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INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA
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Garden of Knowledge and Virtue

TAWHIDIC EPISTEMOLOGY LEADING THE WAY
UMMATIC EXCELLENCE LEADING THE WORLD
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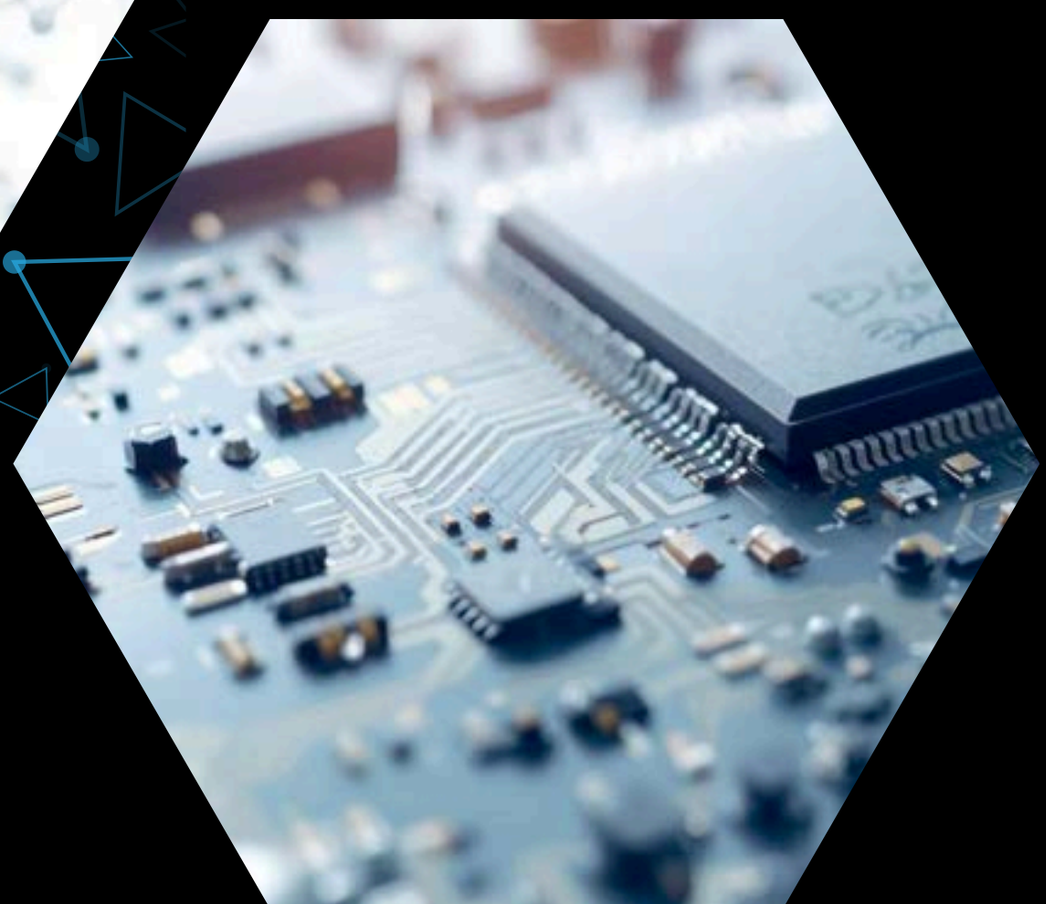
ADVANCING FRONTIERS: KULLIYYAH OF ENGINEERING RESEARCH, INNOVATION & COMMERCIALISATION EXHIBITION (KERICE 2025)



THEME: SUSTAINABLE ACADEMIA-INDUSTRY-COMMUNITY COLLABORATION FOR HUMANITY

ADVANCING FRONTIERS: KULLIYYAH OF ENGINEERING RESEARCH, INNOVATION & COMMERCIALISATION EXHIBITION (KERICE 2025)

Edited by
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Preface

Advancing Frontiers: Kulliyyah of Engineering Research, Innovation and Commercialisation Exhibition Book is published to bring together research findings, innovations, and scholarly ideas that have been presented in the form of posters. This publication aims to document the contributions of researchers while serving as a reference for both the academic and industrial communities.

This book compiles more than 50 posters, covering a wide range of themes including renewable energy, green technology, materials engineering, innovations in education, etc.

KERICE 2025 also serves as an avenue for postgraduate and undergraduate students to interact, exchange ideas, and learn from each other's work. Furthermore, the event offers a space to exhibit the Kulliyyah's research outputs and serves as a bridge between academia and industry, reducing the gap between innovation and real-world application.

With the theme "Sustainable Academia–Industry–Community Collaboration for Humanity," KERICE 2025 emphasizes the importance of partnerships that integrate knowledge, technology, and human values for the betterment of society. It is our hope that this publication will not only serve as a record of these valuable contributions but also as a source of inspiration for future research, collaborations, and innovations that benefit humanity at large.

Foreword

Assoc. Prof. Dr Khairul Azami Sidek
DEAN,
KULLIYYAH OF ENGINEERING, IIUM

In the Name of Allah, the Most Gracious, the Most Merciful.

It gives me great pleasure to extend my warmest welcome to all participants, exhibitors, students, researchers, academicians, and industry partners to the **Kulliyyah of Engineering Research, Innovation and Commercialisation Exhibition (KERICE) 2025**.

This annual event reflects the Kulliyyah's unwavering commitment to advancing research excellence, promoting innovation, and strengthening the bridge between **academia, industry, and the community**. The theme for this year's exhibition, *"Sustainable Academia–Industry–Community Collaboration for Humanity"*, resonates deeply with IIUM's overarching vision of Tawhidic-based knowledge, holistic development, and ummatic excellence. It emphasizes our collective responsibility to drive impactful solutions that benefit not only the industry but also the society at large.

KERICE 2025 provides a vital platform for **our undergraduate and postgraduate students** to present their research ideas and innovations to a broader audience, including fellow scholars and potential industry collaborators. It fosters a culture of creativity, interdisciplinary dialogue, and knowledge-sharing—an environment where ideas are refined, partnerships are formed, and solutions are born.

I would also like to acknowledge the tireless efforts of the organising committee, our dedicated academics, and the participating students for making this event possible. Your passion and perseverance in driving innovation and excellence continue to inspire our Kulliyyah to strive for greater heights.

Let this event be a testament to our shared goal of nurturing research that is not only academically rigorous but also socially responsible and economically relevant. May KERICE 2025 pave the way for future collaborations, impactful commercialisation efforts, and sustainable solutions for humanity.

Thank you and may this exhibition be a success, bi-iznillah.

Wassalamu'alaikum warahmatullahi wabarakatuh.

Foreword

Assoc. Prof. Ir. Dr Fathilah binti Ali
HEAD OF RESEARCH AND INNOVATION,
KULLIYYAH OF ENGINEERING, IIUM

In the Name of Allah, the Most Gracious, the Most Merciful.

It gives us great pleasure to welcome you to the **Kulliyyah of Engineering Research, Innovation and Creativity Exhibition (KERICE 2025)**, organized by the Kulliyyah of Engineering, International Islamic University Malaysia (IIUM). Building on the success of previous years, this year's exhibition is held under the theme **"Sustainable Academia–Industry–Community Collaboration for Humanity."**

This theme reflects the Kulliyyah's strong commitment to fostering impactful partnerships that transcend the boundaries of academia. We believe that true innovation emerges not only from the pursuit of knowledge but also through meaningful engagement with industry and the wider community. By aligning research, creativity, and innovation with the needs of society, KERICE 2025 aspires to strengthen the role of engineering in advancing solutions that are sustainable, ethical, and beneficial to humanity at large.

The Kulliyyah of Engineering views research and innovation as a trust (amānah), one that must be directed towards solving real-world problems and creating a better future for generations to come. Guided by Islamic principles and values, KERICE 2025 provides a platform for our students, researchers, and staff to showcase their work, ranging from cutting-edge technologies to creative solutions with social, environmental, and economic significance.

Over the years, KERICE has evolved into more than just an exhibition. It has become a celebration of dedication, perseverance, and collaboration, an environment where knowledge meets practice, and ideas meet opportunities. The projects presented here represent the efforts of our academic community in striving towards excellence, while also embodying the spirit of "Engineering for the Ummah."

We wish to extend our deepest appreciation to all participants, supervisors, committee members, and partners who have contributed their time, expertise, and support in making KERICE 2025 possible. Your commitment ensures that this event continues to serve as a platform for knowledge-sharing, innovation, and sustainable collaboration.

It is our sincere hope that KERICE 2025 will inspire greater creativity, strengthen academia–industry–community linkages, and spark initiatives that contribute to the betterment of humanity. May Allah (SWT) bless these efforts and guide us in our mission to uphold knowledge, innovation, and service for the benefit of society.

Wassalāmuʿalaikum warahmatullāhi wabarakātuh.

KERICE 2025

Programme *Schedule*

08:00 AM Registration & Breakfast (Coliseum)

09:00 AM Judges' Arrival (Banquet Room, E1)

09:15 AM Judges' Briefing

10:00 AM Judging Session

01:00 PM Lunch Break & Zohor Prayer

Closing Ceremony (Audi A, E2)

02:00 PM Arrival of VIPs & Guests

02:10 PM Welcoming Remarks by MC

02:15 AM National Anthem, IIUM Song & Du'a

02:20 PM Judging Session

02:30 PM Closing Remarks by Assoc. Prof. Dr. Khairul Azami bin Sidek (Dean, Kulliyyah of Engineering)

02:35 PM Closing Speech by Prof. Ts. Ir. Dr. Ahmad Fadzil bin Ismail (Director, Research Management Centre)

02:45 PM Award Presentation

03:45 PM Souvenir Presentation to Assoc. Prof. Dr. Khairul Azami bin Sidek (Dean, KOE) & Prof. Ts. Ir. Dr. Ahmad Fadzil bin Ismail (Director, RMC)

03:50 PM Photography Session

04:00 PM Disperse

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Meet Our Judge

Dr. Fadhli Wong Mohd Hasan Wong is an accomplished energy professional with expertise in engineering, energy management, and advanced fluids technology. He holds a PhD in Future Energy for Mobility from Queen's University Belfast, an MBA in Energy Management from Universiti Teknologi PETRONAS, and a First Class Honours Bachelor's Degree in Computer Engineering from International Islamic University Malaysia.He is currently the General Manager of Fluids Technology Solutions at PETRONAS, where he has led innovations such as the Well Intervention Friction Modifier Fluids, inspired by Formula 1 fluids research and NTNU collaborations

Dr. Tuan Noor Maznee Tuan Ismail is the Head of the Synthesis and Product Development Unit at the Malaysian Palm Oil Board (MPOB), where she has dedicated nearly 26 years of service. Her expertise lies in oleochemistry and materials applications, leading innovations that strengthen the value, versatility, and sustainability of palm oil–based products. She earned his PhD in Materials Science (2019) and Master's in Oleochemistry (2008) from Universiti Putra Malaysia, and a Bachelor's in Chemistry (1996) from Universiti Kebangsaan Malaysia. Dr. Tuan Noor Maznee continues to play a pivotal role in advancing palm oil research, product development, and industry competitiveness.

Lt Col (B) Ir. Mohammad Juani bin Sujana is the Head of Marketing and Business Development at G7 Aerospace Sdn. Bhd. and a Professional Engineer (PE) with the Board of Engineers Malaysia. A retired Royal Malaysian Air Force Engineer with 24 years of service, he has extensive experience in aircraft maintenance, configuration management, and airworthiness certification for fighter aircraft including the SU-30MKM, F/A-18D, and Hawk 208. Ir. Juani spearheaded several defense technology initiatives, including the development of local rocket motor systems and training rockets for the RMAF. His strong background in electrical engineering, public management, and aerospace R&D continues to drive Malaysia's defense innovation and industry collaboration.

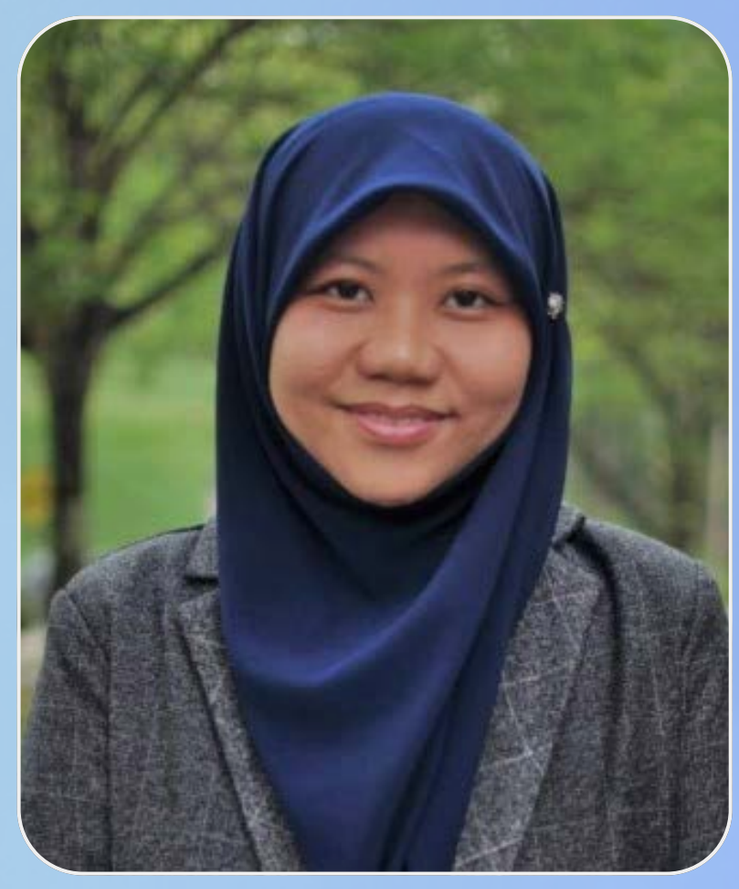
Meet Our Judge

EUR ING. Ir. Ts. Mohamad Faizul Mohamad Aziz is a senior Staff Instrument Engineer at PETRONAS, with over 19 years of experience in instrumentation and control within the oil and gas sector. He earned his B.Eng. (Hons) in Electrical & Electronic Engineering from UTP and is a distinguished Professional Engineer, Chartered Engineer, and ASEAN Chartered Professional Engineer. His expertise lies in project management, where he has successfully delivered complex engineering solutions across multiple project cycles. Notably, he has made significant contributions in Bokor Enhanced Oil Recovery (EOR) project and is recognized for his leadership in both technical and project management roles.

Mrs. Nor Afiqah Zainuddin is a Patent Examiner at the Intellectual Property Corporation of Malaysia, where she has served since 2017. She earned both her Bachelor's and Master's degrees in Mechatronics Engineering from IIUM. Her professional expertise covers the examination of patent applications in the fields of mechanical technologies and machine vision. In addition to her examination work, she also serves as a trainer for new patent examiners. With a strong academic foundation and professional experience, she contributes to strengthening patent examination practices and supporting innovation within Malaysia's intellectual property landscape.

Mrs. Nazwin Sazwina Binti Nasruddin is a Patent Examiner at the Intellectual Property Corporation of Malaysia. She holds a Bachelor of Engineering (Mechatronics) (Honours) from the International Islamic University Malaysia (IIUM). Previously serving as a Production Engineer, she developed OEE systems, optimized spare part utilization, and improved machine stability and efficiency. Her current expertise spans patent examination in instruments (medical technology, control, measurement), and mechanical engineering (machine tools, handling, engines, pumps). With her combined industrial and professional experience, she contributes to strengthening patent practices and supporting technological innovation in Malaysia.

