3%)
- D) Other (with the option to write in a response: 0.3%)

2) Does the gender you identify with align with your sex assigned at birth?

- A) Yes (93.5%)
- B) No (with the option to then write in the term that best described the respondent's gender identity: 0.5%).

The census results reveal that LGBTQIA+ represents a minute fraction of the overall population, despite receiving disproportionate media attention. A survey conducted in 2022 among two million parents of children attending public elementary and high schools revealed the following results (Curridori, 2022).

1) Do you agree with teaching gender theory?

- Yes = 32%
- No = 48%

2) Should parents be the primary source of education regarding sexuality for their children?

- Yes = 79%.
- No = 12%.

These findings clearly indicate that the majority of parents do not support LGBTQIA+ courses and other initiatives implemented in schools. However, despite these statistics, gender theory continues to gain prominence in schools and society at large. Moreover, it receives sponsorship from European institutions, whose decisions are binding for EU countries, including Italy. In 2021, the European Parliament declared that the rights of LGBTQIA+ individuals fall within the protected category of human rights, and all EU countries must become "LGBTQIA+ Freedom Zones" (Parliament, 2021). The European Parliament also appointed an LGBTQIA+ ambassador who introduced the concept of the "transgender Virgin Mary" as a new representation and celebration of Christmas (Zurlo, 2021).

The following year, the Council of Europe ruled in favor of facilitating sex changes for both adults and minors and eliminating gender specification (male or female) on official documents (Galici, 2022). Each year, the European Commission allocates €500 million to finance numerous pro-LGBTQIA+ projects (Aloisi, 2018). Additionally, it promotes Gender theory in schools through the European Network of Young Advisors (Delli Colli, 2023). In 2022, the European Commission declared that same-sex parents and their children should be recognized as families by all EU member states (D'Ascenzo, 2022). Furthermore, in the same year, the European Commission filed a lawsuit against Hungary in the EU Court of Justice because this country passed a law in 2021 that prohibited the dissemination of topics and images related to pornography, gender reassignment, and homosexuality in Hungarian public schools attended by minors. The President of the European Commission deemed this law

“shameful” as it infringes upon the rights of LGBTQIA+ individuals and contradicts the values of the European Union (Pons, 2023). Italy and Europe appear to be moving towards a state of “Gendercracy” which stands in contrast to true “Democracy”. However, many prominent Fig.s in the Western world now demonstrate support and compliance with Gender theory issues in order to be perceived as “modern” and in tune with the times. The recent coronation of HM Charles III and HM the Queen consort, held at Westminster Abbey on May 6, 2023, symbolized inclusivity, with an LGBTQIA+ choir delivering a performance (Rossi, 2023).

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## I-CReST 2023:140-180 - Power Supply Trainer Learning Kit

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### ABSTRACT

The use of Teaching and Learning Aids (ABBM) in the teaching and learning process is crucial to ensure the delivery of information related to the course being taught is clearer and more systematic. This is because most technical courses face several problems during the teaching and learning process, such as limited and outdated equipment, which can cause students to lose interest and have difficulty understanding the learning theory. The Power Supply Trainer is an innovative tool designed to be an effective learning medium that can attract students' interest and facilitate their understanding of the theory and practical work related to the Linear DC Power Supply topic in the DEE30043 Electronics Circuits course. The Power Supply Trainer was developed to replace the connection method using a breadboard, reduce student errors in making circuit connections, and save teaching and learning time in the lab in accordance with the practical learning schedule set out in the curriculum. The Power Supply Trainer allows students to easily analyze circuits because the circuit division is made according to the power supply block diagram sequence, and students can see the actual components used along with the circuit connections made. A set of questionnaires and practical result forms were distributed to third-semester students taking the DEE30043 Electronics Circuits course to obtain data related to student perceptions and the effectiveness of using the Power Supply Trainer. The impact of this innovation is an improvement in understanding and enthusiasm for practical work, as students can easily see the theory learned demonstrated with the use of the Power Supply Trainer. The proper and safe use of equipment can be applied by using the Power Supply Trainer. Time savings can also be proven as practical work can be completed within the allotted time. The working environment is more comfortable, clean, and organized because practical work steps are easier and more organized. The Power Supply Trainer should be developed for use in all other polytechnics in accordance with the requirements of the Polytechnic Education Department's efforts to produce graduates who master OBE.

Top of Form

**Keywords:** Teaching and learning aids; power supply trainer; linear power supply

### 1. INTRODUCTION

The power supply Trainer Learning Kit is a device or tool used by the instructor of the DEE30043 course to assist in conducting practical work during the second workshop of the course. This teaching aid consists of five components: converter, rectifier, filter, voltage regulator, and voltage divider, as learned in the theory class. By using this teaching aid, the course instructor can deliver teaching materials in a more interactive and engaging manner, thus increasing student involvement in the learning process.

Furthermore, this teaching aid also includes testing points for the output of each block, allowing students to easily compare output waveforms from the practical work with the theoretical knowledge they have acquired. Using this teaching aid, the course instructor can create a more dynamic and stimulating learning environment, fostering a deeper understanding of the subject matter among the students.

With the successful completion of the practical work using this teaching aid, students have gained valuable hands-on experience and a better grasp of the concepts covered in the theory class. Overall, the power supply teaching aid has proven to be an effective tool in enhancing the learning experience and knowledge acquisition for the students in the DEE30043 course. It has undoubtedly contributed to their overall learning outcomes and prepared them for future challenges in their academic and professional journey.

### 1.1 Problem Statement

Indeed, the practical task involving power supply connections can present challenges for students. When they encounter difficulties in completing the task, they may have to redo the connections multiple times. This repetition can lead to errors in the connections, and in some cases, it may result in potential damage to the components being used. Establishing the correct connections to achieve the desired output waveforms can be a complex process, especially for students who are still learning and gaining practical experience. The interplay of various components and the intricacies of their interactions can be confusing and require careful attention to detail.

To address these challenges, it is essential for the course instructor to provide clear and detailed instructions during the practical session. Additionally, offering guidance and support during the hands-on work can help students avoid unnecessary errors and prevent damage to the equipment. Creating a supportive learning environment, where students feel comfortable asking questions and seeking assistance, can also contribute to overcoming these challenges. Encouraging teamwork and peer collaboration can further enhance the learning experience, as students can exchange ideas and troubleshoot issues collectively. Refer to Mustapa and Miskon (2014), said education is not only aimed to enhanced good attitudes but also involves the process of changing attitudes and behaviors of one person or group of people in the quest for human beings not only through the teaching process but also through exercises.

Furthermore, incorporating hands-on demonstrations and simulations before the practical task can help familiarize students with the connections and operations, reducing the chances of errors during the actual work. By acknowledging and addressing the challenges that students may face in establishing power supply connections, educators can enhance the learning process and ensure a more successful and meaningful experience for the students in the DEE30043 course.

### 1.2 Objectives

The objectives of this project are:

- i. Students are able to complete the practical work without any errors in making the connections
- ii. Students are able achieve the desired output for the experimental



- iii. Students are able to establish a connection between the theory they have studied and the practical work they are performing.
- iv. Students are able to observe the waveform output, which was previously discussed in the theoretical class, during the practical execution

## 2. LITERATURE RIVIEW

In the present day, some educators still frequently resort to traditional methods such as using chalkboards and delivering lectures, relying heavily on textbook reading. However, research indicates that these approaches have minimal and ineffective impact when it comes to fostering critical and creative thinking abilities in students (Takim, 2014). This standpoint is reinforced by the findings of Ishak, Ariffin, Din, and Karim (2002), who argue that the conventional teaching methods employed by educators hinder students from achieving a comprehensive understanding.

In this context, it is essential to replace outdated teaching approaches with more effective methods that can enhance students' comprehension. The conventional use of chalkboard and lecture-centered methods tends to prioritize the teacher, emphasizing the need for a shift towards techniques that place greater focus on the students. The introduction of the trainer kit facilitates the implementation of student-centered learning and aligns with the requirements of Outcome-Based Education (OBE), enabling students to apply their psychomotor skills in practical tasks and assignments. This transition empowers students to take a more active role in their learning, creating a dynamic and interactive learning environment. Embracing these modern teaching methodologies can significantly improve the overall learning experience and better equip students for real-world challenges.

Md Nor, Selamat, Johari, and Omar (2019) agreed that the user-friendly design of the 'trainer kit' helps to enhance students' motivation in conducting laboratory experiments, thereby facilitating the teaching and learning processes. Mahizan.M, Md Zaid S.N, and Abd Hamid N.D's study (2017) focused on the effectiveness of the 'trainer kit' as a teaching aid. The results of the study showed that the testing period conducted using the 'trainer kit' was faster and easier compared to the conventional connection methods.

Traditional teacher-centered teaching methods are no longer the most effective approach for equipping students with diverse skills. This demonstrates that conventional methods are no longer suitable in today's context. Yunoh & Yaacob (2013) discovered that students' lack of interest in the topic of electricity can be attributed to the absence of practical hands-on experiences. Since electricity is a significant subject, respondents were supposed to observe how circuits are constructed and build their own circuits. Azman, Azli, Mustapha, Balakrishnan, and Isa (2014) argue that incorporating learning aids can significantly enhance technical teachers' ability to explain concepts accurately compared to verbal descriptions alone. Nevertheless, the utilization of learning aids among technical teachers remains at a moderate level, as highlighted by Yasin (2010).

The Power Supply Trainer Learning Kit is created to ensure that students can understand the learning taught in theory classes and can clearly observe the output waveforms at each power supply block. According to the findings of Khamis and Awang (2014), their study

revealed that students face difficulties in understanding the concepts presented in the classroom. They struggle with tasks such as drawing circuit diagrams, distinguishing between series and parallel arrangements, and constructing real circuits. Hamid (2013) also observed that students experience confusion when attempting to differentiate the characteristics of series and parallel circuits. In a similar vein, Ismail and Dahlan (2015) highlighted in their research that students tend to provide incorrect answers and fail to grasp the underlying concept due to their confusion regarding circuit arrangements in both parallel and series configurations.

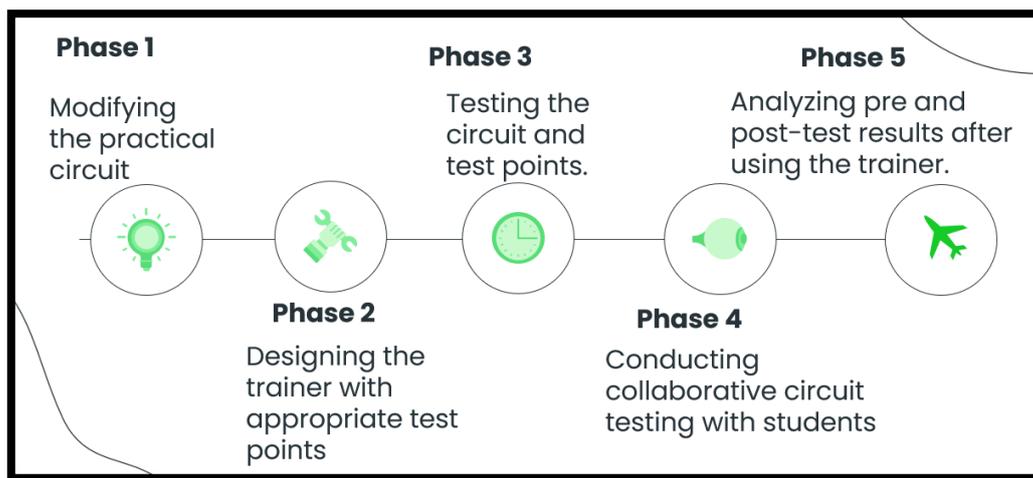
The development of this kit aligns with the requirements of the course curriculum to enable students to perform practical work effectively, meeting the advancements of Industry 4.0 technology. According to Martin eta (2022), based on a review of the available literature and current research projects, it can be concluded that using low-cost equipment and designing low-cost kits is a common practice in academic and university settings. The research findings show that within the context of Industry 4.0, low-cost equipment can be used to educate high-tech technologies.

The prototype, which has been designed for the purpose of helping students gain practical experience in that subject, provides a kind of simulator functionality as well.

### 3. METHODOLOGY

The development of The Power Supply Trainer Learning Kit based on learning theories such as Edgar Dale Theory (1969), Theory of Behaviorism (1913) and Cognitive Theory that characterizes human memory is higher at 90% if they make their own study as well as behavioral learning will change when there is stimulation.

The implementation steps of this Learning Kit consist of 5 development phases as illustrated in the Fig. 1 below.

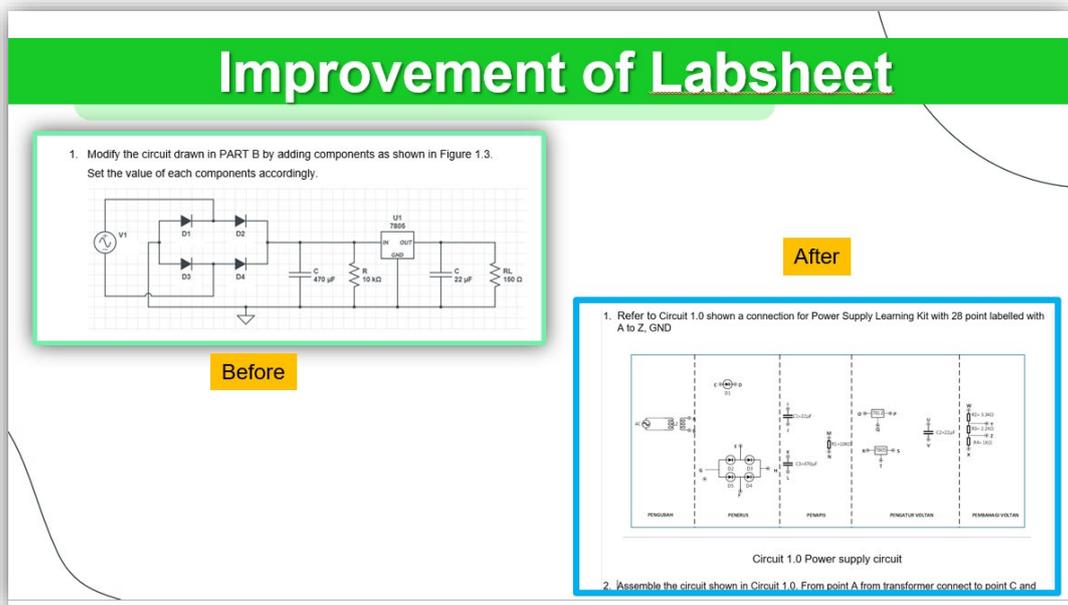


**Fig. 1.** Development phase of Power Supply Learning Kit

The implementation process starts by enhancing the practical circuit, and then moves on to the second phase, which involves designing suitable test points within the developed trainer. These test points are aligned with the theoretical concepts taught in the classroom. The constructed circuit has been improved compared to the previous version by introducing two

types or two different values for each power supply block. For instance, in the rectifier circuit, both half-wave and full-wave rectification are incorporated. In the filter circuit, two different capacitor values are included to observe how these capacitor values affect the ripple voltage in the power supply circuit. Two different types of voltage regulators, namely the 7805 and 7812, are used in the voltage regulator section. This implementation enables students to apply their theoretical knowledge and test the output waveforms of both voltage regulators using the provided test points. The designed circuit and test points are well-organized to ensure ease of understanding and clarity for students, just like the arrangement of blocks in a classroom.

Fig. 2 below illustrates the improvement from the previous circuit to the circuit developed in this trainer.



**Fig. 2.** Improvement of circuit in Lab sheet

In the third phase, the circuit testing and examination of test points are conducted to observe the output waveforms produced and to verify whether they align with the expected outputs as taught in the theoretical class.

In the fourth phase, the practical work is carried out with the students using the developed trainer kit. The students display high interest and motivation while conducting the practical tasks for this course. In the final phase, the process of analyzing the survey questions before and after the use of this trainer is conducted. The analysis results indicate several advantages observed after the students have utilized this trainer.

The lecturer employed self-developed questionnaires as research instruments. Before responding to the questionnaires, the students underwent teaching and learning using conventional methods and by using power supply learning aids kit. Subsequently, the students were required to answer the questionnaires to determine the impact of the learning aids. The lecturers designed these instruments to be customized to the respondents, aligning with the specific issues and objectives they aimed to achieve.

The effectiveness study of the developed kit was tested with 65 students pursuing a Diploma in Electrical Engineering (Computer Technology). These students conducted practical exercises for Power Supply Practices before and after using the developed kit. A survey comprising 15 questions related to the before and after usage of the kit was distributed. The survey findings can be observed in Table 1 below.

Table 1 displays the results before and after the utilization of The Power Supply Trainer Learning Kit. The survey conducted indicates improvements in all the questionnaire items. These findings demonstrate the effectiveness of the developed trainer.

**Table 1.** Table of trainer effectiveness findings

No	Item	%	
		Before	After
1	Enjoyable to use the Power Supply Trainer Learning Kit	62	86
2	Easier for me to conduct practical work	54	92
3	Creative and helps me master Topic 1	62	91
4	Improve my ability to draw waveform	55	82
5	Stimulates the development of ideas in connecting theory and practice	58	86
6	Make me focus in class	46	95
7	Makes me feel excited to learn	54	94
8	Link the theory with an actual situation	57	91
9	Kindly allocate enough time for me to retain and comprehend each learning thoroughly	62	89
10	Can help me enhance my understanding in recognizing the knowledge taught by lecturer	57	91
11	I prefer to ask if I do not understand	54	91
12	I acquired an experience that is not commonly attainable through conventional teaching methods.	58	89
13	Enhancing learning to be more comprehensive and diverse.	57	88
14	The experience encouraged me to explore various issues and potential opportunities that arose.	62	89
15	The topics that being taught are easier to understand	58	91

From Table 1, it is evident that students enjoy using the developed trainer, with 86% of respondents agreeing that they find it enjoyable. Additionally, 92% of respondents concur that the trainer facilitates the implementation of practical tasks. Respondents also acknowledge that the trainer aids in better understanding Topic 1 and makes it easier to master. Moreover, the trainer enables them to improve their ability to draw output waveform shapes for each power supply block.

Indirectly, the development of this trainer has motivated students to ask questions when they do not understand certain topics during the learning process, leading to increased focus and engagement during classes. Refer to Kailani and Rohani (2011) Teaching Kit can enhance students' understanding in studying the subject of Mathematics (angles of elevation and angles of depression). The teaching approach is also expected to encourage students to collaborate within groups, sharing ideas and other contributions that can facilitate the learning process in the classroom.

#### 4. RESULT AND DISCUSSION

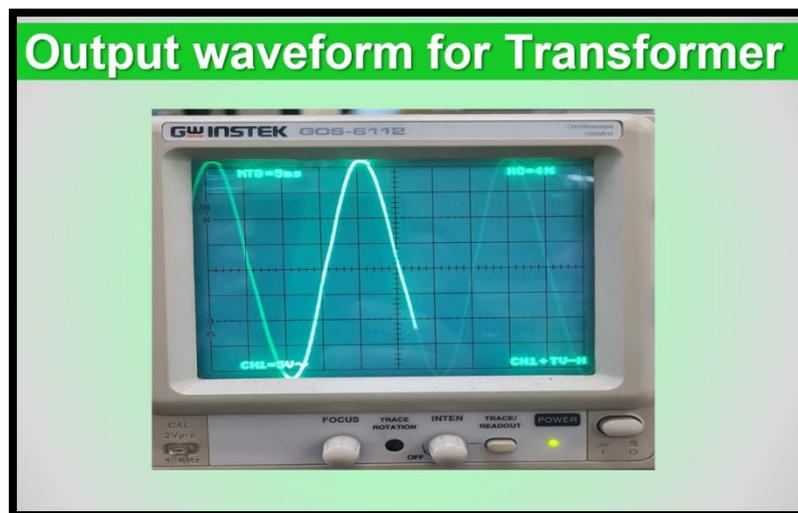
The results of developing this trainer have led to a reduced time required for conducting practical exercises in the course compared to the previous method. Additionally, students can avoid mistakes in making circuit connections that could damage components, resulting in reduced material costs.

The output waveforms for each power supply block have been labelled, making it easier for students to take measurements and comprehend the trainer since its arrangement aligns with the theoretical class setup.

Moreover, the output for each block can be obtained in two examples, such as for the filter circuit, where two different capacitor values are used to demonstrate the varying ripple voltage produced in the power supply. Similarly, for the voltage regulator circuit, two types of voltage regulator ICs, LM7805 and LM7812, are used, enabling students to observe waveform shapes and output values as taught in the theoretical class.

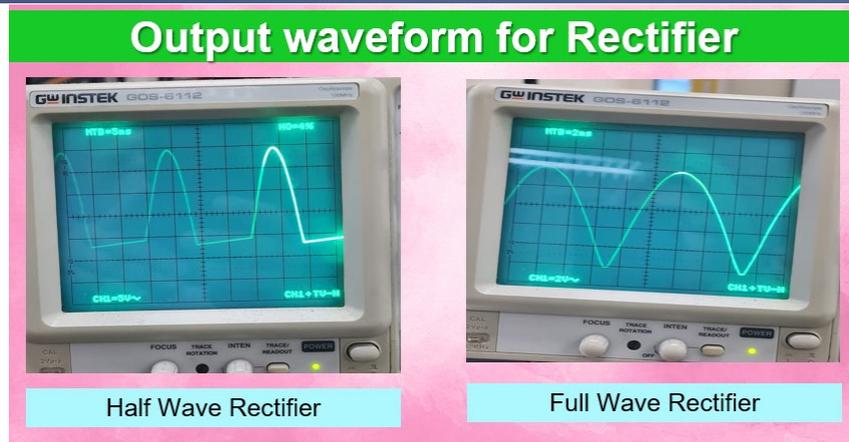
Furthermore, this Power Supply Learning Kit Trainer includes an additional section on the voltage divider that was not present in previous practical exercises. In this section, students can measure the output of the voltage divider and compare the measured values with the theoretical calculations taught in class.

The transformer used in this trainer is of the center-tapped type, providing an output of 12V-0-12V. Students can take measurements and compare the output waveforms of the trainer with the theoretical knowledge they have learned. The transformer's output remains in the form of alternating voltage, and the waveform display from this trainer can be shown in the Fig. 3 below.



**Fig. 3.** Output waveform for center-tap transformer

Students can clearly observe the difference between the half-wave and full-wave output waveforms. Consequently, they can indirectly comprehend the operation of both the half-wave and full-wave rectifier circuits.



**Fig. 4.** Output waveform for rectifier

Referring to Fig. 4, the output waveform of the circuit buffer block is taken from the output test point on this trainer. Students can distinguish the output waveform generated by the trainer from the theoretical waveform they have learned.

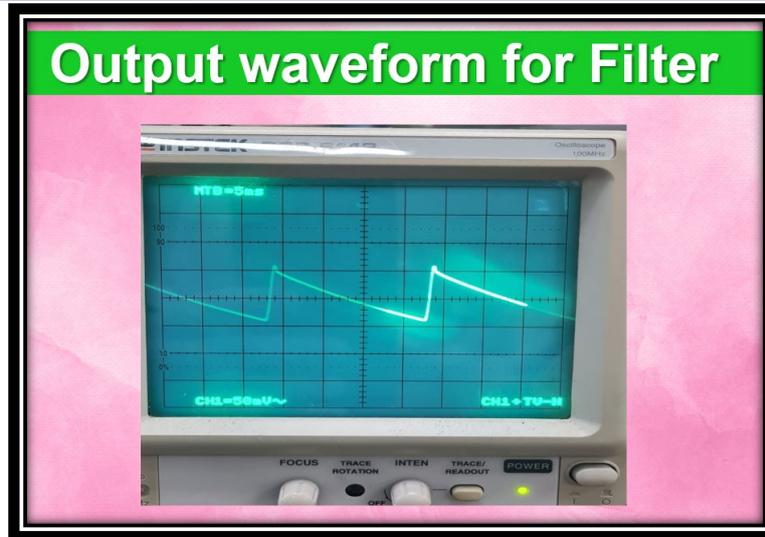
For the filter circuit, two capacitor values, 22 $\mu$ F and 470 $\mu$ F, are included in this trainer so that students can observe how the capacitor value affects the ripple voltage in the filter circuit. Both capacitors are connected in the trainer circuit, and the resulting ripple voltages for both capacitor values are shown in Table 2 below.

Refer to Table 2, it was observed that increasing the capacitor value in the circuit leads to a reduction in the generated ripple voltage in the power supply. Students can easily distinguish the variations in ripple voltage values and the resulting waveform.

**Table 2.** Capacitor value for filter

Capacitor value	Ripple voltage
22 $\mu$ F	0.1V
470 $\mu$ F	0.04V

Fig. 5 illustrates that with a 22 $\mu$ F capacitor, the filter block in the power supply circuit generates a substantial ripple voltage. As a consequence, the output direct current exhibits a noticeable and significant fluctuation. From the theory learned, the ripple voltage generated in this filter can be reduced by altering the capacitor value used in the filter circuit. Increasing the capacitor value will result in a smaller ripple in the output of the direct current voltage.



**Fig. 5.** Output waveform for filter block

The voltage divider block in the circuit consists of two types of voltage regulators, namely 5V and 12V, which utilize IC 7805 and IC 7812, respectively. The practical results indicate that the output voltage from these regulators is a pure direct current, free from any ripple voltage or pulsating direct current from the input as shown in Fig. 6 below.



**Fig. 6.** Output waveform for voltage regulator 12V

In the constructed The Power Supply Trainer Learning Kit circuit, an enhancement has been made to the final block by adding a voltage divider. This voltage divider circuit comprises three different resistor values, dividing the input voltage into three distinct values, as indicated in Table 3.

**Table 3.** Output voltage of divider block

Input Voltage	Voltage at Test Point (V)		
	W	Y	Z
5V	5	3	1
12V	12	6	2

## 5. CONCLUSION

In this paper, we designed and showcased an affordable and improvised Power Supply Learning Kit Trainer constructed using readily available local materials for third-semester students studying the Linear DC Power Supply topic in the DEE30043 Electronics Circuits

course. The study utilized a questionnaire to gather data and address the research questions for effectiveness of this trainer.

The results indicated that the Power Supply Learning Kit Trainer positively impacted the understanding and comprehension of the Linear DC Power Supply topic among students. The findings from the initial study demonstrated that using the Power Supply Learning Kit Trainer was an effective approach for teaching this specific topic.

The appropriateness of teaching aids in the learning process is crucial in ensuring that the content is effectively delivered and well-received by students. Consequently, the development and implementation of learning aids for the DC Power Supply Circuit are highly recommended. This initiative can aid lecturers in enhancing students' understanding and performance in the Linear DC Power Supply topic.

## ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious and Merciful, we begin by expressing our profound gratitude and praise to Him. Alhamdulillah, all thanks and glory belong to Allah, who has bestowed upon us the strength, guidance and blessings needed to successfully complete this trainer. His divine support has been the driving force behind our achievements and we acknowledge His infinite wisdom and mercy in guiding us through this journey. With His grace, we hope that The Power Supply Trainer Learning Kit will be of benefit to many and contribute positively to the field of education. May our efforts be accepted and our intentions pure as we seek to serve and contribute to society.

We extend our heartfelt gratitude to our esteemed colleagues and dedicated students for their unwavering encouragement and support throughout our journey of innovation. Their constant motivation has inspired us to transform our teaching experiences in this field into a comprehensive trainer, which can serve as a valuable reference for future endeavors. Without their support, this achievement would not have been possible. We are truly grateful for their collaboration and belief in our efforts to enhance the learning experience for all.

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## **I-CReST 2023:141-102 - Reconciliation of Science and Religion in Education: A Review of Bediuzzaman Said Nursi's Thought**

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### **ABSTRACT**

Bediuzzaman Said Nursi, a prominent Turkish scholar (1877-1960) put out an alternative approach to education in which he proposed for the reconciliation of science and religion. In his works, Nursi emphasized the importance of integrating scientific knowledge with Islamic belief and practice. Nursi believed that true knowledge could only be attained through the integration of these two fields, and that this integration was essential for the development of a comprehensive and holistic understanding of the world. Although Western scientific advancement has reached a glorious level, there is still a significant achievement difference in terms of spirituality. This may be observed in the steadily rising crime and social statistics that are compiled each year. Students of knowledge are profoundly influenced by Western academics who advocate secularism, one of the factors that contributes problem to obtaining the absolute truth. Therefore, the objective of this research is to discuss Bediuzzaman Said Nursi's perspective on the complementary roles that science and religion play in education. The research method will be descriptive-qualitative, and it will comprise a review of a number of journal articles that are relevant to Bediuzzaman Said Nursi's thoughts on education and the formation of Madrasah al-Zahra, which integrates scientific education and religious in its syllabus. The results of this study will be included into a set of guidelines that will benefit educational institutions at primary and university levels to oneness of religion and science in the curriculum.

**Keywords:** Reconciliation of science and religion; Bediuzzaman Said Nursi; education

### **1. INTRODUCTION**

In the realm of education, reconciling science and religion has been a topic of much debate and discussion. One prominent Fig. who contributed to this discourse is Bediuzzaman Said Nursi. Nursi, a Muslim intellectual from the late Ottoman and early Turkish period, recognized that the advancements of science and technology were often associated with a material and atheistic worldview (Sofi, 2013). In his milieu, many Western-educated elites saw science as contradicting religious beliefs. (Sofi, 2013) However, Nursi believed that science and religion were not contradictory, but rather complemented each other. He argued for the integration of religious and modern sciences in a way that not only addressed the present situation but also established universal principles. According to Nursi, science and religion should not be seen as opposing forces but rather as sources of enlightenment for one another.

Bediuzzaman Said Nursi advocated for the integration of religious and modern sciences and believed that science and religion could coexist harmoniously. In his pursuit of

reconciliation between science and religion, Nursi envisioned the establishment of a prestigious Islamic university like Al Azhar University. Nursi believed that such an institution would provide a platform for the integration of religious and modern knowledge, while also promoting the use of multiple languages in instruction, with Arabic being incumbent, Kurdish being legitimate, and Turkish being obligatory. (Eryilmaz et al., 2019) The objective of this research is threefold: 1. To explore the philosophy of Bediuzzaman Said Nursi with a particular focus on his views about the integration of science and religion. 2. To analyze how Nursi's thoughts help in harmonizing science and religion within the educational landscape, thereby shaping curriculum development and fostering understanding. 3. Lastly, to evaluate the implications of Nursi's philosophy in modern education and thereby shaping curriculum development and fostering understanding. Through these objectives, the research aims to contribute to the ongoing discourse on the reconciliation of science and religion in education.

### 1.1 Who is Bediuzzaman Said Nursi?

Said Nursi, also known as Bediuzzaman and Wonder of the Age, was born in 1876 in the village of Nurs, which is located in the city of Bitlis, which is located in the eastern region of Anatolia. Nursi was a notable Turkish scholar, he stressed the value of scientific knowledge and Islamic belief and practise in his da'wah and works, *Rasail al-Nur*. He was given the title of Bediuzzaman by Molla Fatah Allah of Siirt in recognition of his extraordinary abilities and the lightning-fast pace with which he studied a variety of scientific disciplines. The city of Nurs, where he was born, inspired his family to give him the name Nursi. Mirza was his father's name, and Nure was the name of his mother. He had an extraordinary recall and a great capacity for learning, both of which contributed to his already impressive intelligence. (Geelani, Syed & Mir, Irfan. 2019)

### 1.2 Science

Science is a term derived from the Latin word "scire" which means to know. It is not a phenomenon that is something fresh or new, rather it has a long history spanning from the time of classical Greece to the renaissance of the Europe. Therefore, science and its historical development are usually considered as the process of accumulation of techniques and the refinement of quantitative methods in the study of nature progressively. (Ahmad N. Amir et al. 2012). According to Poedjiadi, cited in Sunhaji (2016), the term science comes from the English word 'science'. In Latin 'science' means '*scientia*' which means learning and seeing (knowing). Knowledge itself is the result of seeing activity. Epistemologically, knowledge in humans is divided into two. First, knowledge is the result of alarm. Second, science is knowledge that is systematic, structured, and organized. Science is a system that is useful for providing an understanding of the universe by observation and controlled trials or experiments.

According to Iqbal, M. (1999), Islam places a strong emphasis on science and the transcendence. Islamization of science is a result of this spiritual component. The Islamic ethical framework is another factor that adds a distinctively Islamic element to the study of nature and life while also defining the nature of inquiry. Islam views science as only a tool for obtaining higher truths. It's not a goal in and of itself. It is one of the disciplines of knowledge, and the Qur'an makes clear why learning is important. Without a purpose, information becomes useless. Then, pursuing it becomes a pointless exercise with no reward. (Iqbal, M. 1999) As for Said Nursi, the term 'ilm must refer to man's knowledge of God. It is clear by now that according to Nursi all sciences and knowledge are religious, and that scientific and religious

knowledge are complementary disciplines. His emphasis is on the knowledge which yields happiness in this world and the one to come (Hasan Hörkürç, 2004).

### 1.3 Religion

All branches of knowledge related to religion have defined religion from their own perspective. While describing religion, Islamic scholars have taken into consideration the way the concept of religion was taken up in the Quran and Islamic beliefs. According to Ningsih, T, et.al (2022), the word religion originates from Sanskrit which is closely related to Buddhism and Hinduism. The root word religion, namely 'gam' that begins with 'a' and ends with 'a' thus becomes 'agama' (religion). The root often gets the beginning with 'I' and ending with the same, so it becomes 'igama', often gets the prefix 'u' thus becomes 'ugama'. The word religion originates from Sanskrit, belongs to the Indonesian-German clump, and it is similar with Dutch and English clump. "Ga", we find in Dutch, 'gan' (gone) in English, and 'go' in English has the same meaning as gam which means to go. However, the meaning will change after getting the prefix and ending a, which means becoming a way.

According to Bayram, F. (2010), religion is a divine law. Consequently, if the rules and beliefs we adopt as religion are not based on divine revelation, they are not acceptable to Allah. According to this part of the definition, every kind of belief and claim to sacredness produced by man is false. Only the system sent by Allah via prophets is the true religion. In this way, man bowing down to man has been prevented and it has been established that all people are one and equal before Allah. "Superiority lies only in piety."

The Holy Quran mentions religion ninety-two times and its derivatives three times. The Quran uses this word mostly to mean "rule, ruled, obedience, law, worship, unity (uniting with Allah), Islam, shariah (laws-regulations), limits (put by Allah), tradition, punishment, accounting (giving account to Allah on judgement day as to how and for what our life passed), and nation (group of people with the same belief)." Religion has two meanings in the Quran: Creator and created. Religion is "being in control, making obedient, taking to account, and giving punishment-reward" to the Creator and those serving him; to the created and those serving, it is "bowing down, understanding one's helplessness, surrendering, and worshipping." (Bayram, F.2010).

Religion is a complex and multi-dimensional concept with various definitions according to different perspectives, but in general, it can be defined as a set of beliefs, practices, and rituals that relate to the conception of the divine or the transcendent. This usually involves beliefs about the nature of reality, the purpose of life, morals, ethics, and the afterlife. Most religions have organized behaviors, including congregational prayers, moral prescriptions, religious laws concerning diet, clothing, and social organization, and rituals such as baptism, circumcision, wedding ceremonies, and funerals. They often contain a moral code governing the conduct of human affairs. Religions also often encompass a narrative or a cosmology that explains how the universe and life emerged, which is sometimes referred to as a religious mythology. They may also depict symbols, traditions, and sacred histories that aim to explain the meaning of life or to connect individuals with their faith community.

## **1.4 Islamic Education : Said Nursi's View**

Bediuzzaman Said Nursi's perspective on Islamic education contributes to the development of human potential by merging religious values with humanity. This is oftentimes referred to as religious humanism. According to Nursi, Islamic education should focus on developing a balanced personality in a person by considering both worldly (*duniawi*) and spiritual or afterlife (*ukhrowi*) aspects. This approach places humans as beings in harmony with their creation's purpose by the Creator. Furthermore, Said Nursi emphasises the teaching of sciences with an unwavering foundation on faith and Quranic understanding to further enhance human potential. He promotes synergy between scientific knowledge and religious teachings. The aim of this concept is to create balanced human beings that have good relationships with their fellow beings (*hablun minannas*) and with their Creator (*hablun minallah*). As a result, the humanistic perspective of Islamic education, according to Nursi, is viewed as essential for personal development. (Alfiyanto et.al, 2023)

## **2. RESEARCH QUESTIONS**

Research questions for this research are 1. How does Bediuzzaman Said Nursi's philosophy reconcile science and religion within the educational landscape? 2. What are the specific implications of Nursi's philosophy on the integration of scientific and religious teachings in the modern education system? 3. How have Nursi's thoughts on science and religion shaped educational theories and curriculum development? 4. In what ways do Nursi's thoughts provide a framework for understanding and addressing the perceived conflict between science and religion in education? 5. How might Nursi's teachings guide the future of science and religion integration in education?

## **3. METHODOLOGY**

This is a descriptive-qualitative research. The methodology for this conceptual research paper is conducting a thorough review of existing literature on Bediuzzaman Said Nursi's philosophy, particularly his thoughts about the integration of science and religion. This review consider both primary sources, like Nursi's works, and secondary sources – scholarly analysis and comments on his philosophy. And develop a conceptual framework based on Nursi's philosophy to map the interaction of science and religion within education. This step involves carefully examining Nursi's writings to identify key principles and positions regarding science, religion, and education.

## **4. RESULTS AND DISCUSSION**

### **4.1 Bediuzzaman Said Nursi's Philosophy Reconcile Science and Religion within the Educational Landscape**

To persuade people that science and religion are peaceful, Said Nursi elucidated the concept of philosophy-based genuine knowledge. And, in his attempt to demonstrate that the source of all knowledge is Allah, the one who is responsible for creating this universe, Said Nursi takes a philosophical approach. (Bediuzzaman Said Nursi, *The Rays*, tr. Şükran Vahide, 2007). Said Nursi defines "Ilm" as all knowledge, not just religious knowledge. However, he has separated it into two main categories: *aqli* for religious sciences and *naqli* for physical sciences. Said Nursi clarifies that all knowledge is religious, regardless of its source or type. He believed

theological and physical sciences (aqli and naqli) were complementary. (Hasan Hörkür, 2004, 336)

There are some differences of opinion between scholars. Sayyid Qutb considered knowledge beyond understanding. Knowledge is the mind's complete grasp of something, linked to the soul and conscience, and realised via action. Knowledge generally signifies mind, soul, and bodily harmony. (Hasan Hörkür, 2004, 88) "Knowledge is like the fruit of a tree and it flows from intellect," says Imām Ghazālī. (Muhammad al-Ghazzālī.1982,109) Whereas, Ibn Khaldūn, a notable Muslim sociologist, believes that knowledge flourishes in a civilised community and may be achieved by reasoning. "Man is a social animal and his prosecution of learning is conditioned by the nature of the material, intellectual and spiritual forces of the civilisation in which he lives,"(A.L Tibawi, 1972) According to Sofī (2013), knowledge can be gained by thinking, senses, and empiricism. Using one's mind—rationality or reasoning—to get knowledge is fine as long as it is guided by Allah's understanding. The mind ('aql) and its usage in rationalism, logic, and empiricism have major limitations. Thus, the intellect might mislead humanity if it is not subordinate to given knowledge.

According to Sofī (2013), Bediuzzaman Said Nursi proposed an integration of religious and scientific knowledge in society, aiming to establish a unitary education system through the revitalization of knowledge. His approach was both practical and intellectual. He believed that religious knowledge and knowledge based on experiments, or scientific knowledge, need to be brought together in order to serve humanity in its entirety. He referenced the concept that all knowledge is religious, irrespective of the source, indicating that there's no opposition or dichotomy between science and religion. Throughout his life, he was interested in reconciling faith and reason, Islam and science, and he encouraged Muslims to engage with scientific progress while maintaining their faith. He emphasized that a materialistic interpretation of scientific findings was absurd and irrational, advocating for a balance of scientific and religious perspectives. Said Nursi's aim was to create a generation of Muslims who would be sincere, devoted, and learned in both religious and scientific knowledge.

Bediuzzaman Said Nursi's writings significantly contributed to the integration of religious and scientific knowledge. He articulated the necessity to marry two different types of knowledge: one grounded in religious faith and the other based on experimental science. His writings reflected a strong belief that it was indeed possible to reconcile these disparate knowledge systems, explicitly rejecting any perceived incompatibility between the truths of religion and the findings of modern science. His work, the *Risale-i Nur*, showcased his vision through practical examples, comparisons, reasoned proofs, and explanations demonstrating that the materialistic interpretations of scientific findings were irrational. He pointed out that the sciences could actually reveal the wonders of God's creations, thus bringing religious and scientific understanding closer together. Nursi's writings acted as guides for the potential bridging of faith and science, and they inspired Muslims to engage enthusiastically with the scientific advancements of the modern age while maintaining strong pillars of faith, presenting an integrated approach to knowledge. His contributions facilitated a broader understanding of knowledge, and were aimed at resolving the perceived controversy surrounding religion-science compatibility. Overall, through these writings, Nursi endeavored to present a holistic approach to knowledge for the all-around development of humanity. (Sofī, 2013)

Resolving the religion-science controversy is significant for several reasons. Firstly, it fosters a holistic understanding of the world by integrating scientific, empirical knowledge with

moral, ethical, and spiritual principles offered by religion. This avoids any unnecessary dichotomy or conflict between two vital components of human knowledge and experience. Second, it promotes open-mindedness, critical thinking, and mutual respect for diverse viewpoints among individuals, leading to more inclusive community dialogues. Third, it benefits education, allowing students to learn and understand both scientific principles and religious beliefs without feeling that they have to choose one reality over the other. Many belief systems and scientific concepts can coexist and complement each other. Lastly, it encourages the application of ethical guidelines in scientific research and human technological advancement. Religious principles often encompass caring for the well-being of others and respecting the sanctity of life, which can guide science in a direction that is more considerate of the consequences of actions, particularly in areas like bioengineering, artificial intelligence, and environmental sustainability. Thus, resolving the religion-science controversy enriches human understanding, fosters unity in diversity, enhances education, and guides science towards ethical advances. (Sofi, 2013)

In other words, science-religion education can be advanced through interdisciplinary dialogue, developing coursework that fosters mutual understanding, and expanding research in areas where these disciplines intersect. Teachings should encourage students to explore how scientific theories, such as evolution, can coexist with religious beliefs without contradiction. This can be achieved by presenting both religious and scientific perspectives on critical issues like the nature of the universe, human existence, ethics, and morality. (Oleksowicz et.al, 2021)

#### **4.2 Emergence of Modern Science and Educational Issues in Turkey**

The Abbasids of Baghdad and the Umayyads of Spain (al-Andalus) were responsible for the growth of science. Muslim Civilization and science advanced rapidly during this time. The creativity, originality, and universality of progress in practically every sector was unsurpassed worldwide. Muslims have made innumerable scientific contributions. (M.Raziuddin Siddiqui, 1988, 193) Unfortunately, Muslims—the leaders in science and technology—lost their way and their long-held scientific supremacy, especially after the fourteenth century. Since then, the status quo in the Muslim world has stayed mostly the same, generating mayhem. The world watched the decline of Muslim science and the rise of "modern science" over the course of days, weeks, months, years, and centuries. The healthy development only occurred when Muslims moved their intellectual and scientific legacy from the East (Muslim World) to the West (European World). The West never stopped striving to improve science and technology. (Sofi, 2013)

Bediuzzaman believed that the current educational system was fostering a gap between two sections of society rather than meeting the needs of the community. Even worse than that, two streams made false assumptions about one another. The globe has recently seen enormous growth and improvement in the field of science. The current trend is influenced by a wide range of variables, including technical development, novel discoveries and innovations, improvements in health and hygiene, globalisation, and others. (Geelani, Syed & Mir, Irfan, 2019)

According to Said Nursi, a time dominated by scientific advancements calls for the fusion of scientific knowledge based on experiments and religious understanding. Said Nursi was therefore dissatisfied with the educational system in use in Turkey at the time. Mektebs and medrasas were the primary dual institutions used to deliver education. The first system was

oriented towards the west and focused on a positivist approach to science, whereas the second provided a classical Islamic education. There was no national educational system at the time that provided instruction in both science and religion. Mekatib and Medaris, the centres of popular education at the period, seemed to take pride in their distinctive curriculum while simultaneously criticising one another. These problems caused Nursi much distress. He frequently expressed his displeasure with conventional religious experts whose discussions failed to address the pressing problems of the day. Nursi was believed that religion encompassed more than just concerns of faith and that it had connections to other fields of research, such as sociology, politics, and economics. (Markham.S, Ian and Pirim, Suendam, 2011).

### **4.3 Reconciliation of Science and Religion: Said Nursi's Approach**

#### **4.3.1 Madrasah al-Zahra Model**

Said Nursi lamented the country's maktab-madrasah education system. Maktab taught modern sciences and madrasah religious sciences. His unhappiness suggests that faith and modern science must be shown to be inseparable. This principle should underpin education policy. Nursi observed that the West eradicated its backwardness by improving science and learning, so he dreamed of establishing a university in eastern Anatolia called Madrasah al-Zahra and determined its aim, organisation, syllabus, nature, and funding. Marazi (2015) says this paradigm promotes "integration of knowledge" by teaching religious subjects in secular schools (maktabs) and positive sciences in religious schools (madrasahs). This protects secular science students from scepticism, while religious science students gain technological skills and development.

He adds that Nursi's ideas on integrating science and technology into education are unique and meaningful in the global Muslim education crisis. Nursi began a discourse between science and religion to establish a philosophical understanding of nature, discovering that religious philosophy shared a lot of the same area as the scientific sciences. He doesn't think science is outside religion. "Modern sciences in particular have awakened and aroused man; he has understood the true nature of humanity," he said. "Madrasah al Zehra" sought to reconcile religious and secular knowledge. Nursi explains, "The people of (medrasah) religious schools accuse the people of modern schools of weakness of belief due to their outward appearance. Modern schools think religious schools are ignorant since they don't know about new science. Different viewpoints and practises undermined Islamic principles and inhibited modern civilization. The only way to fix this is to teach religious sciences properly in modern schools, teach new exact sciences instead of ancient Greek philosophy in religious institutions, and have talented scholars in dervish lodges. He studies science to understand and prove the Quran. Science and life should revolve around understanding the Quran. Bediuzzaman advises students to specialise in a subject they enjoy and only study subjects that compliment it. However, specialisation was a major departure from traditional methods. (Bediuzzaman Said Nursi, 2010)

Nursi began a conversation between science and religion to establish a theological understanding of nature, revealing that theology shared a lot of the same area as the natural sciences. He doesn't think science is outside religion. According to Nursi, "Modern sciences in particular have awakened and aroused man; he has understood the true nature of humanity,". Said Nursi wanted to show that all knowledge is religious. Science and religion coexist in

Bediuzzaman Said Nursi's Risale-i Nur and this is further explained in "The Damascus Sermon", a chapter in The Rays Collection by him. (Bediuzzaman Said Nursi, 2010)

### 4.3.2 A New Methodology of Teachings

According to Geelani, Syed & Mir, Irfan. (2019), Nursi created a new teaching method : pupils should learn in a language they understand and with simple sentences and explicit examples. Teachers must excite students about the subject. Nursi believes madrasahs should adopt a new approach and curriculum. Based on performance, children should be carefully watched and guided. Discussing with pupils helps them learn, synthesise, and discover. Nursi indicates question-and-answer instruction. Badiuzzaman criticises researchers who don't use theory and experiments. Nursi seeks to replace memorization with pragmatic considerations and curious reasoning in students. The teacher should also bring the topic to life, make the lecture exciting with seductive precedents and instances, and convince students that the knowledge he imparts will be useful. Students must feel responsible and believe in school to do well. A spiritually neglected youngster cannot be educated or controlled.

### 4.3.3 The Future of Curriculum Integration

According to Ali (2014), Nursi has distinguished various criteria as reference for Muslims in empowering integrated education. Below are Nursi' s seven guidelines of future curriculum integration.

- 1) Conduct a comprehensive evaluation of all existing educational systems.
- 2) Reevaluating the status quo of religious education and making wholesale changes to its curriculum.
- 3) Integrating traditional religious education with current secular education and Islamic mysticism (Sufism) to form a coherent and effective educational framework.
- 4) Creating a curriculum that balances the teaching of material, spiritual, and moral values.
- 5) Using Arabic as the primary language of instruction and placing a strong emphasis on the use of the student's native language as a second language overall (sometimes known as "tri-lingual").
- 6) Concluding that Islam is an excellent resource for a myriad of disciplines, including cutting-edge science.
- 7) Pushing for the creation of an Islamic university that successfully blends traditional Islamic studies with cutting-edge scientific research.

## 5. CONCLUSION

In conclusion, Bediuzzaman Said Nursi's perspective on the reconciliation of science and religion in education has sparked insightful discussions among various authors. By embracing Nursi's ideas, educators can strive for a balanced approach that bridges the gap between science and religion, promoting a more inclusive and integrated educational experience. Said Nursi's educational approach is vast, complete, dynamic, and progressive, and it can meet both scientific and moral education needs in a holistic way. Nursian education is superior to all other South Asian educational models because it achieves both empowerment through education and

religion-science-technology integration. The Madrasah-al-Zehra model is practical, reasonable, and culturally appropriate for Muslims worldwide due to its unique civilisation qualities. In the context of consumerist tendencies in education and technology that marginalise spiritual and moral values, researching this approach in depth is particularly desired. Nursian model provides an option that satisfies modern demands but does not disregard the ideals education should instill to address civilization's problems in the face of atheism and materialism in the guise of development, modernization, and progress.

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## I-CReST 2023:147-113 - Level of Job Satisfaction of Employees in the Department of General Studies, Sultan Idris Shah Polytechnic, Sabak Bernam

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### ABSTRACT

Job satisfaction is one of the factors that influences the emotion and action of employees in carrying out their responsibilities at the workplace. Therefore, it should be paid attention to by the management so that the staff can do their work competently. This study has been carried out to measure the General Studies Department of Politeknik Sultan Idris Shah staff's job satisfaction. The instrument used in this study is Minnesota Satisfaction Questionnaire (MSQ) which comprises 20 questionnaire items aiming at identifying Intrinsic and Extrinsic factors that influence job satisfaction. It is found that the General Studies Department of Politeknik Sultan Idris Shah staff has a high job satisfaction level.

**Keyword:** Job satisfaction; Minnesota Satisfaction Questionnaire (MSQ); intrinsic and extrinsic

### 1. INTRODUCTION

Work is defined as performing or carrying out various activities to produce something (Kamus Dewan). While performing a job, employees often spend a significant amount of time completing their tasks. A study conducted found that 32 per cent of workers in Malaysia work between nine to eleven hours per day (Cyrill et al., 2020). This indirectly affects the emotions and perceptions of employees towards their work.

Job satisfaction is a feeling that arises within an individual. According to Zaffar Ahmad Nadaf (2018), satisfaction in performing a job is crucial for every worker throughout their employment. According to Mohammad Rezal Hamzah (2011), job satisfaction at every level of an organization is an important benchmark for maintaining emotions, thought processes, and objective acceptance of the organization, thus creating a positive and continuous work culture. Furthermore, employees' attitudes towards the tasks assigned can significantly impact individual job satisfaction (Brooke et al., 1988).

Job satisfaction can be measured through the emotional level resulting from the perception of the work being performed (Locke, 1976). An individual's sense of responsibility towards their tasks is also believed to influence their level of job satisfaction (Bishay, 2004). The sense of satisfaction in performing a job can change, either improving or declining, depending on various factors that may vary over time.

Job satisfaction can stem from several factors. For example, the level of job satisfaction can be determined by the interaction between an employee and their work (Ahmad Jawaher,

2000). Internal communication is also believed to influence job satisfaction and employee motivation in carrying out their tasks (Martha, 2004). In terms of communication, job satisfaction and performance have a strong positive relationship with communication, whether it is horizontal, upward, or downward communication (Pincus, 1986). Moreover, the role played in the work environment (Savery, 1996) and high motivation are essential for individuals in shaping their personality and job satisfaction as a group (Nurhannan Ramli, 2015).

## **2. PROBLEM STATEMENT**

According to Everts (2001), job satisfaction is a crucial concept for an organization to generate the "natural character" of a job, as employee dissatisfaction may have a negative impact on task performance. Therefore, it is essential for employers to pay attention to enhancing job satisfaction to maintain job performance (Ostroff, 1992). Previous studies have shown that employees with high levels of job satisfaction demonstrate enthusiasm, energy, and a high level of enjoyment in performing their tasks (Heller et al., 2002).

There are two factors that influence the level of job satisfaction: intrinsic and extrinsic factors. Examples of intrinsic factors include recognition and relationships with colleagues, while extrinsic factors encompass the work environment, salary, and safety issues (Lai, 2018). The characteristics and backgrounds of employees can also affect their level of job satisfaction, such as education level, gender, age, and work experience (Cron and Slocum, 1986). Analyzing these factors can provide an understanding of the level of job satisfaction, both individually and collectively, within an organization.

Politeknik Sultan Idris Shah, located in Sabak Bernam, is an institution that offers higher education services with various programs and courses. The Department of General Studies is one of the academic departments responsible for fulfilling the needs of providing educational services. Thus, job satisfaction among employees in this department is crucial for achieving the objectives and goals of Politeknik Sultan Idris Shah.

Therefore, in order to determine the level of job satisfaction, a study has been conducted on the employees working in the Department of General Studies, Politeknik Sultan Idris Shah, Sabak Bernam. The findings from this study are valuable in understanding the perceived level of job satisfaction. The data collected from this study are important in determining the necessary steps to maintain job satisfaction among employees.

## **3. RESEARCH OBJECTIVES**

The objectives of this study are as follows:

1. To identify the level of job satisfaction among employees of the Department of General Studies, Politeknik Sultan Idris Shah, Sabak Bernam using the Minnesota Satisfaction Questionnaire (MSQ) instrument.
2. To examine the intrinsic and extrinsic factors that influence the level of job satisfaction among employees of the Department of General Studies, Politeknik Sultan Idris Shah, Sabak Bernam.

## 4. RESEARCH METHODOLOGY

The study conducted is a quantitative research in the form of a descriptive survey. The questionnaire was developed and divided into two parts: Part A to gather information about the respondents' background, and Part B to measure the level of job satisfaction of the respondents. The collected data were then analyzed using the Statistical Package for the Social Sciences Version 21.0 (SPSS 21) software.

### 4.1 Population, Sample, and Study Location

The study population for this research consisted of the employees in the Department of General Studies, Politeknik Sultan Idris Shah, Sabak Bernam, Selangor. The study was conducted from October 24th to October 31st, 2022, involving a total of 22 respondents who participated in answering the provided questionnaire.

### 4.2 Research Instrument

The research instrument used in this study was the Minnesota Satisfaction Questionnaire (MSQ) developed by Weiss et al. (1967). This instrument consists of 20 items and uses a 5-point Likert scale as a response format (Buitendach and Rothmann, 2009). According to Helena (2012) and Fields (2002), MSQ has been widely used in many previous studies.

Using the Minnesota Satisfaction Questionnaire (MSQ) instrument, job satisfaction can be measured through various factors such as salary, work environment, co-workers, and supervision. These factors are considered important in determining an individual's job satisfaction (Halimatussaedyah and Noraini, 2015).

## 5. RESEARCH FINDINGS

### 5.1 Reliability of the Research Instrument

Based on the Cronbach's alpha value, the reliability of the research instrument used in this study is high, with a value of 0.95. This data is consistent with the range of values reported by Weiss et al. (1967), where the reliability of the MSQ instrument used in previous studies ranged from 0.77 to 0.91.

**Table 1.** Reliability statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.950	.951	20

Referring to the Cronbach's Alpha Score Interpretation table (Bond & Fox, 2015), it can be concluded that the value of 0.95 indicates that the instrument used is excellent, effective, and can be utilized in actual research.

**Table 2.** Interpretation of Cronbach's Alpha scores (Bond & Fox, 2015)

The Cronbach's Alpha score	Reliability Level
0.8 to 1.0	Very good and effective with high level of consistency
0.7 to 0.8	Good and acceptable
0.6 to 0.7	Acceptable
<0.6	Items need to be corrected
<0.5	Items need to be dropped

## 5.2 Descriptive Findings (Demographics)

Each respondent was asked to provide their demographic information, allowing the researcher to examine the background of the respondents who answered the provided questions in this study. Some demographic information collected includes gender, age, years of service, highest academic achievement, and income.

Based on Table 3, the total number of employees involved as respondents in this study was 22 individuals, with 9 individuals (40.9%) being male and 13 individuals (59.1%) being female.

**Table 3.** Distribution of respondents by gender

<b>Sex</b>	<b>Numbers</b>	<b>Percentage</b>
Male	09	40.9%
Female	13	59.1%

The highest age range recorded based on the information provided by the respondents participating in this study consists of individuals between the ages of 31 and 40 (50%), followed by the age range of 41 to 50 years (27.3%), the age range of 21 to 30 years (13.6%), and the lowest is in the age range of 51 to 60 years (9.1%). Based on the information presented in Table 4, we can see that half of the respondents fall within the age range of 31 to 40 years.

**Table 4.** Distribution of respondents by age range

<b>Age</b>	<b>Numbers</b>	<b>Percentage</b>
21 – 30 years	03	13.6%
31 – 40 years	11	50.0%
41 – 50 years	06	27.3%
51 – 60 years	02	9.1%

All employees of the Department of General Studies, Politeknik Sultan Idris Shah hold the position of Higher Education Service Officers (PPPT) under the DH scheme code. Referring to Table 5, out of a total of 22 respondents, 7 individuals (31.8%) have served between 0 and 10 years, while 15 individuals (68.2%) have served within the range of 11 to 20 years. Indirectly, this information indicates that there are no respondents who have served for more than 21 years in their service scheme.

**Table 5.** Distribution of respondents by years of service range

<b>Ta</b>	<b>years of service</b>	<b>Numbers</b>	<b>Percentage</b>
0 – 10 years	07	31.8%	
11 – 20 years	15	68.2%	

Referring to Table 6, based on the academic level of the employees, more than half of the respondents have an undergraduate degree, with a total of 12 individuals (54.5%), while the remaining 10 individuals (45.5%) have a master's degree.

**Table 6.** Distribution of respondents by highest academic level

<b>Academic Level</b>	<b>Numbers</b>	<b>Percentage</b>
Bachelor's Degree	12	54.5%
Master's Degree	10	45.5%

The data on the monthly income level of the Department of General Studies employees indicates that more than half, specifically 12 individuals (54.2%) of the respondents, have a monthly income exceeding RM5,000. Additionally, 4 individuals (18.2%) have an income ranging between RM4,000 and RM5,000, 5 individuals (22.7%) have a monthly income ranging from RM3,000 to RM4,000, and one individual (4.5%) has an income between RM2,000 and RM3,000. The breakdown of income ranges can be referred to in Table 7 below.

**Table 7.** Distribution of respondents by income range

Income	Numbers	Percentage
RM2,000 – RM3,000	01	4.5%
RM3,001 – RM4,000	05	22.7%
RM4,001 – RM5,000	04	18.2%
>RM5,000	12	54.5%

### 5.3 Descriptive Findings (Intrinsic Factors)

The Minnesota Satisfaction Questionnaire (MSQ) used in this study consists of 20 items. The items in this instrument measure two main factors, namely intrinsic and extrinsic factors.

**Table 8.** Findings for intrinsic factors based on the Minnesota Satisfaction Questionnaire instrument

Code	Item	SDA	DA	N	A	SA	Mean	Standard deviation
B1	Opportunities to work independently on a task			2 (9.1%)	14 (63.6%)	6 (27.3%)	4.18	.588
B3	Opportunities to become someone within the community		1 (4.5%)	3 (13.6%)	8 (36.4%)	10 (45.5%)	4.00	1.07
B4	Opportunities to do something for others		1 (4.5%)	0 (0.0%)	12 (54.5%)	9 (40.9%)	4.32	.716
B6	Opportunities to try my own methods of doing work		1 (4.5%)	1 (4.5%)	13 (59.1%)	7 (31.8%)	4.18	.733
B7	Opportunities to do something useful with my own abilities		1 (4.5%)	2 (9.1%)	11 (50.0%)	8 (36.4%)	4.18	.795
B8	Opportunities for self-advancement in the job			2 (9.1%)	11 (50%)	9 (40.9%)	4.32	.646
B9	Ability to stay busy all the time		2 (9.1%)	6 (27.3%)	9 (40.9%)	5 (22.7%)	3.77	.922
B11	Ability to do things that are not against my conscience			3 (13.6%)	13 (59.1%)	6 (27.3%)	4.14	.639
B15	The way my colleagues work together			1 (4.5%)	9 (40.9%)	12 (54.5%)	4.50	.597
B16	My salary and the amount of work I do			1 (4.5%)	12 (54.5%)	9 (40.9%)	4.36	.581



B18	The atmosphere and environment at the workplace	2 (9.1%)	10 (45.5%)	10 (45.5%)	4.36	.658
B20	The sense of accomplishment I get from my work	1 (4.5%)	2 (9.1%)	8 (36.4%)	10 (45.5%)	4.23 .869

Table 8 shows the findings of the intrinsic factors of job satisfaction among the respondents. The highest mean value recorded is 4.50 for the item "The way my colleagues work together." The lowest mean value is 3.77 for the item "Being able to stay busy all the time." Overall, the mean value for the intrinsic factors is found to be high at 4.21, as shown in Table 9.

**Table 9.** Descriptive statistics

	N	Mean
MinIntrinsic	22	4.2121
Valid N (listwise)	22	

#### 5.4 Descriptive Findings (Extrinsic Factors)

**Table 10.** Descriptive findings

Code	Item	SDA	DA	N	A	SA	Mean	Standard deviation
B2	Opportunity to do different things from time to time	1 (4.5%)	3 (13.6%)	8 (36.4%)	10 (45.5%)	4.23	.869	
B5	Opportunity to tell others what needs to be done	1 (4.5%)	3 (13.6%)	10 (45.5%)	8 (36.4%)	4.13	.834	
B10	Effectiveness of my supervisor in decision-making		5 (22.7%)	10 (45.5%)	7 (31.8%)	4.09	.750	
B12	How my job provides stable employment		2 (9.1%)	15 (68.2%)	5 (22.7%)	4.14	.560	
B13	How company/organizational policies are implemented		5 (22.7%)	11 (50.0%)	6 (27.3%)	4.05	.722	
B14	How my employer handles their employees		3 (13.6%)	11 (50.0%)	8 (36.4%)	4.23	.686	
B17	Freedom to use my own judgment	2 (9.1%)	2 (9.1%)	8 (36.4%)	10 (45.5%)	4.18	.957	

B19	Praise I receive for doing a good job	4 (18.2%)	9 (40.9%)	9 (40.9%)	4.23	.752
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Table 10 displays several items that measure the extrinsic factor in the Minnesota Satisfaction Questionnaire (MSQ) instrument. The findings revealed that the highest mean reading of 4.23 is recorded for items B2 and B19. Item B2 assesses the level of "Opportunities to do different things from time to time," while item B19 states "Recognition I receive for doing a good job." The lowest mean value is observed for item B10, with a recorded minimum value of 4.05. Item B10 assesses the level of "My supervisor's competence in making decisions." Overall, the researcher found that the mean value for the extrinsic factor is also high, at a value of 4.15, as shown in Table 11.