Meet Our *Judge*



Dr. Nik Nur Wahidah Nik Hashim received her B.S., M.S., and Ph.D. in Electrical and Computer Engineering from Vanderbilt University, USA, and is currently a Researcher with the Advanced Materials and Subsea Technology Department at PETRONAS Research Sdn. Bhd. Her career spans both academia and industry, with expertise in speech and signal processing, computer vision, and data-driven modeling. She has developed AI solutions for healthcare, including speech-based systems for depression and suicidal risk detection, as well as robotics platforms for autonomous inspection and digital solutions such as Virtual Flow Metering for oil and gas operations. Her current work focuses on generative AI for advanced materials discovery and language-based scientific knowledge systems. She was also a recipient of the Malaysia Technology Expo (MTEX) award for innovation in AI-driven healthcare.

Mrs. Ida Liyana bt Johan is a highly experienced Mechanical Engineer with over 18 years in the Oil & Gas industry. She has provided expert consultation and technical solutions on static fired and unfired equipment for PETRONAS's global business units, subsidiaries, joint ventures, external stakeholders, as well as Malaysian regulatory bodies and industry associations. Her expertise spans design, fabrication, troubleshooting, and thermal design of heat transfer equipment. Well-trained in establishing problem statements, site investigation, harnessing relevant data, identifying damage mechanism and root cause contributing to improvement of asset integrity. Familiar with the International Code and Standards i.e. ASME, ASTM, API, TEMA, JIP33 as well as PETRONAS Technical Standard (PTS).

Meet Our Judge

Prof. Dr. Tanveer Saleh is a Professor and Head of Responsible Research and Innovation at the Department of Mechatronics Engineering, IIUM. He holds a B.Eng. in Mechanical Engineering from BUET (2002), an M.Eng. in Mechatronics (2005), and a Ph.D. in Mechanical Engineering (2009) from NUS, where his doctoral work focused on intelligent ELID grinding. He has held roles as Post-Doctoral Fellow at the University of British Columbia and Product Engineer at Mikrotools before joining IIUM in 2012. His research spans machine learning, hybrid micromachining, automation, and additive manufacturing, supported by grants of over RM700,000. He has published widely, secured patents, and received multiple awards, including IIUM's High Impact Responsible Innovation Award, and international recognition at the Seoul International Invention Fair (2021) and Malaysia Technology EXPO (2021).

Prof. Ir. Ts. Dr. Teddy Surya Gunawan has been listed among the Top 2% Scientists worldwide by Elsevier in the field of Networking and Telecommunications. He received his B.Eng. (cum laude) in Electrical Engineering from Institut Teknologi Bandung (ITB), Indonesia in 1998, M.Eng. from Nanyang Technological University, Singapore in 2001, and PhD from The University of New South Wales, Australia in 2007. Currently a Professor at the Department of Electrical and Computer Engineering, International Islamic University Malaysia (IIUM), his research focuses on speech and audio processing, biomedical signal processing, image and video processing, and parallel computing. He is an IEEE Senior Member, Chartered Engineer (IET, UK), and ASEAN Engineer.

Assoc. Prof. Dr. Aliza Aini Md Ralib obtained her B.Eng. in Computer and Information Engineering (Electronics) in 2006, followed by MSc (2011) and PhD (2016) in Electronics Engineering from IIUM. She began her career as a Layout Design Engineer at Intel Microelectronics Malaysia before serving as a Research Assistant at UNITEN. Her research focuses on printed electronics, MEMS, CMOS-MEMS acoustic wave sensors, and piezoelectric energy harvesting. She has authored and co-authored over 90 papers published in both local and international journals and conference proceedings. Since 2017, she has been serving as an Executive Committee Member of the IEEE Electron Device Society (EDS) Malaysia Chapter. In recognition of her research, she received the Best Paper Award (Emerging Technologies) at the 2025 IEEE Regional Symposium on Micro and Nanoelectronics. She is also a certified AI for Good instructor after completed the AISG-META AI For Good Train The Trainer Program.

Meet Our Judge

Assoc. Prof. Dr. Farah Ahmad graduated with a B.Eng. (Biochemical-Biotechnology) with First Class Honours from IIUM and obtained her Ph.D. in Energy and Process Engineering from Queensland University of Technology (QUT), Australia, in 2016. She previously worked as Research Officer at Renewable Energy Research Center, SIRIM Berhad (Malaysia) (2011-2012) and Sessional Academic at QUT (2013-2015). She was the recipient of Denis Foster Chemistry/Chemical Engineering Award in 2016 and the Best Presentation Award from the 6th International Conference of Fuel Cell and Hydrogen Technology in 2017. Her current research focuses on bioprocessing, specifically sustainable biofuel production and biorefineries, especially from lignocellulosic biomass; biomaterial synthesis from biomass, especially chitosan; membrane technology and biosensors including electrochemical- and piezoelectric-based sensors.

Assoc. Prof. Ts. Dr. Hasan Firdaus bin Mohd Zaki is the Director of the Centre for Unmanned Technologies (CUTe) at the International Islamic University Malaysia (IIUM). His expertise lies in computer and robotic vision, deep learning for robotics, and unmanned technologies. He holds a Ph.D. in Computer Science (Computer Vision) from the University of Western Australia, an M.Eng. in Mechatronics from the University of Malaya, and a B.Eng. (Hons.) in Mechatronics from IIUM. Formerly Head of Embedded AI at CUTe, he has led numerous projects on autonomous surface vessels, driver assistance systems, defect detection, and VOC gas recognition. A passionate educator and researcher, he has published widely and collaborates actively with industry and government agencies including KDN, MIMOS, MySA, MARii, and others to advance AI and robotics integration in real-world applications

Assoc. Prof. Dr. Noorasikin Samat is a lecturer in the Department of Manufacturing and Materials Engineering, International Islamic University Malaysia (IIUM), Kuala Lumpur. She received her PhD in Materials Science and Engineering from the University of New South Wales (UNSW), Sydney, Australia, in 2010, specializing in polymer nanocomposites. Dr. Noorasikin's research interests include green composites and nanocomposites, as well as the development of sustainable aerogels for flame-retardant and thermal insulation applications. Her recent work focuses on poly(vinyl alcohol) (PVA)-based aerogels tailored for enhanced fire resistance and lightweight thermal insulating materials. She has been actively involved in teaching, research, publications, and postgraduate supervision, and currently serves as the academic advisor for the Materials Programme.

Meet Our Judge

Assoc. Prof. Ir. Ts. Dr. Norhidayu Binti Kasim is an Associate Professor of Civil Engineering at the International Islamic University Malaysia (IIUM) and currently serves as the Coordinator for the Professional Engineer Unit at the Department of Civil Engineering. Before joining academia, she gained valuable experience as a Civil Engineer with the Public Works Department (JKR) and as a Structural Design Engineer in a consulting firm. She obtained her bachelor's degree in civil engineering (Hons.), a Master of Science in Structural Engineering, and a Doctor of Philosophy in Geotechnical Engineering, all from Universiti Kebangsaan Malaysia. Her expertise lies in geotechnical engineering, particularly in slope stability, debris flow, and the use of innovative materials in road construction.

Assoc. Prof. Dr. Mohd Sultan Ibrahim is a lecturer in the Department of Mechanical and Aerospace Engineering at the International Islamic University Malaysia (IIUM). He earned his Bachelor's and Master's degrees in Manufacturing Engineering from IIUM in 1999 and 2002, respectively, and completed his Ph.D. in Aeronautics at Imperial College London in 2010. At IIUM, he teaches courses such as Finite Element Analysis, Composite Structures, and Machine Design. His consultancy work includes designing composite poles for Dalia Industries and conducting springback analysis of aerospace composite parts with CTRM. His research primarily focuses on the finite element analysis of composite structures.

Assoc. Prof. Dr. Wan Mohd Fazli is a lecturer in the Department of Chemical Engineering & Sustainability at IIUM, where he has served since 2016. He obtained his BSc and MSc in Biochemical-Biotechnology Engineering from IIUM, and later earned his PhD in Chemical Engineering from Imperial College London. He also spent several months at the Vienna University of Technology, Austria, as a research scientist with the Polymer and Composite Engineering (PaCE) group. His current research focuses on the development of green nanocomposites from natural fibers, with a particular emphasis on fungal-derived chitin nanofibers as promising candidates for bio-based composite reinforcement.

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Final Year Project

OPTIMAL PLACEMENT OF PHASOR MEASUREMENT UNIT (PMU) USING GENETIC ALGORITHM & CUCKOO SEARCH ALGORITHM

Nur Shahida Midi*, Nurhazwani Mohd Hanafi, Mohd Fahmi Husin, Mohd Shahrin Abu Hanifah
International Islamic University Malaysia

1 Abstract

The usage of Phasor Measurement Units (PMUs) are becoming popular and populating the power system grids rapidly due to the need for big data in electrical power system analysis. It is a crucial component for managing, controlling and monitoring system performance by providing synchronized measurements of voltage, current and frequency in real-time. However, the expensive cost of PMUs makes it impractical to install them on every bus in the power system grid. This work investigates the use of metaheuristic algorithms to solve the Optimal PMU Placement (OPP) problem, aiming to minimize the number of PMUs required. The IEEE 57-bus test system is used as the benchmark model for algorithm evaluation. Two algorithms, Genetic Algorithm (GA) and Cuckoo Search Algorithm (CSA), are implemented and tested under normal operating conditions and with the consideration of Zero Injection Buses (ZIBs). The algorithms are assessed using key performance metrics, including the Bus Observability Index (BOI) and the System Observability Redundancy Index (SORI).

2 Problem statement

Smart Grids Need Smart Monitoring

Data is the Foundation — but SCADA is Limited

PMUs Solve This — But Come at a Cost

This Leads to the Optimal PMU Placement (OPP)

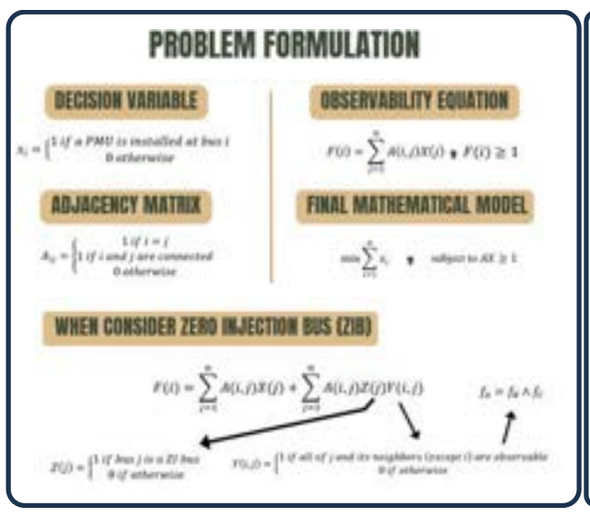
How can full system observability be achieved while minimizing the number of PMUs installed?

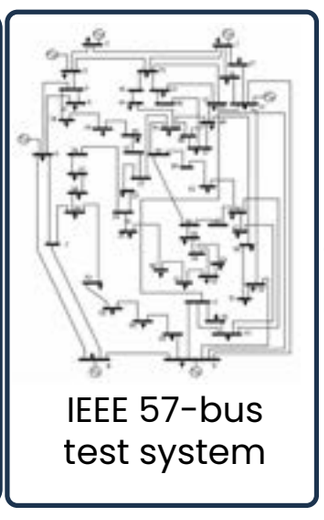
3 Objectives

1. To investigate the suitable algorithms in solving optimal PMUs placement problem.
2. To compare different algorithms for PMUs optimal placement using standard IEEE bus test system.
3. To evaluate and validate the performance of the algorithm based on number of PMUs, BOI and SORI.

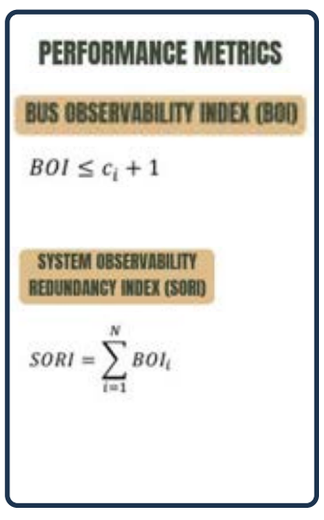
4 Methodology

Using the IEEE 57-bus test system, two algorithms, Genetic Algorithm (GA) and Cuckoo Search Algorithm (CSA), are implemented and tested under for solving the OPP problem. Then the simulation are also run under normal operating conditions and with the consideration of Zero Injection Buses (ZIBs).





IEEE 57-bus test system



5 Results & Findings

GA found a solution using only 18 PMUs, while CSA needed 25 to achieve full observability. Fewer PMUs reduce both installation and maintenance costs, making GA the more cost-effective option.
CSA provided better redundancy with a higher SORI value, meaning more buses were observed by multiple PMUs. CSA also had higher BOI.
Overall, GA is the better method considering the main goal of minimum number of PMUs, and due to its balance between performance, cost, and speed.
Comparison between normal condition and ZIB consideration shows that both reach full system observability. However, higher SORI value was recorded by considering ZIB; confirming its advantage in reducing measurement redundancy.

Comparison between GA and CSA

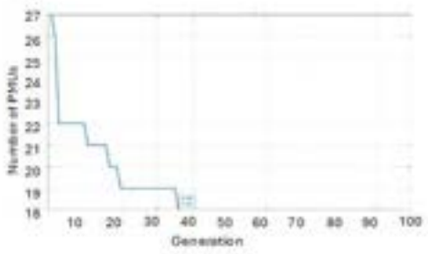


Fig. 1. Convergence of GA under normal condition

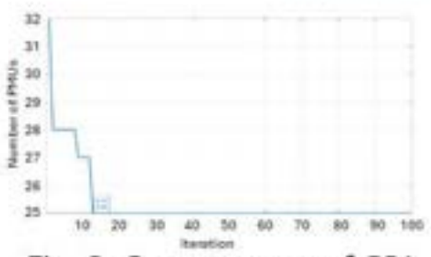


Fig. 2. Convergence of CSA under normal condition

Table 1. Comparison of GA and CSA Performance

Criteria	Genetic Algorithm (GA)	Cuckoo Search Algorithm (CSA)
Number of PMUs	18	25
PMUs Location	2, 4, 6, 12, 15, 20, 24, 28, 30, 32, 36, 38, 41, 46, 50, 53, 55, 57	1, 4, 8, 9, 12, 15, 19, 22, 24, 25, 27, 31, 32, 34, 37, 38, 39, 40, 41, 42, 46, 49, 50, 52, 54
Computational Time	0.31897	20.8851
SORI	72	101
Maximum BOI	3	4

Comparison between normal condition and ZIB (using GA)

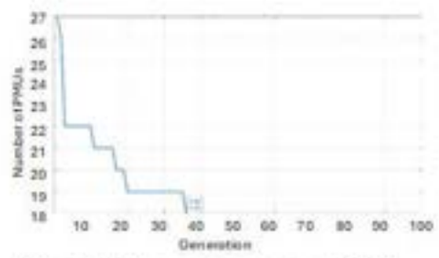


Fig. 3. Convergence of GA under normal condition

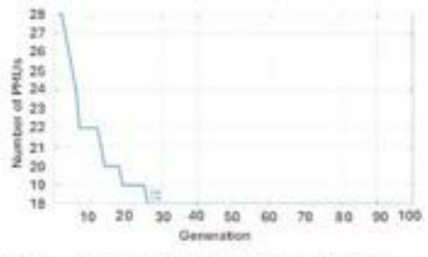


Fig. 4. Convergence of GA under ZIB consideration

Table 2. OPP using GA under normal condition and with ZIB consideration

Criteria	Genetic Algorithm under Normal Condition	Genetic Algorithm (GA) with ZIB
Number of PMUs	18	18
PMUs Location	2, 4, 6, 12, 15, 20, 24, 28, 30, 32, 36, 38, 41, 46, 50, 53, 55, 57	1, 4, 6, 9, 11, 15, 20, 24, 25, 28, 32, 36, 37, 38, 46, 52, 53, 56
Computational Time	0.31897	0.30240
SORI	72	78
Maximum BOI	3	3

6 Conclusion

Under normal condition, GA consistently produced better outcomes compared to the CSA, particularly in achieving full system observability with fewer PMUs.
When considering Zero Injection Bus, GA showed better results with higher SORI and faster computational time.