**Table 11.** Descriptive statistics

	N	Mean
Extrinsic Mean	22	4.1591
Valid N (listwise)	22	

From both factors tested in this instrument, the researcher was able to determine the level of job satisfaction among the employees of the Department of General Studies, Politeknik Sultan Idris Shah, Sabak Bernam. The overall mean value for all the items tested in this instrument is also high, which is 4.19, as shown in Table 12.

**Table 12.** Descriptive Statistics

	N	Mean
All Mean	22	4.1909
Valid N (listwise)	22	

## 6. CONCLUSION AND RECOMMENDATIONS

Based on the findings of the study conducted among 22 employees of the Department of General Studies, Politeknik Sultan Idris Shah, Sabak Bernam, it can be concluded that the level of job satisfaction among the employees is very good and satisfactory.

From another perspective, the factors influencing job satisfaction, such as intrinsic and extrinsic factors, also indicate a similar positive picture. It can be inferred that both factors play a significant role in determining the level of job satisfaction.

At the same time, the researchers recommend conducting a follow-up study on job satisfaction with the same respondents in the future to assess whether job satisfaction has improved or not.

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## **I-CReST 2023:152-117 - Learning Mathematics Online: Issues and Perceptions of Secondary School Students in Rural Areas**

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### **ABSTRACT**

In April 2020, the Malaysian Government ordered all students to continue their studies via online learning. Even if the instructional materials are easily accessible and the students can choose when to learn, not all students, especially those who live in remote rural areas, have access to online learning. Inadequate online learning infrastructures and limited internet access make online learning more difficult for students. Additionally, because they have limited resources and access to online learning, students belonging to underprivileged communities may encounter challenges in achieving success in online learning. This study was having the following specific objective: 1. To identify the perceptions and issues faced by the secondary school students in rural areas regarding online mathematics classes and 2. To investigate students ability to cope with mathematics online learning based on their grade and perceptions. A quantitative case study was carried out on Form 1, Form 2 and Form 4 students at a secondary school in Perak, Malaysia. The study aimed to collect data on the students' problems and issues during online learning, as well as their perceptions of learning mathematical subjects online. To gather this data, a questionnaire consists of 26 Likert-scale questions was used. The result of this research indicates that most of the students have doubt about their ability to learn mathematics through online classes and feel that they cannot get the good grades in mathematics when learning through online. Aside from that, majority of them agree that it is difficult to disregard and avoid distractions in their surroundings while learning through online classes. They also unwilling to attend or spend more than 15 hours per week for online classes. To summarize, students' perceptions and challenges in online mathematics learning intertwined the students' ability to cope with online learning.

**Keywords:** Mathematics online learning; rural areas; secondary school students

### **1. INTRODUCTION**

A fundamental subject, mathematics, serves as the foundation for many academic fields and practical applications. For the development of analytical skills, problem-solving aptitudes, and critical thinking, mathematical proficiency is crucial. However, a major obstacle to students' academic development and future chances is the lack of access to high-quality mathematics education in many rural areas of the world. Rural students' potential is limited and existing educational imbalances are made worse by the differences in mathematics education between urban and rural areas.

Although beneficial in some contexts, the traditional face-to-face teaching paradigm might not be the best option for enhancing mathematics education in rural areas. Innovative strategies that may transcend regional boundaries, increase teacher capacity, and more fully involve students are needed to overcome these obstacles. With its accessibility, adaptability, and flexibility, online learning presents a viable way to overcome the aforementioned problems and transform mathematics teaching in rural areas. Online learning may offer distant students chances for self-paced study, interactive resources, and real-time feedback, all of which are crucial elements of an effective mathematics education. This is accomplished through utilising technology and educational platforms.

The importance and difficulty of mathematics are widely acknowledged in educational institutions. Previous studies have looked at the challenges that students face while trying to understand mathematical terminology and concepts, particularly when trying to master the basics. However, students can develop critical thinking abilities and use their mathematical knowledge successfully when they engage with mathematical problems, assess potential solutions, and justify their reasoning [1]. The government was forced to enact a mobility control order (MCO) as a result of the COVID-19 epidemic, which broke out in 2020. This forced Malaysians to stay at home and caused a quick switch from traditional in-person education to online learning. Numerous facets of people's lives have been impacted by this worldwide catastrophe, including employment, education, communication, economics, and health [2].

Access to high-quality mathematics education is frequently constrained in many rural locations due to problems like distance from other rural areas, subpar infrastructure, and a shortage of competent teachers. Through online learning, there is a chance to close this gap and provide remote students with equal access to high-quality mathematical instruction. As a result, online distance learning (ODL) has become a very successful educational strategy. With ODL, students can access a variety of learning platforms, including Google Meet, Zoom, WebEx, Telegram, and Google Classroom, from any location as long as they have internet access. The restricted internet connectivity in rural or remote places, however, may provide difficulties for students who wish to use these online learning resources. Consequently, students from rural areas often experience lower academic performance as a result of restricted access to and use of technology for learning [3]. This study aims to thoroughly investigate the specific issues encountered by secondary school students in rural areas when participating in online mathematics classes. Through a comprehensive analysis of access, engagement, and academic performance, this research endeavours to contribute to the development of equitable and inclusive educational practices that empower students in underserved regions.

## 2. LITERATURE REVIEW

Mathematics is one of the subjects learned in secondary school. According to Ariyanti and Fransiskus in [4], it is of the basic educational components that students need to be skilled and understand for the various methods that have been used. After Covid-19 has infected more than 4.7 million people around the world, the Minister of Education stated new rules where the learning activities that are usually carried out at school have to take place through online. Regarding learning from home, online distance learning (ODL) is carried out to provide meaningful learning experiences for students. Online learning is education that occurs over the Internet rather than in a traditional classroom setting. Online learning provides students with greater access to education than traditional methods because they can study from anywhere and

at any time. When students learn online, they will be evaluated using a learning management system based on their formative assessment and the various learning activities [4].

According to Radhika in [5], there are three layers of context that influence a child's development and the school context which is the school environment is the major factor that affects the child's development. According to Bronfenbrenner's theory, there are several variables existing at various ecological structural levels that interact with one another and have an impact on human development. Based on Bronfenbrenner's Ecological System Theory, it goes into greater detail about how a child develops themselves and how interactions with their environment have an impact on their development and growth at each of the five levels—microsystem, mesosystem, exosystem, macrosystem, and chronosystem—from the most intimate to the broadest. The Macrosystem and Chronosystem systems are the primary focus of this investigation. This Bronfenbrennerian theory truly makes it clear that ecological elements might affect how pupils in rural schools interact with one another and relate to their surroundings. Compared to metropolitan schools, rural schools face significantly more obstacles to overcome.

Perceptions and attitudes of students are important for motivation and learning, according to [6]. There has been an increase in studies examining how students view and anticipate online learning [7]. The goal of this study is to examine how rural secondary school students feel about learning maths online. Despite being a topic that is required in the majority of countries, including Malaysia, the majority of students despise mathematics more than other courses. However, in order to succeed, students must have a positive outlook towards mathematics, particularly in the midst of the pandemic when they are forced to take classes virtually rather than in person.

Numerous academics contend that face-to-face interactions result in higher student satisfaction as compared to online learning [6]. Traditional classrooms won't compare to the convenience of online learning. However, because to problems they encounter, students will not always fulfil their learning objectives. This affects their attitudes towards enjoying or disliking mathematics. Although some students are content with their online education, there are several variables that can affect students' perspectives [7]. Rural students' opinions on online mathematics education are varied.

Numerous studies have looked into the factors affecting students' mathematical achievement. The background of the learner, self-related mathematical cognition, learning preferences, and educational environment are the main determinants of accomplishment. Mathematical achievement is significantly impacted by one's attitudes towards mathematics, self-confidence in one's ability to solve problems, and success attributable to effort [8].

The ability and flexibility of students to direct their own mathematics learning is referred to as "learner autonomy" [9]. This responsibility calls for students to take the lead, participate in discussions, plan and carry out self-beneficial mathematics learning activities, jointly determine with their teachers what they want to learn, how they prefer to learn it, at what pace, and why, and simultaneously reflect on these decisions. Since the pandemic's start, students should feel accountable for their learning, particularly when it happens online. They must take the initiative to complete the assignments set by their teachers, view the instructional videos created by their teachers, and sign up for the online course.

### 3. METHODOLOGY

Secondary school students in the remote SMK Tronoh in the Malaysian state of Perak were the study's target group. It takes the researcher a long time because the population has a large size. Therefore, just a sample will be picked as the chosen population's representative. Students from Forms 1, 2, and 4 of secondary schools made up the sample of respondents. These students become the population's representatives, therefore the findings will apply to that specific group as a whole. The sample was chosen at random from the entire population of Forms 1, 2, and 4. Only 92 samples out of the total 103 students could be reached to complete the surveys. Participation in this study was voluntary and no incentive or payments were given. By using a random sampling procedure, each member of the population in the group had an equal chance of being selected. Those students become a representative of the population and the result will be generalized to that particular population [10].

The researcher employed the questionnaire approach to get the necessary data in order to measure all of the research's objectives. Because the questionnaire is one of the methods frequently employed by researchers in descriptive studies, this type of instrument was used for this study. Additionally, one of the benefits of using questionnaires is that it is the least expensive option to get quantitative data. Data collection through questionnaires is rapid and simple.

The questionnaire was the research tool employed in this study. The questionnaire instrument was chosen in order to gather the respondents' ideas and views in order to accomplish the research goals of this study. The survey's respondents have the freedom to react without outside interference. The questionnaire was also quickly distributed to a significant number of people. Additionally, the outcome was simple to tabulate and analyse [10]. The study's appendices contain the questionnaires that were used in the research. To achieve the goals of this study, the questionnaire items were modified from those used in earlier investigations. There are just closed-ended questions on the survey. A scale was provided for the closed-ended questions to help the respondents grade the question. using the survey. The questionnaire consist of three parts, the demographic background of the participants (Part A-6 items), the issues faced by the secondary school students in rural areas when learning mathematics online (Part B-11 items), and students' perception towards online learning in mathematics which have positive and negative perception (Part C-15 items). Furthermore, the questionnaire has been made in the form of Likert scale for Section B and Section C. Each section is given with a 5-point scale. A Likert-type in the order of agreement from 'strongly disagree', 'disagree', 'neutral', 'agree' to 'strongly agree'.

The reliability analysis for research questions number one and two and the Cronbach alpha value were computed using the Statistical Package for Social Science (SPSS). Using Cronbach's alpha, the items' internal reliability will be determined; the alpha value must be at least more than 0.6. The Cronbach's alpha should ideally be greater than 0.7 [11].

### 4. RESULTS AND DISCUSSIONS

As discussed previously, this study is to find the issues faced by the secondary school students in rural areas regarding online mathematics classes, their abilities to cope with mathematics online learning based on their performance and the perceptions of secondary students in rural areas when learning mathematics via online.

#### 4.1 Issues Faced by the Secondary School Students in Rural Areas Regarding Online Mathematics Classes

The findings for the first research questions showed that the overall issues faced by the secondary school students in rural areas regarding online mathematics classes were of a moderate level. Comparison to the findings of earlier studies, Gocotano, et al. [12], reveals that the majority of students own at least one device, have an average internet connection, and have a moderate level of digital literacy. So, from this finding, the similarity that can be shown is that the majority of the respondents expressed that they have their own computer or small gadget; respondents have moderate skills or not fully equipped with enough skills to operate the online learning platforms; and also, based on Table 1, most of the respondents have an average on internet facility with a fairly fast and reliable connection.

**Table 1.** Descriptive statistics on issues faced by the secondary school students in rural areas regarding online mathematics classes

Items	Mean	Standard deviation
I have a personal computer or small gadget for online classes	3.29	1.53
I have good enough skills to operate the online learning platforms	3.14	1.02
I have an internet facility with a good and reliable connection	3.55	1.06
I am willing to spend 15 to 20 hours per week for online classes	2.49	1.14
I can ignore distractions around me when I learned through online classes	2.73	1.12
I can understand mathematics subject through online classes in audio/video form	3.02	1.31
I can interact with the teacher via online to clarify my doubts	2.99	1.01
I can effectively use the educational platforms (Google Classroom, Yahoo, etc.) to refer the additional materials of the subject contents	3.25	1.02
I get continuous motivation from my teachers, parents and friends for online study	3.14	1.07
I can learn individually without the support of my families, teachers and friends	2.75	1.26
I am learning well in online classes rather than traditional classroom teaching	2.61	1.15

(Note:  $Min = 1$ ,  $Max = 5$ )

From the finding, it follows that most of the respondents were not sure whether they can understand mathematics subject through online classes in audio or video form. This could be their environment was too noisy or they have limited access of internet. In addition, data from the past studies, said that the respondents learned more in video tutorials and their research also found that students can understand and remember much better when they are faced with the visual explanation video. Most of the respondents cannot learn individually without the support of their fellow mates. The findings agreed with previous studies [13], in which parental and teacher support was found to be important for the development of positive attitudes toward learning and can ensure that students acquire the attitudes and dispositions that can maximise their ability to take advantage of online learning opportunities. Hence, majority of the respondents get continuous motivation from their teachers, parents and friends for online study. Furthermore, comparison to the findings of earlier studies, Jeyaraj [14] reveals that students prefer and enjoy classroom based learning more as compared to online learning and this can support the finding where most of the respondents prefer learning traditional classroom rather than online classes based on Table 1.

## 4.2 Students Perceptions About Learning Mathematics Via Online

The findings for the second research questions showed that the students' perception about learning mathematics via online were of a moderate level. Comparison to earlier studies, Takeuchi et al. [15] stated that 70.5% of the children reported positive feelings and they liked mathematics. To like mathematics and happy while doing mathematics, students In order to like and be happy doing math subjects, students should be trained from an early age, as the saying goes 'bend the bamboo let it be from the bamboo'. When trained from a young age, they will think more critically in solving mathematical problems. The students dealing with Mathematical problem, identifying possible solutions and evaluating and justifying their reasons for the results, students can develop the ability to enhance and expand their critical thinking and utilize their discipline of mathematical skills [1]. Due to the fact, students will get good grades in mathematics. However, according to the findings that shown in Table 2, most students are unable to achieve good grades in mathematics when learning online. This is because there are several barriers to online learning, such as limited Internet access, technology, and interruptions, particularly for students living in rural areas [16]. As a result, the majority of respondents are unable to learn mathematics through online classes.

**Table 2.** Descriptive statistics on students perception of learning mathematics via online

Items	Mean	Standard deviation
I like mathematics very much	3.40	1.09
I always feel happy and excited when doing mathematics	3.28	1.02
I am sure that I can learn mathematics through online classes	2.71	1.18
I can get good grades in mathematics when learning through online	2.38	1.08
I feel confident while using online learning system	2.62	0.96
I feel confident while operating online learning functions	2.72	1.02
I feel confident while using online learning content	2.95	1.01
I believe online learning platforms are user friendly	3.21	1.05
It would be easy for me to find necessary information when using an online platforms	3.78	1.03
I believe that using online learning service can simplify the learning process	3.08	1.14
The setup of the online learning service is compatible with the way I learn	2.68	1.04
I lack interaction with teachers in online classes	3.16	1.10
I find it difficult to adhere to the online class study schedule	3.04	1.25
I think online classes are not comfortable compared to offline classes	3.27	1.25
I do not understand the content presented in the online classes	2.88	1.19

(Note: Min = 1, Max = 5)

## 4.3 The Ability of Students to Cope with Online Learning is Determined by Their Grade That Based on Their Perceptions

The findings for the third research question showed that there is a weak negative correlation between students' perceptions of learning mathematics via online and their grade in mathematics. Thus, the null hypothesis is rejected. This study accepts an alternative hypothesis where there is a significant difference in students' grades and students' perceptions about learning mathematics via online especially in item 4: "I can get good grades in mathematics when learning through the Internet," where the majority of the respondents said that they cannot get good grades in mathematics when learning online. The findings agreed with those of previous studies, which stated that the shift from face-to-face classes to online classes had a

negative impact on the mathematics self-concept of learners [16]. From their studies, they found that more than 80% of the respondents perceived that they would have a lower grade in mathematics. To summarize, students' perceptions of online mathematics learning and their grades will be intertwined in determining students' ability to cope with online mathematics learning. So, from the findings, it is clear that most of the respondents cannot cope with mathematics online learning, as most of them got poor grades in mathematics.

## 5. CONCLUSION

To sum up, the research revealed that the challenges experienced by secondary school students in rural regions with respect to online math classes, as well as students' viewpoints on learning math through online platforms, exhibited a moderate level. It can be said that half of the students have a negative experience with online learning, while the other half can adapt and adopt what is going on around them based on the suitability of online learning. With sudden outbreak due to COVID-19, students faced difficulties as a result of the abrupt transition from face-to-face to online learning platforms. Furthermore, students' perceptions are very important because they relate to his/her ability to cope with mathematics online learning and can also be related to their mathematics achievement, which is their exam grade in mathematics.

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## I-CReST 2023:152-259 - Playing to Learn: Gamification's Role in Strengthening Mathematical Understanding among Secondary School Students

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### ABSTRACT

In the 21st century, the role of technology in reshaping pedagogical approaches for teaching and learning is undeniable. Among the technological advancements that have garnered significant attention in the realm of education, gamification stands out. Gamification has emerged as a promising tool for augmenting students' engagement and motivation in the learning process. However, the extent of educators' familiarity with gamification and their perspectives on its integration into instructional practises remain areas of uncertainty. Moreover, the potential of gamification to enhance students' grasp of mathematics warrants investigation. Addressing these inquiries, this study employs a quantitative approach to explore the awareness and perceptions of gamification among 25 mathematics teachers in Kuala Selangor, Malaysia. By employing closed-ended and Likert-scale surveys, the research delves into the teachers' attitudes towards incorporating gamification into their pedagogical strategies. The findings reveal a consensus among the respondents, indicating a positive correlation between the integration of gamification and the rapid development of cognitive skills in students. Notably, the outcomes also underscore the potency of leveraging multimedia elements, such as videos, within gamified educational applications to captivate students' interest in mathematics. Consequently, the study suggests that the incorporation of gamification into contemporary teaching methodologies holds the potential to enrich the learning experience within educational institutions. By leveraging gamification, educators can tap into enhanced engagement and cognitive agility, thereby augmenting the overall effectiveness of the learning process.

**Keywords:** Game-based activities; mathematical understanding; effectiveness of learning; secondary school students

### 1. INTRODUCTION

Mathematics serves as the foundational cornerstone for comprehending disciplines such as science, philosophy, and engineering, underpinning their core principles. Evolving over time, mathematics has transcended basic arithmetic operations like addition and subtraction, encompassing algebraic expressions and intricate trigonometric equations. Among the factors contributing to this challenge is the potential inadequacy of teaching methodologies, which

may fail to unveil the interconnectedness within mathematical concepts. In pursuit of an education paradigm aligned with the demands of the 21st century, pedagogical innovations become imperative [1]. Among the diverse avenues for innovative instruction, interactive game-based platforms like Kahoot and Quizizz stand out. Kahoot, a dynamic educational tool, harnesses active student engagement, necessitating critical thinking, ownership of learning, and analytical reasoning in the pursuit of academic content [2]. This study underscores the pivotal role of Kahoot in augmenting the mathematical comprehension of secondary school students.

The backdrop of the global COVID-19 pandemic has catalysed a transformative shift in pedagogy, transitioning from traditional face-to-face teaching to online distance learning (ODL). In this context, students engage in virtual classrooms facilitated by video conferencing. However, challenges abound as some students encounter difficulties acclimating to this modality. Consequently, innovative tools like Kahoot offer a promising avenue to inject enthusiasm and interactive participation into the online learning environment, reinvigorating student engagement and fostering a more vibrant educational experience. Frequently, instruction takes on a unidirectional format, characterised by educators dispensing information without assessing students' engagement levels or interests. To complement online distance learning (ODL), Learning management systems like u-Future have gained prominence, providing avenues for dispensing online content, facilitating interactive discussions, and conducting task assessments [3]. Building on this notion, it is argued that traditional, monotonous, and one-sided teaching techniques contribute to students' struggles with grasping concepts [4]. To summarise, the contemporary educational milieu, influenced by the shift towards online learning and its attendant challenges, underscores the imperative for dynamic teaching methodologies that proactively involve students, nurture inquisitiveness, and reinvigorate the learning encounter.

## **2. LITERATURE REVIEW**

Extensive research has delved into the advantages of game-based activities, with particular emphasis on platforms like Kahoot, which has demonstrated its potential to yield educational benefits for individuals globally. This section will be focused on the explanation, which will be supported by various publications, journals, and previous research.

### **2.1 Tom Malone's Motivating Theory**

In 1980, Tom Malone proposed the concept of motivating instruction [5]. He delineated three distinct categories that contribute to fostering an engaging learning experience. This conceptual framework finds profound applicability within the realm of education. The second category manifests as a transformation of fantasy into a game show scenario, where the teacher takes on the role of a host while students become competitors. Initially, students are tasked with responding to instructor-generated questions, vying against opposing teams. The final category channels curiosity into inspiring learners to unravel cognitive challenges utilising visual or auditory stimuli. The competitive element inherent in gameplay compensates for potential monotony, spurring students to strive for accurate responses.

### **2.2 Gamification in Education**

The advent of the technological era has catalysed expansion across various sectors, notably transforming the landscape of pedagogy to align with the burgeoning technological growth.

Within this evolving landscape, gamification has emerged as a dynamic trend spanning diverse domains, including business, organisational management, in-service training, social policy, and education [6]. Among nations at the forefront of gamification integration in education, prominent examples include the United States of America, England, Spain, the Netherlands, and Germany, in stark contrast to developing nations where its utilisation remains minimal. This divergence can be attributed to the profound influence of new technology, particularly within the realm of education [7]. As a means to heighten learner involvement and augment educational outcomes, educators have pioneered the development of gamified learning environments [8]. The present gamification wave seamlessly integrates with mobile devices, crafting streamlined learning modules; however, it is imperative for developers to be attentive to users' security and safety [7]. Simultaneously, the realm of popular and well-established free mobile games has evolved into vibrant arenas for social interaction, granting players the freedom to engage at their convenience from any location [9].

### **2.3 Awareness of Game-Based Activity in Education.**

The challenges encountered by students during Online Distance Learning (ODL) encompass their individual learning styles, adaptability to new concepts, and readiness for e-learning. The novelty of e-learning within the Malaysian educational framework aligns with the researcher's concurrence, a sentiment shared by students [1]. The 2014 Global Gaming Stat from the United Kingdom revealed that 74% of K–8 (elementary–middle school) educators employ digital games to enhance learning, 33% utilise them to assess student knowledge, and 29% rely on traditional formative assessments to gauge skills and understanding [10]. This assertion from the journal underscores the implementation of game-based learning in the United Kingdom since 2014, aimed at enhancing students' competencies and knowledge. This trend predates the COVID-19 pandemic, reflecting the researcher's perspective as a student that the occasional integration of game-based learning within the classroom can significantly sustain interest in the learning process. Consequently, the imperative for educators to embrace game-based activities within their teaching methodologies becomes evident. This strategy has the potential to inject enthusiasm and engagement into the learning experience, thereby warranting increased awareness and consideration by teachers in the current teaching and learning paradigm.

### **2.4 Opinion of The Teachers on Using Game Activity**

The researcher contends that the extensive employment of game-based activities in the United Kingdom serves as a substantial resource for enhancing students' learning across various academic disciplines [1]. Among valuable technological tools, teacher-led online video conferencing platforms like Google Meet and Zoom present students with a highly effective means to engage during ODL [3]. Notably, 56% of parents in the United Kingdom hold the belief that incorporating games into the learning process yields favourable outcomes for their children. This statistic underscores a significant preference among nearly half of UK parents for integrating game-based activities into instructional methods. Evidently, students constitute a pivotal force within the framework of successful learning. Their active participation serves as a linchpin for achieving educational objectives. Given this context, the perspective and endorsement of gamification by educators carry paramount importance, bearing directly on the effective attainment of course requirements [11].

## 2.5 Effectiveness of Game-Based Activity for Enhance Students Understanding

As generations continue to evolve, educational practises naturally undergo transformation [10]. Within this evolving landscape, gamification emerges as a potent catalyst capable of invigorating student engagement and fostering a heightened zeal for learning [12]. The infusion of game-based learning holds the potential to infuse the teaching and learning journey with a new level of dynamism, thereby enhancing the overall quality of education. As a case in point, Mahat et al. [13], developed freeware software, Interactive Game Involving Integration Techniques: The Substitution Rule, named as Integration Puzzle, that helps to more interactive environment in teaching and learning method. This game-based application has created a positive attitude to the students towards mathematics especially for students who get lower performance in mathematics.

However, a pressing concern arises: the extent to which educators are acquainted with and attuned to the potential of game-based learning platforms and their integration within teaching and learning activities [10]. This issue resonates deeply with the researcher, as it underscores the transformative impact that game-based activities can wield on students' motivation and learning spirit, ultimately contributing to a more profound comprehension of subject matter.

## 3. METHODOLOGY

This study investigates the potential of game-based activities to enhance the grasp of mathematics among secondary school students from the teachers' standpoint. One approach for educators to determine the most effective pedagogy for teaching and learning is to identify the optimal tools for knowledge dissemination. The study's overall goal is to identify teachers' awareness of the use of game-based activity in their teaching and learning process, teachers' opinions on using game-based activity in enhancing students' mathematical understanding, and the effectiveness of using game-based activity (Kahoot) in mathematical understanding.

Employing a quantitative methodology simplifies the execution of a study with a substantial number of participants, enabling the quantification and analysis of relationships among variables to yield meaningful insights [14]. This method involves the collection of numerical data and employs mathematical techniques to deduce conclusions about a given issue [15]. The sample size, comprising 25 high school mathematics teachers across Kuala Selangor, encompasses educators from diverse school environments, thus providing a well-rounded array of perspectives. To fulfil the study's objectives, a questionnaire was designed, comprising three sections: Part A, encompassing demographic inquiries; Part B, consisting of closed-ended surveys; and Part C, featuring Likert scale questions. This comprehensive approach aims to garner diverse viewpoints from respondents. The construction of these questionnaire items adhered to five pertinent criteria, ensuring their relevance, clarity, simplicity of response even under stress, avoidance of further distress to respondents, and impartiality [16]. By meticulously crafting these items, the survey's modest sample size remains conducive to ease the completion for responders. The reliability of the Likert scale survey was assessed through a Cronbach's Alpha test, yielding a score of 0.956 for the total of 12 items. This robust Cronbach's Alpha coefficient, depicted in Table 1, underscores the survey's high level of reliability.

**Table 1.** Cronbach's Alpha

Cronbach's Alpha	N of items
0.956	12

#### 4. RESULTS AND DISCUSSIONS

In this section, the primary focus will be directed towards conducting data analysis on a survey dataset comprising 25 samples obtained by the researcher. The objective of this section is to elucidate the findings, aiming to discern the level of awareness among respondents regarding the utilisation of game-based activities within their teaching and learning processes. Furthermore, it seeks to explore the respondents' perceptions of game-based activities and ascertain their effectiveness in enhancing students' comprehension of mathematics as viewed through the lens of educators.

##### 4.1 Research Objective 1: To Identify the Teachers' Awareness on the Use of Game-based Activities (Kahoot and Quizizz) in Their Teaching and Learning Process

Drawing insights from Table 2, it becomes evident that all 25 respondents possess awareness of gamification's role in education. Among this group, merely two respondents indicated unfamiliarity with Kahoot while responding to the survey.

**Table 2.** Teachers' awareness on the use of game-based activities in their teaching and learning process

Item	Yes	No
Have you ever used any gamification for your teaching?	21	4
Have you ever heard about Kahoot?	23	2
Have you ever heard about gamification in education?	25	0
Have you ever discovered any other gamification applications aside from Kahoot?	19	6
Do you think gamification helps students understand the lesson more?	23	2
Do the students prefers learning using gamifications more often than regular learning methods?	19	6
Do you think the gamification applications help the students' learning?	24	1
Do you think gamification applications improve the students' understanding of the lessons?	23	2

A prevailing consensus emerged, with a significant majority of respondents expressing agreement that gamification tools like Kahoot hold the potential to enhance students' comprehension of mathematics within the teaching and learning context. Notably, a substantial 76.0% (19 respondents) demonstrated familiarity with other gamification applications beyond Kahoot. This observation underscores the respondents' exposure to a diverse array of gamification tools, indicative of a wider spectrum of options that can contribute to students' enriched understanding of mathematics.

##### 4.2 Research Objective 2: To Identify the Teachers' Opinion on Using Game-based Activities (Kahoot and Quizizz) in Enhancing Students' Understanding in Mathematics

Table 3 presents the statistical analysis of respondents' viewpoints concerning the implementation of gamification activities to enhance students' mathematical comprehension.

The data is characterised by mean scores (M) and standard deviations (SD), shedding light on the prevailing sentiments. A balanced perspective emerges, with nearly half of the respondents affirming that the utilisation of gamification applications holds potential to heighten students' interest in learning mathematics (M = 3.84, SD = 0.80). In contrast, a different sentiment prevails, with respondents indicating that gamification methods can foster increased competition among students within the classroom setting (M = 4.00, SD = 0.91).

Furthermore, respondents conveyed a positive viewpoint regarding the synergy between gamification and blended learning, attesting that this combination can effectively bolster students' grasp of mathematics, as evidenced by a mean score of 4.24 and a standard deviation of 0.60. Additionally, respondents acknowledged the utility of gamification applications in aiding teachers to assess students' knowledge levels and pinpoint areas of mathematical weakness (M = 3.64, SD = 0.64). This underscores the potential of gamification as a diagnostic tool. The respondents also indicated that gamification applications hold promise in facilitating students' comprehension of challenging material (M = 3.28, SD = 0.98) and enhancing their ability to retain lessons more effectively (M = 3.72, SD = 0.94). These observations highlight gamification's multifaceted contributions to the learning process.

**Table 3.** Teachers' opinion on using game-based activities in enhancing students' understanding in mathematics

Item	Mean	Standard Deviation
Kahoot increase the students' interest in learning mathematics.	3.84	0.8000
The gamification method allows the teacher to analyse the students' level of understanding and recognize the area of students' weaknesses.	3.64	0.6377
Use of a learning method blended with a gamification method helped students to understand the lesson better.	4.24	0.5972
Lessons can be recalled more easily through gamifications.	3.72	0.9363
Gamifications methods increase the competition among the students in class.	4.00	0.9129
Gamifications methods enable students to learn and understand difficult topics.	3.28	0.9798

#### 4.3 Research Objective 3: To Identify the Effectiveness of Using Gamification Activities in Improving Students' Mathematical Understanding Through Teachers' Perspectives

The respondents believed that educational procedures that have been completed with gamification activities enable permanent learning in comparison to learning memory in traditional methods, as shown in Table 4 with a mean score, M, and standard deviation, SD (M = 3.56, SD = 0.96). With M = 3.80 and SD = 0.87, the teachers can facilitate easy learning of the material by applying gamification approaches. The respondents also concurred that using pictures in gamification applications makes it easier for students to understand the lessons' content (M = 3.96 and SD = 0.93), and that using videos in gamification can draw students' interest and attention (M = 4.04 and SD = 0.61). With a mean score of 3.88 and a standard deviation of 0.88, respondents agreed that gamification activities can increase the effectiveness of the lessons. The respondents also agreed that applying gamification applications can improve students' thinking skills, with a mean score of 4.00M and a standard deviation of 0.96.

**Table 4.** Effectiveness of using gamification activities in improving students' mathematical understanding through teachers' perspective

Item	Mean	Standard Deviation
Lessons performed with gamification methods enable permanent learning compared to learning memory in traditional classroom environments method.	3.56	0.9609
Conducting activities using gamification methods allow for easy learning of the topic.	3.80	0.8660
Using pictures in gamification applications allows students to understand the content easily.	3.96	0.9345
Using videos in gamification applications attracts the student's attention to learn.	4.04	0.6110
Gamifications increases the effectiveness of the lessons.	3.88	0.8813
Gamifications applications improve students' fast-thinking abilities.	4.00	0.9574

## 5. CONCLUSION

In summary, the findings gleaned from the survey shed light on the prevailing landscape of gamification practices among mathematics instructors in Kuala Selangor. It becomes evident that a substantial proportion of educators possess familiarity with and incorporate various gamification activities within their pedagogical endeavours. The survey garnered responses from an impressive 86% of participating teachers, a notable majority of whom endorsed the notion that gamification initiatives hold the potential to render mathematical concepts more accessible to students. This alignment of views prompts a compelling inference: the infusion of gamification into the realm of mathematics education contributes to cultivating a heightened interest and enthusiasm among students.

In effect, the integration of gamification into the pedagogical framework serves as a dynamic catalyst that not only makes the learning process more captivating for students but also propels their educational journey towards a pathway of enhanced proficiency. The convergence of educators' awareness, students' engagement, and the inherent versatility of gamification establishes it as a promising avenue to elevate the effectiveness of mathematics education, paving the way for a more holistic and enriching learning experience.

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## **I-CReST 2023:153-126 - Visitors Preferences in Fulfilling Leisure Activities at Public Open Space Case Study of Malacca Botanical Garden**

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### **ABSTRACT**

Public open spaces are deemed important parts of the cities' history and glory that some of which date back to the era of colonialism. Of their prime importance, public open spaces in Malaysia create the arenas for multivariate ethnicities to accomplish their ritual activities. With an area size of with 228-acre (92-hectare), Malacca Botanical Garden is one of the largest recreational parks in Malacca. With its size advantage, this park is an exciting place to visit and do activities. However, despite being an attraction for visitors coming from Malacca or outside of Malacca, the question that arises is regarding satisfaction of the people who come here for leisure activities. This study's objectives were to identify visitors' preferences for leisure activities and to determine visitor's satisfaction toward Malacca Botanical Garden as a public open space. Based on previous literature, visitors' preferences to do leisure activities will be based on psychological impact, facilities management and impact on society. This study used an interview method that comprised of numerous questions about the specified topic that each respondent had to answer. A total of six respondents were chosen for this interview. All respondents explained that they chose Malacca Botanical Gardens because of the large area to do leisure activities. The natural area also attracted them with a comfortable atmosphere and fresh air. They were also interested in the activities being offered such as bicycle, scooter and buggy rental service for visitors. Additionally, respondents were interested in the extreme activities at Malacca Botanical Gardens even though the activities were for not free of charge. In conclusion, even though this study indicated that respondents were satisfied with Malacca Botanical Garden's offerings, but it was found there was room for improvement such as the need to advertise the activities in mass media. Also, improvement on the facilities should be done to attract more visitors to the place.

**Keywords:** User preferences; visitors perception; parks attraction

### **1. INTRODUCTION**

In the context of Malaysia, public open spaces are deemed important parts of the cities' history and glory that some of which date back to the era of colonialism. These spaces manifest the glorious appreciation of art and aesthetic pleasantness and satisfaction 'Padang' Kota lama in Georgetown in Penang, Dataran Merdeka in Malacca, Ipoh 'Padang', 'Padang' Merdeka in Kota Bharu, and 'Medan' Bandar in Alor Setar are some of the exemplary public open spaces in Malaysia that reminisce about the colonial dominance reflecting the very essence of communal gatherings and social interaction.

The use of a public open space as a place for meeting, resting, learning, observing, watching people, and most probably interacting with others is an essential component of the public culture. Activities that occur in public open spaces in cities are divided into three categories. These activities encompass necessary activities (e.g., shopping, waiting for a bus or a person, going to school or work, etc.), optional activities (walking to get fresh air, standing around, enjoying life, or sitting), and social activities (playing children, greetings and conversations, communal activities of various kinds, and finally, as the most widespread social activity, passive contacts, i.e., simply seeing and hearing other people).

This research study was conducted to provide useful information about the level of visitor satisfaction when it comes to the Malacca Botanical Garden which is one of the most popular destinations in Malacca. As this site is an important public open space, its characteristics should be studied because many people depend on this public open space to fulfill recreational needs. An important study was to find out why visitors choose the park to do recreational activities at the site. The importance of this study is also to find out the level of visitor satisfaction when at the site. Therefore, this research study's focus on the quality of the physical elements of public open space as a destination to do leisure activities so as to provide an idea of how managers should develop the area and not be to be left behind by other similar attractions nearby.

The selection of recreational activities is now a trend where people choose these activities to reduce stress, find peace and create fun in their free time in doing exercises. Then, this can bring great memories and experiences. However, to get an exciting adventure in recreational activities, one should do the activity by using well-conditioned facilities. At 228-acre (92-hectare) Malacca Botanical Garden is one of the largest recreational parks in Malacca. No doubt this shows that this park is an exciting place to visit for activities. Therefore, this study's objectives were to identify visitors' preferences for leisure activities and to determine visitor's satisfaction toward Malacca Botanical Garden as a public open space.

## **2. LITERATURE REVIEW**

There are several aspects of prior research that are included in this section. It begins by looking at open space, public open space, perception on public open space and definition of leisure that directly relate with this research study. Therefore, these elements mentioned in this review would set the way this research study be conducted by asking the right questions to fulfill the study's objectives. Ultimately, asking the right questions would not only fulfill the research study's objectives but also uncover new insights coming from the perspective of visitors at the site of study.

### **2.1 Open Space**

According to Thompson (2002), there are more than ever, a recognition of the value of wild spaces, informal, loose-fit, sometimes messy places, that turn out often to be as valuable as the tidy and the formal. Intelligent landscapes of the future may allow us to enjoy and make diverse use of our urban streets and squares in ways that are personally satisfying in a pluralist society, but we shall still need spaces where we can engage with natural processes, where we can intervene and change the landscape, and where we can watch things grow. The element of time is always important in landscape architecture; just as the designs for some urban squares may have a very short life-span, so we may need to adopt a much longer time-frame for engaging effectively with the entirety of the ecological networks which structure our towns and cities.

Consequently, this research study sees open space in cities as places to celebrate cultural diversity, to engage with natural processes and to conserve memories. Urban open space must provide a place for the meeting of strangers and a place where one can transcend the crowd and be anonymous or alone. And in all of this, the urban park will continue to serve a central function in society's self-definition.

## 2.2 Public Open Space

According to Ahirrao and Khan (2021), Public Open Space (POS) are one of the key components in urban areas that contribute to improving the quality of life of citizens. The results from their research study demonstrated that the characteristics of POSs, such as the built environment, aesthetics, facilities, services and maintenance have an impact on people's use and perception. These characteristics are responsible for inviting a wide range of users and providing them with a psychological and physical console. It indicates that although the available POSs are inadequate in quantity, proper initiatives will improve their character and use, and enable them to serve different facilities at their optimum level. When inclusive, functional, and aesthetically strong POSs emerge within cities and satisfy the needs of users, they convey accurate expressions to sustain a healthy public life. Therefore, this research study would put more focus on the so-called characteristics of POSs that are likely to influence people's perception and use of public open space especially at Malacca Botanical Garden.

## 2.3 Perception on Public Open Space

With low physical quality of public open space and fast-growing high quality privatized public space, communities would have perceived public open space well and kept using it in an intensive way. According to Nasution and Zahrah (2014), it showed that people hardly needed the public open space no matter how bad the quality was. After all, the study found that some factors of public open space have a strong correlation with the public open space perception. Thus, in a city of a developing country, the enhancement of public open space factors will make a better perception of public open space and next to quality of life. The urban planning policy has to place the public open space as one of the development priorities, by increasing the quantity and quality of public open space, both in urban and neighborhood scale. Even though for low-income communities there seems to be limited choice of quality public space to choose from, it did not mean that this aspect should be ignored. Rather, public open spaces should be improved further for the benefit of low-income population.

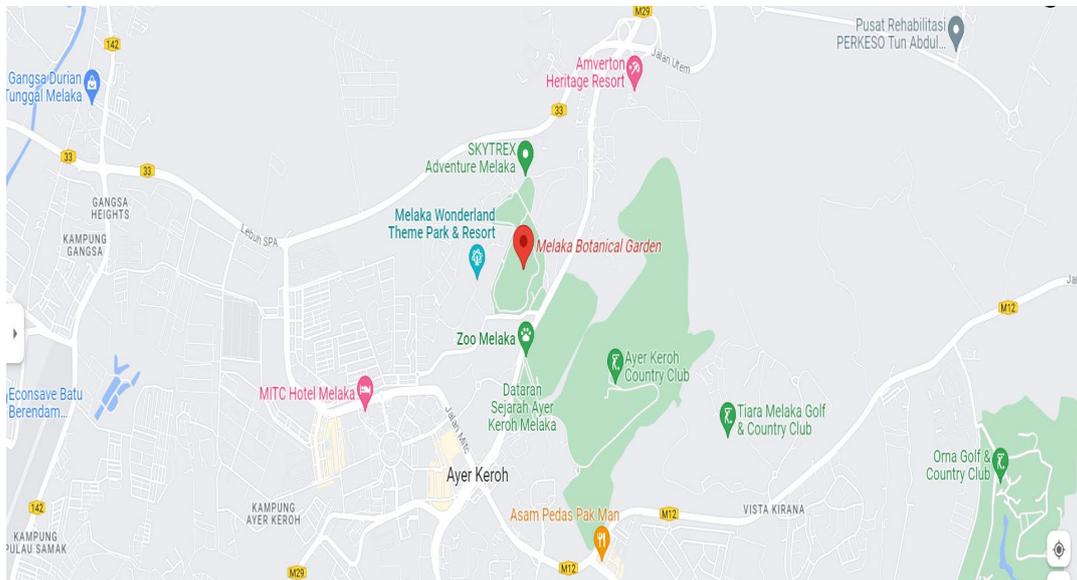
## 2.4 Leisure Time

Various terms and concepts have been used by previous researchers to define leisure time. In general, leisure time is referred to as an activity, attitude and also a state of mind. Leisure was defined as time as the time used by a person to carry out non-productive work such as resting, playing sports, sightseeing and so on. Etymologically, the term leisure comes from the Latin word 'licere' which means to be free. From the word 'licere', comes the term 'loisir' in French which means free to deviate from rules, practices and so on. All these words are related, suggesting freedom of choice and no coercion. In other words, during leisure time, the individual does not have any responsibilities to perform. While at work, individual time does not belong to him. They have to perform their responsibilities to the employer. After work hours, they still have responsibilities to perform, responsibilities to family, community and so on. When all these responsibilities are done, they have free time, this is when they can do

whatever they want, and this free time is called free time. Therefore, given how important it is for people to have leisure time and be able to do meaningful leisure activities, this research study would look into Malacca Botanical Garden as one of the most important leisure sites for visitors across the country. High quality public open spaces that cater to leisure activities for visitors are very important so that many people would be able to engage in quality activities.

### 3. METHODOLOGY

The Botanical Garden or previously known as the Hutan Rekreasi Ayer Keroh, Malacca was developed from an idea mooted by the then Chief Minister of Malacca, YAB Datuk Seri Hj Mohd Ali bin Mohd Rustam on 1st June, 2006. It is encircled by a woodland that contains over 300 types of special flora and fauna. The garden resembles Jurassic Park because due to the lots of life-like statues of dinosaurs which kids will enjoy. Visitors can walk across the long hanging bridge over the lake for a better view of the location.



**Fig. 1.** The location of study area

A botanical garden is a location where plants, especially ferns, conifers and flowering plants are grown and shown for the purposes of research, education, and preservation. This distinguishes them from parks and satisfaction gardens where plants, usually with showy flowers, are expanded for public feature just. Rich and tranquil it offers an ideal setting for leisure tasks varying from jungle trekking, hiking, running and camping to boating. A botanical yard is a place where plants, especially ferns, conifers and flowering plants, are grown and displayed for the functions of research, education and learning, and preservation.



**Fig. 2.** Malacca Botanical Garden

Current research advances the components of public open spaces that are successful in the sense that they meet people's needs mostly based on their age group and build good places for people to socialize with each other. This requires the selection of a comprehensive inclusive group of interviewees with various knowledge. The researcher targeted visitors to the Malacca Botanical Gardens based on research on visitors' perceptions of the park. To obtain the consent of the interviewees to attend the interview, the researcher randomly sent the questions along with a cover letter emphasizing the confidentiality of the results

While inter-subjectivity deals with topics like meanings, interpretations, ethnic background, etc. that centre on the connection between the research and the context, subjectivity includes the researcher's personal biases and viewpoints. Therefore, it is essential to critically analyse the findings in order to conduct research that adheres to ethical standards. This research is a qualitative approach that aims to determine what makes people want to go to Malacca Botanical Garden. Using a qualitative method, it could provide suggestions to improve the parks in Malacca Botanical Garden

Those interviewed were selected respondent 1, respondent 2, respondent 3, respondent 4, respondent 5 and respondent 6. The emphasis is to respond with their level of satisfaction when in Malacca Botanical Garden. This research focuses on visitors' perceptions of the park. Using purposive sampling, six respondents were selected based on their availability and willingness to participate in this study. The researcher conducted a structured interview in June-July 2022. The duration of the structured interview took 15 to 30 minutes according to their response in revealing various aspects of the discussion. The interview comprised of numerous questions about the specified topic that each respondent had to answer.

#### **4. RESULTS & DISCUSSION**

In order to identify the respond about visitor's preferences in choosing a public open space for leisure activities of Malacca Botanical Garden various literatures has been studied on. This

research developed the research framework that consists of seven questions by referring to the literature. Below are the discussion on this research study's findings according to the seven questions being asked to the selected respondents.

**Table 1.** Findings on visitors' preference in choosing Malacca Botanical Garden

The visitor's preferences in choosing a public open space for leisure activities of Malacca Botanical Garden	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6
Visited the Malacca Botanical Garden in 2022	March, 2022	Every month	Every weekend	June, 2022	February, 2022	Every weekend
Place of residence	Segamat	Bandar Jasin	Alor Gajah	Negeri Sembilan	Tangkak	Segamat
Vehicle do they ride	Own vehicle	Public Transport	Own vehicle	Own vehicle	Own vehicle	Own vehicle
Platform they know and hear	Social Media	Social Media	Social Media	Work colleagues	Social Media	Social Media

The first question is doing they visited the Malacca Botanical Garden in 2022. All respondents responded to this question. The respondent says they have been to Malacca Botanical Gardens in 2022. respondents 1, 4 and 5 have been to Malacca Botanical Garden only once in 2022. Meanwhile, respondents 3 and 6 go to Malacca Botanical Gardens weekly to do leisure activities. Respondent 2 goes to Malacca Botanical Garden every month on holidays. The second question is whether their residence is close to the Malacca Botanical Garden. This question is being responded to by all respondents 1, 2, 3, 4, 5 and 6. Only respondents 2 and 3 live near the Malacca Botanical Garden. Meanwhile, the other respondents live outside the state of Malacca. The third question is what kind of vehicle they ride at Malacca Botanical Garden. This question was responded to by all respondents 1, 2, 3, 4, 5 and 6. only respondent 2 used public vehicles to Malacca Botanical Gardens, while the others used their vehicles for their reasons. The fourth question concerns the platform they know and hear about Malacca Botanical Garden. All respondents are responding to this question. All respondents knew about Malacca Botanical Garden from social media, but only respondent 5 knew about it from his colleagues.

**Table 2.** Findings on visitors' preference in choosing Malacca Botanical Garden

Interesting attraction for visitor	Garden is huge and has several replicas	The place of residence is close to the	Area has a mini gym element where she can do sports activities	Various things	Many civilians have done activities there	The natural area
Factor influence the arrival of visitors	Suitable to attract the attention of families	Comfortable and quiet area with nature	Comfortable area	Comfortable atmosphere with natural factors	Relaxed setting with natural elements	Comfortable and quiet area with nature
Prioritize the safety of visitor	The area is quiet and has no security guards	The playground is also in an unsafe condition.	They lack of security in car parking.	Do not have emergency boxes in certain places	They not have a call box for the convenience safety.	Many elements of the garden are old and damaged

The fifth question is doing Malacca Botanical Garden have an exciting attraction for visitors. All respondents stated that various things could attract their attention in the Botanical Garden. For respondents 1, 2, 3, 4, and 5, the vast area influenced them to go to Malacca Botanical Garden. For respondent 6, the natural area attracts him to the garden. The sixth question is about factors that influence the arrival of visitors to Malacca Botanical Garden. All respondents stated that they were attracted to Malacca Botanical Garden because of the comfortable and quiet area with nature. The last question is whether the facilities of Malacca Botanical Garden prioritize the visitor's safety. All respondents stated that they were not satisfied with the security in the garden. Respondents 2 and 6 stated that most of the equipment at Malacca Botanical Garden was damaged and rusted. Respondents 4 and 5 said that the Malacca Botanical Garden does not have a safety box in the gardening area.

**Table 3.** Findings on visitors’ satisfaction toward Malacca Botanical Garden

The visitor’s satisfaction toward public open space that fulfil their leisure needs of Malacca Botanical Garden.	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6
The services available at Malacca Botanical Garden	Interesting activities than other parks in the state of Malacca	Extreme activities	Jogging track that is long and wide	Rent electric scooters and buggy	Provides a place to buy many souvenirs for visitors	Rent electric scooters and buggy
Level of cleanliness of the area	A lot of dry leaves that is not clean.	Garbage left and filled with dry leaves	Very good	Playground in the Malacca Botanic Garden area is also in a dirty and unsanitary condition.	That the playground and dinosaur replica were also in an unclean condition.	Medium level

The first question is doing they think with the services available at Malacca Botanical Garden. This question being responded by all respondents. Respondents 1, 2, 4, 5 and 6 said that they are interested in the Malacca Botanical Garden area. While respondent 3 said that he only felt normal when he was in Malacca Botanical Garden. The second question is level of cleanliness of the area around the Malacca Botanical Garden. This question being respond by all respondents. Respondents 1, 2, 5 and 6 said that the area of the botanical garden is in a medium level of cleanliness which is fine. Meanwhile, respondents 3 and 4 were satisfied with the level of cleanliness in the Malacca Botanical Garden.

**Table 4.** Findings on visitors' satisfaction toward Malacca Botanical Garden

The service provided by the officer on duty	Helped a lot	Friendly	Friendly	Helped a lot	Friendly	Friendly
The facilities at Malacca Botanical Garden	Good condition	Toilets are also lacking in the garden.	The directions are lacking and maps are not placed in each area	No signs indicating the way out	The resting place in the garden was also dirty to rest or relax	Mini gym equipment that was broken.
Opinion needs to improve to attract many visitors	Advertisement	Improve and repair the facilities and equipment	Advertisement	Advertisement	Improve and repair the facilities and equipment area with nature	Advertisement

The third question is the service provided by the officer on duty very helpful when respondent at the Garden Botanical Malacca. The respondents 1, 4 and 6 said that the worker there helped them when the Malacca Botanical Garden. Meanwhile, respondents 2, 3 and 6 strongly said that the workers at the Malacca Botanical Garden are friendly when they are in the Garden. The fourth question is they think with the facilities at the Malacca Botanical Garden. This question being respond by all respondents. All respondents said their level of satisfaction with the facilities in Malacca Botanical Garden in a medium level only. The fifth question is they opinion needs to improve to attract many visitors to the Malacca Botanical Garden to do activities in the leisure time. The respondent 1, 3, 4 and 6 said that the Malacca Botanical Garden should make an advertisement to spread the word about the garden. Respondents 2 and 5 also said that the Malacca Botanical Garden should improve and repair the facilities and equipment in the Malacca Botanical Garden.

## 5. CONCLUSION

It can be determined that the objective of this study was achieved based on the determination and analysis of the first objective. The aim is to visitor's preferences in choosing a public open space for leisure activities of Malacca Botanical Garden. All respondents have gone to Malacca Botanical Garden and made their own perception in 2022. They know about Malacca Botanical Garden mostly from social media. This is because visitors who have come will upload pictures of their leisure activities at Malacca Botanical Gardens. Next, all of the respondents stated that it is easier for them to ride in their own vehicles than in public vehicles. This is because they live far from the Malacca Botanical Garden and they come from outside the state of Malacca.

All respondents answered that they chose Malacca Botanical Gardens because of the large area to do leisure activities. The natural area also attracts them with a comfortable atmosphere and fresh air. This is because the Malacca Botanical Garden is surrounded by natural trees that are cared for by the Botanical Garden. However, they are not satisfied with the safety in Malacca Botanical Gardens. This is because the park is a quiet area that will cause danger to visitors. The study found that the facilities at the Malacca Botanical Garden were mostly damaged and caused injuries to visitors. The study recommends that a comprehensive study identifies the role of universal design principles in shaping visitors in the public open spaces of the Malacca Botanical Garden. For example, creating a special area for children only such as a spacious playground that is not risky for older children.

From this study, the respondents think that Malacca Botanical Garden should be improved so that visitors come to do leisure activities. Most of them said that the Malacca Botanical Garden could advertise the activities in the park. Also, the Malacca Botanical Garden should improve the park facilities to attract visitors to the Malacca Botanical Garden. Overall, from the statements and findings up to objective two, the researcher concluded that visitors are satisfied with the public open space that meets their leisure needs in Malacca Botanical Garden. However, there are things that need to be improved by the Malacca Botanical Garden to attract more visitors to the park. The researcher also suggested that more signage be placed in each area so that visitors can identify the road in the in Malacca Botanical Gardens.

In addition, future studies should identify how consideration of the needs of people with disabilities in public spaces differs from the needs of people with physical disabilities, the research recommends that studies comprehensively identify the needs of people with physical disabilities in public spaces. The study also suggests that the study examines the role of public open spaces in improving the image of the Malacca Botanical Garden in order to improve the area to attract the attention of visitors Overall, from the statements and findings, the researcher concluded that this study found that the preference of visitors who come to the Malacca Botanical Gardens is to choose public open spaces to do leisure activities.

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## I-CReST 2023:163-129 - Flipbook: Tools for Enhancing Students' Understanding

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### ABSTRACT

Teaching and instructional materials are vital components of teaching and learning. However, conventional instructional materials such as printed text books and notebooks cater to certain types of learners. Besides, they are not interactive and lead to boredom among students. In the digital age, instructional materials must be varied and inventive to deliver an efficient, enjoyable, and effective learning experience. A flipbook is one of the tools that can be employed. It is a digital reading experience that recreates the layout of a print publication like magazines, brochures, or conventional digital PDFs by displaying content left to right and page flipping animation, supported by digital media such as animation, images, video, and audio. This study aims to develop the flipbook to enhance students' understanding of the subject matter in a more interactive and effective way. The tool also enables students to relate the subject matter with images and illustrations and motivates them to study independently. Simultaneously, it creates excitement among students about the learning process and leads to the effectiveness of teaching and learning mechanisms.

**Keywords:** Flipbook; interactive; teaching and learning

### 1. INTRODUCTION

The pace of technological advancement is accelerating in this globalised and revolutionised world. This growth had an impact on a number of fields, including education. Additionally, numerous studies and reports from the preceding few years have revealed that many students have difficulty learning from the textbooks used in their subject-matter classrooms. The situation is made worse by the fact that many students admit they do not actually study their textbooks because the instructor usually covers the important parts in class. To increase the quality of institutional services and outputs that are prepared to tackle the challenges of the times, educators must take advantage of the numerous innovations that arise from the use of science and technology in education. The use of technological media, sometimes known as multimedia, as a support for educational activities is becoming more widespread and is set for continued expansion in the future. Multimedia, according to Mayer (2001), is the combination of visual and audio representations. These representations might incorporate aspects of text, graphic design, sound, animation, and video.

A supportive environment for learning and healthy connections between teachers and students can certainly promote effective learning (John et al., 2017). Additionally, Manson (2007) claims that a well-designed learning environment can improve learning quality and

motivate students to show their comprehension in the learning activities, giving students more control over their learning experience. As a result, the learning process will be successful if varied infrastructure and facilities are used, including a variety of learning media. Learning using multimedia is typically considerably more enjoyable for students than reading dense textbooks, which can actually boost their understanding of and enthusiasm for the subject being taught. According to Richard Mayer's Cognitive Theory of Multimedia Learning, the brain processes information received through aural and visual channels in various ways (Mayer, 2002). When students are able to learn simultaneously through both of these methods, they are able to retain more of the material in their memories and take in more sensory information.

In relation to that, raising educational standards is one strategy to create a generation of students that are more educated and skilled thanks to advancements in science and technology. Furthermore, a wide variety of teaching and learning aids have evolved along with technology, such as e-books and flipbooks. Flipbooks are just one of many elements of educational instruments that have been changed by the acceptance and use of technology, which has sparked a pattern shift in how things are done in the constantly evolving pattern of education. The flipbook concept was once exclusively used to display animation, but it has now been embraced by numerous industries for a variety of digital applications, including magazines, novels, comics, and others. It can also be used to provide educational topics and feature an appealing combination of words, images, and colours. Flipbooks also have the advantage of being presented electronically, making learning more engaging and interactive (G. O. Ilhan & S. Oruc, 2016).

In light of the flexibility of flipbooks, Riyanto et al. (2020) claim that the flipbook is a tool created to make textbook usage simpler. Educators can take advantage of this benefit by incorporating flipbook-based teaching resources into challenging classes to make them more engaging. In general, this multimedia tool can incorporate PDF files, photographs, videos, and animations to make the flipbook creator more appealing, according to Wibowo & Purnamasari (2019). Flipbook aids students in enhancing the pleasant connotations they associate with words and images. It is incredibly good at facilitating learning and knowledge acquisition (Jain, 2017). It successfully and engagingly gives students a thorough understanding of the subject. The use of interactive flipbooks as learning media is anticipated to revitalise the classroom learning process and boost student accomplishment. Another purpose of the use of learning media is the expectation that it would create a stimulating and conducive learning environment (Sugianto et al., 2017).

All teachers and educators understand that teaching and instructional materials are critical components of classroom education and learning. Traditional or conventional educational tools, such as printed textbooks and notes, appeal to specific sorts of students. Furthermore, they are not participatory and cause students to become bored. To provide an efficient, entertaining, and successful learning experience in the digital age, instructional materials must be varied and imaginative. As a result, a teaching tool to support the teaching and learning session is developed to enhance students' understanding of the subject matter and to make the learning experience more engaging and interactive.

This present work aims to introduce flipbooks as a tool to enhance students' understanding of the subject matter more interactively and effectively. It also aims to spark student interest in the learning process, which contributes to the effectiveness of teaching and learning mechanisms.

## 2. METHODOLOGY

This research was conducted at the Centre for Foundation Studies IIUM Gambang Campus. The approach used in this study is a quantitative approach and uses experimental research methods with a pre-experimental one-group (correspondent) research design. The method described the flipbook as a tool for enhancing students' understanding. The respondents were the Centre for Foundation Studies students who used the flipbook in learning Understanding Islam II. Understanding Islam II is one of the Centre-required courses taught at the foundational level at International Islamic University Malaysia.

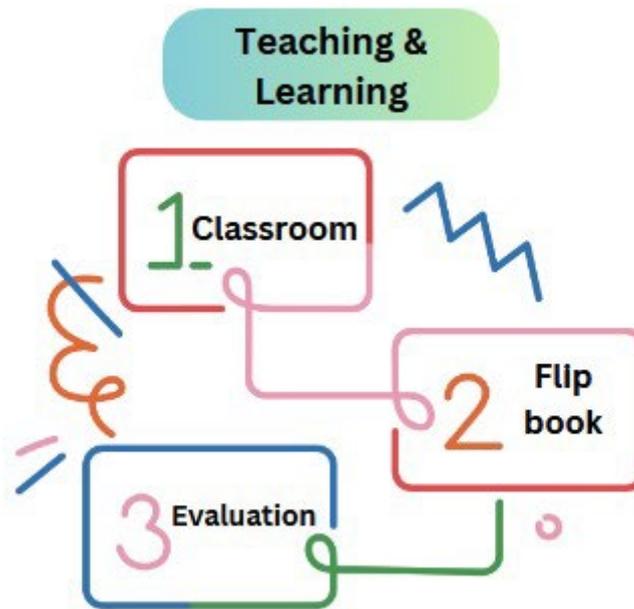


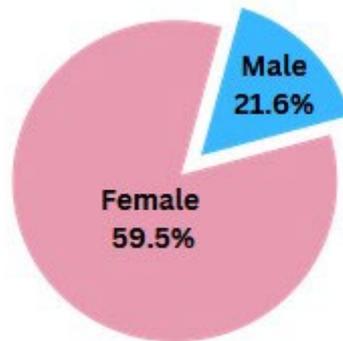
Fig. 1. Research methodology in collecting data

## 3. RESULTS AND DISCUSSION

Teachers and lecturers rarely use learning media tools to deliver the course material in the classroom, according to a review of the needs of digital flipbook learning media in the Centre for Foundation Studies' Understanding Islam II course. Instead, teachers often instruct in a traditional manner. The traditional mode of instruction in this area is for teachers of Understanding Islam II to lecture and to use a Microsoft PowerPoint slideshow as a learning resource. Frequently, teachers will simply use the lecture technique to teach Understanding Islam II in class. So, in order for students to enhance their understanding of the topics covered in Understanding Islam II, they need to use the interactive learning media resources.

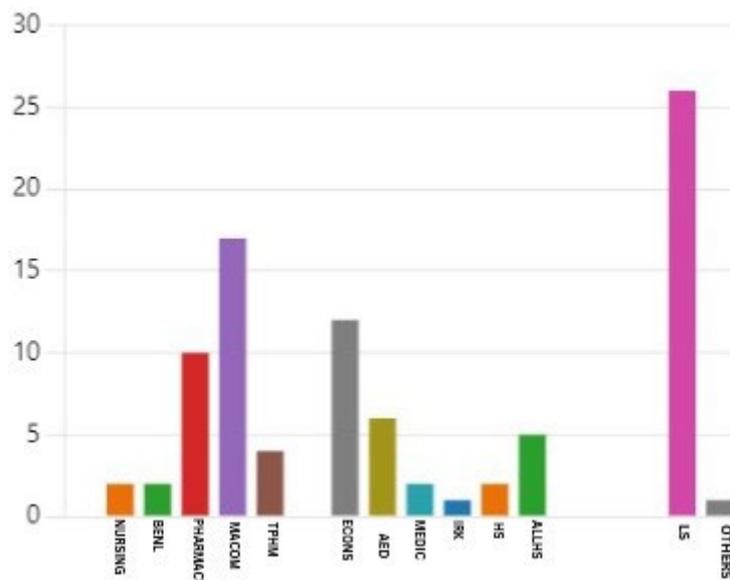
Following their experience with the interactive flipbook learning in the Understanding Islam II course, 90 students from various programmes participated in the survey. Fig. 2 shows the respondents' demographic profile in terms of gender and programme. Male respondents made up 21.6% of the sample, while female respondents made up 59.5%. According to various studies, one reason why there are more females than males in public universities is that they are given more financial incentives to pursue higher education. Francisco Paro claims that "studies empirically show that the undergraduate wage premium for women is higher than the

undergraduate wage premium for men and has been for at least 40 years," adding that the relatively higher financial returns for women may help to explain the gender disparity (Parro, 2012).