PERGh
(previously known as RERG)

HARMONIC ANALYSIS OF DIFFERENT ELECTRIC VEHICLE MODELS

Nur Shahida Midi*, Nurul Syazana Khairul Anuar, Siti Hajar Yusoff, Faridah Abd Rahman
International Islamic University Malaysia

1 Abstract

The global initiative to lower carbon emissions has benefited greatly from the swift introduction of electric vehicles (EVs). The incorporation of EV charging stations into the electrical grid brings about power quality challenges, especially harmonic distortion because of the nonlinear properties of EV chargers. These harmonics may lead to waveform distortion, overheating of equipment, electromagnetic interference, and could jeopardize grid stability. This research aims to study the detection and analysis of harmonics produced by electric vehicle charging through signal processing methods. Datasets of EV charging profiles that are publicly accessible were used, centering on the current waveforms of differing battery capacities from two distinct EV models. The Stockwell Transform (ST) and Discrete Wavelet Transform (DWT) were used to detect harmonics and extract essential features like harmonic ordering and Total Harmonic Distortion (THD). The findings indicated a possible risk to grid performance and power quality as the BMW iX xDrive50 (BMW) had a greater THD value, surpassing IEEE 519 recommended limitations, while the Hyundai Ioniq Electric (HIE) showed reduced THD values that were still within permissible limits.

2 Problem statement

The nonlinear nature of EV chargers and rising power demand contribute to harmonic distortions, which can harm power quality by causing EMI, insulation damage, equipment overheating, voltage and current distortion, and grid instability. While power quality issues have been studied, there is limited research specifically focused on harmonics caused by EV charging, highlighting the need for targeted studies and detection methods to address these disturbances.

3 Objectives

1. To investigate the signal processing and detection methods for harmonics.
2. To perform the signal processing and detection methods of harmonics due to EV charging.
3. To analyse the characteristics of harmonics due to EV charging.

4 Methodology

Data Preparation

Data collection

Publicly accessible EV charging profiles and EV charging waveforms (L2 charging), consisted of the current waveforms (eight waveform cycles, with 512 data values per cycle (60 Hz)) for two electric vehicle (EV) models:

- BMW iX xDrive50 (BMW) (111 kWh)
- Hyundai Ioniq Electric (HIE) (30 kWh)

Pre-processing

- Signal amplitudes were normalized to the maximum and minimum value.
- Bandpass Filter through MATLAB
  - Low-pass filter: 40 Hz
  - High-pass Filter: 2000 Hz

Detection Methods

- **Discrete Wavelet Transform (DWT)**
  - Mother Wavelet: Daubechies4 (db4)
  - Decomposed to 8 levels
  - 30 kHz sampling frequency
- **Stockwell Transform (ST)**
  - Gaussian Window
  - ST Matrix
  - 30 kHz sampling frequency

5 Results & Findings

DWT

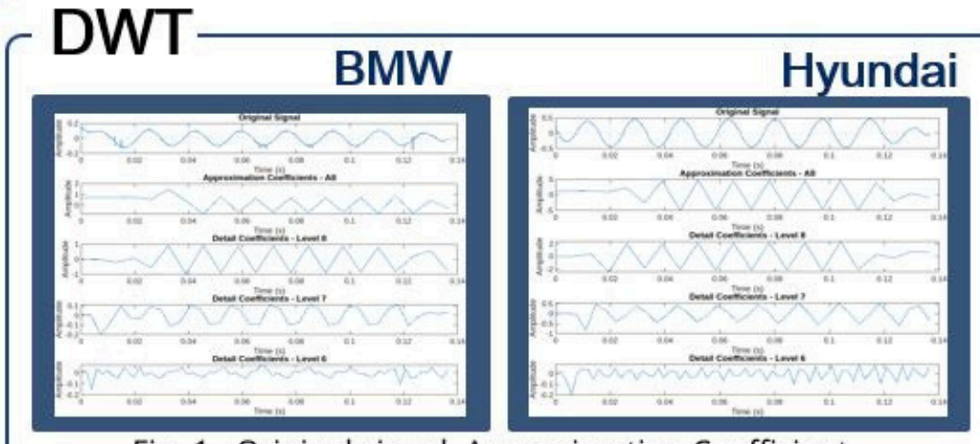


Fig. 1. Original signal, Approximation Coefficient, Detail Coefficients of level 8 to 6

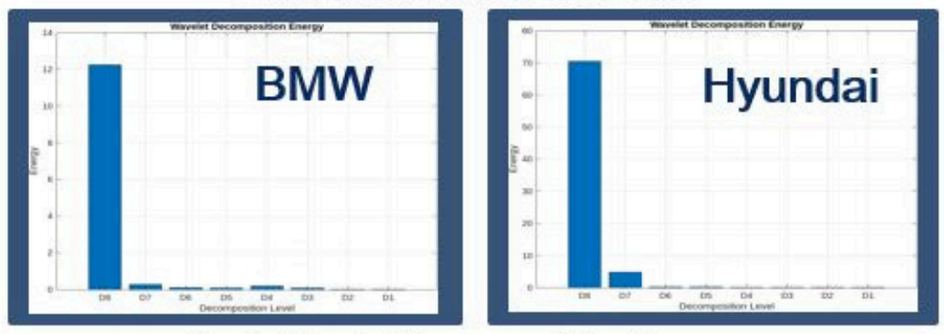


Fig. 2. Wavelet Decomposition Energy

ST

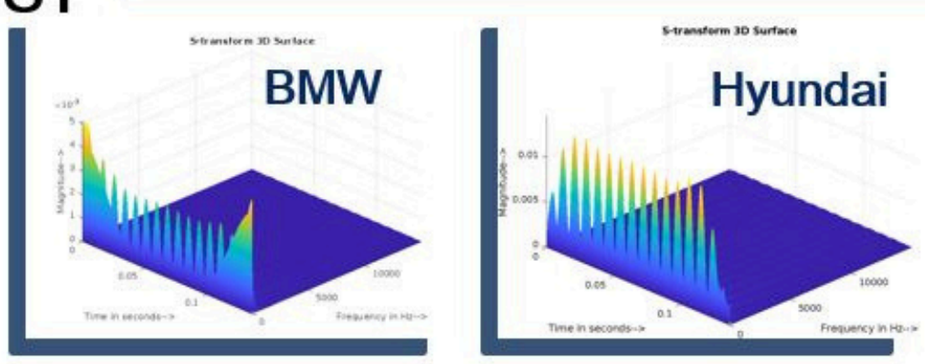


Fig. 3 3D surface plot

Harmonic characteristics

Harmonics Characteristics	BMW (111 kWh)		Hyundai (30 kWh)	
	DWT	ST	DWT	ST
THD (%)	6.74	6.73	2.84	2.84
Dominance Harmonics	2nd to 8th orders and 16th to 32nd orders	2nd to 8th orders	2nd to 8th orders	2nd to 8th orders

6 Conclusion

This study successfully detected and analyzed harmonics from EV charging using DWT and ST. The study underscored the importance of precise harmonic identification and evaluation for maintaining grid stability amid increasing EV adoption. Information regarding the battery's state of charge (SOC) before and after charging was excluded from the dataset.

TRADE-SPACE EXPLORATION COMPARISON OF PARAMETRIC COST MODELS FOR SATELLITE ANOMALIES WITH RMSE AND RRMSE

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Department of Information Systems, Faculty of Science and Technology, UIN Syarif Hidayatullah Jakarta, Benten, 15412, Indonesia

1 Abstract

Satellites are vital but vulnerable to anomalies that cause huge financial losses. This study investigates design life versus anomaly cost for key subsystems such as Antenna, Payload, Power, and Attitude Control. The models that are used in this research are the exponential, Weibull, and Poisson. Best fit is measured using RMSE & RRMSE. Hence, it can be deduced that the Exponential model performed best across subsystems. For instance, the payload subsystem achieved the lowest RMSE and RRMSE of 115.73 and 41.66% in the two-variable case. Similarly, the attitude control subsystem showed strong performance with an RMSE of 110.57 and RRMSE of 40.59%. In contrast, the Poisson distribution yielded the highest errors across most subsystems, with the antenna subsystem reaching an RMSE of 489.87 and RRMSE of 102.65% in the two-variable fitting. The Weibull model demonstrated mixed performance, performing moderately for the payload subsystem (RMSE 186.21, RRMSE 67.03%), but poorly for the power system and antenna subsystems, particularly when two variables were used.

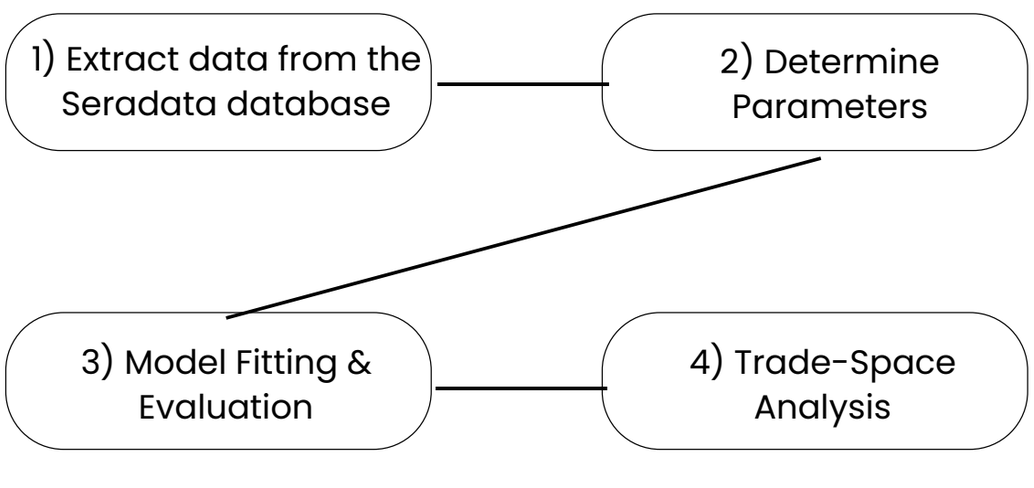
2 Problem statement

Problems:
Existing cost models oversimplify failures and ignore nonlinear cost escalation & insurance impact.
Hard for satellite operators to balance design life, reliability, and cost.

3 Objectives

Objectives:
- Identify the financial impact of anomalies in major subsystems.
- Develop parametric cost models (Exponential, Weibull, Poisson).
- Compare models using RMSE/RRMSE.
- Explore trade-space → find optimal subsystem design life vs cost trade-offs.

4 Methodology



4 Results & Findings

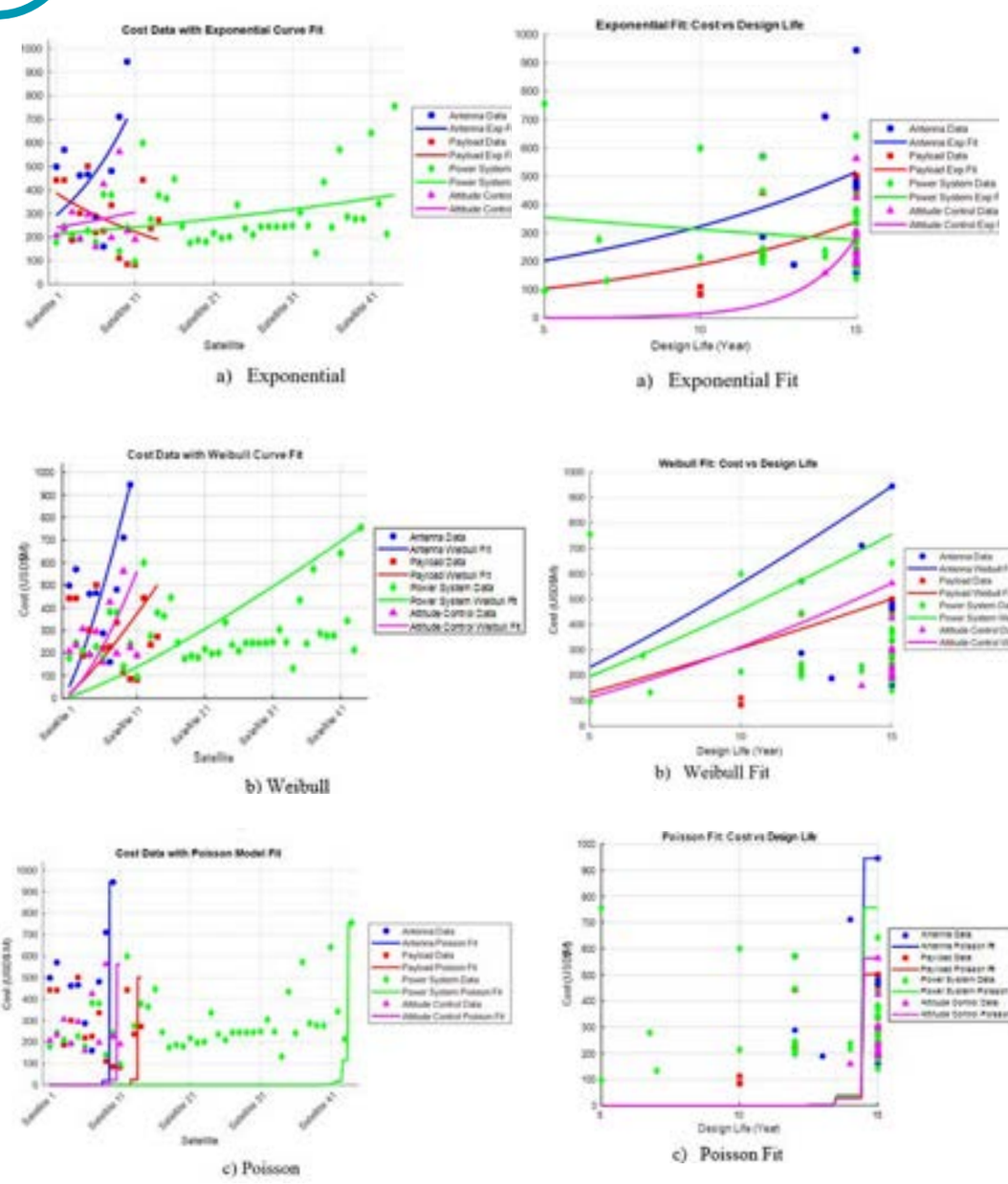


Table 1: RMSE and RRMSE results

Subsystems	Model	RMSE (1 variable)	RRMSE (1 variable)	RMSE (2 variable)	RRMSE (2 variable)
Antenna	Exponential	194.94	71.56%	218.16	45.72%
	Weibull	271.85	99.80%	455.24	95.40%
	Poisson	431.14	158.27%	489.87	102.65%
Payload	Exponential	121.84	44.73%	115.73	41.66%
	Weibull	239.07	87.76%	186.21	67.03%
	Poisson	304.71	111.86%	240.17	86.45%
Power System	Exponential	128.17	47.05%	134.70	46.73%
	Weibull	229.69	84.32%	434.17	150.64%
	Poisson	295.86	108.61%	442.79	153.63%
Attitude Control	Exponential	114.15	41.91%	110.57	40.59%
	Weibull	194.22	71.30%	307.02	112.71%

5 Conclusion

The Exponential distribution is the most reliable model for anomaly cost prediction. Whereas the Weibull offers partial flexibility; the Poisson is deemed to be unsuitable.The trade-space exploration approach helps in finding the optimal design life before costs outweigh benefits.This framework improves decision-making, cost management, and reliability planning for future satellite

6 Acknowledgement

The authors thank the Asian Office of Aerospace Research And Development (AOARD) for the monetary assistance with Grant Numbers: FA2386-23-1-4073 and SPI23-179-0179. The authors appreciate the IIUM CPS Khair Award for tuition fees coverage.