**Fig. 2.** Demographic profile based on gender

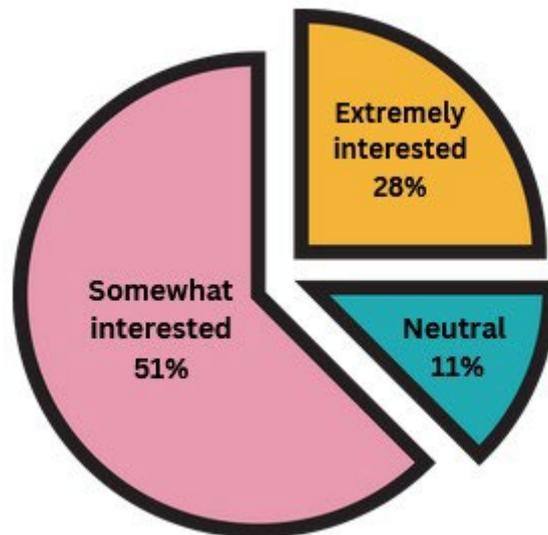
Students studying Engineering and Computer Sciences (26) ranked highest among those who responded to the survey, as shown in Fig. 3. The result also reveals that students studying Malay for International Communication (17) came in second, followed by those studying Economics and Management Sciences (12) and those studying English for International Communication (10). The remaining programmes are Architecture and Environmental Designs (6), Allied Health Sciences (5), Tourism Planning Hospitality and Management (4), Human Sciences (2), English Language and Literature (2), Medicine (2), Nursing (2), and Dentistry (1).



**Fig. 3.** Demographic profile based on programme

When asked how interested they were in studying Understanding Islam II, students' responses ranged from "extremely interested" in 28 cases to "somewhat interested" in 51 cases and "neutral" in 11 cases, as shown in Fig. 4. As one of the Centre-required courses, Understanding Islam II covers some of the important aspects of a Muslim's life. Among the major themes that have been discussed in this course are the universality of Islam as a religion

and the Maqasid al-Shari‘ah which provides a clear framework and guidance to the process of solving issues in education, leadership, society, and economics while conforming to the human interest and complying with the will of Allah. And more interestingly, it also briefly discusses belief systems and ideologies.

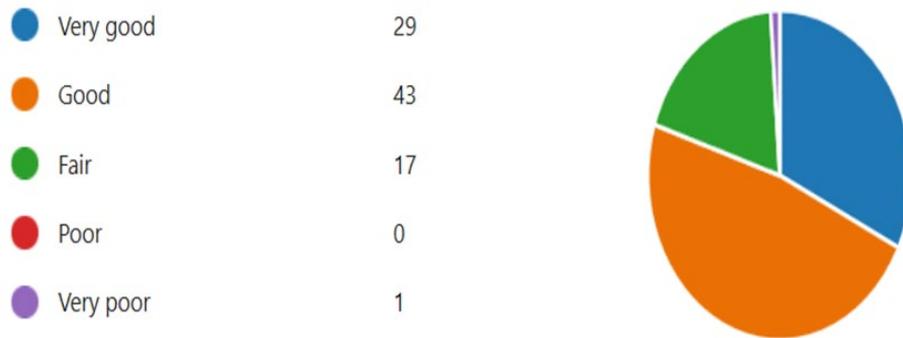


**Fig. 4.** Response of students on the subject of understanding Islam II

The survey shows that the most challenging topic in Understanding Islam II, according to 55 respondents—more than half of the sample—was "Islam, Belief Systems, and Ideologies". Islam and Economics were mentioned by 18 respondents; Islam and Leadership by 7 respondents; Islam and Society by 6 respondents; Islam and its Universality by 3 respondents; and Islam and Education by 1 respondent. Fig. 5 presents students’ ratings on the effectiveness of the Flipbook as a tool for enhancing their understanding of the given topic.

The effectiveness of flipbooks as a tool for enhancing students' understanding was rated as "very good" by 29 respondents, "good" by 43 respondents, "fair" by 17 respondents, and "very poor" by 1 respondent. Hence, the majority of students (72 respondents out of 90) are satisfied with the effectiveness of the tool since it is a one-stop avenue for all additional teaching and reading materials, such as slide presentations and relevant videos, made available to them. Besides, the flipbook also provides exercises to gauge their understanding of the topic.

This shows flipbooks can stimulate learning, improve motivation and interests among students, and even have an impact on their psychological health when used in teaching and learning.



**Fig. 5.** Students' rating on the effectiveness of Flipbook

It is impossible to refute that flipbooks' ability to engage students originates from their unique combination of simplicity and interaction. In an age dominated by digital screens and virtual encounters, the tactile aspect of flipbooks is a welcome change. Students may physically turn the pages, giving them a sense of action and control over the animation's speed.

Students become active participants in the learning process when they use flipbooks, translating theoretical information into concrete and experience learning. As students observe the cause-and-effect links within the animations and get a greater awareness of the underlying ideas that illustrate, this engagement can spark interest and a desire to learn more.

#### 4. CONCLUSION

The development of flipbook can assist instructors who are teaching the Centre-required course, Understanding Islam II, to enhance students' understanding of the material in the classroom. In order to deliver teaching and learning for Understanding Islam II in the classroom, creativity and innovation are required. With a positive response to this innovation, it can be said that flipbook learning media is a type of digital learning media that can be developed. Students can more easily study the course when given a flipbook as a supportive learning aid. No doubt, the lecturers' inventiveness in developing flipbooks increases the motivation to learn among the students.

In conclusion, the flipbook exemplifies the continuing usefulness of simple yet inventive technologies in capturing the spirit of motion and storytelling. Its attractiveness develops not just from its mechanical qualities, but also from its ability to bridge the gap between static pictures and fluid motion, resulting in a seamless and compelling visual experience. The process of turning the pages creates a sense of involvement and interactivity, bringing readers into the story with expectation and amazement.

#### ACKNOWLEDGEMENT

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## I-CReST 2023:198-273 - Examining the Malaysian Hospitality Workforce Crisis: Exploring Hospitality Students' Post-Pandemic Intention to Enter the Industry

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### ABSTRACT

In line with Twelfth Malaysia Plan which wants to develop future talent, skilled manpower in the hospitality and tourism industry is very much needed. To achieve this goal, the government has revamped and shaped Malaysian educational institutions. It started with a new vision followed by planning and execution to accomplish the goal. However, the findings of previous studies show a negative phenomenon where not many students who have graduated join this industry. It is compounded badly by the high turnover rate of workers in this industry. This problem has attracted the interest of researchers to understand from the students' point of view their perception and their interest in the hospitality industry. The researcher emphasizes student perception on pay benefits (PB), parental influence (PaI), career development (CR), and personal interest (PeI) and how that affects students working intention (WI). Execution of a convenient survey using an online platform is the most appropriate method in conducting this survey as Gen-Z and above is more attracted to interact with an online platform. Pearson correlation and regression analysis are used to analyse the gathered data as this. The findings of this study were very interesting as the data show that three out of four variables studied do affect students' desire to work in the industry. This study is expected to provide some data to the industry regarding the recruitment requirement and offer to student from higher education institutions which represented the skilled worker for hospitality industry.

**Keywords:** Pay benefit; parental influence; career development; personal interest; working intention

### 1. INTRODUCTION

The hospitality industries were among the most affected industries when the pandemic Covid-19 hit the world. The pandemic has made many hospitality industry workers lose their job including in Malaysia. After the pandemic has been lifted to endemic, the hospitality industry showed good recovery progress as many hotels and tourist attraction in Malaysia was full of guest and tourist. Department of Statistics Malaysia (DoSM) has released data that shows an increase in accommodation GDP from -11% last year to 24% this year 2022 [1]. The increase in revenue was a good indicator for the hospitality workers as it may secure their current employment and it's also will attract new prospects to work in this line.

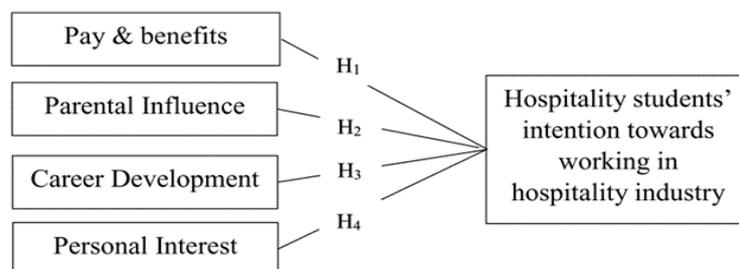
According to some news [2] & [3], the number of hospitality industry workers still does not match the revenue for tourism recovery. They added that the employee still did not want to work in this industry due to the uncertainty of the industry itself after the pandemic. The general

manager in the article [2] added that their employees still leave the hotel even though the hotel provided good incentives to their employees such as cash, accommodation, meals, and more to make them stay. To address this concern, the management of the hospitality industry has come up with several options. The short-term solution is by taking a foreign workforce to cover the shortage of their manpower and suggest the government encourage the student to build their career in hospitality for a long-term solution. Regardless of the effort to overcome the issue, a study from [4] cited a few past pieces of literature and found that unattractive earnings packages, tiring working hours, and uncertainties of career advancement have made them leave the industry. A constructive plan needs to be discussed among the industry player and government to overcome this matter. To support all the parties involved, this study proposes to add more valuable data to respected parties by investigating the student's perceptions and intentions to join the hospitality industry.

Even though the subject of intention to join the industry has become a general publication, exploration of this topic is still reliable, especially after the pandemic Covid-19 which hugely affected the world economy. Alongside that, the Z generation attributes also contribute to this study significantly as many forums and conferences of future workforce discuss their generation which they are the generation that currently entering the workforce. Therefore, it fills the gaps in the literature on student intention to join the workforce after the pandemic crisis. The following issues were addressed in this study to meet the afore mentioned study goal:

1. What do the pay and benefits impact on hospitality students' working intention in the hospitality industry after Covid-19?
2. How does the parental influence involve the student's intention to work in the hospitality industry after Covid-19?
3. Is there any relationship between career development toward hospitality students' intention to work in the hospitality industry after Covid-19?
4. What is the relationship between personal interest and hospitality students' intention to work in the hospitality industry after Covid-19?

The response to these questions may serve as support data for all the involved parties (industry and government) in developing the plan and action for this matter. In line with the questions asked, the study utilized an adapted conceptual framework from Ying and Selvanayagam [5] that investigate the above matter.



**Fig. 1.** Conceptual framework adapted from Ying and Selvanayagam [5]



## **2. LITERATURE REVIEW**

### **2.1 Pay & Benefits**

Achim, Badrolhisam and Zulkipli (2019) has described pay & benefit as a total reward system that characterizes the compensation structure. They added that salary is the payment obligation of employers to the employees as it will affect employees' short term and long-term financial position as the amount of money an employee receives in exchange for his or her services such as salary, commission, or any other form of payment. Benefits, on the other hand, are non-wages that an employer offers in addition to normal wages which may include health insurance, retirement plans, vacation time, or sick leave [6]. The hospitality industry may look bad in this section as this industry is known as a low-paying industry [7]. This may be due to the structure of wages which uses a point system based on the monthly hotel revenue. But, in Malaysia, some hotels already follow the new minimum wage that is enforced by the Malaysian government since 2013 [8]. The new minimum wage has open a new dimension in the hospitality industry which might attract people to join the industry.

### **2.2 Parental Influence**

A person's profession or employment choice or education may be influenced by family [9]. They added that parental value and parental pressure can affect students' career choice. A study in Italy which explored the impact of teenage-parent career comparison on teenagers' well-being and future intention to select a university course. The data showed that being in line with what parents wanted had a significant effect on academic motivation, work hope, and feeling like one's work matters. This, in turn, had a positive and significant effect on the participants' future plans to go to college and their well-being at work [9]. Parental influence not only Families can affect a person's career decision by offering industry information, employment leads, or financial support which they think will give a full benefit to their children. However, families can pressure them to choose a career track that doesn't match their interests or skills. Nowadays, student has been exposed to their career choice since school. Many universities have done a career exhibition that will give informative data to both parents and the student itself. Electronic and printed media also play an important role to help students and parents expose career selection.

### **2.3 Career Development**

The present research examines the concept of career development, which pertains to the systematic augmentation of an individual's skills, knowledge, expertise, and proficiency in order to achieve their desired professional objectives [10]. This process encompasses various activities, including formal education, specialised training, and personal development, with the goal of augmenting an individual's capacity to achieve their professional goals. According to the Career Development Association of Alberta [11], an alternative definition of career development is described as "the ongoing and lifelong process of effectively managing learning, work, leisure, and transitions with the aim of progressing towards an individually determined and continuously evolving desired future". Beside the definition a scholarly article [12] also put an input for career development proses. The process of career development involves four distinct steps. The first step entails the identification of career needs, followed by the development of career opportunities. Subsequently, the integration of employees' needs with the available career opportunities takes place. Finally, the last step involves the regular monitoring of the career development process.

## 2.4 Personal Interest

Holland's idea of "Career Typology" posits that individuals tend to select professional environments that align with their personality traits and personal interests [12]. According to Harackiewicz and Hulleman, personal interest can be defined as an individual's inclination towards a certain subject or activity, indicating their level of concern, significance, and predominantly positive emotional disposition towards it [13]. The researchers have indicated that they have discovered a significant relationship between situational and individual interest, which has the potential to strongly influence future decision-making and career trajectories. In the hospitality sector, the level of interest in a career choice is of utmost importance, since it has the potential to significantly impact work retention within the profession. Without a sufficient level of interest, it is possible that the student's tenure within the sector may be short-lived, or even worse, they may choose not to pursue a career in the industry following their graduation.

## 3. METHODOLOGY

In this study, a descriptive cross-sectional technique was utilised in order to investigate the connection between the many different tested factors. To develop the questionnaire, the study drew upon existing literature and created a structured survey, which was distributed to hospitality student in UiTM via non-probability convenience sampling. According to the website of the Faculty of Hotel and Tourism Management [15], there are approximately 6000 students enrolled in Malaysia's UiTM system . Based establish and famous sample size table from Krejcie & Morgan [16], it was calculated that a sample of 361 students would be sufficient for a comprehensive analysis in this study. Among 361 samples, only 72 percent of responses are collected and usable for analysis. The survey instrument contained three sections that measured independent variables, dependent variables, and demographic profiles, with independent variables further subdivided into three attributes: PB, PaI, CD and PeI. Meanwhile, the dependent variable will analyse student intention to work in industry. On a five-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree," respondents were ask to score for each survey items . The instrument's dependability was assessed using Cronbach Alpha. There were no severe concerns with the instrument for the 260 questionnaires received, and the resulting data was coded and analysed using the Social Statistical Package (SPSS). The coefficient alpha values of 0.892 for PB, 0.878 for PaI, 0.707 for CD, and 0.737 for PeI indicate the reliability of the instrument and items.

**Table 1.** Reliability analysis (n=260)

UTAUT Construct	Cronbach's Alpha	Number of Items
<i>Pay &amp; Benefit</i>	.892	5
<i>Parental Influence</i>	.878	4
<i>Career Development</i>	.720	5
<i>Personal Interest</i>	.882	5
<i>Working Intention</i>	.567	4



## 4. RESULT & DISCUSSION

### 4.1 Descriptive Analysis

This study presents the descriptive result displayed in Table 2, illustrating the mean and standard deviation values for all constructs examined. Pay & Benefit (PB) analysis reveals that PB2 had the lowest mean ( $M = 4.51$ ) and PB5 had the greatest mean ( $M = 4.66$ ). The majority of respondents concurred that the pay and benefits offered by the job are a significant factor in their decision to join the industry, according to these findings. Intriguingly, the Parental Influence (PaI) construct produced intriguing results, with the highest PaI3 value ( $M = 4.28$ ), and the lowest PaI2 value ( $M = 4.02$ ). In accordance with current trends, this indicates that many students' career decisions are influenced by their parents.

Concerning career development (CD), respondents disagreed with the greatest CD4 ( $M = 3.01$ ) and lowest CD2 ( $M = 2.10$ ), indicating that they do not see the industry as helpful to their professional advancement. In contrast, the Personal Interest (PeI) construct yielded a more balanced result, with PeI3 scoring relatively highly ( $M = 4.33$ ) and PeI2 scoring relatively poorly ( $M = 2.37$ ). Therefore, the median PeI score was 3.35, indicating a moderate level of student interest in entering the industry. Finally, according to the Working Intention (WI) construct, the majority of respondents were inclined to work in the industry, most likely as a result of their internship experiences and exposure to the hospitality sector. WI1 had the greatest mean ( $M = 4.00$ ) among the WI items, whereas WI3 had the lowest mean ( $M = 3.78$ ). These descriptive data give some data on respondents' perceptions and intentions regarding income and benefits, parental influence, career development, personal interest, and employment intentions in the industry.

**Table 2.** Descriptive statistic of measurement items (n=260)

Questionnaire Item	Mean	Std. Deviation
<i>PB1</i>	4.17	.939
<i>PB2</i>	4.51	.821
<i>PB3</i>	3.95	1.095
<i>PB4</i>	4.21	.950
<i>PB5</i>	4.66	.763
<i>PaI1</i>	3.82	1.119
<i>PaI2</i>	4.03	.864
<i>PaI3</i>	4.28	.867
<i>PaI4</i>	3.94	1.002
<i>CD1</i>	2.01	1.863
<i>CD2</i>	2.09	1.854
<i>CD3</i>	3.21	1.149
<i>CD4</i>	3.01	1.720
<i>CD5</i>	2.95	1.051
<i>PeI1</i>	3.99	1.017
<i>PeI2</i>	3.90	1.093
<i>PeI3</i>	3.84	1.101
<i>PeI4</i>	4.04	.773
<i>PeI5</i>	3.01	1.061
<i>WI1</i>	4.04	1.277
<i>WI2</i>	4.16	1.814
<i>WI3</i>	3.89	.865
<i>WI4</i>	4.17	.867

## 4.2 Correlation Analysis

This study performed a correlation analysis and determined the strength of the relationship between variables based on Table 3 [17]. The correlation result presented in Table 4, indicating a statistically significant result for every test conducted.

**Table 3.** The scale of Pearson's correlation coefficient

Scale of correlation coefficient	Value
$0 < r \leq 0.19$	Very Low Correlation
$0.2 \leq r \leq 0.39$	Low Correlation
$0.4 \leq r \leq 0.59$	Moderate Correlation
$0.6 \leq r \leq 0.79$	High Correlation
$0.8 \leq r \leq 1.0$	Very High Correlation

The results of the Pearson correlation analysis for this study are shown below in Table 4 with five different constructs. The data was then analysed using a correlation coefficient guide by above Table 3. According to the findings of the study, there is a significant positive link between pay and benefits (PB) and working intention (WI), with a correlation coefficient of 0.801 ( $p < 0.05$ ). The value of personal interest (PeI) exhibits a strong strength of link to working intention, with a correlation coefficient of 0.789 and a significance level of 0.05 or below. In the meantime, parental influence (PaI) has the same high positive connection with working intention as indicated in Table 4, with a correlation coefficient of 0.687 and a significance level of  $p < 0.05$ . The result value of the correlation between working intention and career development (CD) was found weak as the  $r$  value equal to 0.381 ( $p < 0.05$ ). In general, the majority of the hypotheses that were tested indicate a positive linkage between independent variables toward the dependent variables; nevertheless, the finding should not be generalised as the study that was done had certain constraints that could potentially affect the conclusion.

**Table 4.** Table of Pearson correlation

		PB	PaI	CD	PeI	WI
<b>PB</b>	Pearson Correlation	1	.672**	.401**	.793**	.801**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	260	260	260	260	260
<b>PaI</b>	Pearson Correlation	.672**	1	.556**	.752**	.687**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	260	260	260	260	260
<b>CD</b>	Pearson Correlation	.401**	.556**	1	.416**	.381**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	260	260	260	260	260
<b>PeI</b>	Pearson Correlation	.793**	.752**	.416**	1	.789**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	260	260	260	260	260
<b>WI</b>	Pearson Correlation	.801**	.687**	.381**	.789**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	260	260	260	260	260

\*\* . Correlation is significant at the 0.05 level (2-tailed).

### 4.3 Regression Model Summary

**Table 5.** Model summary

Model Summary<sup>b</sup>

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.524 <sup>a</sup>	.768	.259	.40455	2.113

a. Predictors: (Constant), PB, PaI, CD, PeI, WI  
b. Dependent Variable: WI

Table 5 indicates that the Durbin-Watson value is 2.113%. A Durbin-Watson value between 1 and 3 indicates that there is no autocorrelation (homoscedasticity) issue with the residuals. Therefore, it indicates that there is no correlation between the independent error terms. In addition, R square plays an important function in the model summary. R value from the table refers to the measured intensity of the relationship between the forecast and the measured result of this research study. According to the preceding table, R square is 0.768, or 76.8%. It also indicates that 76.8% of the independent variables, namely pay & benefit, parental influence, career development, and personal interest, have a direct effect on the dependent variable, working intention. In addition, it indicates that the independent variable explains 76.8% of the total variance in the dependent variable. Therefore, the remaining 23.3% is attributable to variables outside the scope of this study.

## 5. DISCUSSION & FUTURE RESEARCH

This study examines the factors influencing students' intentions to pursue a career in the hospitality business in Malaysia. Based on the preceding discussion, there are numerous noteworthy critical points that warrant attention in this section. The initial aims of this study pertain to examining the influence of pay and benefits on the working intention of hospitality students within the hotel business subsequent to the Covid-19 pandemic. The response to these aims was highly lucid, as the remuneration and perks have a substantial impact on students' inclination to enter the sector. In essence, individuals will pursue employment in the industry if the compensation and benefits align with their anticipated standards. This conclusion was consistent with several previous studies [18]–[20]. However, a recent study conducted by [21] has indicated that work-life balance has emerged as an additional benefit that significantly influences individuals' decision to enter the labour force. The changing lifestyle of individuals in contemporary society has emerged as a significant determinant within the pay and benefits domain. In addition to the pursuit of work-life balance, the implementation of effective minimum wage enforcement in Malaysia presents itself as a potential remedy for the prevalent issue of low pay within the hospitality sector. An additional recommendation to potentially cultivate a student's interest in pursuing a career in the hotel industry is to emphasise the positive aspects associated with this field. This experience throughout their internship may potentially influence students' perceptions of the sector.

The second purpose of this study focuses on examining the variable of parental influence towards the career choice. Previous research has indicated that these variables typically exhibit a poor correlation [22], [23], [24] with the variables related to working intention. This suggests that a significant portion of the participants in the study desire autonomy in making their own decisions regarding their future. However, a significant finding in this study reveals that contemporary students exhibit a preference for receiving guidance or emulating their parents' job choices. A study conducted by researchers [25] centred on low-income families revealed

that the involvement of parents in college preparation, their role as positive role models, establishment of high academic standards at an early stage, and cultivation of kids' sense of career volition were found to promote students' self-determination. The educational exhibition organised by the institution serves as a valuable resource for students to gather information pertaining to their prospective career paths. The information provided has been beneficial to numerous parents in guiding their decision-making process about their children's course selection and subsequent career paths.

The investigation of career development as a third variable in relation to students' profession choices, particularly in the aftermath of the COVID-19 pandemic, is being examined. The findings of this survey indicate that a significant proportion of students do not perceive the hospitality business as a viable option for their future career path and professional growth. The significant downsizing of the hospitality industry in Malaysia has had an impact on students' perceptions of the profession. Individuals may experience a sense of uneasiness regarding their future prospects when contemplating the pursuit of a career within this particular industry. However, this outcome may vary for a new cohort of students who have not experienced the effects of the epidemic. In addition, it is imperative for both the government and the industry to develop a comprehensive contingency plan to address the potential impact of a future pandemic on industry players and their workforce.

Finally, this study aims to examine the correlation between individual interests and the inclination of hospitality students to pursue careers in the hospitality industry post-Covid-19. The findings of this study are consistent with previous research, which indicates that hospitality students express a desire to pursue careers in the business once completing their education [18], [26]–[28]. Despite the literature supporting the findings of this study, it is not possible to definitively infer that the variables examined were robust, given the study was limited in scope and focused solely on one university. The primary constraint of this study pertains to the narrow sample selection, which was confined to a single university in Malaysia. Consequently, the findings cannot be extrapolated to the broader community. This particular sample was selected due of the researcher's convenient access to it. This study suggests that future researchers should consider investigating additional hospitality institutions in order to enhance the diversity of findings. In addition, it is worth considering the inclusion of additional variables or aspects, such as work-life balance, utilisation of information and communication technology (ICT), and peer influence, which are relevant to the future hospitality workforce comprising Generation Z and Generation Alpha. Incorporating these elements into future research may yield more precise and comprehensive analyses.

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## **AUTHORS' CONTRIBUTION**

All the authors involve in wrote and analyse the article.



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## I-CReST 2023:198-277 - Equipping Generation Z for Career Opportunities in the Hotel Industry: Challenges and Strategies

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### ABSTRACT

Generation Z refers to individuals born between 1990 and 2010 is a generation growing up in an entirely digital age and interconnected world. As an industry notoriously slow to implement technology, the hotel industry is alarmed by Gen Z's dependence on technology in their daily and also work environment. Besides that, there is other challenge faced that need to be address by Generation Z in pursuing careers within the hotel industry. This arising issues has opened an opportunity for researcher to investigate more on this issue. The research direction encompasses three key aspects: (1) understanding the challenges faced by Generation Z in entering the hotel industry and (2) proposing effective strategies to mitigate them. Utilizing the PRISMA framework as a research guide, the paper provides a comprehensive overview of the challenges. To investigate the challenges, a comprehensive analysis of existing literature and industry reports is conducted. The Scopus and Web of Science databases were utilized to ensure a thorough exploration of scholarly publications. However, the review revealed a limited number of publications specifically discussing Generation Z in the context of the hotel industry, indicating a research gap that requires further exploration. Despite the scarcity of literature, the study synthesizes the available research to shed light on the unique challenges encountered by Generation Z in the hotel industry. Drawing upon the findings, the paper proposes strategies to equip Generation Z for success in the hotel industry. These strategies encompass a range of initiatives, including targeted educational programs, practical training opportunities, mentorship programs, and promoting digital fluency. The aim is to empower Generation Z with the necessary skills, knowledge, and adaptability to thrive in the dynamic and competitive hotel industry. By identifying and addressing these challenges through evidence-based strategies, this study seeks to provide valuable insights for educators, industry professionals, and policymakers involved in preparing and supporting Generation Z's entry into the hotel industry. Future research should prioritize investigating this under-researched area and exploring innovative approaches to optimize Generation Z's integration into the evolving hospitality sector.

**Keywords:** Generation Z; systematic review; hotel industry; strategy; challenge

### 1. INTRODUCTION

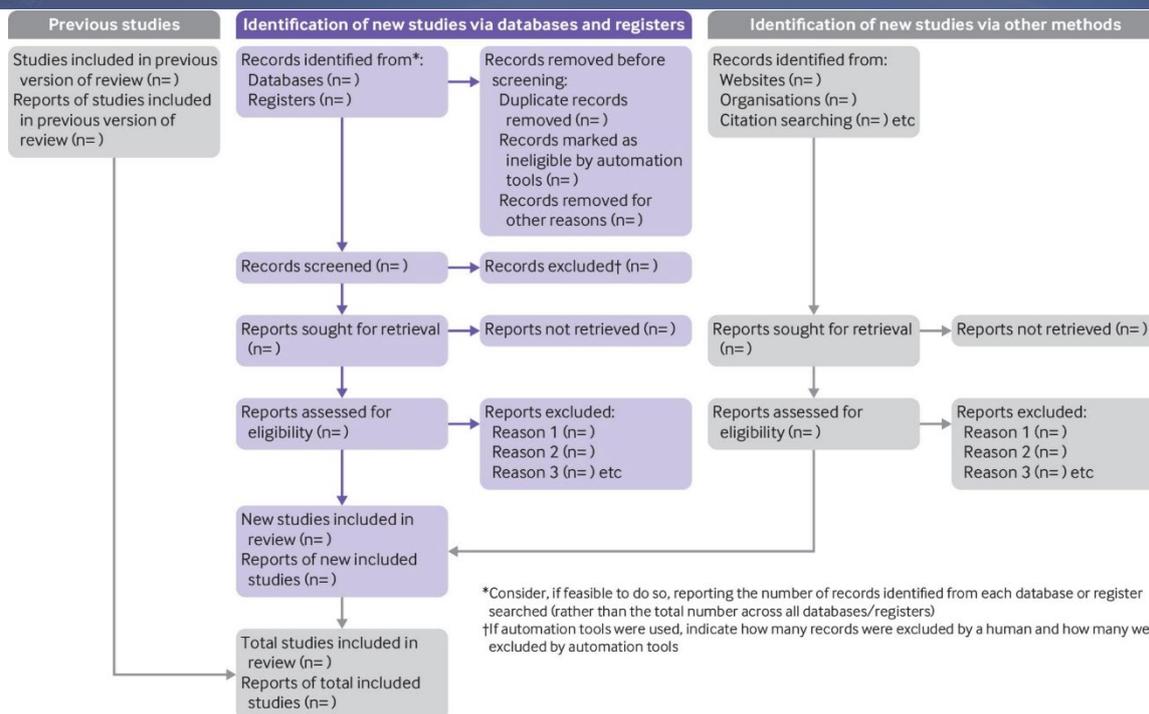
Generation Z, colloquially referred to as Gen Z, denotes the cohort of individuals born during the period spanning from the late 1990s to the early 2010s [1]. Generation Z is characterised by its notable diversity, particularly in terms of race and ethnicity. This generation has a higher level of racial and ethnic diversity compared to preceding generations. They symbolise the forefront of the nation's evolving racial and ethnic composition. In the realm of education,

Generation Z is poised to become the most highly educated generation to date. They place a high importance on education and are renowned for their dedication to attaining advanced levels of education. It is widely acknowledged that the current generation, commonly referred to as Generation Z, can be characterised as digital natives due to their upbringing in a technologically advanced and socially mediated environment. The individuals in question are sometimes referred to as "digital natives" and possess a high level of proficiency in utilising technology. Another noteworthy characteristic of this age is their inclination towards collaboration and pragmatism. Individuals exhibit a profound concern for the well-being of others and adopt a practical approach to tackling pressing matters such as climate change.

The present cohort represents the contemporary and forthcoming labour force, encompassing the realm of hospitality. The hospitality business, commonly recognised as a labour-intensive sector, is unlikely to transition to autonomous machines in the foreseeable future [2]–[4]. According to the aforementioned statement, persons belonging to the Generation Z cohort continue to play a crucial role in the functioning of the hotel business. The hotel business, which has faced significant challenges in the aftermath of the epidemic, may soon find it necessary to develop strategic approaches to recruit fresh talent to the sector [5]. The issue not only face after the pandemic but already being raise by other literature [6]. In order to attract this talent, operators must possess an understanding of the characteristics of their prospective staff. Comprehending human behaviour is a formidable challenge, although it remains feasible through the use of surveys, research, and scholarly investigation conducted by experts in the field. This research aims to contribute to the understanding of Generation Z by providing valuable insights to the industry and other relevant entities. The research direction encompasses three key aspects: (1) understanding the challenges faced by Generation Z in entering the hotel industry and (2) proposing effective strategies to mitigate them.