Shahrul Ariffin, Muhammad Aryss Zafran, Abdul Rahim, Nadirah, & Mutholib, Abdul (2025). Trade-Space Exploration Comparison of Parametric Cost Models for Satellite Anomalies With RMSE and RRMSE. IIUM Engineering Journal, Vol 26, No 3.

ELECTRON-BEAM TUNED GRAPHENE: ENHANCING CONDUCTIVITY VIA HIGH-ENERGY IRRADIATION FOR RADIATION-HARDENED NANOELECTRONICS

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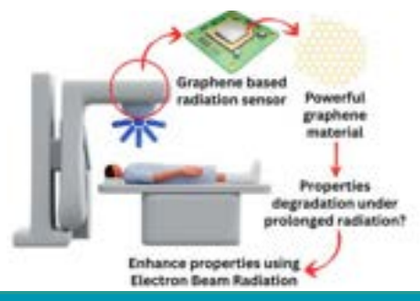
[2]*Material Technology Group, Malaysian Nuclear Agency, Bangi, 43000, Kajang, Selangor, Malaysia*

1 Abstract

Graphene's performance under high-radiation environments is critical for its application in radiation-hardened electronics. This innovation **explores the novel use of high-energy electron beam radiation as an innovative technique in the semiconductor industry**, not only for testing graphene's resilience under radiation harsh environment, but **for modulation and enhancement of graphene's electrical performance**. The findings **demonstrate how high-energy electron irradiation can be repurposed to fine-tune in enhancing graphene conductivity and structural properties** for the next generation radiation-hardened electronics across semiconductor industry, including medical and nuclear engineering applications .

Semiconductor-medical Industry



2 Problem statement

Today, electronics are everywhere, from satellites in space, to medical devices in hospitals, even sensors in nuclear facilities. The challenge is they are exposed to **prolong radiation exposure.** Conventional semiconductors degrade, lose conductivity, and eventually fail. Therefore, how do we make nanoelectronics that can survive in these harsh conditions?

3 Objectives

- To explore the use of **graphene and high energy electron radiation as an innovative technique in enhancing graphene's performance**.
- To investigate the **structural and electrical behavior of graphene** grown via chemical vapor deposition (CVD) on SiO_2/Si substrates, under exposure to high-energy electron beam irradiation

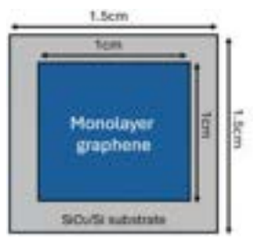
4 Methodology

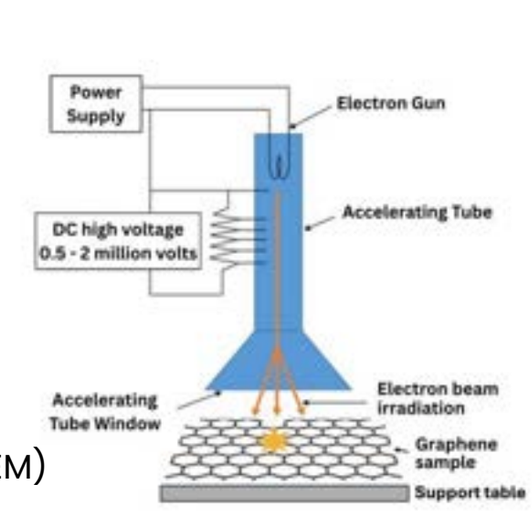
Sample Preparation

- Single layer graphene prepared by Chemical Vapor Deposition (CVD) grown on Silicon Dioxide/Silicon substrate

Electron Beam Irradiation (EBI)

- Voltage Power : 3 MeV
- Dose variation : 50, 100, 200 [kGy]
- Cleaner method and less harmful to the material
- Commonly use in fabricating semiconductor devices

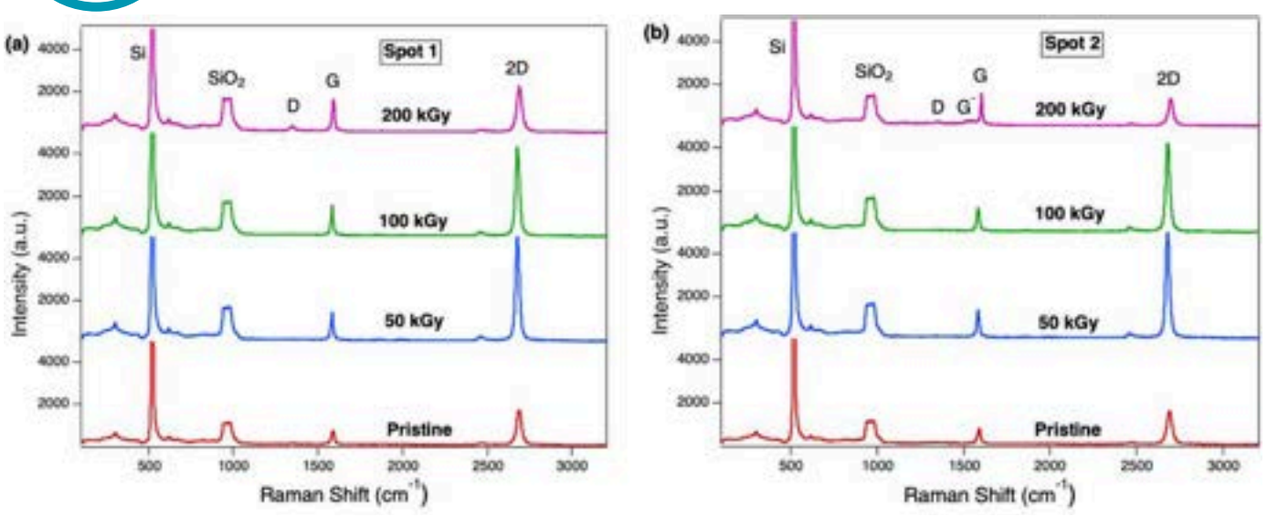




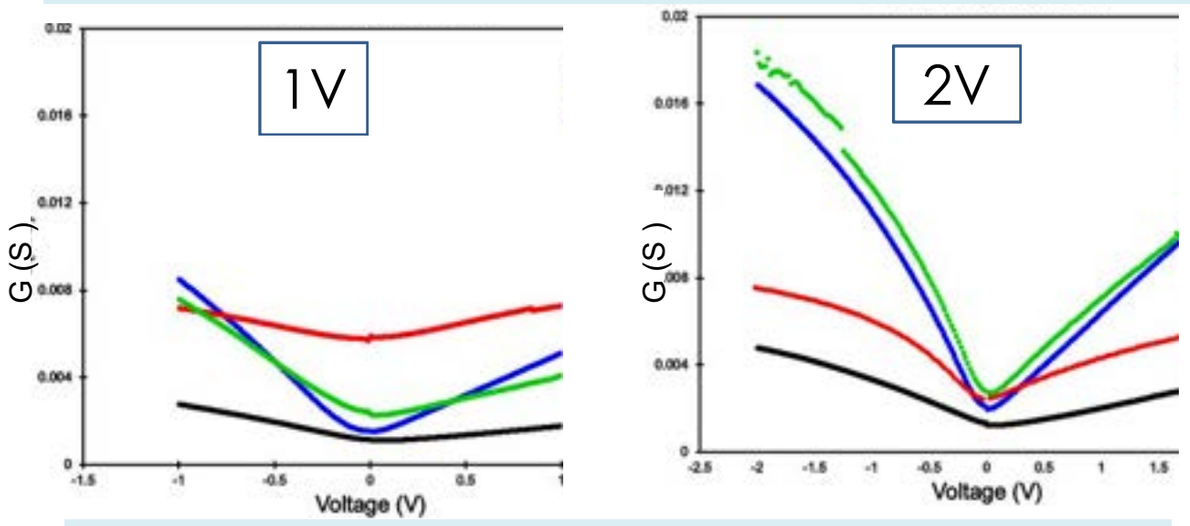
Electrical and Structural Characterization

- Raman Microscopy
- Field Emission Scanning Electron Microscopy (FESEM)
- Current-Voltage (I-V) Measurement

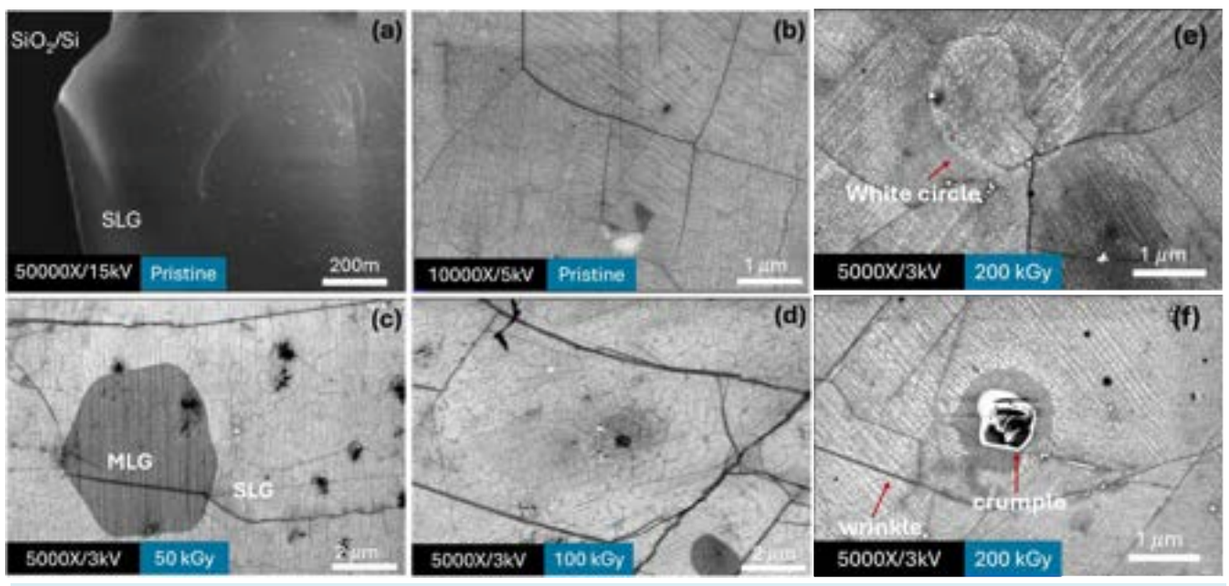
4 Results & Findings



- Graphene retained its crystallinity with minimal structural disorder



- Conductance rises after 200 kGy dose of electron irradiation



- Grain boundaries of graphene layer remain observed despite of other small defects or structural changes after 200 kGy dose

5 Conclusion

Precision Engineering: Repurposes high-energy electron irradiation to fine-tunes graphene's conductivity and structure for advanced radiation-hardened electronics.

Scalable & Cost-Effective: Boosts device performance with low-cost, industry-ready methods.

National Impact: Grows Malaysia's semiconductor and nanoelectronics capabilities.

Talent & Knowledge Growth: Builds expertise in advanced materials and radiation engineering.

Sustainability Gains: Longer-lasting devices reduce waste and support green manufacturing.

6 Acknowledgement

MoHE FRGS Grant No. FRGS/1/2022/TK07/UIAM/02/1 and Malaysian Nuclear Agency

Guzali, H., Ayob, N. I., Mohamad, M. N. H., Zamzuri, A. S., Che Hak, C. R., Ahmad, Z. and Md. Ralib, A. A., (2025), High energy electron radiation inducing non-homogeneous structural changes on single layer graphene/SiO_2/Si substrate. Radiation Physics and Chemistry 235: 112848.
Zamzuri, A.K., Ayob, N.I., Abdullah, Y., Saidin, N.U., Hak, C.R.C. (2020), Electrical behavior of graphene/SiO2/silicon material irradiated by electron for field effect transistor (FET) applications. Mater. Sci. Forum 6: 339–345.
Zamzuri, A.S., Ayob, N.I., Abdullah, Y., Hasbullah, N.F., 2020. Effect of irradiation upon single layer graphene on SiO2/Si substrate using electron beam irradiation (EBI). Mater. Today Proc. 29, 115–118.

AMSERU & PHORAD

RELIABILITY TRADE-SPACE EXPLORATION MODELLING FOR SATELLITE ANOMALIES USING EXPONENTIAL DISTRIBUTION

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1 Abstract

This study analyzes satellite reliability using anomaly data only (normal satellites excluded). Reliability data from 87 satellites (Seradata) are modeled with parametric (Weibull, Exponential, Poisson) and non-parametric (Kaplan–Meier, Monte Carlo) approaches. The data consist of reliability values for antennas, transponders, amplifiers, and batteries. The models are compared by RMSE to find the best fit. Results show the Exponential model achieves the lowest RMSE across the communication subsystem case study. A Trade-Space Exploration (TSE) framework is then built on the best mathematical model to relate Design Dependent Parameters (DDPs)—reliability, design life, and performance. The results conclude that the newly developed exponential-based reliability TSE model shows a promising outcome, with RMSE values of 34.2, 10.2, 19.6, and 19.9 compared to Nadirah's model and Shazana's model, which have RMSE values of 16.1, 49.7, 28.2, and 27.6 for antenna, transponder, amplifier, and battery, respectively.

2 Problem statement

- Satellite anomalies cause service disruption and cost; prior work often lacks structured, model-based reliability analysis grounded in real anomaly data.
- Existing models do not adequately integrate reliability trends with design-life and performance considerations for decision-making.

3 Objectives

- Identify prominent subsystem components of satellite anomalies.
- Analyse parametric and non-parametric mathematical models in reliability analysis.
- Develop a mathematical-based TSE model consisting of DDPs (reliability, design life, performance).

4 Methodology

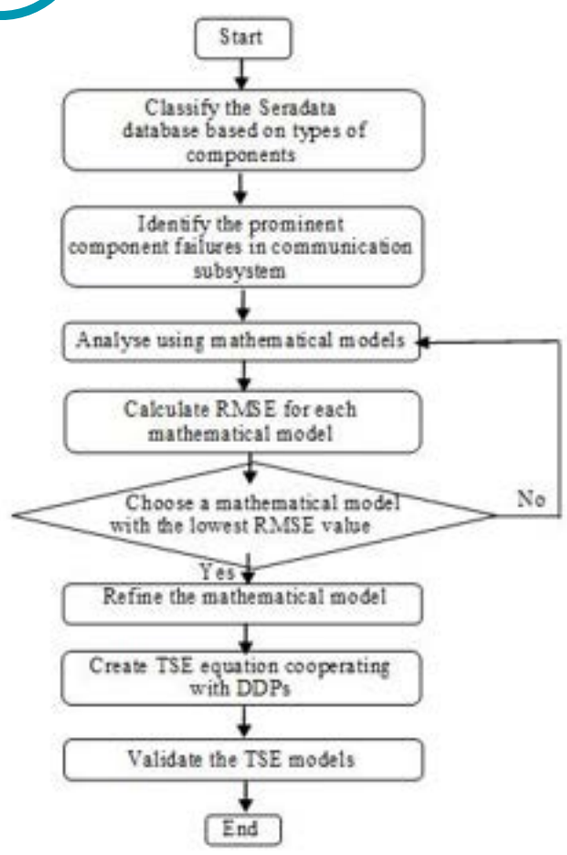

Fig. 1 : Flowchart of research methodology

Dataset: 87 failed satellites from Seradata for each subsystem.

Tools/Scope:
MATLAB for modeling and plots.