## 2. METHODOLOGY

This study employed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria to enhance the rigour of its design and the suggestions provided in this paper. To facilitate the systematic review, initial articles were obtained from the Scopus database by Elsevier and the Web of Science (WOS) database by Clarivate. Both search databases are considered suitable for use, as they have been utilised in numerous systematic reviews across a range of fields [7], [8], [9]. Both databases provide a substantial collection of literature that academics can utilise as a resource for their investigations. The literature search for the current review employed specific keywords to refine the results and focus on the relevant subject matter. The acquisition of the ultimate reports for assessment will adhere to the PRISMA 2020 flow diagram [10], as depicted in Fig. 1, in accordance with the procedure for "identifying new studies through databases and registers."



**Fig. 1.** The PRISMA 2020 flow diagram

## 2.1 Formulation of Research Objectives

This paper employs the PICo framework [11] as a tool for developing research questions and designing research objectives. This tool aids researchers in formulating objectives that are appropriate for the review. This tool comprises three primary components, namely Population or Problem, Interest, and Context (PICo). Based on the guidelines provided, the writers have chosen Generation Z for Population, career opportunities for Interest and hotel industry for Context. The subject of interest pertains to the hotel industry, as indicated in Table 1.

**Table 1.** Research question development tools - PICo

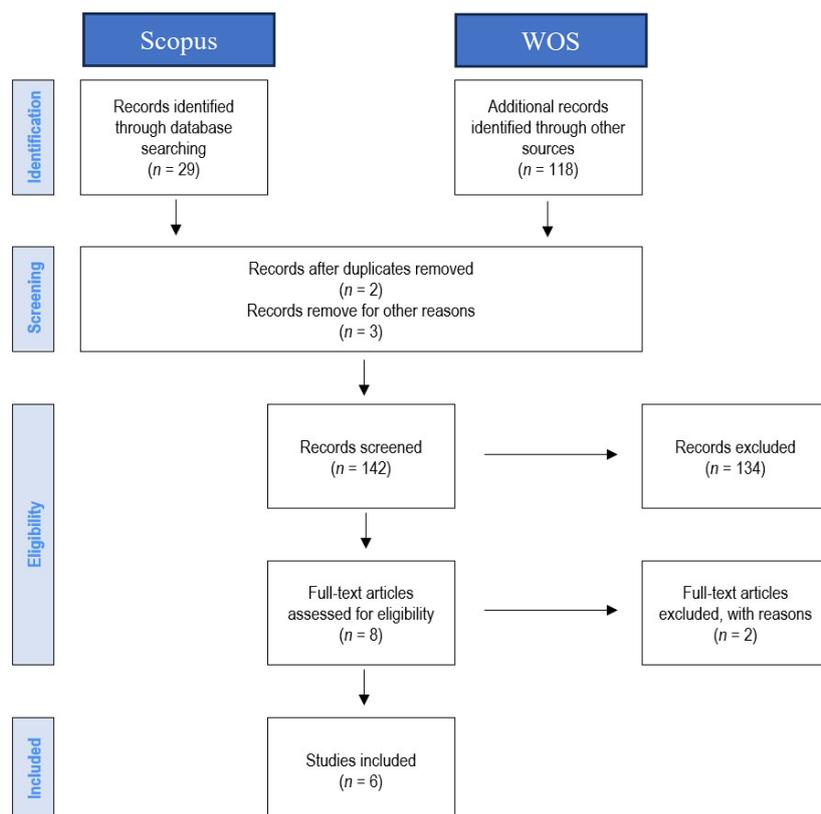
Population	Interest	Context
<i>Generation Z</i>	<i>Career opportunities</i>	<i>Hotel industry</i>

Base on the objectives above, this research employs the query string "Generation Z" OR "Generation-Z" OR "Gen Z" OR "Gen-Z" AND "Hotel" OR "Hotels" to gather relevant material. The aforementioned keywords were present in the titles, abstracts, and keywords inside the database during the initial literature search.

## 2.2 Data Collection and Screening

The aforementioned search yielded a total of 29 publications from Scopus and 118 publications from Web of Science (WOS) for the researcher. The literature that was gathered is subsequently screened to determine its suitability for subsequent reporting and analysis. The outcomes obtained from both databases are subsequently exported to Microsoft Excel for further analysis and discussion. The records are being screened by three reviewers, who evaluate them based on the title, abstract, and keywords. The reviewer will also apply various eligibility criteria in order to filter and obtain pertinent records. The criteria for the records are as follows: (1) they

must encompass research studies specifically focused on Generation Z, (2) the variable of interest should be Career, and (3) the environment of study should be the Hotel Industry. Two records were removed owing to duplication, while three additional records were removed due to the presence of incorrect data. After screening based on the condition above, it was determined that the paper unrelated to condition 131 papers has been excluded. Furthermore, two other papers [12] & [13] were unable to be reviewed due to restrictions on accessing the papers. It should be noted that this research only allows for the analysis of six papers [14]–[19] as presented in the Fig. 2.



**Fig. 2.** The selection flow chart

### 3. RESULT

#### 3.1 Themes of Gen Z Challenges

The reviewer has extracted the material from the selected paper. Table 2 presents a factor that has been extracted from the selected study. This factor can be categorised into three themes, namely the working-related factor (WRF), the personal-related factor (PRF), and other-related factors (ORF). The topic of working-related factors has been addressed in four papers, namely [14], [15], [17], and [18], which are referred to as WRF in Table 2. According to the findings of Tang et al. [14], the hotel and tourism business is characterised by a high demand for workforce, leading to challenges such as labour shortages, high turnover rates, and recruitment issues. This observation is corroborated by other sources in the literature [20]–[22]. This remark is commonly found in hospitality research and is typically employed to articulate the professional aspects within the study. In the subsequent paper [15], the focus shifts towards the examination of work-related factors as a difficulty. Within this study, a survey participant was cited, who expressed the viewpoint that “The biggest issue is we don’t pay enough money at

entry level. I have been carrying out some wage analysis and compared to other sectors, we need to have an overall increase”. The aforementioned issue can also be categorised as a work-related aspect that poses a significant difficulty for Generation Z individuals seeking to enter the hospitality business. In a recent study conducted in 2021, [17] researchers have brought attention to previous scholarly works [23] that have consistently emphasised the prevalent concerns over inadequate remuneration, extended working hours, and physically strenuous labour, which have contributed to the hesitancy of Generation Z individuals to pursue careers in the hotel business. The issue being emphasised pertains to work-related concerns that prompt members of Generation Z to disengage from the sector following their graduation. The introductory section of the previous study [18] began by presenting a compilation of challenges associated with entering the hospitality industry, as identified in various previous scholarly works. These challenges encompassed factors such as low compensation, labour-intensive nature of the work, limited opportunities for career advancement, emotional demands, and long and irregular working hours [24]–[26]. The various factors identified in the factor analysis can be consolidated into a single theme, namely, work-related factors influencing the decision of Generation Z individuals to enter the sector.

Another trend that emerged from the investigation was the influence of personal-related factors (PRFs). Table 2 presented three papers that focused on the particular phenomenon known as the PRF. According to the initial investigation conducted by Tang et al. (2020), it is asserted that individuals belonging to the Generation prioritise personal pleasure as their primary factor for work retention. The hotel sector faces a significant difficulty that has been extensively discussed in prior literature. It is well recognised as a highly stressful industry to work in [27], [28]. Moreover, the investigation on "Generation Z and hospitality careers" shed light on some personal challenges faced by individuals belonging to Generation Z in relation to the hospitality sector. The findings revealed that a significant portion of this demographic lacked clarity regarding their career choices, had varying attitudes towards the career field, and possessed an incomplete understanding of the requisite skills for success within the industry. The study extensively examines the negative attitudes and perceptions about the hotel industry among graduate students and their surroundings. The negative reputation around the hospitality business poses a significant challenge for both industry stakeholders and governmental entities to address. In a recent study conducted by Goh and Baum (2021), it was discovered that previous research [29] has indicated that younger workers perceive the hospitality business as lacking in meaning and attractiveness, which may discourage their long-term commitment to this field. This section mostly focuses on personal factors pertaining to the individual. Certain challenges can be effectively addressed through training initiatives and a shift in perspective. However, it is imperative to consider the perspectives of all parties involved and develop a strategic strategy in order to effectively mitigate or overcome this difficulty.

Finally, this discussion will address other related factors (ORFs) that present challenges to Generation Z. Only one study cited in reference [18] does not appear related to the theme being discussed. The initial investigation conducted in 2020 [14], indicates that the hotel business demonstrates a notable concentration of young individuals in its workforce. The elder worker is unable to keep up with the rapid pace of technological advancements in this industry. The rapid advancement of technology, which is highly prevalent among the younger generation, has resulted in feelings of exclusion within the elder generation. Consequently, some individuals within this demographic exhibit resistance towards embracing change or accepting novel ideas. Walmsley et al. (2020) express concerns on the perceived lack of job security within the hotel business, as indicated by the relatively high scores reported by their study



participants. The issue of work security, which is shared with other studies, is being reviewed in this research [17]. The sector faces the problem of ensuring that Generation Z see it as capable of offering robust employment security for their future. The research conducted by Jung and Yoon (2021) on "Generational effects" sheds light on the distinct expectations that individuals from different generations possess when entering the hospitality sector. In their study, the authors assert that there has been a significant transformation in the makeup and structure of organisational workforces. The comprehension and effective management of intergenerational expectations have assumed growing significance in contemporary society. Another element that has recently been a concern is the impact of automation and robotics on job opportunities for the Generation Z. The difficulty under discussion is addressed in the current study (Reference 19).

**Table 2.** Summary of challenge entry for Gen Z

Year	Paper Title	Author	Factor
2020	Do Gen Zs feel happy about their first job? A cultural values perspective from the hospitality and tourism industry	Tang, J., Tosun, C., & Baum, T.	<ul style="list-style-type: none"> <li>• Labour intensive (WRF)</li> <li>• Youth-intensives industry (ORF)</li> <li>• Value personal happiness (PRF)</li> </ul>
2020	Generation Z and hospitality careers	Walmsley, A., Cripps, K. & Hine, C.	<ul style="list-style-type: none"> <li>• Majority did not understand their career choice (PRF)</li> <li>• Attitudes towards careers in tourism and hospitality (PRF)</li> <li>• Work value – job security (ORF)</li> <li>• Fair wages (WRF)</li> <li>• Lack of career development opportunities (WRF)</li> <li>• Hospitality graduates' skills (PRF)</li> <li>• Different generation expectation (ORF)</li> </ul>
2021	Generational effects of workplace flexibility on work engagement, satisfaction, and commitment in south Korean deluxe hotels	Jung, H.S.; Yoon, H.H.	
2021	How the hotel industry attracts Generation Z employees: An application of social capital theory	Xi Y. Leung, Jie Sun, Huiying Zhang, Ye Ding	<ul style="list-style-type: none"> <li>• Low pay, long working hours, and physically demanding work (WRF)</li> <li>• Concerns for job security and achievement (ORF)</li> </ul>
2021	Job perceptions of Generation Z hotel employees towards working in Covid-19 quarantine hotels: the role of meaningful work	Edmund Goh, Tom Baum	<ul style="list-style-type: none"> <li>• Low remunerated, labour-intensive, limited career progression, emotionally demanding, long odd working hours (WRF)</li> <li>• Hospitality work less meaningful and less attractive (PRF)</li> </ul>
2022	Robots can't take my job: antecedents and outcomes of Gen Z employees' service robot risk awareness	Heyao Yu, Cass Shum, Michelle Alcorn, Jie Sun, Zhaoli He	<ul style="list-style-type: none"> <li>• Jobs worldwide are at risk of automation and being replaced by robots (ORF)</li> <li>• Employee's job insecurity threatened by the adoption of service robots (ORF)</li> </ul>

### 3.2 Industry Recruitment Strategy

Table 3 presented below provides a concise summary of all the research recommendations aimed at enticing Generation Z individuals to participate in the industry.

**Table 3.** Summary of industry recruitment strategy

Year	Paper Title	Author	Factor
2020	Do Gen Zs feel happy about their first job? A cultural values perspective from the hospitality and tourism industry	Tang, J., Tosun, C., & Baum, T.	<ul style="list-style-type: none"> <li>• Focus on adaptable cultural priming</li> <li>• Instil job prestige</li> <li>• Stimulate or removal some of working barriers</li> <li>• Remodelling organizational culture toward Gen-Z</li> <li>• Emphasized intrinsic value</li> <li>• Give proper sense of responsibilities</li> <li>• Family &amp; friend influence</li> </ul>
2020	Generation Z and hospitality careers	Walmsley, A., Cripps, K. & Hine, C.	<ul style="list-style-type: none"> <li>• Provided opportunity for personal development</li> <li>• Turning negative aspects of work into something positive</li> <li>• Awareness of employment opportunities</li> <li>• Create flexible policies and organizational climates</li> </ul>
2021	Generational effects of workplace flexibility on work engagement, satisfaction, and commitment in south Korean deluxe hotels	Jung, H.S.; Yoon, H.H.	<ul style="list-style-type: none"> <li>• Establishing new norm associated with the organization's culture and flexibility</li> <li>• Active and strategic organizational environment</li> </ul>
2021	How the hotel industry attracts Generation Z employees: An application of social capital theory	Xi Y. Leung, Jie Sun, Huiying Zhang, Ye Ding	<ul style="list-style-type: none"> <li>• Person-organization fit increases cognitive trust and affective trust, subsequently affecting hotels' organizational attractiveness.</li> <li>• Positive image developed by the CSR campaign yields a source of competitive advantage in attracting quality employees</li> </ul>
2021	Job perceptions of Generation Z hotel employees towards working in Covid-19 quarantine hotels: the role of meaningful work	Edmund Goh, Tom Baum	<ul style="list-style-type: none"> <li>• Emphasize the positive job aspects such as a career that is exciting, courageous and respectable</li> <li>• present future career prospects and long-term opportunities</li> </ul>
2022	Robots can't take my job: antecedents and outcomes of Gen Z employees' service robot risk awareness	Heyao Yu, Cass Shum, Michelle Alcorn, Jie Sun, Zhaoli He	<ul style="list-style-type: none"> <li>• Tech-savviness and social skills – reduce SRRA and lower Gen-Z employees' intention to leave the industry</li> <li>• HRM should ensure that hotel leadership's recruitment, selection and training focus on transformational leadership qualities, including soft skills such as communication, encouraging innovation, instilling confidence in subordinates</li> </ul>

It is noteworthy that the data patterns pertaining to the second research goals exhibited significant dispersion across all six studies. Nevertheless, certain patterns may be obscured

within the records. One of the initial patterns identified in terms of strategy is the employer strategy (ES). This study examines strategies that hotels might employ to effectively engage and attract Generation Z individuals to pursue careers within the hospitality sector. In their study, Tang, Tosun, and Baum [14] identified a range of strategies that hotels might employ. These strategies include prioritising flexible cultural priming, addressing and eliminating barriers to effective work, reshaping organisational culture to align with the preferences and needs of Generation Z, and placing greater emphasis on intrinsic value. The strategy mentioned is in line with the findings of Jung, H.S. and Yoon, H.H. (2021), who argue that employers should develop adaptable policies and foster organisational climates that promote a new set of norms aligned with the organization's culture, flexibility, and strategic organisational environment specifically tailored to accommodate the needs and preferences of Generation Z. The study conducted by [17], examined the strategies employed by the hotel industry to attract employees from Generation Z. The findings suggest that hotels should establish a favourable reputation by actively participating in corporate social responsibility (CSR) campaigns, as this can effectively appeal to high-calibre individuals seeking employment in the hotel sector. The most recent report pertaining to this subject was authored by [19]. In their findings, it was suggested that Human Resource Managers in the hotel industry should prioritise the recruitment, selection, and training of leaders who possess transformational leadership qualities. This includes emphasising soft skills such as effective communication, fostering innovation, and instilling confidence in subordinates.

The subsequent pattern seen was the utilisation of graduate strategy (GS) as a means of entering the sector. One [15] out of the six papers discusses the method of reframing unfavourable aspects of work into positive ones. This approach is also echoed by E. Goh and T. Baum, who suggest that graduates should prioritise highlighting the positive features of a work, such as its excitement, courage, and respectability, rather than focusing on the negative parts. The study conducted by [19] in 2022 highlights the importance of enhancing the technological proficiency and interpersonal abilities of graduates in order to mitigate the occurrence of SRRA and decrease the likelihood of Gen-Z employees' inclination to exit the company.

The most recent pattern that has been used involves the utilisation of strategies from external entities, such as government agencies, universities, or parents, in order to appeal to the generation Z demographic and encourage their participation in the sector. According to a suggestion put up by [14], it is recommended that the sector takes steps to cultivate a sense of prestige surrounding careers in hospitality in order to effectively entice members of Generation Z to pursue such careers. According to Walmsley, Cripps, and Hine (2020), it is proposed that the current generation should be influenced by their family and friends to pursue a career in the hospitality industry. Additionally, it is worth noting that this measure has the potential to enhance the level of awareness pertaining to career prospects within this particular area. In order to support the hotel business, a study conducted by [18] underscores the shared obligation of all stakeholders, including universities, to provide comprehensive information on future job prospects and long-term opportunities. The task of fostering awareness regarding future employment prospects among hospitality graduates can be effectively shared among the government, universities, and industry stakeholders.

#### 4. DISCUSSION

This literature review investigates the challenges encountered by Generation Z in accessing employment opportunities within the hotel sector, along with the strategies taken to attract their participation in the field. The analysis is grounded in the articles that were subjected to review. The review was conducted with a focus on two main inquiries: (1) understanding the challenges faced by Generation Z in entering the hotel industry and (2) proposing effective strategies to mitigate them. This review aims to conduct a comparative analysis of different research findings by utilising existing literature on Generation Z. The objective is to examine prospective areas for future research.

The research pertaining to Generation Z career and challenges in the hotel business has been quite restricted, with only eight reports compiled from both Scopus and Web of Science databases. The examination of this topic commenced in early 2020. The most recent survey conducted in 2022 has exhibited a growing emphasis on automation, particularly as this technological advancement gradually permeates the hotel industry. The importance of studying for the current generation is being discussed by scholars [15] and [16], as the imminent entry of Generation Z into the workforce underscores the significance of this matter. The report has a limitation in terms of its focus on a specific topic and industry, accounting for just 5% of the total reports retrieved from the database. This indicates a significant potential for researchers to engage in this field.

The examination of the obstacles encountered by Generation Z in their pursuit of employment within the hotel sector has yielded noteworthy trends and topics. This study successfully categorised all the findings into three distinct themes, including job-related factors, personal-related factors, and other-related factors. The reports retrieved highlight the challenges faced by the hotel business, emphasising the necessity for a transformation in their outdated perceptions. Equipping the emerging workforce with a novel perspective has the potential to significantly influence the trajectory of this particular sector.

The retrieved report presents a strategy for addressing the aforementioned issue, which encompasses several ideas. These ideas include the remodelling of hospitality careers to enhance work-life balance, job prestige, and the removal of barriers in order to attract new talent. Additionally, the report suggests implementing awareness programmes targeting parents, corporate social responsibility initiatives, and highlighting the positive aspects of jobs in the industry. Furthermore, the report emphasises the importance of upgrading graduate skills, particularly in areas such as technological proficiency and social skills, to adapt to the evolving landscape of the industry. These discussions are extensively covered in the various analytical papers.

#### 5. CONCLUSION & FUTURE RESEARCH

Based on the analysis reports, it has been observed that the pursuit of a profession in the hotel business has numerous challenges for those belonging to the Generation Z demographic. The discovery sheds some light on the involvement of all parties in the issue, as they seek to identify the break-even point that could potentially yield a mutually beneficial outcome for both workers and employers. In addition to the worker-employer dyad, other entities such as universities and governments may provide assistance to both sides in addressing their respective challenges related to the problem at hand. The strategy being discussed in the

selected publications within this study may maybe provide insights for addressing the issue at hand.

It may be asserted that the challenge of entering the hospitality sector for Generation Z has arisen from both the industry itself and the graduates themselves. Other researchers that are investigating the same subject may utilise the data from this study to authenticate or compare their research findings. Therefore, future research may undertake a comprehensive examination of each of the characteristics that have been outlined above. The systematic literature review is constrained by the predefined scope set by the researcher. As a result, future examinations of career intention in the hotel sector may consider broadening the review through the implementation of a meta-analytical review. Furthermore, it is recommended that future research endeavours focus on further investigating the variables discussed in this study. This may be achieved through the implementation of a meta-analysis, which would provide a comprehensive overview of the current state of knowledge. Additionally, it is suggested that studies be conducted to explore additional pertinent variables that are significant to the hotel industry.

This study presents certain limitations that require attention and resolution. The initial database being utilised comprises Scopus and Web of Science. Although these two databases are popular among researchers, expanding the search to include other databases like ProQuest, SAGE, and even Google Scholar can potentially improve the availability of reports that can be analysed. The substantial quantity of available reports has the potential to introduce new variables for future research. Another potential barrier that could be addressed in future research is the acquisition of complete papers for examination. This issue can be resolved by requesting the manuscript directly from the author or the journal, however it may require a certain amount of time for them to answer. This study implies that future researchers should allocate an adequate amount of time for the comprehensive collection of full papers prior to conducting any analysis.

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## AUTHORS' CONTRIBUTION

All the authors involve in wrote and analyse the article.

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## **I-CReST 2023:200-156 - Penerimaan Pelajar Kursus Bahasa Arab Politeknik Sultan Idris Shah terhadap Aplikasi M-Hiwar Menggunakan *Technology Acceptance Model (TAM)***

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### **Abstrak**

Senario pengajaran dan pembelajaran telah mengalami perubahan selepas pandemik Covid-19. Kaedah pengajaran dan pembelajaran yang menggabungkan elemen teknologi adalah keperluan pelajar zaman kini. Justeru itu, kajian deskriptif ini bagi mengenalpasti tahap dan hubungan antara faktor penerimaan pelajar terhadap aplikasi M-Hiwar. Nilai kebolehpercayaan *alpha cronbach* 0.940 hasil daripada kajian rintis yang dijalankan terhadap 30 orang pelajar. Kajian ini dijalankan kepada pelajar semester dua dan lima Jabatan Perdagangan yang mengambil kursus Bahasa Arab. Sampel kajian ini melibatkan 73 orang responden dan menggunakan instrumen soal selidik dalam mendapatkan maklum balas. Perisian *Statistical Package for Social Science (SPSS)* versi 25.0 digunakan bagi mengira min, sisihan piawai dan korelasi. Hasil analisis deskriptif mendapati bahawa faktor Persepsi Penggunaan Berkesan (PU) mencatatkan nilai min 4.59, Persepsi Mudah Guna (PEOU) dengan nilai min 4.54. Manakala pemboleh ubah Tingkah laku (BI) menunjukkan nilai min 3.67 dan Sikap (AT) mencatatkan nilai min 4.53. Hasil analisis ujian Korelasi Pearson pula mendapati terdapat hubungan signifikan yang tinggi antara penggunaan berkesan dan sikap dengan nilai kolerasi 0.832. Manakala terdapat hubungan signifikan yang sederhana antara pemboleh ubah persepsi mudah guna dengan tingkah laku dengan nilai koleasi 0.506. Kesimpulannya, walaupun respon pelajar adalah positif dari sudut penggunaan berkesan dan persepsi mudah guna namun terdapat beberapa faktor seperti sikap dan tingkahlaku perlu diberi perhatian supaya proses pengajaran dan pembelajaran menggunakan aplikasi M-Hiwar dapat digunakan secara optimum kepada semua pelajar yang mengambil kursus Bahasa Arab.

**Kata kunci:** Aplikasi M-Hiwar; mudahguna; sikap dan tingkahlaku; Bahasa Arab

### **1. PENDAHULUAN**

Walaupun bahasa Arab telah diajar sebagai mata pelajaran di sekolah rendah dan menengah, masih terdapat sejumlah besar pelajar di Malaysia yang tidak dapat menguasai dengan baik. Awang et al. (2013) menggariskan bahawa pelajar tidak mempunyai keyakinan untuk menggunakan bahasa Arab di dalam dan di luar bilik darjah. Menurut Teh et al. (2009), kekurangan kecekapan pelajar dalam bahasa Arab telah mencetuskan kebimbangan yang besar mengenai kualiti pengajaran dan pembelajaran bahasa Arab di sekolah Malaysia. Selain itu, penyelidik seperti Sardi (2017) juga menyatakan bahawa sistem pedagogi semasa tidak

menyediakan pelajar dengan peluang yang mencukupi untuk menguasai kemahiran bahasa yang diperlukan. Akibatnya, pelajar berasa kurang termotivasi dan tidak mahu menyertai secara aktif dalam bilik darjah. Oleh itu, Noor et al. (2016) berpendapat bahawa untuk menggalakkan pelajar untuk belajar bahasa Arab, guru harus memperkenalkan strategi pembelajaran yang menarik seperti pembelajaran secara aktif dan bebas melalui penggunaan bahan-bahan elektronik (Samah, 2017).

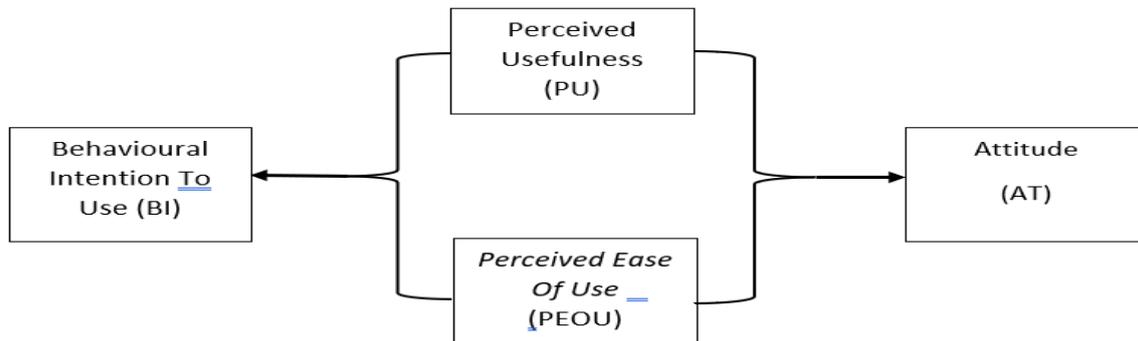
Dalam konteks globalisasi masa kini, pengenalan kemajuan teknologi terkini telah mendorong pengenalan pendekatan pengajaran bahasa yang inovatif dan baru untuk menggantikan metodologi pembelajaran konvensional. Kemunculan pembelajaran berasaskan android telah memperluas peluang bagi proses pengajaran dan pembelajaran termasuklah pembelajaran bahasa Arab. Pembelajaran berasaskan aplikasi android boleh menjadi bentuk intervensi pendidikan yang dapat mempengaruhi pelajar aktif dan memotivasikan mereka untuk menyertai secara aktif dalam bilik darjah.

Untuk memenuhi objektif kajian ini, satu soal selidik berdasarkan Model Penerimaan Teknologi (TAM) telah disediakan untuk mengkaji tahap penerimaan pelajar terhadap penggunaan permainan digital mudah alih untuk pembelajaran bahasa Arab di peringkat pendidikan tinggi. Terdapat empat pembolehubah yang dikaji, iaitu kegunaan yang dirasakan, kemudahan penggunaan yang dirasakan, sikap dan niat tingkah laku untuk menggunakan. Ujian kebolehpercayaan dan kebolehvalidan kandungan telah dijalankan untuk memastikan kebolehpercayaan dan konsistensi item dalam soal selidik tersebut.

## 2. MODEL PENERIMAAN TEKNOLOGI

*Technology Acceptance Model* (TAM) adalah antara model yang paling banyak digunakan oleh para pengkaji dalam menilai penerimaan pengguna terhadap sesuatu aplikasi berkaitan teknologi maklumat (Lee, 2005). Pada peringkat awal, ia dicetuskan oleh Ajzen & Fishbein (1980). Kemudian diasas dan dipekatkan oleh Fred Davis (1986). Dalam model ini dicadangkan apabila pengguna diperkenalkan dengan sesuatu inovasi yang baharu, beberapa pembolehubah akan mempengaruhi keputusan pengguna bagaimana dan bila mereka akan menggunakannya (Norazah & Ramayah, 2010).

*Technology Acceptance Model* (TAM) secara umumnya digunakan bagi menjangkakan penerimaan seseorang terhadap teknologi bersandarkan kepada dua konstruk iaitu kebergunaan (*perceived usefulness, PU*) dan kemudahgunaan (*perceived ease of use, PEOU*). PU merujuk kepada darjah kepercayaan pengguna bahawa dengan menggunakan sistem, prestasi mereka dapat ditingkatkan. Manakala konstruk PEOU pula merujuk kepada darjah kepercayaan pengguna bahawa sistem dapat digunakan dengan mudah dan pembelajaran sendiri dapat dijalankan.



Rajah 1. *Technology Acceptance Model*, TAM (Davis, 1989)

### 3. PERNYATAAN MASALAH

Kajian menunjukkan tahap penguasaan kemahiran mendengar dan bertutur dalam kalangan pelajar yang mengambil kursus Bahasa Arab adalah pada tahap tidak memuaskan (Khairulzaman & Mat Taib, 2011). Ada pelbagai faktor dikenal pasti yang mempengaruhi tahap penguasaan kemahiran bertutur dalam Bahasa Arab di kalangan pelajar antaranya adalah malu, tidak yakin pada diri dan takut melakukan kesilapan dalam bertutur (Khairulzaman & Mat Taib, 2011).

### 4. OBJEKTIF KAJIAN

Dalam kajian ini dua(2) objektif yang akan dikaji :

1. Mengenalpasti tahap penerimaan pelajar terhadap aplikasi M-Hiwar
2. Mengetahui hubungan diantara Penggunaan M-Hiwar terhadap sikap dan tingkahlaku pelajar
3. Mengetahui hubungan diantara Persepsi Mudah Guna M-Hiwar terhadap sikap dan tingkahlaku pelajar

### 5. KAJIAN LITERATUR

#### 5.1 *Technology Acceptance Model (TAM)*

Dalam tempoh sedekad yang lalu terlalu banyak kajian yang menggunakan *Technology Acceptance Model (TAM)* sebagai instrumen kajian (Alsharida et al., 2021), sama ada dalam dan luar negara. Di Malaysia antara kajian yang menggunakan *Technology Acceptance Model (TAM)* sebagai model kajian adalah kajian Annamalai et al., (2021) Investigating the Use of Learning Management System (LMS) for Distance Education in Malaysia: A Mixed-Method Approach.

Model Penerimaan Teknologi atau *Technology Acceptance Model (TAM)* dibangunkan berdasarkan konstruk Davis et al. (1989). Ia direka khas untuk menjelaskan dan meramalkan penerimaan pengguna terhadap jenis teknologi tertentu. Menurut Ngai et al. (2005), *Technology Acceptance Model (TAM)* dibina berdasarkan dapatan kolektif yang menunjukkan teknologi yang dikehendaki sangat bergantung pada penerimaan pengguna terhadap teknologi. Selain itu, *Technology Acceptance Model (TAM)* mencadangkan bahawa persepsi kegunaan

dan persepsi kemudahan penggunaan adalah faktor penting dalam menentukan penggunaan sistem maklumat.

Sejak pembangunannya, *Technology Acceptance Model* (TAM) telah menerima perhatian dari pelbagai penyelidik (Ngai et al., 2005; Weng et al., 2018; Muhamad Amin, S.S, 2019). Pelbagai penyelidikan yang dijalankan menunjukkan bahawa *Technology Acceptance Model* (TAM) telah digunakan dan disahkan secara meluas. Menurut Davis (1989), terdapat dua faktor iaitu persepsi kemudahan penggunaan (PEoU) dan persepsi kegunaan (PU) yang dapat mempengaruhi sikap pengguna dan niat mereka dalam menggunakan inovasi teknologi.

Davis (1989) mentakrifkan persepsi kegunaan sebagai kebarangkalian subjektif pengguna yang bakal bahawa menggunakan sistem aplikasi tertentu akan meningkatkan prestasi kerja atau kehidupan mereka. Sementara itu, kemudahan penggunaan (EOU) pula ditakrifkan sebagai tahap yang dijangka oleh pengguna bahawa sistem sasaran akan bebas dari usaha. Dalam mentakrifkan sikap, Davis menyatakan bahawa ia berkaitan dengan penilaian pengguna terhadap keinginan untuk menggunakan sesuatu aplikasi sistem maklumat tertentu. Akhir sekali, niat ditakrifkan sebagai ukuran kebarangkalian seseorang dalam menggunakan aplikasi tersebut. Rajah 1 menggambarkan *Technology Acceptance Model* (TAM) seperti yang digunakan dalam kajian ini.

## 6. APLIKASI M-HIWAR

Aplikasi M-Hiwar adalah aplikasi yang dibangunkan oleh pengkaji menggunakan medium aplikasi android. Ini selari dengan kajian Saleh et al., (2020) yang menunjukkan 92.9% responden bersetuju bahawa kaedah pembelajaran menggunakan aplikasi Android meningkatkan kemahiran mendengar dan bertutur. Aplikasi M-Hiwar memberikan fokus penguasaan Bahasa Arab melalui kemahiran mendengar dan bertutur. Ia mengandungi 36 topik yang terdiri daripada dua kategori iaitu mengikut nisbah tempat dan kategori mengikut nisbah fokus pembelajaran. Aplikasi ini membolehkan pelajar belajar secara sendiri di mana-mana sahaja tanpa rasa malu. Bahkan ada aplikasi rakaman suara yang membolehkan para pelajar merakam dan mendengar suara sendiri. Dengan cara itu mereka boleh berlatih berkali-kali sebelum menuturkan dialog yang diberikan di dalam kelas. Ini akan menambah keyakinan pelajar.

Kajian menunjukkan bahawa mendengar dan bertutur adalah dua asas paling utama dalam proses pembelajaran dan pengajaran Bahasa Arab (Zawawi et al., 2011) selain daripada kemahiran menulis dan membaca. Bahkan menurut Saleh et al., (2020) kemahiran mendengar dan bertutur turut meningkatkan kemahiran berbahasa yang lain seperti menulis dan membaca. Hal ini kerana dengan mendengar, berpotensi merangsang seseorang menulis apa yang didengari dan membacanya.

## 7. METODOLOGI KAJIAN

Kajian ini menggunakan reka bentuk penyelidikan kuantitatif. Satu set soal selidik berdasarkan konstruk Davis (1989) dan diadaptasi daripada penyelidikan terdahulu seperti Ngai et al (2005), Weng et al (2018) dan Muhamad Sufi (2019) telah diedarkan pelajar Politeknik Sultan Idris Shah yang sedang mengambil kursus Bahasa Arab. Oleh kerana jumlah populasi pelajar adalah 85 pelajar, saiz sampel yang terdiri daripada 73 pelajar sebagai responden berdasarkan kepada pandangan Krejcie and Morgan dilihat sebagai boleh diterima

Soal selidik terdiri daripada dua bahagian; Bahagian A tentang profil demografi manakala Bahagian B tentang persepsi responden mengenai Penggunaan Berkesan (4 item), Persepsi mudah guna (4 item), Sikap (4 item) dan Tingkah laku (3 item). Semua item adalah pada skala 1 (Sangat tidak bersetuju) hingga 5 (Sangat bersetuju). Berdasarkan teori *Technology Acceptance Model* (TAM), semua pemboleh ubah yang mempengaruhi penerimaan M-Hiwar telah diteliti. Alpha Cronbach digunakan untuk menentukan kebolehpercayaan. Dapatan nilai alpha Cronbach kajian ini ialah 0.940. Ini menunjukkan soal selidik yang diberikan kepada pelajar boleh dipercayai dan mempunyai kesahan yang tinggi.

Analisis kolerasi telah dijalankan untuk menentukan hubungan antara dua pemboleh ubah menggunakan *pearson correlation*. Temuan berdasarkan analisis kolerasi telah dirujuk dalam mencari jawapan kepada soalan-soalan penyelidikan.

## 8. DAPATAN KAJIAN

Melalui dapatan kajian dapat dikenalpasti tahap penerimaan pelajar terhadap aplikasi M-HIWAR yang mana menjawab objektif pertama kajian ini. Jadual 1 menunjukkan tahap skor min bagi penerimaan pelajar sama ada berada di tahap tinggi, sederhana atau rendah.

**Jadual 1.** Interpretasi min dan tahap

SKOR MIN	TAHAP
3.67 – 5.00	Tinggi
2.34 – 3.66	Sederhana
1.00 – 2.33	Rendah

### 8.1 Kegunaan yang Dirasai (Perceived Usefulness)

**Jadual 2.** Tahap penilaian persepsi penggunaan berkesan

Konstruk	N	Min (M)	Sisihan Piawai	Tahap
Persepsi Penggunaan Berkesan (PU)	73	4.5959	0.47256	Tinggi

Berdasarkan Jadual 2, tahap penilaian persepsi penggunaan berkesan terhadap aplikasi M-hiwar ialah (M=4.5959, SD=0.47256) berada pada tahap tinggi. Oleh yang demikian, dapat dirumuskan bahawa tahap penilaian pelajar berkaitan keberkesanan aplikasi M-hiwar ini sangat setuju dan mempunyai tahap yang tinggi.

### 8.2 Kemudahan Penggunaan yang Dirasai (Perceived Ease of Use)

**Jadual 3.** Tahap penilaian mudah guna

Konstruk	N	Min (M)	Sisihan Piawai	Tahap
Persepsi Mudah Guna (PEOU)	73	4.5479	0.47445	Tinggi

Berdasarkan Jadual 3, tahap kemudahan aplikasi M-Hiwar ini ialah (M=4.5479, SD=0.47445) berada pada tahap tinggi. Justeru, dapat dirumuskan bahawa aplikasi M-hiwar ini sangat membantu pelajar berinteraksi dengan jelas dan mudah difahami serta membantu dalam mencari maklumat untuk kursus Bahasa arab.



### 8.3 Sikap (Attitude)

**Jadual 4.** Tahap penilaian sikap pelajar

Konstruk	N	Min (M)	Sisihan Piawai	Tahap
Sikap (AT)	73	4.5342	0.46643	Tinggi

Berdasarkan Jadual 4, tahap penilaian sikap pelajar terhadap aplikasi M-Hiwar ini ialah (M=4.5342, SD=0.46643) berada pada tahap tinggi. Justeru, dapat dirumuskan bahawa aplikasi M-hiwar ini sangat membantu pelajar dalam memberikan idea yang baik dan bernas dalam menyelesaikan tugas dalam Bahasa arab seterusnya ianya memberikan pelajar sikap yang begitu positif terhadap aplikasi tersebut.

### 8.4 Niat Tingkah Laku untuk Menggunakan (*Behavioural Intention to Use*)

**Jadual 5.** Tahap penilaian tingkahlaku pelajar

Konstruk	N	Min (M)	Sisihan Piawai	Tahap
Tingkah laku (BI)	73	3.6758	0.72642	Tinggi

Berdasarkan Jadual 5 pula, dapatan kajian berkaitan tahap penilaian tingkahlaku pelajar terhadap penerimaan aplikasi M-Hiwar ini ialah (M=3.6758, SD=0.72642) berada pada tahap sederhana . keadaan ini berlaku kerana, berkemungkinan hampir sebahagian besar responden kurang setuju bahawa mereka sentiasa menggunakan aplikasi M-hiwar ini , mereka hanya menggunakan aplikasi M-hiwar ini bagi tujuan pengajaran dan pembelajaran di dalam kelas serta menggunakan aplikasi tersebut bagi menyiapkan tugas penilaian kerja kursus mereka.

### 8.5 Hubungan di antara Sikap/tingkahlaku Pelajar terhadap Penggunaan yang Berkesan dan Persepsi Mudah Guna Aplikasi M-HIWAR

Pengkaji juga mengkaji berkaitan dengan hubungan di antara sikap/ tingkah laku pelajar terhadap penggunaan dan persepsi M-HIWAR melalui dapatan kajian yang dianalisis menggunakan SPSS (*pearson colleration*) dalam menentukan nilai hubungan tersebut sama ada signifikan atau tidak signifikan.

**Jadual 6.** Hubungan di antara dua pemboleh ubah menggunakan *Pearson correlation*

	Penggunaan Berkesan (PU)	Persepsi Mudah Guna (PEOU)
Sikap (AT)	.832**	.859**
Tingkahlaku (BI)	.476**	.506**

Jadual 6 menunjukkan terdapat hubungan yang signifikan dalam semua pembolehubah. Hubungan yang kuat dalam menganalisis korelasi apabila nilai signifikan hampir dengan 1.0. Oleh itu, pelajar amat cenderung bahawa aplikasi M-hiwar amat mudah digunakan dalam setiap tugasannya iaitu menunjukkan signifikan 0.832. Seterusnya, pelajar cenderung untuk untuk bersikap positif bahawa M-Hiwar ini memberikan idea yang baik dalam melaksanakan kerja kursus serta pengajaran dan pembelajaran di dalam kelas dengan signifikan yang tinggi iaitu 0.859.

Manakala dalam konteks tingkahlaku pelajar terhadap penggunaan aplikasi M-hiwar terhadap peningkatan produktiviti dalam kerja kursus yang dilaksanakan , terdapat hubungan signifikan yang rendah sedikit iaitu sebanyak 0.476, ini kerana pelajar hanya menggunakan aplikasi M-hiwar hanya

ketika didalam kelas sahaja bagi tujuan pengajaran dan pembelajaran , ini kerana keperluan penggunaan ketika diluar kelas belum ada keperluan yang mendesak dan berkepentingan kalau dilihat dalam konteks sikap pelajar terhadap kemudahan dalam aplikasi M-hiwar ini dilihat amat positif berdasarkan kepada signifikan yang tinggi iaitu 0.506 dan ini juga menunjukkan ianya juga merupakan satu idea yang bernas dalam penggunaan aplikasi tersebut.

## 9. KESIMPULAN

Berdasarkan dapatan kajian penilaian, skor min yang tertinggi menunjukkan responden memilih bersetuju dengan pernyataan “*Aplikasi M-hiwar dapat meningkatkan keberkesanan dan prestasi kursus Bahasa Arab*” (4.5959) Walaubagaimanapun skor min terendah pada penilaian tingkahlaku terhadap aplikasi M-Hiwar iaitu “*Saya melakukan pendekatan Aplikasi M-Hiwar sepanjang semester.*” dengan nilai min (3.6758). Dapatan Ini selari dengan kajian Saleh et al., (2020) yang menunjukkan 92.9% responden bersetuju bahawa kaedah pembelajaran menggunakan aplikasi Android dapat meningkatkan kemahiran mendengar dan bertutur serta mampu meningkatkan pemahaman pelajar untuk mendalami sesuatu topik dan disertakan aktiviti yang merangsang minat pelajar.

Di samping itu, berpandukan dapatan kajian bagi konstruk *Perceived Ease Of Use* (PEOU) atau persepsi mudah guna , kesemua skor min adalah tinggi menunjukkan responden memilih bersetuju dengan pernyataan “Belajar menggunakan M-Hiwar akan menjadi mudah untuk saya.”, “ Interaksi saya terhadap M-Hiwar jelas dan mudah difahami.” dan “Saya mendapati M-Hiwar mudah digunakan.” dengan nilai min 4.54. Justeru, dapat dirumuskan bahawa pelajar menerima aplikasi M-Hiwar dalam membantu mereka menguasai bercakap atau bertutur dalam Bahasa Arab seterusnya membantu para pelajar mempelajari Bahasa Arab ketika didalam bilik kuliah.

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## **I-CReST 2023:237-197 - Animatic in a Nutshell: Animated Storyboard**

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### **ABSTRACT**

An animatic serves as a planning tool for animation, allowing for the precise sequencing of shots and soundtrack. An animatic essentially consists of a series of storyboard images arranged in the correct order to narrate the story. However, there is limited research focused on the animatic within the pre-production pipeline. Many students encounter difficulties at the initial stages of pre-production, such as the inability to effectively convey the storyboard images in their intended storyline and the absence of a standardized resolution format. Hence, this study aims to emphasize a workflow method that covers the entire process, starting from the conception of the idea and concept, all the way through to the execution of the animatic itself. By establishing this workflow method, educators can provide students with a valuable tool to facilitate brainstorming and the creation of composite animatic for animation. Additionally, this workflow method can be implemented across other animation subjects that involve storytelling and the production of short animated films.

**Keywords:** Animation; storytelling; animatic; storyboard; pre-production

### **1. INTRODUCTION**

According to Kelly and [1], an animatic is simply the separate storyboard images displayed in the proper sequence to tell the story. The images are placed on a timeline in Adobe After Effects to make a rough edit of the animation's final year project. This helps to determine exactly what the audience will be seeing and for how long it will be on the screen. Sound effects and background music can even be added to the audio timeline (if the project has dialogue) to determine the timing of spoken lines. This method is established to provide educators with a tool to help the learners in brainstorming, and compositing animatics for animation. This method was established to help the students of Animation in College of Creative Arts, especially the new ones, to execute animatics better so they will be able to produce good quality creative work in the future. According to Adib and Naghdi [2], animatic is a unique opportunity to test the overall visual flow and timing of the project and check if the intended meaning is conveyed or not. Hence, as the lecturer for the course, a teaching method was developed to help the students to understand how to develop animatics for animation. First, it provides educators with a tool to help learners in brainstorming and compositing animatics in animation. Next, to help the students of Animation in the College of Creative Arts, especially the new ones, to execute animatics better so they will be able to produce good quality creative work in the future. Finally, to make learners and students understand how to develop animatics for animation.

This teaching method is novel in terms of its structure. By developing this pipeline, it helps countless students and learners to develop animatics from the early stage of pre-production, after the storyboard has been produced, to act as timing/pacing guidelines for the animators and directors. At this stage, it will help to give a whole outlook of the animation and could save time and costs while making changes to the visual storyline. It is especially useful when students will apply this pipeline when working in the industry after they have graduated.

There is limited research in terms of the pre-production pipeline, specifically for animatics. Most students are facing the same problem at the beginning of the pre-production, the images from the storyboard are not conveyed into their storyline and they are not using the standardized resolution format. Thus, this research is to highlight the workflow method from the beginning of idea and concept, into the execution of animatics itself.

## 2. ANIMATIC PIPELINE

This pipeline is useful for educators and students, especially in animation fields in producing good quality creative works. It can help students to have a better understanding of pre-production for animation final-year projects. Hence, this knowledge will become beneficial to them when they are working in the industry.

According to Chamber [3], animatics are a reference point for frame timing, without this, it is easy to get lost in the details of the animation and lose sight of the overarching storytelling. Also, it helps in making quick changes, in case there are multiple scenes that are not relevant or required, it will save much time by removing those scenes in the early stage of animation.

At this stage, dialogues/voice-overs and sound effects were placed together in the animatics. It eliminates the need for complementary explanations beneath the storyboard and speaks much more through moves, dialogues and soundtracks. Compared to the storyboard, the animatic is a much clearer representation of the final product. It provides an opportunity to refine camera angles and framing before getting into production.

In the realm of student group projects, the 2D animation pipeline unfolds as a collaborative masterpiece. It commences with conceptualization, where a tapestry of ideas converges into a storyboard, setting the visual narrative in motion. With meticulous finesse, illustrators sketch characters and backgrounds, infusing essence into each stroke. As frames dance in sequence, animators breathe life into the drawings, orchestrating a mesmerizing choreography. Colorists infuse vibrancy, while sound designers add the auditory dimension, culminating in a harmonious synthesis. Through seamless teamwork, editing, and post-production finesse, the 2D animation springs to life, embodying the collective talent and synergy of the student ensemble. To put it into the image, here are some examples of the animation pipeline through students' group work for the final year project.

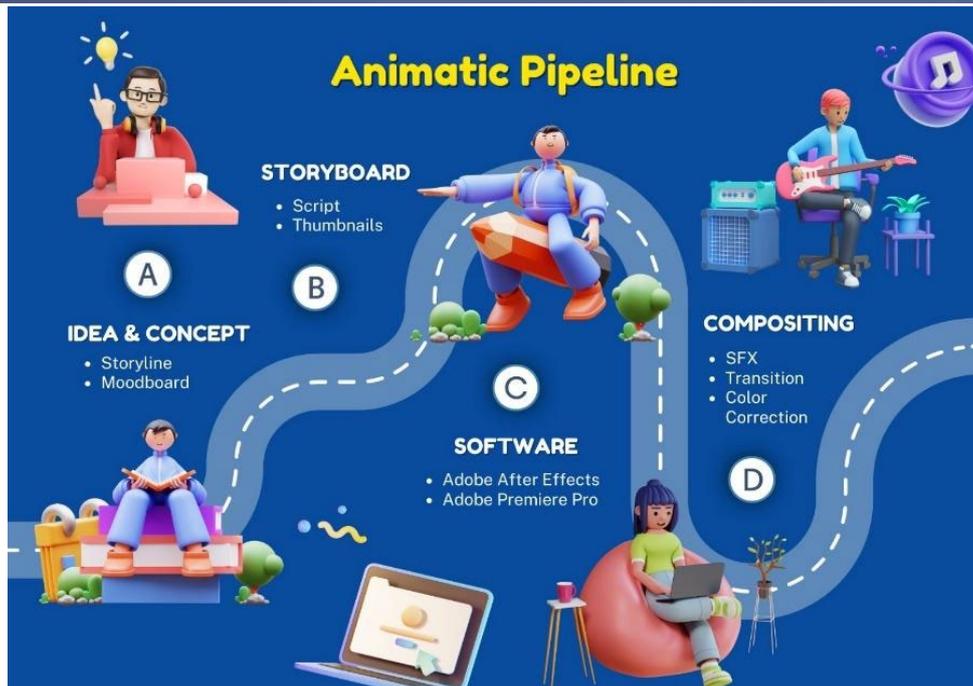


Fig. 1. Animatic process

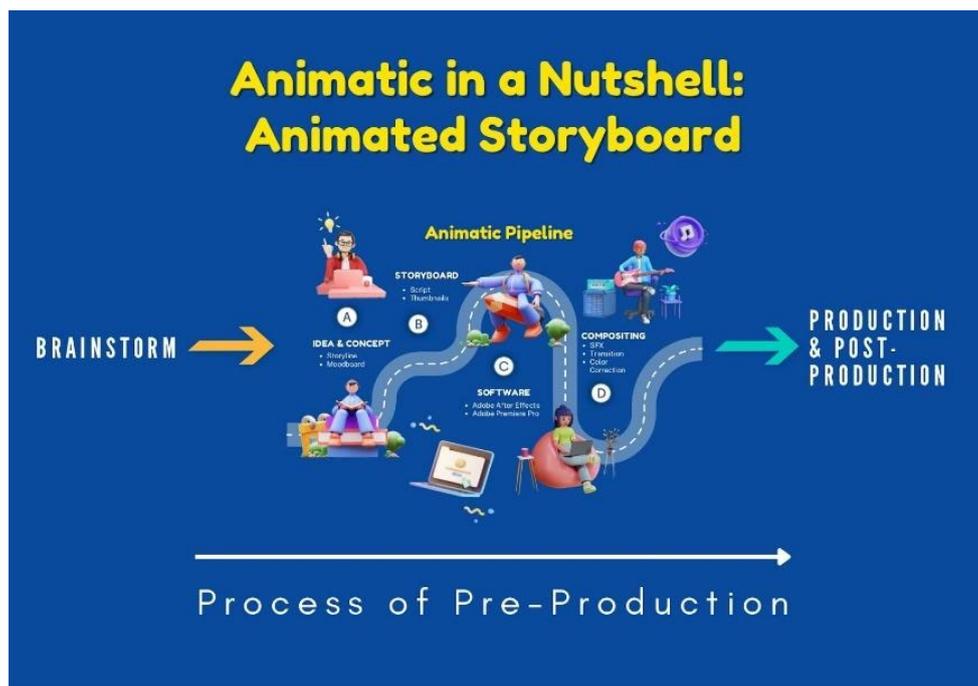
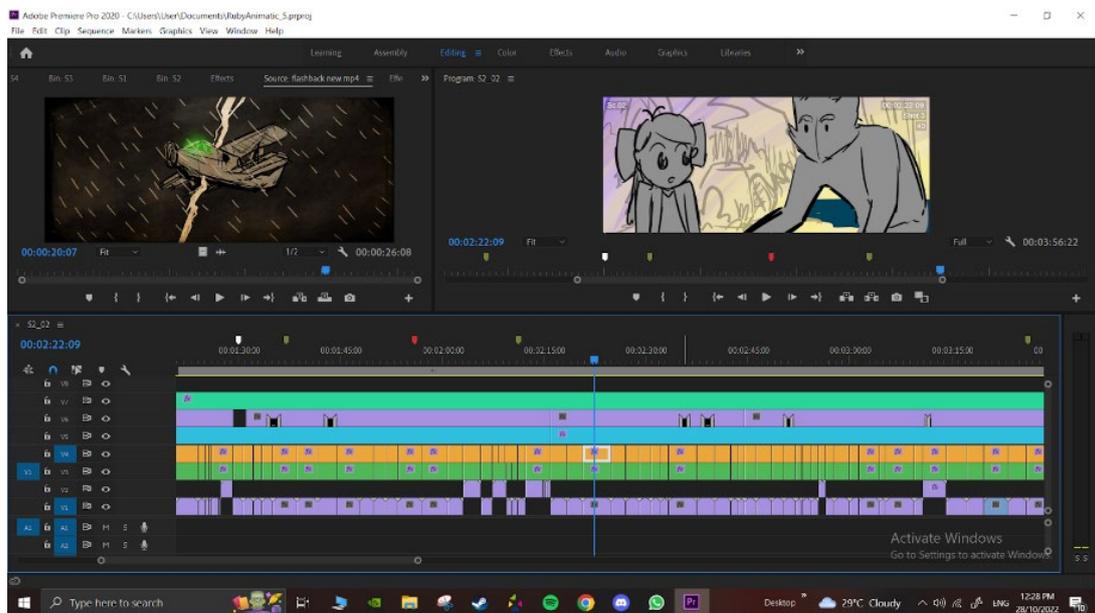


Fig. 2. Animatic pipeline

The lecturer's role is to guide the students, while students will do a collaboration together to share ideas and knowledge to accommodate new information. Collaboration among students is a cornerstone of modern education, and lecturers play an instrumental role in fostering this collaborative spirit.



**Fig. 3.** Process of animation pipeline in student's final year project



**Fig. 4.** Process of animation pipeline in student's final year project



**Fig. 5.** A collaboration of ideas in group work among students

In a collaborative learning environment, the exchange of ideas and knowledge takes centre stage. Students draw from their individual experiences and backgrounds, enriching the collective pool of understanding. This sharing of ideas not only leads to a deeper comprehension of the subject matter but also enables the accommodation of new information. Lecturers empower students to be active contributors to this process, fostering an atmosphere where curiosity thrives and creativity flourishes.

## 2.1 Animatic Contribution

According to Torta and Minuty [4], animated storyboards can streamline pre-production and production for a more effective and time-saving workflow when you have a project using a script or narrative that needs to be translated into a visual form. It can help the Director to save the cost by using the same animatics for different kinds of purposes in their production. This innovation has an influence on what we contribute to the world by creating a new process that can be refined to meet other requirements in the future.

This method will help the student and animation producer to produce a good, animated storyboard and ultimately give impacts to the industries. Animatic in a Nutshell: Animated storyboard gives complete control of the outcome during the animatic process and any potential problems can be resolved before the production phase begins.

### 2.1.1 Conceptual Framework

There are three educational theories of learning. Firstly is Behaviorism, which is learning is the passive acquisition of new behavior. Behaviorism in action is where the role of the teacher is to present, and the role of the student is to observe. The closest example is the students observing the behavior of the teacher while teaching in class. Secondly is Cognitivism, where learning involves actively acquiring and reorganizing cognitive structures through participation. Cognitivism in action is when the role of the teacher is to encourage problem-solving and guide thinking; the student's role is to develop concepts and reflect. For example, during handing out assignments in class, the teacher will advise students on how to go through

the assignments step-by-step, and the students will execute the assignment by developing their own ideas and concepts, and reflecting on the execution. Lastly is Constructivism, where learning is the active search for meaning, building on the existing understanding of the individual. Constructivism in action is where the role of the teacher is to guide, and the role of the students is to collaborate with other students and incorporate new information.

This pipeline uses the theory of learning in constructivism as it is seen as suitable for the process of creating an animatic storyboard. Through the educational theory of learning in Constructivism, it has been treated into four parts: a short historical introduction, a discussion of the view of knowledge presupposed by the theory, an account of how the theory treats learning and student motivation, and, finally, an overview of some of the instructional methods promoted by the theory is presented in GSI Teaching & Resource Centre [5].

**Table 1.** Educational theories of learning, GSI teaching & resource centre [5]

	<b>Behaviorism</b>	<b>Cognitive Constructivism</b>	<b>Social Constructivism</b>
<b>View of knowledge</b>	Knowledge is a repertoire of behavioral responses to environmental stimuli.	Knowledge systems of cognitive structures are actively constructed by learners based on pre-existing cognitive structures.	Knowledge is constructed within social contexts through interactions with a knowledge community.
<b>View of learning</b>	Passive absorption of a predefined body of knowledge by the learner. Promoted by repetition and positive reinforcement.	Active assimilation and accommodation of new information to existing cognitive structures. Discovery by learners is emphasized.	Integration of students into a knowledge community. Collaborative assimilation and accommodation of new information.
<b>View of motivation</b>	Extrinsic, involving positive and negative reinforcement.	Intrinsic; learners set their own goals and motivate themselves to learn.	Intrinsic and extrinsic. Learning goals and motives are determined both by learners and extrinsic rewards provided by the knowledge community.
<b>Implications for teaching</b>	Correct behavioral responses are transmitted by the teacher and absorbed by the students.	The teacher facilitates learning by providing an environment that promotes discovery and assimilation/accommodation.	Collaborative learning is facilitated and guided by the teacher. Group work is encouraged.

### 3. CONCLUSION

In conclusion, the development of a comprehensive animatic pipeline for animation pre-production is a crucial innovation in the field of education and creative work. This method, as proposed by Kelly and Rosson [1], Adib and Naghdi [6], serves multiple purposes, such as aiding educators in guiding learners through brainstorming and compositing animatics, enabling students to understand the process of animatic creation, and enhancing the overall quality of creative projects. The animatic pipeline not only provides a visual and auditory representation of the final animation but also acts as a timing and pacing guideline, helping

animators and directors refine their work before production. By integrating dialogues, sound effects, and background music, the animatic offers a comprehensive understanding of the project's flow and storytelling. Moreover, this method addresses the common challenges faced by students during pre-production, ensuring that the transition from storyboard to animatic is smooth and effective. This pipeline's significance extends beyond the educational realm, as it prepares students for the industry by instilling essential skills and practices. Through seamless teamwork, this pipeline transforms conceptualization into a vibrant and captivating 2D animation, showcasing the collaborative talent and dedication of student groups. As a result, this novel teaching method significantly contributes to the growth and success of animation students, equipping them with the tools they need to excel in their creative endeavors.

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## **I-CReST 2023:246-214 - The Effectiveness of Flipped Classroom Approach in Enhancing Students' Mastery in Using Passive Voice**

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### **ABSTRACT**

Flipped Classroom has emerged as a viable alternative to conventional lesson as it provides ample time for students to explore the subject matter prior the class, and extra time to practice during in-class activities. These characteristics of flipped classroom approach matches the needs of Generation Z who needs personalized experiences, autonomous learning, and collaborative ways in learning. Since the students in polytechnics seemed to have problem with constructing passive voice sentence, flipped classroom is expected to be the solution to this problem. Therefore, the main objectives of this study are to explore the effectiveness of flipped classroom in helping students mastering passive voice; and to study students' perception towards flipped classroom. The participants were 60 Semester 2 students from Polytechnic of Muadzam Shah. Pre-test and post-test were given to both experimental and control group to measure their mastery in using passive voice. A questionnaire was also employed to elicit students' perception towards flipped classroom for grammar lesson. The data were analysed and reported using Statistical Package for Social Science (SPSS) version 24. Findings suggest that the experimental group showed a greater improvement than the controlled group in using passive voice after the implementation of flipped classroom. The students also believed that flipped classroom is useful, giving them a sense of autonomy, while providing more engagement, satisfaction, and motivation, as well as reducing their anxiety.

**Keywords:** Communicative English; flipped classroom; grammar; passive voice

### **1. INTRODUCTION**

Contemporary practices to teaching and learning are constantly being explored in today's rapidly shifting educational environment to address the diverse needs of students, especially the Generation Z. Generation Z, or better known as Gen Z are the individuals born from 1996-2010 [1]. Being technologically savvy from birth, they have specific learning preferences that have been influenced by their experiences. This generation desire personalized experiences [2] as well as autonomous learning [3]. Designing effective educational strategies that appeal to Gen Z students requires an understanding of these inclinations.

The flipped classroom strategy fits in well with the learning styles of students in Generation Z. Their demands for active involvement, independence, and individualised learning experiences are met by its features. It can enable students to invest their time in independent self-study away from the classroom [4] and it increased students' self-efficacy to learn independently [5]. The Flipped Classroom makes use of Gen Z's comfort with digital

tools and platforms, encourages active learning through hands-on activities, and permits flexibility and personalization in the educational process.

Grammar proficiency is crucial for effective communication in language learning. Many students, however, find it difficult to perform successfully in grammar lectures. Karnine, Preece, and Muhammad [6] investigated the skills in English language learning required for tertiary level students in a polytechnic and found that majority of students claimed they have a weakness in using grammar correctly. Despite using typical classroom strategies to teach grammar, this issue still exists, indicating the need for creative teaching strategies that can improve students' knowledge of these concepts. A meta-analysis was done on the use and implementation of flipped classroom in Malaysia, and it is suggested further research be carried out specifically to study the impact of using the Flipped Classroom technique in teaching English among students [7].

Although the Flipped Classroom strategy has gained popularity throughout the world, there is still a study deficit on its use in Malaysian tertiary education, particularly in relation to grammar instruction. According to Rahman, Yunus and Hashim [8], the studies conducted on Flipped Classroom in Malaysia are still limited compared to the studies done worldwide. This study intends to add to the body of information on cutting-edge teaching techniques suited to Gen Z students' preferred learning styles by filling in these gaps and investigating the possibility of the Flipped Classroom approach in improving students' mastery of grammar, or passive voice in particular and thus seeking answer to the research questions:

1. Does the implementation of flipped classroom help in improving students' mastery in using passive voice?
2. What is the perception of students towards flipped classroom?