4 Results & Findings

Model performance (RMSE, lower is better):
Exponential provides the best overall fit across subsystems; representative RMSE values in the study are 0.22 (antenna), 0.27 (transponder), 0.30 (amplifier), and 0.30 (battery).

Prominent components analysed:
Antenna, Transponder, Amplifier, Battery.

TSE outcome:
The Exponential-based TSE links reliability to design life and performance, enabling clearer design trade-off decisions compared to prior models. The new mathematical TSE model is in Eq. (1). Where:

$$TSE_{R(t)} = e^{-\alpha\lambda t}(1 - \mathrm{RMSE}) \quad (1)$$

$R(t)$ = reliability at time t
λ = failure rate of the component
α = scaling coefficient

- RMSE indicates the difference between the predicted reliability and the actual reliability value to evaluate the accuracy of the model.
- The higher the RMSE, the lower the performance.
- Because (1-RMSE) is included, models with large RMSE errors receive a lower prediction of reliability, compared to those with lower RMSE errors.

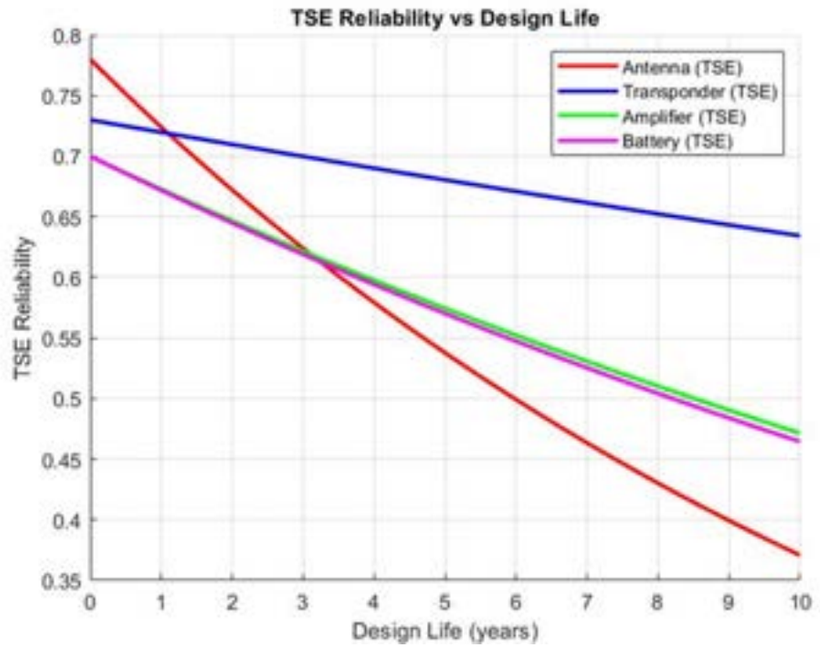

Fig. 2: Reliability Exponential-Based TSE Model Prediction For Each Satellite Anomaly

5 Conclusion

- An Exponential reliability model best fits the anomaly-only satellite dataset, and a new Exponential-based TSE incorporating DDPs (reliability, design life, performance) was developed.
Future work:
- Broaden subsystems and incorporate environmental factors to improve predictive accuracy further;
- Later, AI/ML can be explored as an extension, not a replacement, of the mathematical baseline.

6 Acknowledgement

The authors thank the Asian Office of Aerospace Research And Development (AOARD) for the monetary assistance withGrant Numbers: FA2386-23-1-4073 and SPI23-179-0179. The authors appreciate the IIUM CPS Khair Award for tuition fees coverage.

Ahmad Mahmood, Muhamad Imran Haris, Abdul Rahim, Nadirah, & Mutholib, Abdul (2025). Reliability Trade-Space Exploration Modelling for Satellite Anomalies Using Exponential Distribution. IIUM Engineering Journal, Vol 26, No 3.

POLARITY EFFECTS OF BAMBOO FIBER ON THE CHEMICAL AND PHYSICAL PROPERTIES OF BITUMEN

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1 Abstract

Bitumen is widely used in pavement construction, but its long-term performance is limited by ageing, traffic loading, temperature susceptibility, and environmental factors, leading to premature failures and higher maintenance costs. Natural fibers have emerged as sustainable modifiers due to their lignocellulosic composition, which introduces polarity and can enhance the chemical and physical properties of bitumen. This study evaluated untreated and alkali-treated bamboo fibers, incorporated at low dosages into 60/70 grade bitumen. Chemical interactions were analyzed using Fourier Transform Infrared Spectroscopy (FTIR-ATR), while physical properties were assessed through penetration and softening point tests. FTIR confirmed polar functional groups in bamboo fibers, particularly treated samples, indicating chemical interactions with bitumen and improved binder compatibility. Physical tests showed lower penetration and higher softening points compared to the control, with treated fibers giving stronger effects. These results suggest that bamboo fiber acts not only as a physical additive but also as a chemical modifier, enhancing binder stiffness, thermal stability, and potentially adhesion. Overall, bamboo fiber offers a sustainable pathway for improving pavement performance, warranting further studies on dosage, treatment, and mixture-level behavior under service conditions.

2 Problem statement

Pavement deterioration is a persistent challenge, as roads are constantly exposed to ageing, heavy traffic loads, temperature variations, and environmental stresses that reduce durability and service life. In Malaysia, potholes and structural failures are often linked to high traffic volumes, heavy axle loads, and inadequate adhesion between aggregate and asphalt, which weaken bonding and lead to defects such as ravelling and stripping, especially under heavy rainfall. Poor drainage systems further aggravate these failures by allowing water to accumulate on road surfaces, causing rutting, depressions, and increased risks of hydroplaning, particularly during monsoon seasons. These issues accelerate pavement deterioration, increase maintenance costs, and compromise road safety. To address these concerns, sustainable alternatives are increasingly explored, with bamboo fiber emerging as a promising additive due to its natural ability to enhance adhesion, ductility, and durability of asphalt mixtures. Its rough surface and high oil absorption capacity strengthen bitumen–aggregate bonding while acting as a barrier against moisture infiltration, offering a cost-efficient and eco-friendly pathway to improve pavement performance and extend service life.

3 Objectives

This project aims to analyze the chemical interactions between the polar functional groups of bamboo fiber and bitumen, as well as to evaluate their influence on the physical properties of bitumen.

4 Methodology

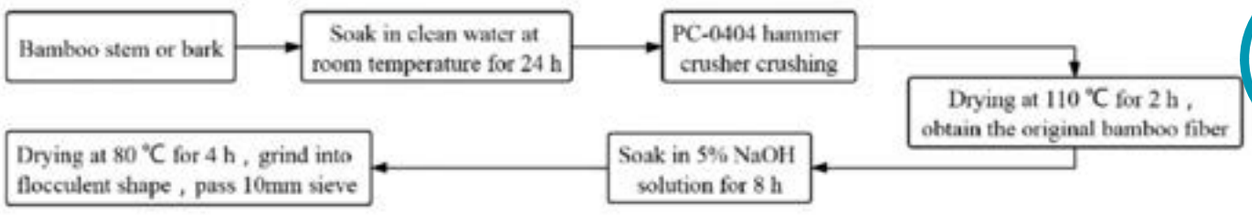

Figure 1: Bamboo Fibers Preparation

6 Acknowledgement

The support provided by the Fundamental Research Grant Scheme (FRGS) from the Malaysian Ministry of Higher Education (MOHE) and Department of Civil Engineering, International Islamic University of Malaysia (IIUM) in the form of a research grant number FRGS/1/2024/TK08/UIAM/02/6 (Project ID: FRGS24-325-0934) for this study is highly appreciated.

4 Results & Findings

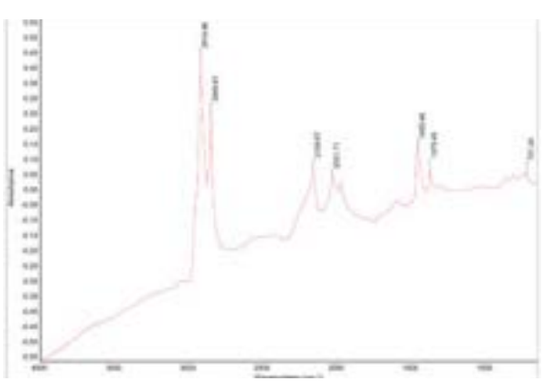

Figure 2: Control Sample FTIR

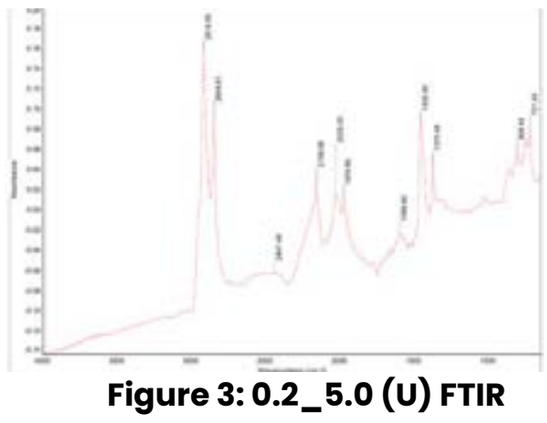

Figure 3: 0.2_5.0 (U) FTIR

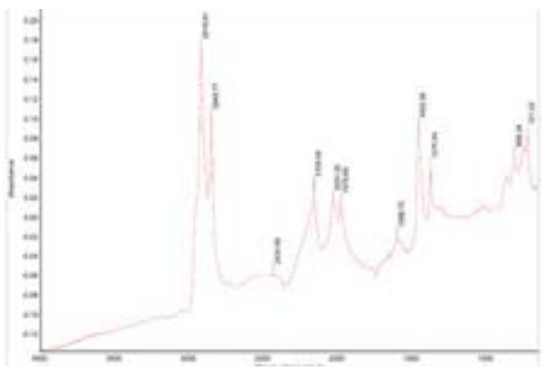

Figure 3: 0.2_5.0 (T) FTIR

The FTIR analysis of the control bitumen sample showed characteristic hydrocarbon peaks at ~2918 cm^{-1} and ~2849 cm^{-1} (C–H stretching), ~1455 cm^{-1} and ~1375 cm^{-1} (C–H bending), and ~721 cm^{-1} (long-chain alkanes), confirming its predominantly non-polar composition.

When bamboo fiber was incorporated, new absorption bands appeared around ~1598 cm^{-1} and ~808 cm^{-1}, indicating the presence of polar functional groups such as hydroxyl (–OH) and carboxyl (–COOH) derived from the fiber's lignocellulosic structure. These polar groups enhance the chemical interactions between fiber and bitumen, improving overall polarity within the binder. The effect was more pronounced in the alkali-treated fiber samples, where peaks were sharper and more intense, suggesting that treatment exposed more active functional groups. The increased polarity improves binder compatibility and adhesion with aggregates, reducing moisture-induced stripping and enhancing pavement durability.

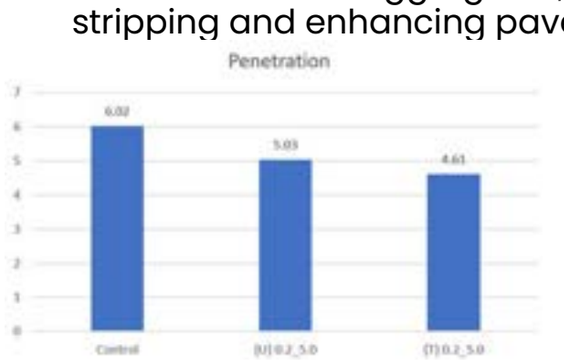

Figure 4: Penetration Test

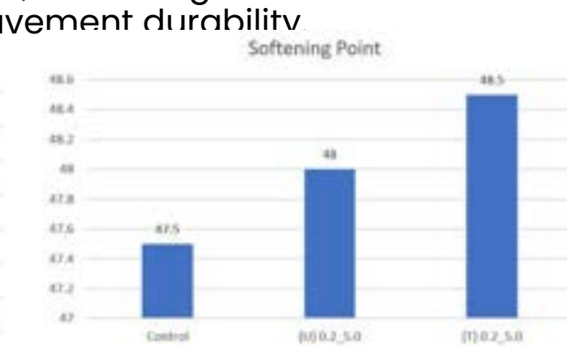

Figure 4: Softening Point Test

The penetration test results show that the addition of bamboo fiber reduced penetration values compared to the control (6.02 mm). Untreated fiber lowered the value to 5.03 mm, while treated fiber further reduced it to 4.61 mm. This reduction indicates increased binder stiffness, which is attributed to the polar functional groups (–OH, –COOH) in bamboo fiber that restrict molecular mobility. Treated fiber was more effective due to the alkali treatment exposing more active sites for chemical interaction.

Similarly, the softening point results demonstrate improved thermal stability with fiber modification. The control binder recorded the lowest softening point (47.5 °C), which increased to 48.0 °C with untreated fiber and 48.5 °C with treated fiber. A higher softening point suggests better resistance to high-temperature deformation, showing that bamboo fiber, especially treated fiber, enhances binder stability and durability. These findings highlight bamboo fiber's potential as a sustainable modifier to improve bitumen performance.

5 Conclusion

The incorporation of bamboo fiber into bitumen enhances binder performance through both chemical and physical mechanisms. FTIR analysis confirmed the introduction of polar functional groups (–OH, –COOH), which improved polarity and chemical interactions within the binder, particularly in treated fibers. These interactions translated into lower penetration values and higher softening points, indicating increased stiffness, improved thermal stability, and stronger adhesion with aggregates. Overall, bamboo fiber demonstrates strong potential as a sustainable and eco-friendly modifier to improve pavement durability, reduce moisture-related damage, and extend service life, making it a viable alternative to synthetic additives.

LOW COST PORTABLE WATER PURIFIER SYSTEM FOR DISASTER RELIEF USING SUSTAINABLE ENERGY

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Department of Mechatronics Engineering, International Islamic University Malaysia[1]

1 Abstract

This project presents a portable solar-powered water purification system designed for disaster relief. The backpack device integrates filters, UV disinfection, sensors and Arduino control. Testing on puddle water showed improved clarity, odor, pH and TDS reduction by 50–70%. Future works are upgrade battery enhanced solar charging and IoT monitoring.

2 Problem statement

Natural disasters disrupt clean water access raising disease risks. Conventional systems are tend to be bulky and grid dependent and impractical for emergency settings

3 Objectives

- Design a solar-powered portable purifier with filtration, UV, storage and monitoring.
- Develop and integrate all components into a working system.
- Test and evaluate system performance.

4 Methodology

The process starts with raw water in the upper tank pumped through sediment and carbon filters to remove impurities illustrated in Fig.1 . It then enters the lower tank where a UV lamp disinfects pathogens. pH and TDS sensors evaluate quality with results shown on an LCD. Safe water is dispensed while unsafe water is re-cycled for further purification.

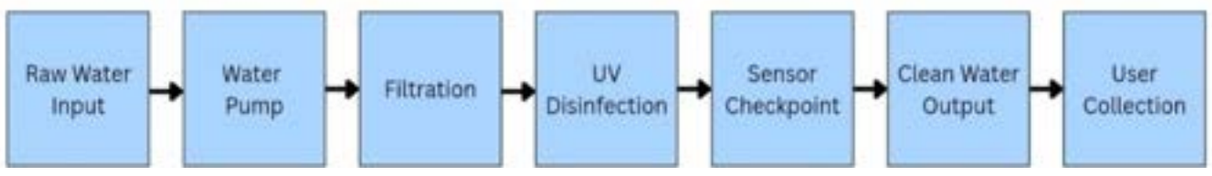


Fig. 1 Conceptual block diagram

The block diagram (Fig. 2) illustrates system operation. The solar powered battery supplies power to the pump, UV lamp, sensors and LCD. An Arduino Uno functions as the central controller processing sensor inputs and regulating outputs to ensure coordinated purification performance.

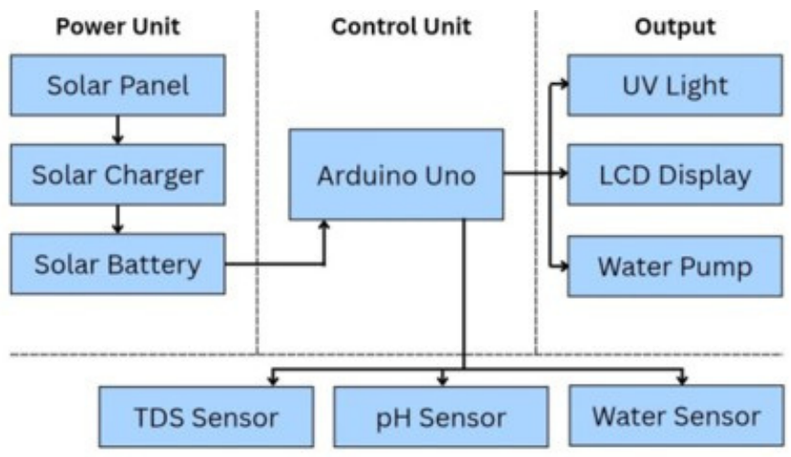


Fig. 2 Device block diagram

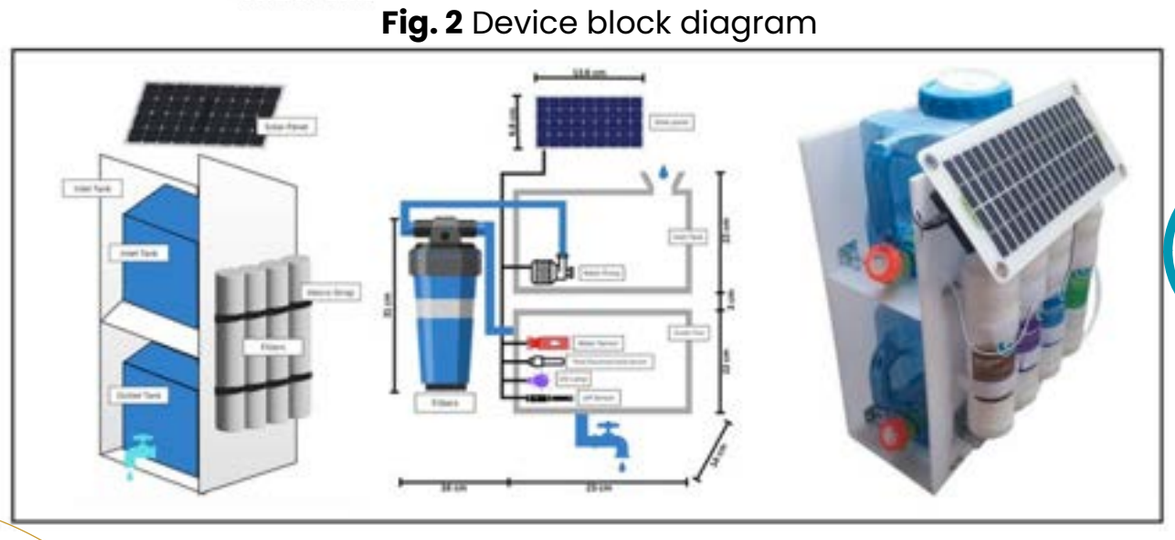


Fig. 3 Device design and final construction of the device

5 Results & Findings

The effectiveness of the purification device were investigated. Five raw water samples were collected from outdoor environments representing contaminated sources. Table 1 and 2 illustrated the results

Sample	pH (before)	pH (after)	TDS (ppm) Before	TDS (ppm) After
1	6.1	7.0	920	350
2	5.2	7.3	1020	400
3	5.8	7.2	1270	410
4	6.4	7.1	870	290
5	5.9	6.9	980	360

Table 1 Water quality before and after treatment

Table 2 Water visual and odour before and after treatment

Sample	Odour Before	Odour After	Clarity Before	Clarity After
1	Soily	None	Cloudy	Clear
2	Soily	None	Muddy	Clear
3	Soily	None	Muddy	Clear
4	Soily	None	Cloudy	Clear
5	Metallic	None	Cloudy	Clear

After filtration, all samples were observed to be odourless and clear showing a improvement. Fig. 4 shows samples before and after treatment proves the visual clarity enhancement

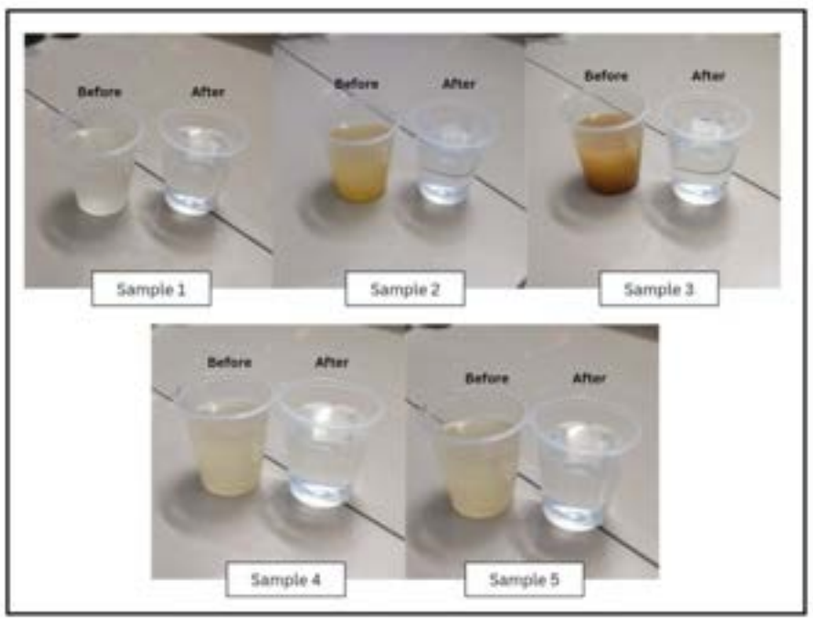


Fig. 4 Samples before and after treatment

After filtration, all samples were observed to be odourless and clear showing a improvement. Fig. 4 shows samples before and after treatment proves the visual clarity enhancement

Table I presents pH and TDS results before and after filtration. Raw water pH ranged 5.2–6.4 slightly acidic but improved to 6.9–7.3, within WHO's safe range. TDS dropped from 870–1050 ppm to 290–410 ppm achieving 50–70% reduction though still above ideal palatability (<250 ppm). Table 2 shows qualitative improvement with unpleasant odours and cloudy appearances eliminated demonstrating the system's effectiveness in enhancing water quality.

6 Conclusion

In conclusion, testing confirmed effective filtration performance and disinfection with pH and TDS sensors validating safe standards. Solar energy ensured sustainability while the compact backpack design enabled portability. The project achieved affordability and portability showing strong potential for humanitarian and disaster response applications.

7 Acknowledgment

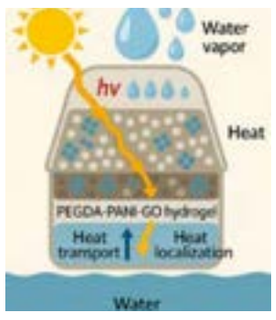
All praise to Allah for enabling me to complete this project. I sincerely thank KOE lecturers, my project advisor, Dr. Nadzril bin Sulaiman, friends and my parents for their guidance, support and encouragement making this project comes to life.

TAWHIDIC EPISTEMOLOGY LEADING THE WAY UMMATIC EXCELLENCE LEADING THE WORLD
KHALĪFAH · AMĀNAH · IQRA' · RAHMATAN LIL-ĀLAMĪN
KULLIYYAH OF ENGINEERING
RESEARCH, INNOVATION & COMMERCIALISATION
KERICE 2025

SOLARGEL: REVOLUTIONIZING SOLAR WATER GENERATION WITH SMART GRAPHENE HYDROGELS

Nurul Aqilah Bt Awang, *Dr Syazwani Bt Mohd Zaki*, *Flora Serati*, *Ahmad Akid Zulkifli* and *Saiffaqrullah b.Shamsulamri*
International Islamic University Malaysia (IIUM)

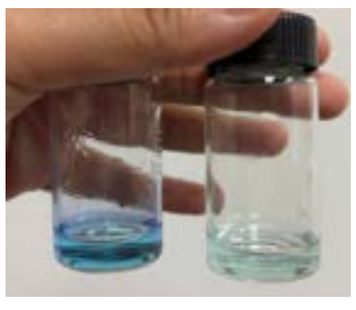
S-Sustainable
(Renewed power)



O-Optimized
(91.5%
high solar efficiency)

L-Low cost
(Due to In-house made chemicals)

A-Adaptable
(Customizable via mold)



R- Refining
(Effective purification)

1 Abstract

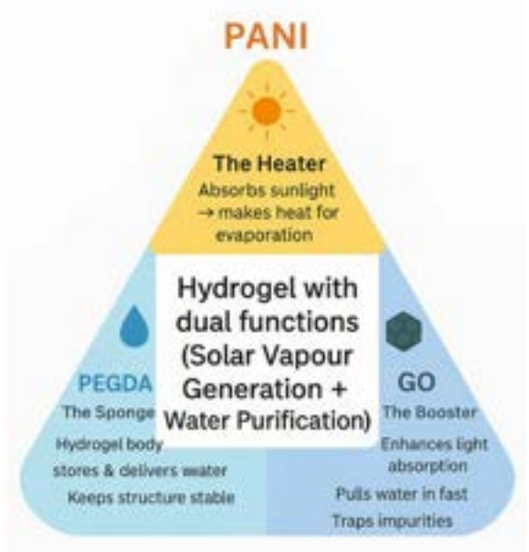
Global Challenge:
Clean water scarcity affects al
hitting the less fortunate harde

Smart Solution:
SolarGel – PEGDA–PANI–GO hydrogel.

Dual Action:
Solar vapor + contaminant removal.

Beyond Desalination:
Treats wastewater & industrial effluents.

Big Impact:
Low-cost, scalable, user-friendly → clean water for everyone.



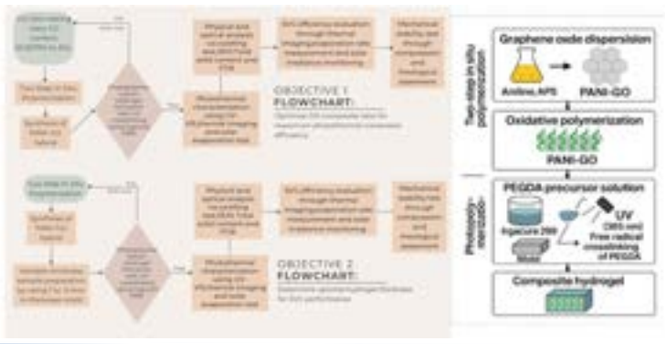
2 Problem statement

- Over 2.2 billion people lack access to safe water, with the greatest burden on rural, indigenous, and underserved communities
- Reverse Osmosis (RO) is effective but unsuitable for villages.
- Distillation requires constant heating, impractical for off-grid use.
- Conventional hydrogels show low efficiency and limited purification, restricting real-world use.
- A renewable, low-cost, dual-function solution is urgently needed to provideboth water generation and purification for underserved communities and small industries.

3 Objectives

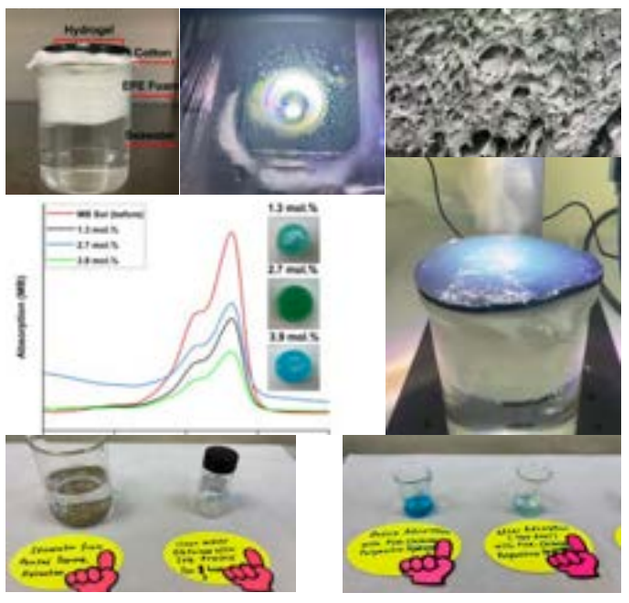
- Optimize GO dispersion for maximum heat conversion. This will help to increase the rate of solar vapor generation (SVG), allowing higher absorption of sunlight and conversion to heat for evaporation.
- To determine the ideal hydrogel thickness that balances efficient heat localization and sufficient water transport to improve overall system efficiency and water output. Optimal thickness is crucial for maximizing SVG performance, as too thin hydrogel may not hold enough water, while too thick can waste energy due to the large volume.

4 Methodology



4 Results & Findings

The SOLARGEL photothermal system demonstrated exceptional performance, achieving a **solar-to-vapor efficiency of up to 91.5%**. This high efficiency is attributed to the synergistic integration of PANI, which maximizes light absorption, and GO, which enhances heat conduction and adsorption, all within a stable PEGDA matrix. The system's unique structure provides dual-functionality, effectively generating clean water through solar vapor generation while simultaneously removing various contaminants, including salts and dyes. Furthermore, the material's low-cost, scalable, and modular design makes it highly suitable for practical deployment in both rural and small-scale industrial applications, directly supporting the goals of UN SDG 6: Clean Water & Sanitation.



5 Conclusion

- Exceptional Solar Efficiency – Achieved up to 91.5% efficiency through PANI's light absorption and GO's heat conduction/adsorption. This minimizes energy loss by localizing heat at the water surface.
- Dual Functionality – Produces clean water via distillation and removes contaminants. Unlike most systems that only desalinate, it enables wastewater treatment and industrial recycling.
- **Practical & Scalable** – Low-cost, viable, and scalable for real-world use. Supports global water access and aligns with UN SDG 6: Clean Water & Sanitation.
- Easy to manage and maintain - The system is easy to be removed and can be replaced with a new one when old one degrade, making it accessible for all ages to use it.

SolarGel proves a practical, scalable, and sustainable pathway toward universal clean water access

6 Acknowledgement

This research was funded by a grant from the Ministry of Higher Education of Malaysia (FRGS Grant FRGS/1/2022/TK09/UIAM/02/8.

MECHANICAL PERFORMANCE EVALUATION OF AN ENHANCED-COOLING SMA ACTUATOR FOR MULTI-DIRECTIONAL ASSISTIVE FACIAL REHABILITATION DEVICE

Raudhatul Ilmii binti Rahazlan Affandi. Dr. Azni Nabela binti Wahid*
Department of Mechatronics Engineering, International Islamic University Malaysia

1 Abstract

Facial paralysis impairs voluntary facial muscle control and typically requires precise, repetitive exercises to achieve neuromuscular recovery. This paper presents the conceptual and mechanical design of a shape memory alloy (SMA)-based, multi-directional rehabilitation device targeting key facial muscles such as the forehead and cheek. SMA actuators offer advantages like high force-to-weight ratio and compactness, but their slow cooling limits dynamic response. To enhance actuation speed, this device integrates external cooling through forced air convection with a DC fan. Experimental results reveal that axial and radial forced convection improves SMA actuation speed by 79% and 85.8% compared to free air cooling. Design optimization using smaller spring diameters further improves martensite-austenite transition time by 27.5% and reduces austenite-martensite transition time by 58.2%. The prototype achieves an operational frequency of 0.04 Hz, and further refinement in control system and cooling strategy utilizing liquid may improve response time and efficiency. Results from this study contribute to the mechanical design optimization of SMA-actuated rehabilitation devices, forming a foundation for future clinical integration.