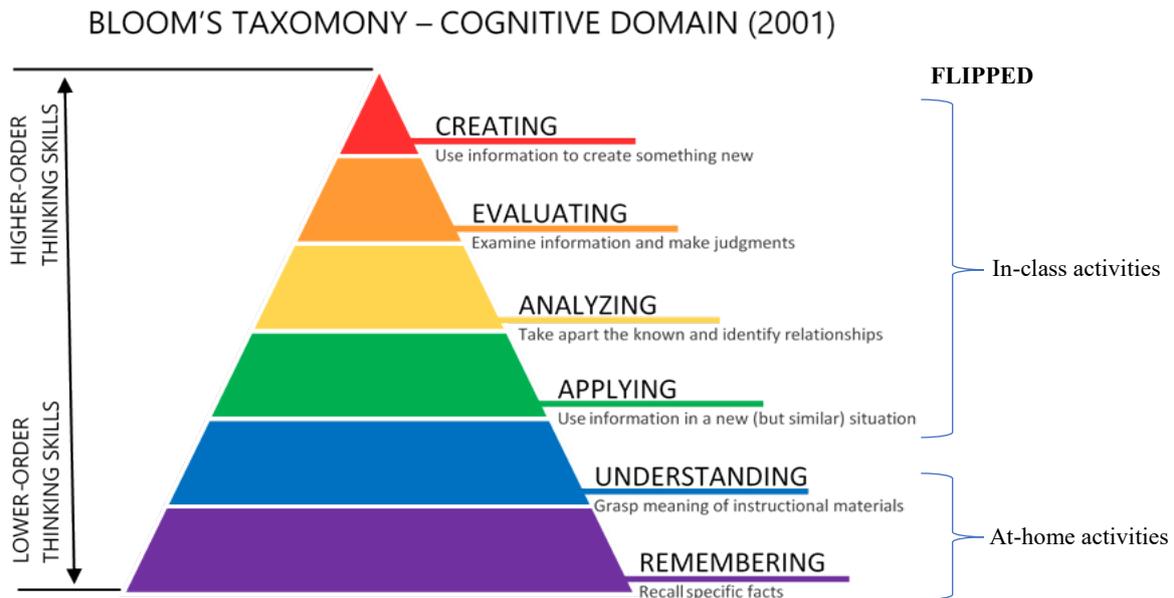
## **2. LITERATURE REVIEW**

### **2.1 Flipped Classroom and the Theories Behind It**

Based on the previous research, Bloom's Taxonomy is said to be one of the relevant theories for Flipped Classroom. It is fair to say that Bloom's taxonomy was primarily chosen as the framework for designing and implementing the Flipped Classroom [9]. It is because students engage in lower-level cognitive work (remembering and understanding) outside of class and concentrate on higher-level cognitive work (applying, analysing, evaluating, and creating) in class, where they have their peers' and the instructor's support [10]. Zain and Sailin [11] also proposed the same idea where low-level thinking skills such as memorizing and understanding are attained outside classroom while high-level thinking skills such as applying, analyzing, evaluating, and creating are developed during class. This claim is supported by Ghufron and Nurdianingsih [12] who agreed that the lower stages of Bloom's taxonomy, is performed at home and the higher-level activities are done during lectures. In another study, it is appealed that Flipped Classroom moves the two indispensable concepts of Bloom's Taxonomy (remember and understand) to the home environment, while the more intricate concepts (apply, analyze, evaluate, and create) stay in the classroom [13].

In reference to Fig. 1, the skills emphasised at the base of the triangle (remembering and understanding) occur outside of class without the instructor supervision. It means that students can revise the stimuli given by the instructor as many times as necessary in order to help them recall information and grasp concepts. As for the skills in the middle – analysing and applying

– they take place in class with the assistance from the instructor or the peers. This stage provides a more collaborative opportunity than the lower levels. Next, at the higher levels namely evaluating and creating, they are shifting towards student autonomy even though collaboration is still possible at this level. Theoretically, once students grasp a topic, they should be able to do assignments independently and accurately [14].



## 2.2 Flipped Classroom in ESL Classroom

In the past few years, many studies have focused on student accomplishment and how flipped classroom improves students' levels of English language performance, particularly the writing skills. A review done by Turan and Akdag-Cimen [15] revealed that writing was the most studied language skills after speaking. This claim was further strengthened by Baltaci [9] who discovered the same findings where writing was the most frequently studied skill. Even so, that does not mean Flipped Classroom is not applicable to other language skills such as speaking, reading, listening, or even grammar components.

Flipped Classroom also assists students in improving their speaking skills where the effectiveness was proven when 27 undergraduate students show improvement in their speaking post oral test [16]. Students also show improvement in speech act production when Flipped Classroom was applied to the experimental group of students aged 13 to 19 [17]. Bin-Hady and Hazaea [18] discovered that with the intervention of Flipped Classroom, students' pronunciation was getting better. As for reading skills, Abbasian and Azeez [19] claimed that Flipped Classroom has a positive effect on the students' reading comprehension.

## 2.3 Attitudes and Perceptions towards Flipped Classroom

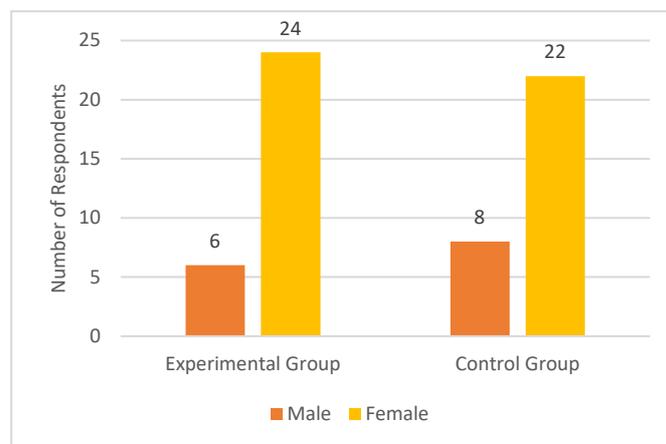
A vast number of studies has been conducted to study students as well as educators' attitude and perceptions towards Flipped Classroom. The majority of the studies observed that Flipped Classroom contributes essentially to students' motivation and engagement. Students aged 19 to 36 were found to be more motivated and engaged to the lesson when Flipped Classroom was

implemented [20]. On the other hand, Zain and Sailin [11] discovered that the higher education students showed positive attitudes towards Flipped Classroom which supports the engagement model. Betaubun [21] who did research on 200 students further discovered the Flipped Classroom encouraged motivation. Hajebi [22] studied a wide age range of students also concluded that Flipped Classroom boost the motivation of students thus improving their attitude and performance. In other studies, Flipped Classroom was found to make learning process more effective by enhancing students’ motivation, involvement, and engagement [23], [17]. Hashim and Shaari [24] who studied the perception of Malaysian teachers documented the respondents agreed that Flipped Classroom motivates students to be independent.

### 3. METHODOLOGY

Experimental research design which is under quantitative research method was adopted in this study as it employs the use of two groups, experimental and control groups, in which only the experimental group received treatment with the aim of determining the nature of relationship between variables under study [25].

The target population are Semester 2 students of Polytechnic of Muadzam Shah and convenience sampling was done to get the sample size of 60 respondents as the respondents are easily accessible to the researcher [26]. The demographic details of the respondents are as presented in **Fig. 2**.



**Fig. 2.** Demographic details by gender

The sample of this study comprised of 14 male students and 46 female students from Commerce Department, studying Communicative English in Semester 2. The sample was separated into two equal groups. The experimental group experienced the implementation of flipped classroom while the control group were taught using the traditional way.

Pre-test and post-test were executed as the mean to study the first research question. The tests were following the format and rubrics of the Assessment 2 from the course Communicative English 2. Additionally, a questionnaire was employed to answer the second research question. The questionnaire was adopted and adapted from Haghghi, Jafarigohar, Khoshsima, and Vahdany [27]. The questionnaire was divided into two sections only, namely Section A and B, where Section A focuses on demographic details while Section B which comprises of 20 items seeks to examine the perceptions of students towards flipped classroom.

The pre-test and post-test scores were then analysed in SPSS 24 to study the difference and the data from the questionnaire were also analysed in SPSS 24 to compare the mean scores.

#### 4. FINDINGS AND DISCUSSIONS

##### 4.1 Does the Implementation of Flipped Classroom Help in Improving Students' Mastery in Using Passive Voice?

To answer the first research question, pre-test and post-test were employed in the experimental group. As shown in **Table 1**, a paired sample t-test revealed a significance difference in the pre-test and post-test scores before and after the flipped classroom,  $t(29)=-9.483$ ,  $p < 0.05$ . This indicates that the mean post-test score after the implementation of flipped classroom ( $M=14.08$ ) was significantly higher than the mean before the implementation ( $M=10.13$ ). It is shown that the implementation of flipped classroom has positive effect to the respondents.

**Table 1.** The value of t and its significance for the differences between the pre-test and post-test scores of the experimental group

Test	N	Mean	Std. Deviation	t-value	Sig (2-tailed)
Pre-Test	30	10.13	3.014	-9.483	0.00
Post-Test	30	14.80	2.441		

An independent t-test was also run to identify the difference in the mean of post-test scores between controlled and experimental group. The results in **Table 2** indicate that there was a significant difference in students' mean scores between controlled and experimental group after the implementation of flipped classroom in teaching passive voice  $t(58)=3.661$ ,  $p\text{-value} = 0.01$ . That is, the mean of post-test scores of the experimental group ( $M= 14.08$ ,  $SD=2.441$ ) was significantly different from the controlled group ( $M=12.67$ ,  $SD=2.057$ ). The mean scores of the experimental group are slightly higher than the mean scores of the controlled group.

**Table 2.** The value of t and its significance for the differences between the experimental and control groups in the post-test scores

Group	N	Mean	Std. Deviation	t-value	Sig. (2-tailed)
Experimental Group	30	14.80	2.441	3.661	0.01
Control Group	30	12.67	2.057		

##### 4.2 What is the Perception of Students towards Flipped Classroom?

To address the second research question, students' perceptions towards flipped learning experiences was assessed using the Flipped Learning Experience questionnaire. The questionnaire statements represented the dimensions of usefulness, autonomy, engagement, satisfaction, motivation, and anxiety. **Table 3** shows that participants with flipped instruction had a favourable attitude, with mean scores of 4.35, 4.39, 4.35, 4.37, 4.40, and 4.43 for usefulness, autonomy, engagement, satisfaction, motivation, and anxiety, respectively. The high mean scores proved that the students agreed the flipped classroom (1) helped them in learning passive voice, (2) evoked the sense of autonomy to learn in themselves, (3) encouraged them to engage in classroom activities, (4) promoted their motivation to learn grammar, (5) increased their satisfaction in learning grammar, and (6) lessened their anxiety to learn.

**Table 3.** Mean score and standard deviation of the dimensions

	Usefulness	Autonomy	Engagement	Satisfaction	Motivation	Anxiety
<b>Mean</b>	4.35	4.39	4.35	4.37	4.40	4.43
<b>SD</b>	.567	.586	.593	.678	.603	.626

### 4.3 Discussions

The main objective of this study is to determine the effectiveness of flipped classroom. Based on the results in 4.1, it is found that flipped classroom does benefit students to master passive voice when there was a significant increase in the mean score of the post-test score of students in the Experimental Group. It is also found that there was also a significant difference between the post-test score of the Experimental Group and Controlled Group. This signals the effectiveness of the flipped classroom in developing students' understanding of passive voice structure.

This finding is in line with Khasawneh [28] who projected flipped classroom strategy to be effective in developing grammatical concept among students. Looking at the same context of learning grammar, Teo and Sathappan [29] also discovered that flipped classroom assists students better in building their mastery level of English adjectives when compared to the traditional classroom approach. Nguyen, Tan and Lee's [30] claim further supports the idea of using flipped classroom in teaching grammar when they indicated flipped classroom to be a promising teaching approach in the field of English grammar instruction.

The second objective of this study, which is to study students' perception towards flipped classroom, has led to a discovery where students exhibited favourable perceptions towards the flipped classroom. In reference to 4.2, albeit all dimensions received positive feedbacks, Anxiety, Motivation, and Autonomy appeared to be the dimensions with the highest mean score at 4.43, 4.40 and 4.39 respectively.

Learning grammar has always been associated with complexity thus leading to anxiety and lack of motivation. However, with an effective flipped classroom approach, it impacts the learning environment which has proven to alleviate students' anxiety [31]. Abdullah, Hussin and Ismail [16] also found their respondents to perform better when their anxiety is eased in flipped classroom. Aside from reducing the anxiety, a study by Afzali and Izadpanah [17] revealed that the implementation of flipped classroom in grammar classes has effect on learners' motivation regardless of their level of proficiency. This is due to the integration of digital tools in flipped classroom which promotes learning outside classroom and enhances the motivation of Gen Z who desire personalized experiences [2]. It is also closely related to their desires to be autonomous. Looking back at the Revised Bloom's Taxonomy, flipped classroom allows the first two level to be experienced without the strict supervision from the educators which contributes to differentiation, personalization of learning as well as promoting students' autonomy [8]. They also added that flipped classroom promotes autonomy by offering the class times for more discussions, collaborative inquiry, interaction, and hands-on activities.

## 5. CONCLUSION

This study is highly relevant to the study of grammar instruction and the teaching of the passive voice in language education. The goal of this study is to shed light on a pedagogical strategy that could raise students' proficiency level with the passive voice by examining the efficacy of

the flipped classroom approach. The results of this study have ramifications for language educators since they show how well the flipped classroom approach help students understand and use passive voice. With the knowledge of the benefits of flipped classroom, the educators should maximize the flipped classroom to tap the interest of the students in learning grammar. They could also create a more participatory and motivating learning environment by using the flipped classroom paradigm, which could boost student motivation, and autonomy as well as lessen the anxiety in learning grammar. Therefore, it would be a great initiative to further study on teachers' readiness and needs to implement flipped classroom for grammar courses.

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## **I-CRest 2023:284-257 - Computer-aided Experiments as A Learning Tool in Learning Physics at the Center for Foundation Studies, IIUM (CFS IIUM)**

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### **ABSTRACT**

Physics is comprehended by students as an intricate and tough subject, hence innovative approach in teaching Physics is very essential. Students shall be engaged and motivated in learning Physics whenever they have an interest in Physics. Conducting experiments as one of the methods used to help the students in understanding physics concepts could promote interest in students. This study presents the role of computer-aided experiments as a learning tool in making the physics subject more interesting at CFS, IIUM. To ensure the students are more engaged in the learning process the practical session in the laboratory is embedded in between the classroom theory session. The experiments established in our laboratory comprised of manual experiments and computer-aided experiments. In performing manual experiments, the experimental data is gained by using a ruler, stopwatch, thermometer or by direct observation. Apart from the manual experiments, the students are also performing computer-aided experiments. These experiments use sensors linked to an interface namely the Science Workshop and connected to computer with Data Studio software as a data acquisition, display and analysis program. Three computer-aided experiments conducted in our Physics Laboratory were discussed in this paper, explicitly the Standing Wave, Induction and Simple Harmonic Motion. The technique in performing computer-aided experiments is providing automation in controlling and manipulating the parameters, analysing processes in creating graphs efficiently and the data can be examined directly and accurately in real-time by the students. A questionnaire with six survey items on computer-aided experiments was distributed to CFS IIUM students undergoing physics courses. Of 178 respondents, more than 80% agreed on the use of computer-aided experiments enhanced their interest and ability to integrate theory with practice in learning physics.

**Keywords:** Computer-aided experiment; data studio; science workshop interface

### **1. INTRODUCTION**

Innovative methods in teaching physics are important since physics is perceived by the students as a difficult subject. Promoting interest can contribute to a more engaged and motivated learning experience for the students. It is crucial to have practical and hands-on experiments to aid the teaching and learning of Physics and other science subjects in general. Physics as a component of natural science is a science where students are not only required to memorize formulas and work on problems with formulas that are already available but are also required to know the problem, describe problems, and provide ideas and opinions of each problem found

[1]. Rozanski, 2020 has studied the need of using computer-aided experiments in the physics teaching process. He concluded that after acquiring the skill of performing computer-aided experiments, students are better at methods of data processing, presentation of measurement results, modelling, and in applying modern theories in the interpretation of physical phenomena [2]. Through experiments, the learners can develop their scientific abilities, improve their attitude toward science and understand the nature of science and the process of scientific investigation [3].

Particularly, Physics experiments can certainly become tools to increase interest in learning Physics. Nugroho and Waslam (2020) in their studies on Physics experiment activities to stimulate interest in learning Physics in high school concluded that physics experiment activities accompanied by challenging questions can improve students' interest in their learning [4]. Physics experiments can be done manually or aided by computer software. In recent years, computer-aided experiments play an increasing role in teaching physics at various levels of education. Educators can create a more creative learning environment with computer-aided experiments to enhance their student understanding of the Physics concept. As early as 2003, Jeskova in his study encountered the positive influence of computer-aided experiments on students' understanding of kinematics and direct electric current concepts. His finding indicated that even though it has not been proved in the case of magnetic field teaching, from the research results he still can conclude a definite improvement in student's abilities to interpret graphs [5].

This study reported on the role of computer-aided experiments as a teaching and learning tool in making the physics subject more interesting at Centre for Foundation Studies, International Islamic University Malaysia (CFS, IIUM). The practical session in the laboratory is embedded in between the classroom theory session to ensure the students are more engaged in the learning process. The experiments developed in our laboratory consist of manual experiments and computer-aided experiments. In performing manual experiments, the experimental data are gained by using rulers, stopwatches, thermometers or by direct observation where the data are prone to human error, time-consuming and less accurate. The computer aided experiments use sensors linked to an interface namely the 750 Science Workshop and are connected to the computer with Data Studio software as a data acquisition, display, and analysis program. Three computer-aided experiments performed in our Physics Laboratory were discussed in this study, namely the Standing Wave, Induction and Simple Harmonic Motion. The method of performing computer-aided experiments provides automation in controlling and manipulating the parameters, an efficient analysis process in creating graphs and the data can be analyzed directly and accurately in real-time.

## **2. WHAT IS A COMPUTER-AIDED EXPERIMENT?**

Traditionally, experimental data is gained manually by using a ruler, stopwatch, or direct observation. No computer is involved in the experiment and is prone to human error. Furthermore, it is very slow and not so accurate. Computer-aided experiments are experiments that use sensors hooked to an interface. The interface will interpret the data and send it to the computer. The software inside the computer will analyze the data to get a result. The method is very fast and accurate. The data can be analyzed directly, and it is very versatile which allows more choices of experiments to be performed. Fig. 1 shows the working principle of computer-aided experiment which consists of the four main components: interface experimental set-up, sensors, and software.

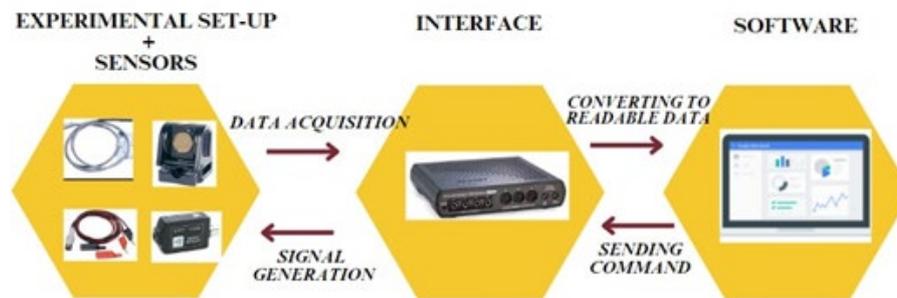


Fig. 1. Working principle of computer-aided experiment

Experimental data are retrieved using sensors such as force sensors, motion sensors, temperature sensors or sound sensors that are connected to the 750 Science Workshop interface. The interface will interpret the data and send it to Data Studio software to be further analyzed. The interface could also generate signals, for example, the sine wave or the square wave. On the other hand, the Data Studio acted as a software tool to facilitate data acquisition, display and analysis programs. Four digital channels and three analogue channels are on the 750 Science Workshop interface. Multiple sensors could be attached to the interface simultaneously, allowing more parameters to be measured and analyzed. The sensors then need to be set on the Data Studio software, for the system to communicate.

### 3. EXAMPLES OF COMPUTER-AIDED PHYSICS EXPERIMENTS

Three computer-aided experiments conducted in our Physics Laboratory were discussed in this paper, explicitly the Standing Wave, Induction and Simple Harmonic Motion.

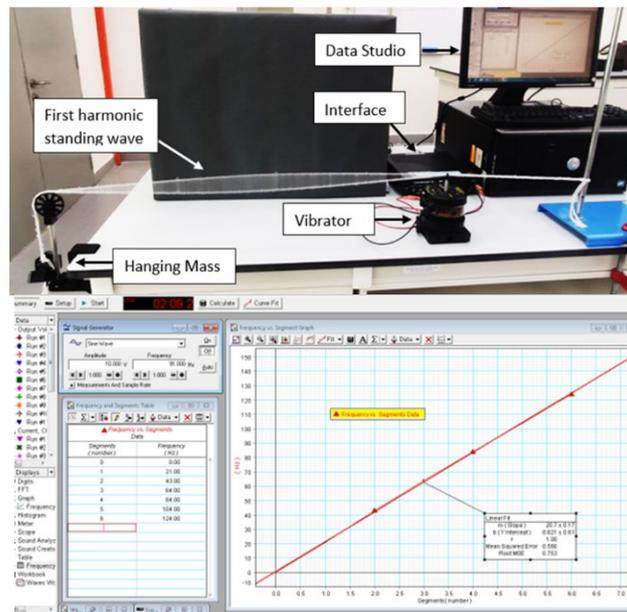
#### 3.1 Standing Waves

Standing waves occur when two identical waves travelling in opposite directions interact with each other at a specific vibrating frequency. In a string fixed at both ends the resonance frequencies at which the standing waves occur are given by,

$$f_n = \frac{n}{2L} \sqrt{\frac{T}{\mu}} \quad (1)$$

where  $n$  is the number of harmonic series,  $T$  is the tension of the string,  $\mu$  is the linear mass density of the string and  $L$  is the effective length. When the frequency is increased, the number of segments observed will also increase.

Fig. 2(a) shows the experimental setup where a hanging mass is suspended at one end of the string to provide tension to the string. The other end of the string is connected to the vibrator whose frequencies are controlled by the Data Studio software using the signal generator function.



**Fig. 2(a)** Experimental set-up for standing waves and **(b)** graph of frequency versus number of segments

The frequency of the vibrator is adjusted to get various harmonics of standing waves. The number of segments of the respective frequency is recorded. From these data, a graph of frequency versus number of segments as in Fig. 2(b) is automatically plotted and displayed. The linear mass density could be calculated from the slope of the graph by using Equation (1).

### 3.2 Induction

Faraday's Law of induction is applied in magnetic induction experiments. When a magnet is moving passed a coil, it will create a change in the magnitude of the magnetic flux in the coil. The changing magnetic flux will induce an emf in the coil as given by

$$\varepsilon = -N \frac{\Delta\phi}{\Delta t} \quad (2)$$

where  $\varepsilon$  is the induced electromotive force (emf),  $N$  is the number of turns of the coil,  $\frac{\Delta\phi}{\Delta t}$  is the rate of change in the magnetic flux through the coil. The magnetic flux through the coil with area  $A$  is defined as

$$\phi = BA \cos \theta \quad (3)$$

where  $B$  is the magnetic field strength,  $A$  is the area of the loop, and  $\theta$  is the angle between  $B$  and normal to the plane of the area. In this experiment, a plot of emf versus time and the area under the curve is found by an integral process of the curve. This area represents magnetic flux.

Fig. 3(a) shows a permanent magnetic bar released through a coil with  $N$  turns of loops that is connected to a voltage sensor. As changes of flux occur through the coil, induced emf will be produced and measured by the voltage sensor. The induced emf is collected in a very short time which is less than 0.3 s and displayed by the software as shown in Fig. 3(b).

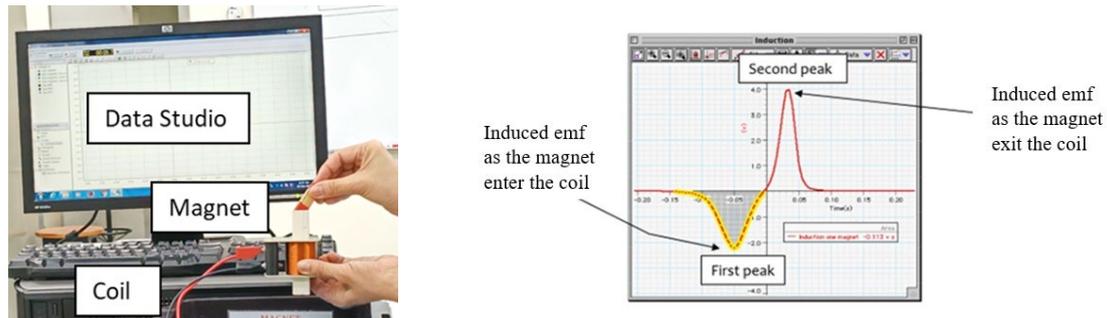


Fig. 3(a) Experimental set-up for magnetic induction and (b) Graph of induced emf versus time [6]

### 3.3 Simple Harmonic Motion

Simple harmonic motion (SHM) experimentation is a great way for students to explore the world of physics in the classroom [7]. It is a type of periodic and repetitive motion of an object from its equilibrium position. One of the examples of SHM is the mass-spring system where a mass is attached to the end of the spring. If the mass is stretched or compressed for a small distance  $x$  from its equilibrium position, it exerts a spring force,  $F$  known as restoring force. This force  $F$ , is found to obey Hooke's Law given by the equation of

$$F = -kx \quad (4)$$

where  $k$  is the constant called the spring constant. Fig. 4 shows a variation in amplitude, frequency, and period of a vertical mass-spring system. The position of the oscillating mass in SHM is described by the equation,

$$y = A \sin \omega t \quad (5)$$

where  $y$  is the distance from the equilibrium position at time  $t$ ,  $A$  is the amplitude of the motion and  $\omega$  is the angular frequency of the oscillation.

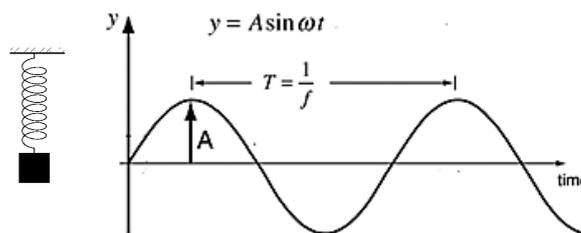


Fig. 4. Variation of amplitude, frequency and period of a vertical mass-spring system [6]

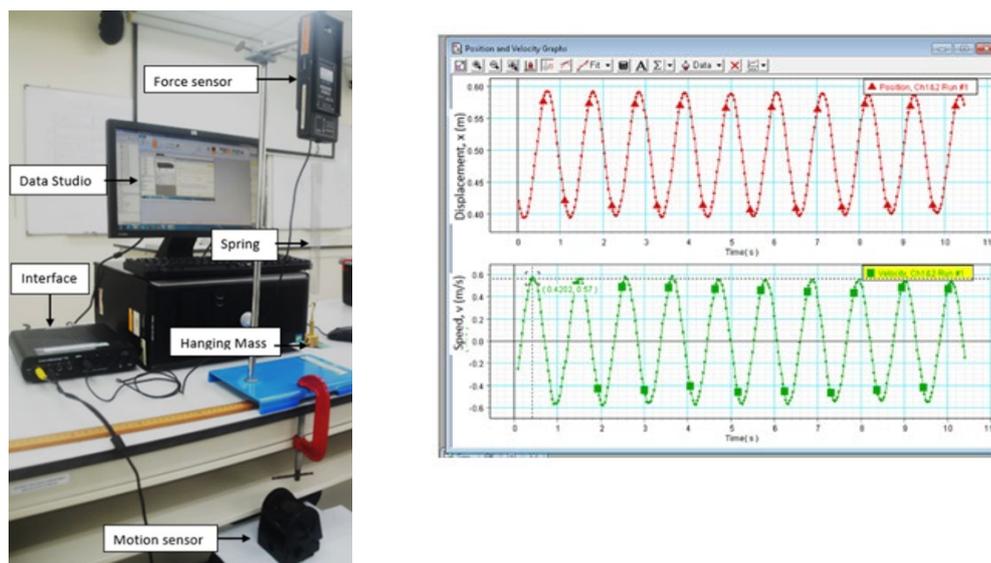
The period,  $T$  of a mass-spring system, is given by

$$T = 2\pi \sqrt{\frac{m}{k}} \quad (6)$$

Fig. 5(a) shows the computer-aided experiment set up for the simple harmonic motion of an oscillating vertical spring. The setup consists of a force sensor that is connected to a spring with a hanging mass attached to it. The function of the force sensor is to record the magnitude of the force in real time. The motion sensor located at the bottom of the spring is used to detect

the relative distance of the oscillating mass. All these sensors are controlled in Data Studio software through the interface.

The spring is stretched a small distance from its equilibrium position when a hanging mass is put at the end of the spring. From the Data Studio software, the measurement of real-time force corresponding to the displacement of the spring for a set of different masses is recorded. From the data, a graph of force versus displacement is automatically generated and the slope of the graph, representing the spring constant could be obtained instantaneously.



**Fig. 5(a)** Experimental set-up of simple harmonics motion and **(b)** Displacement and speed versus time graphs of a mass-spring system

The other part of this experiment is to study the period of the mass-spring system. The oscillation of the mass hung at the end of the spring is recorded by the motion sensor. The graphs of displacement versus time and velocity versus time of the oscillation are generated on Data Studio as shown in Fig. 5(b). The period of the motion was determined by using the Smart tool function from the Data Studio software.

#### 4. STUDENTS' RESPONSES TO USING COMPUTER-AIDED EXPERIMENTS

A survey had been carried out to get students' feedback about the effectiveness of computer-aided experiments in learning physics. The survey makes use of the Likert scale as it is a reliable tool for measuring attitudes, opinions, and perceptions of individuals. It consists of a series of statements or items, to which students are asked to indicate their level of agreement or disagreement. The Likert scale ranges from 1 to 4, with 1 representing strongly disagree, 2 representing disagree, 3 representing agree, and 4 representing strongly agree. The result of the survey conducted on 178 physics students shows that 88.7% agreed and strongly agreed that computer-aided experiments help them to understand physics concepts taught in classes. 92.2% of students agreed and strongly agreed that plotting graphs and data analyzing is much easier. 85.3% of students agreed and strongly agreed that they spent less time doing computer-aided experiments compared to manual experiments. 91.1% of students agreed and strongly agreed that computer-aided experiments help to visualize experimental data in real-time. 94.3% of

students agreed and strongly agreed that the use of sensors in computer-aided experiments produces results with higher accuracy. 93.2% of students agreed and strongly agreed that computer-aided experiments enabled complicated procedures to be done easily.

## 5. CONCLUSION

Examples of three experiments utilizing computer-aided experiments are presented in this paper. The first one is standing waves on a string. Practically, this experiment is not easily performed manually in the first place. The string cannot be vibrated at a controlled frequency using bare hands. However, with the aid of a computer and other devices standing waves could be generated and it enables further analysis to be easily done. It will help the students tremendously in understanding and digesting the concepts of standing waves with various harmonics patterns.

Secondly, the magnetic induction experiment in a coil. Manually, this experiment can only observe the existence of the induced emf by using galvanometer. However, with the introduction of computerized experiments, the induced emf can be measured accurately in a very short time interval.

Thirdly, the SHM in a vertical spring. Traditionally, the period of an oscillation is obtained by means of a stopwatch. During this process, measurements can be inaccurate due to parallax error and the response time of the students handling it. On the contrary, the computer-aided experiment could provide fast and accurate measurements.

From the survey done on students undergoing computer-aided experiments, the finding shows that the use of computer-aided experiments as a teaching tool enhanced the student's ability in integrating theory with practice in learning physics.

From this study, it can be concluded that the computer-aided experiment improves the precision and accuracy of data collection and therefore enhances student comprehension by applying Physics theories in the interpretation of physical phenomena. It also provides an interactive and exploratory learning experience, fosters collaboration and critical thinking skills, and reduces costs and time associated with traditional experiments.

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