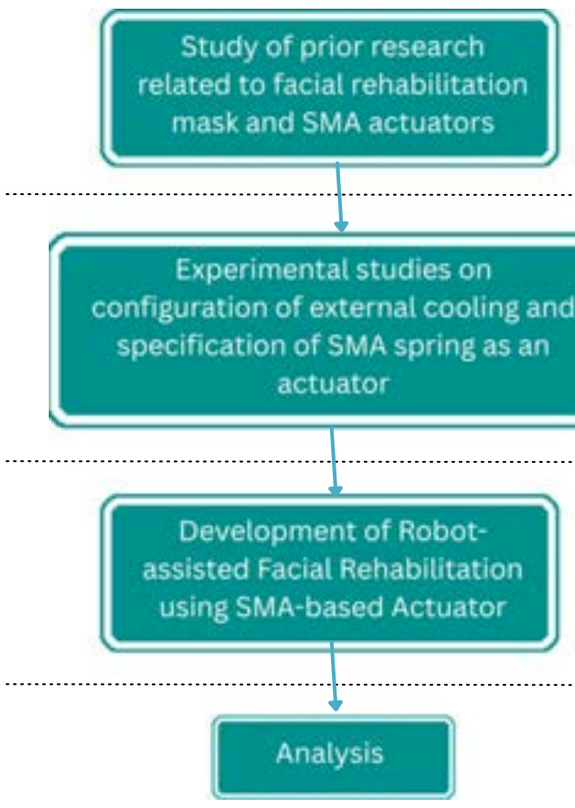
2 Problem statement

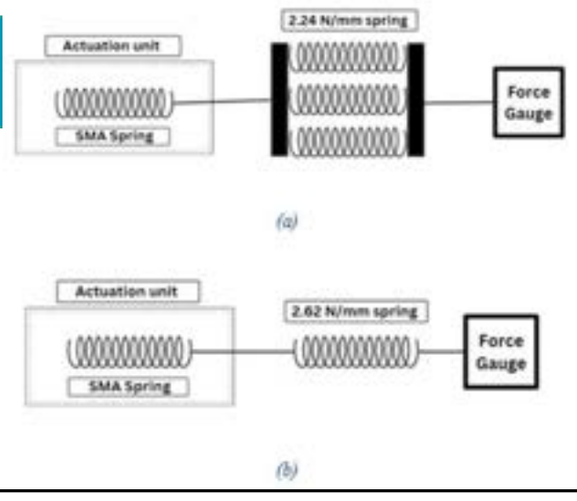
The integration of robotics system as assistive device in facial rehabilitation offers a promising avenue for a more personalized and efficient therapy by providing a controlled and targeted muscle activation. Traditional actuators in robotic system are mostly bulky and noisy, hence lead to the application of SMA as actuator. However, the configurations of SMA wires play a major roles in the development of an actuator as it might delayed the actuation process and reduce responsiveness. Additionally, the slow cooling properties of the SMA material affect the speed of actuation and produce small force output.

3 Objectives

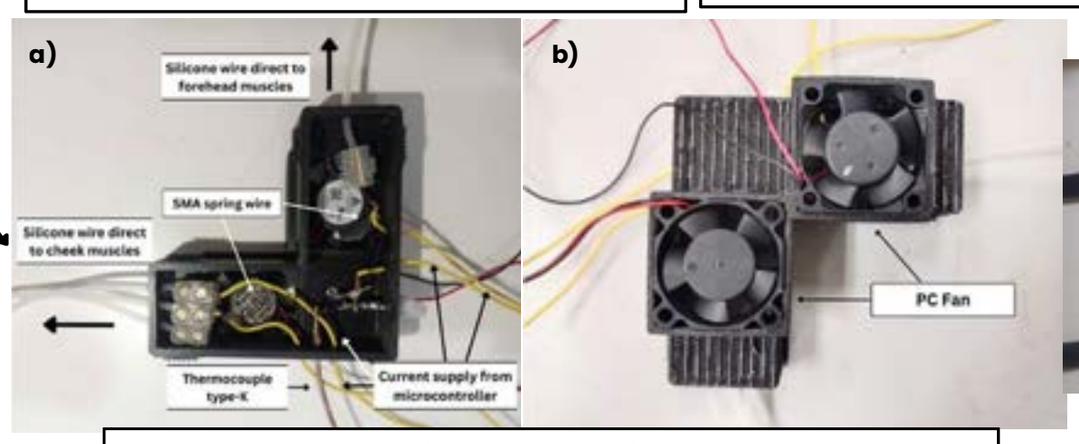
The main objective of the research is to develop an efficient SMA-based robot-assisted facial rehabilitation by enhancing its actuation speed through external cooling and improving the design by targeting multiple facial muscles for actuation.

4 Methodology





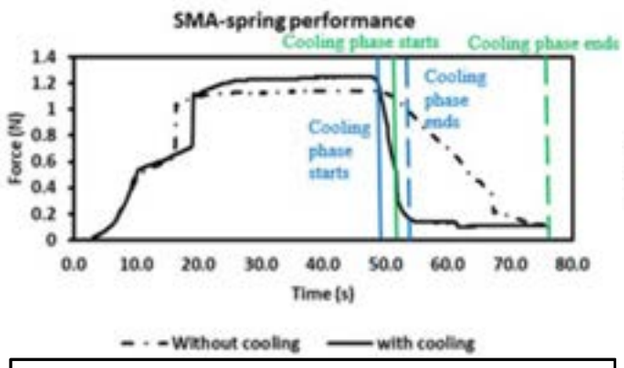
Schematic diagram of Biomechanical modelling. (a) a mimic of cheek muscles (b) a mimic of forehead muscle



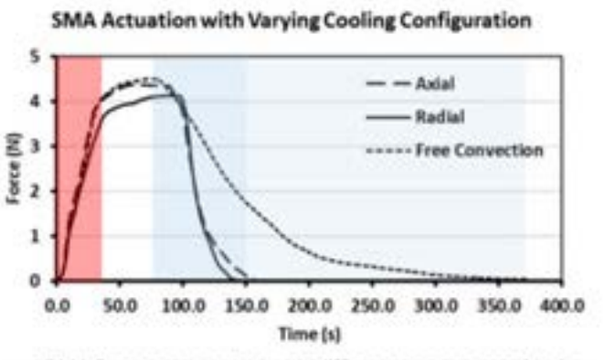
SMA based actuation unit a) complete setup b) top view showing the PC fan to provide radial cooling

5 Results & Findings

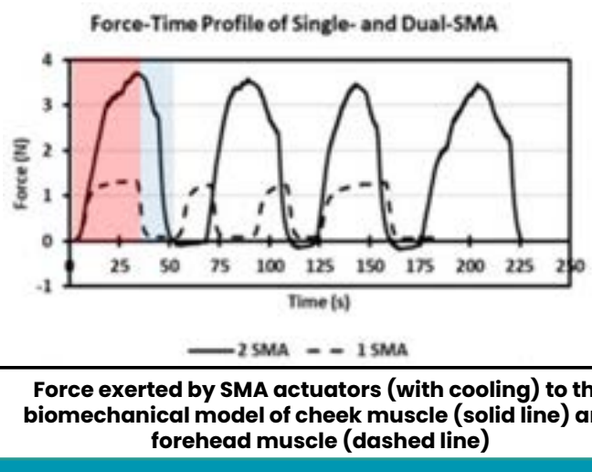
- The SMA springs under radial forced convection demonstrated a 58.2% improvement in response time compared to natural air cooling.
- Radial cooling reached steady-state fastest (47 s), followed by axial cooling (70 s), while free convection was slowest (333 s). Radial cooling provided the most effective heat transfer due to uniform airflow, whereas axial cooling caused uneven temperature distribution.
- A single spring for the forehead produced 1.4 N, while two springs for the cheek generated 3.5–3.8 N, sufficient to actuate three facial tissues. Both setups showed similar force rates, but the single spring completed cycles faster (~184 s) than the dual-spring (~218 s) due to lower thermal mass.



SMA spring performance with cooling (solid) and without cooling (dashed) mechanism



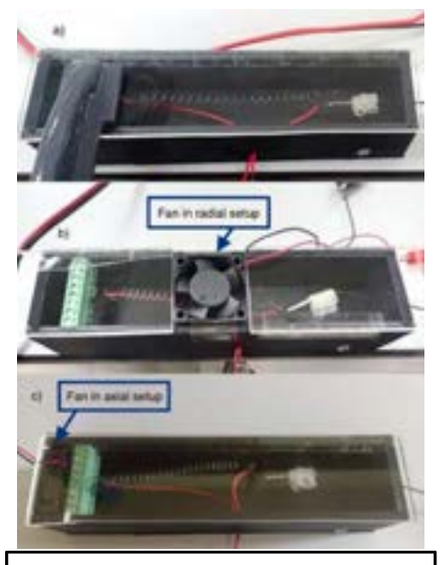
SMA force generation with different cooling methods (red – heating phase, blue – cooling phase)



Force exerted by SMA actuators (with cooling) to the biomechanical model of cheek muscle (solid line) and forehead muscle (dashed line)

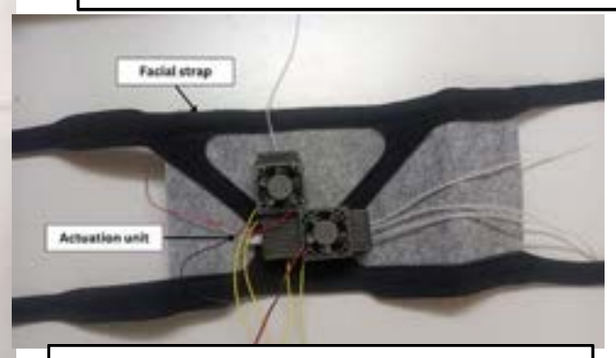
6 Conclusion

SMA actuators with external cooling improved actuation speed and performance, enabling effective multi-muscle activation with comfort. Future work will optimize cooling methods and emphasize lightweight, compact designs for better wearability.



SMA spring with a) free convection b) radial cooling c) axial cooling

Prototype placed on a subject (Approval acquired from IIUM Research Ethics Committee no. IREC 2023-022)



Prototype of the SMA-based facial rehabilitation device

PRODUCTION OF OIL PALM MESOCARP FIBER-DERIVED ACTIVATED CARBON (PMF-AC) FOR SUPERCAPACITOR ELECTRODE APPLICATION

Nabiil Ahmadi Mohd [1], Mariatul Fadzillah Mansor[1], Mohamad Azri Sukiran[2]*
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[2]*Engineering and Processing Department, Malaysian Palm Oil Board (MPOB)*

1 Abstract

This project investigates the production of activated carbon (AC) from oil palm mesocarp fiber (PMF) for supercapacitor electrode applications. PMF biochar obtained from pyrolysis at 600°C showed optimal properties for activation. Using KOH chemical activation and Central Composite Design (CCD) optimization, the best condition was identified at 30% KOH and 600°C, yielding AC with a surface area of 306.86 m²/g. Characterization confirmed hierarchical pores, high carbon content, and functional groups favorable for electrochemical applications. The study highlights PMF as a sustainable precursor for energy storage materials.

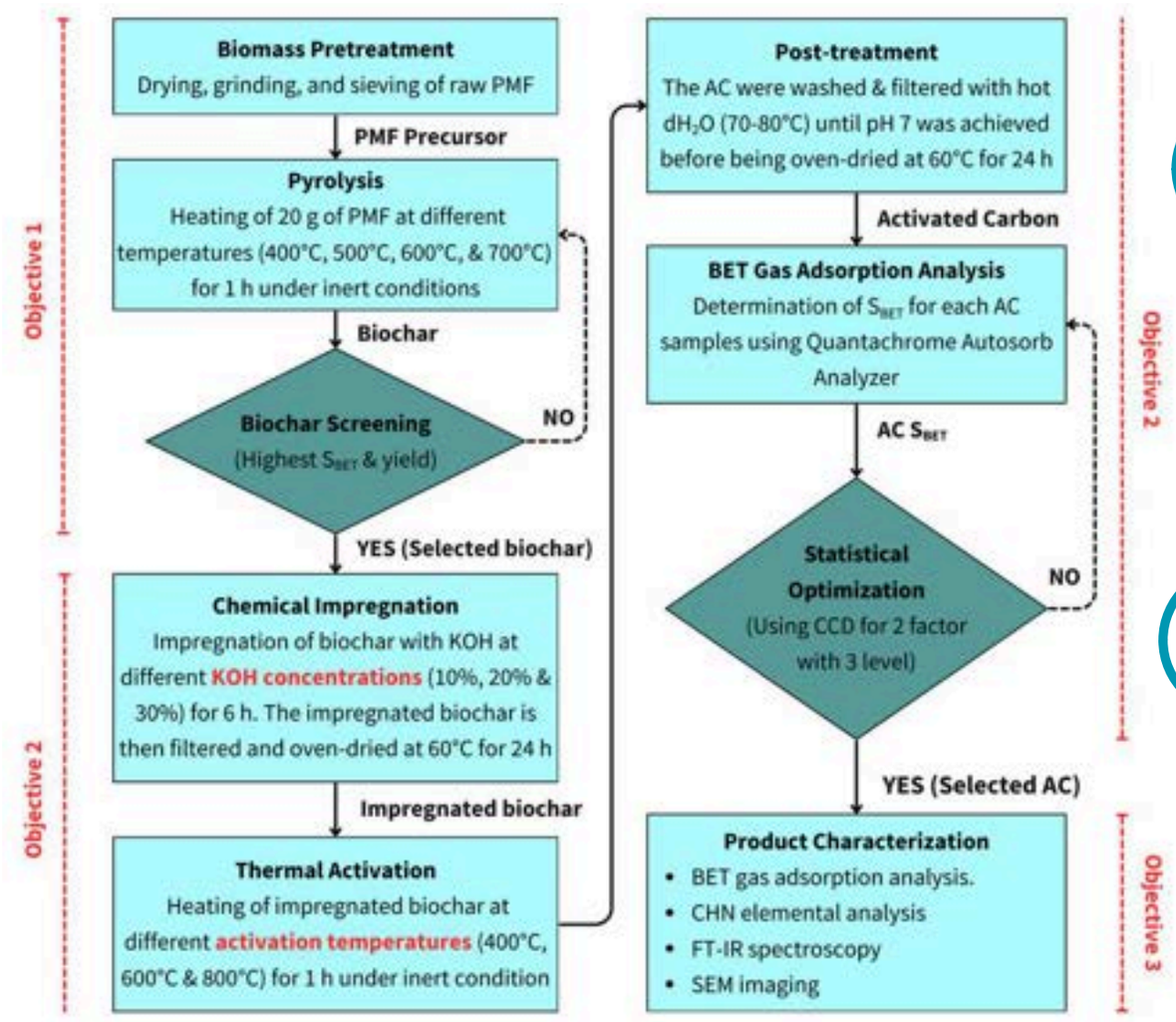
2 Problem statement

- Abundance of underutilized oil palm biomass cause concern of environmental pollution.
- Demand for sustainable energy storage derived from biomass.
- Gaps in the optimization of AC production process.

3 Objectives

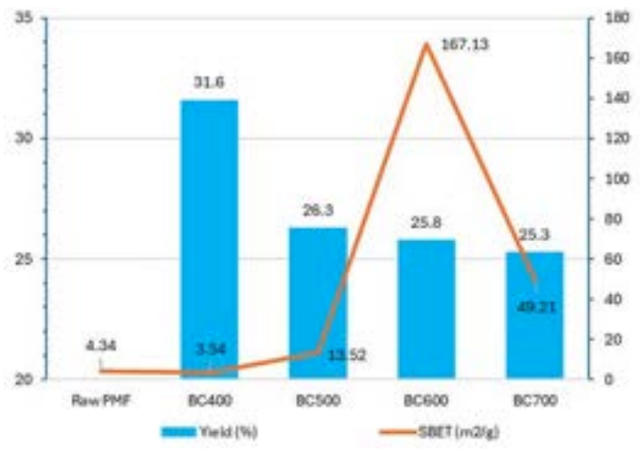
1. To identify the ideal pyrolysis temperature for producing biochar with the highest surface area.
2. To statistically optimize the **impregnation concentration** and **activation temperature** in the production of activated carbon.
3. To evaluate the AC characteristics and its suitability as electrode material.

4 Methodology



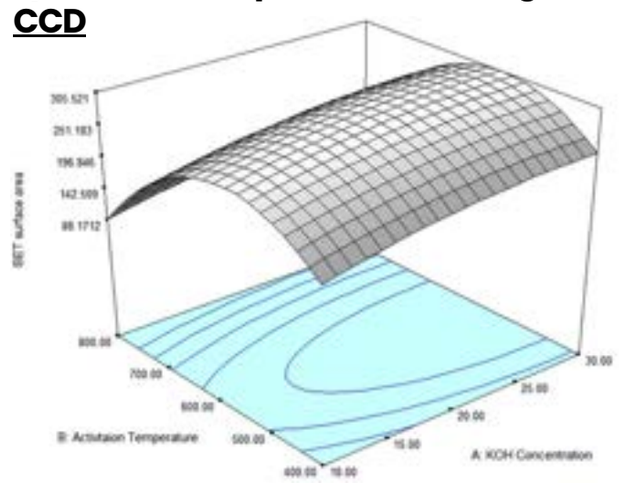
5 Results & Findings

1) Screening for ideal biochar



BC600 was determined to be the ideal biochar for AC production due to its large SBET (167.13 m2/g) and moderate yield (25.8%)

2) Parameter optimization using CCD

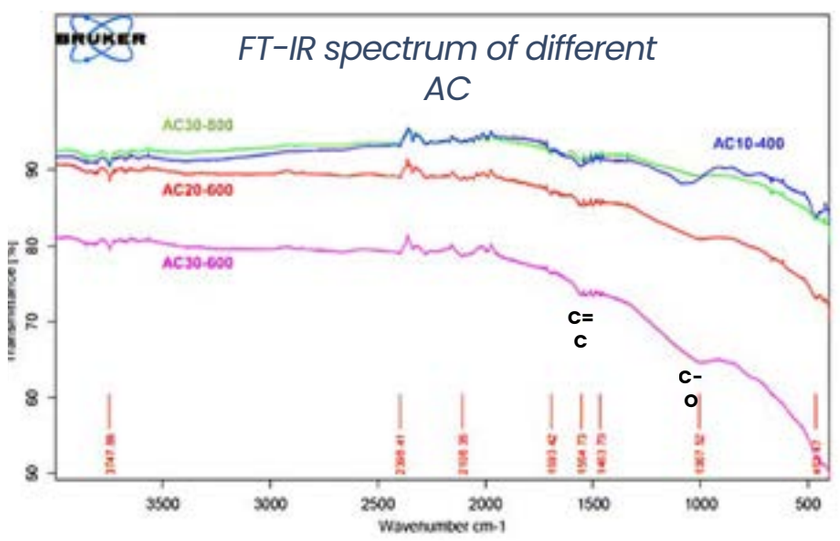


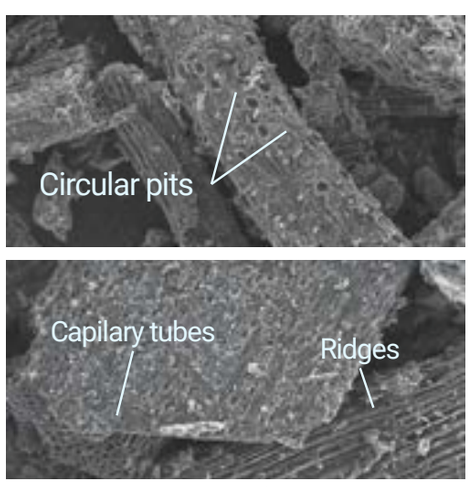
Model predicted the optimum SBET (305.53 m2/g) at 29.5% KOH concentration and 560.64°C activation temperature

3) AC characterization

BET surface area (SBET), total pore volume (Vtotal), micropore volume (Vmicro), average pore diameter (DP), and elemental composition of AC with different activation severity

Sample	S_{BET} (m²/g)	V_{total} (cm³/g)	V_{micro} (cm³/g)	D_P (nm)	Relative composition (%)			
					C	H	N	O
AC10-400	195.28	0.1302	0.0951	2.67	68.32	2.18	1.50	28.00
AC20-600	309.15	0.1858	0.1549	2.40	71.85	1.71	1.47	24.97
AC30-600	306.86	0.1592	0.1259	2.53	72.14	1.56	1.66	24.64
AC30-800	115.20	0.0878	0.0532	3.05	71.00	0.32	1.60	27.08





SEM images of AC30-600

6 Conclusion

- Optimized conditions (30% KOH, 600°C) yield AC with desirable porosity, high carbon content & structural stability.
- Although the surface area produced is lower than commercial AC, the hierarchical pores & functional groups make it competitive.
- Overall, this study shows that PMF can be converted into AC suitable for supercapacitor electrode application.

7 Acknowledgement

This research is fully supported by the Kulliyyah of Engineering, IIUM. The authors would also like to express their deep gratitude to the Engineering and Processing Department, Malaysian Palm Oil Board (MPOB) for providing the PMF samples and technical assistance throughout this project.

WHEEL-LEGGED STAIR CLIMBING ROBOT

Ahmad Fakhri Hassan Bin Ahmad Nazmi[1], Hesnawi Mohamad[1], *Md. Raisuddin Khan[1]

[1]*Department of Mechatronics Engineering, Kulliyyah of Engineering, International Islamic University Malaysia*

1 Abstract

This project presents a novel wheel-legged stair-climbing robot designed for stable and efficient mobility. The main goal of this research is to use the robot as an assisting platform for the existing motorized wheelchairs. Several configurations of the robot were evaluated using Onshape and 3D modeling in MATLAB simulations to optimize the climbing performance of the robot. A prototype was built to replicate simulation results, but testing was limited by fabrication quality and low-torque motors. Simulations confirmed the design's stair-climbing potential, while future improvements will focus on parametric optimization and professional fabrication for reliable real-world performance..

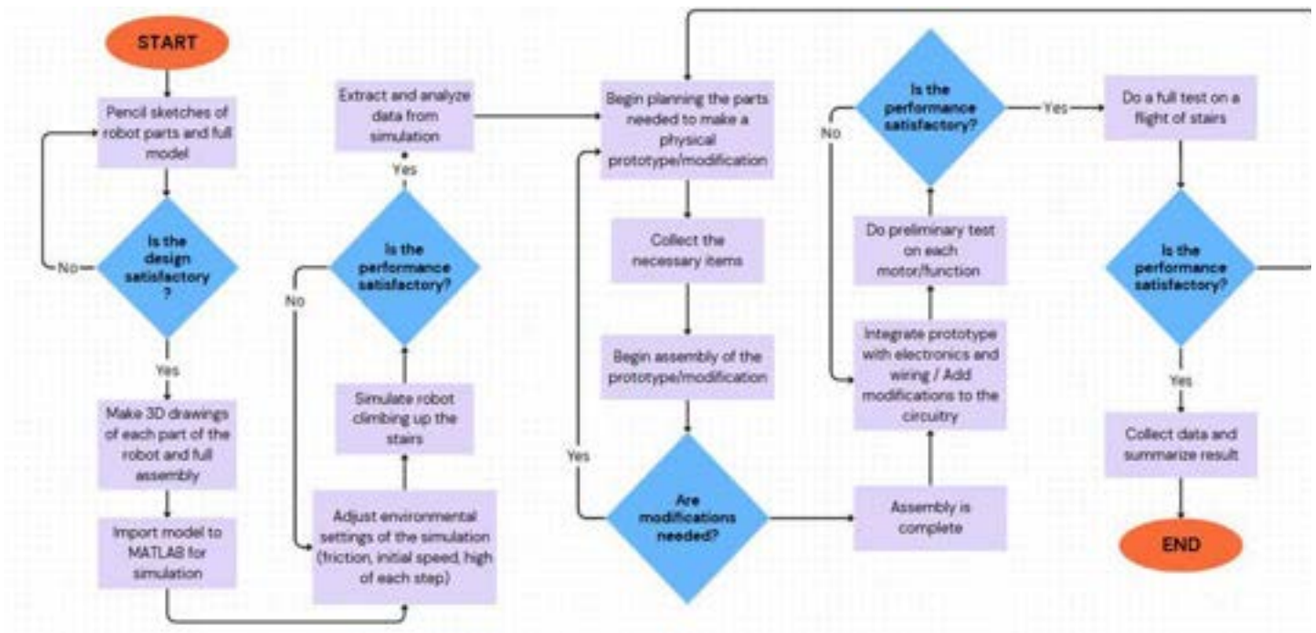
2 Problem statement

Conventional wheeled robots struggle on uneven terrain, with staircases being a major obstacle in urban and residential areas. There is a clear need for specialized stair-climbing robots to ensure safe and reliable vertical mobility. However, a fully autonomous stair-climbing robot will be expensive in terms of owning as well as maintenance. An assistive stair-climbing attachment to the existing wheelchairs could be an affordable solution to this problem.

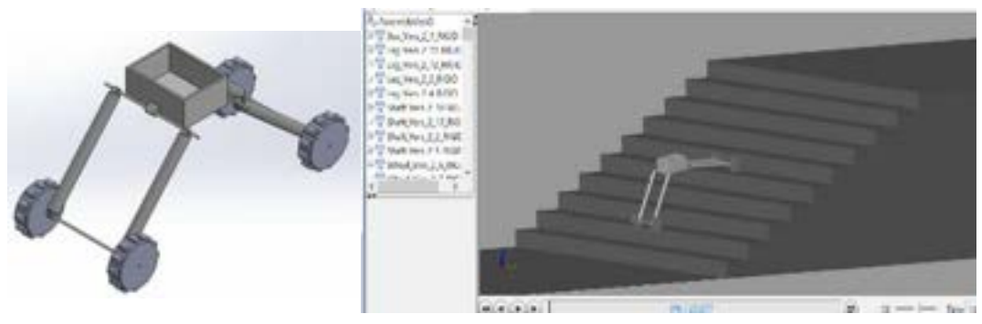
3 Objectives

- To design a stair-climbing robot combining wheels and legs
- To simulate stair-climbing motion
- To evaluate climbing performance through testing

4 Methodology



5 Results & Findings



(a) (b)

Figure 1: Model of the wheel-legged robot (a) Oneshape model (b) Simscape simulation (screen-shot of animation)

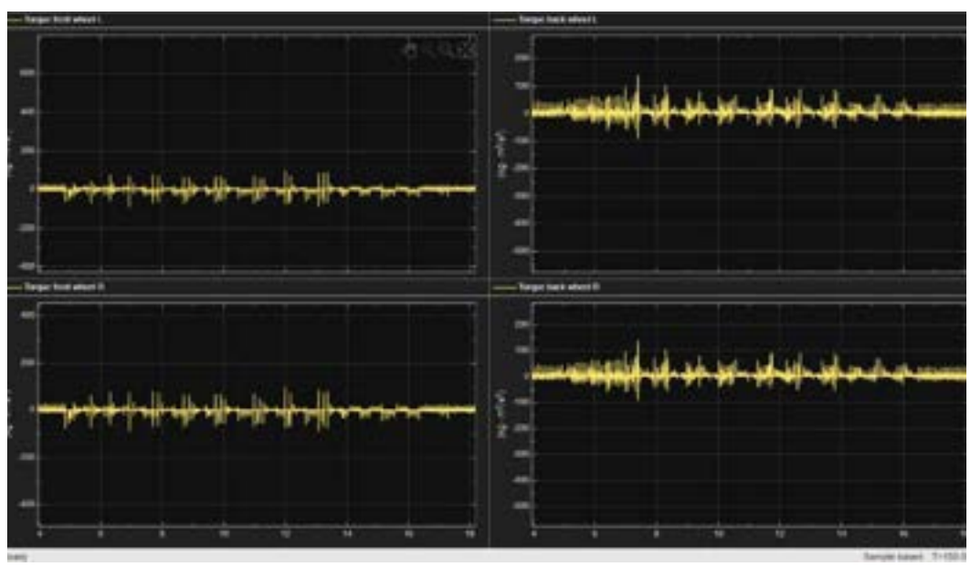


Figure 2: MATLAB simulation results using Simscape Toolbox

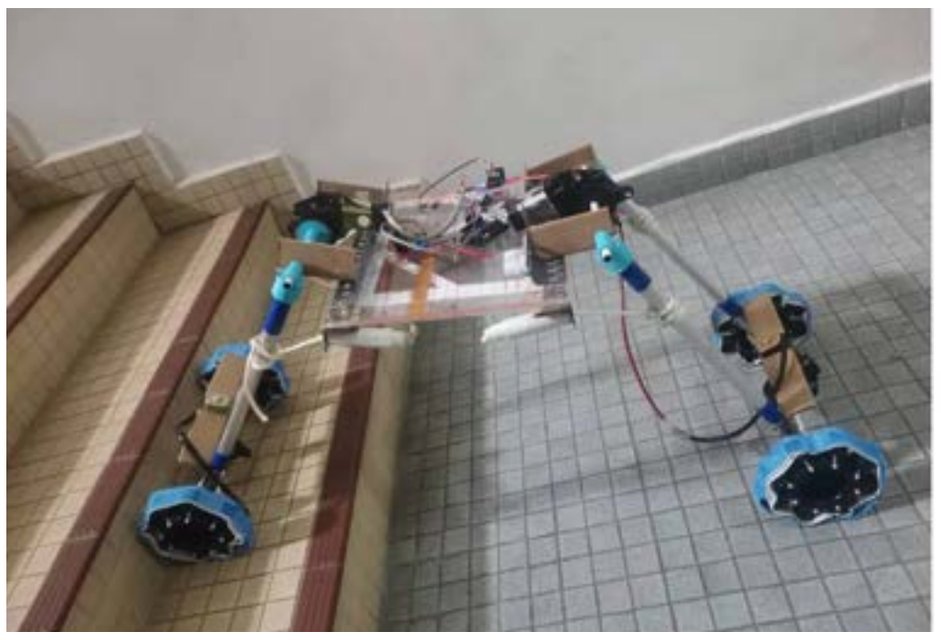


Figure 3: Prototype of the wheel-legged robot

6 Conclusion

This work was designed, simulated, and prototyped a stair-climbing robot. Simulations showed stable climbing, but the heavier prototype lacked sufficient motor torque. Future improvements include stronger attachments and high-torque motors.

7 Acknowledgement

The authors sincerely acknowledge the support of the Autonomous Systems Laboratory for helping with space and components for this project.

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Pan, Y., Khan, R. A. I., Zhang, C., Zhang, A., & Shang, H. (2024). Pegasus: A novel bio-inspired quadruped robot with underactuated wheeled-legged mechanism. IEEE Robotics and Automation Letters, 9(2), 1464–1469. https://doi.org/10.1109/icra57147.2024.10611633

THERMAL AND MECHANICAL STABILITY OF HIGH ENTROPY ALLOY (HEA) FOR RADAR ABSORBING MATERIAL IN HARSH ENVIRONMENT TOWARDS STEALTH TECHNOLOGY

Muhammad Azim bin Abd Rahim & Norhuda Hidayah binti *
Department of Manufacturing and Materials Engineering, Kulliyah of Engineering, International Islamic University Malaysia

1 Abstract

Radar absorbing materials (RAMs) are integral to stealth technology, enabling the reduction of radar wave reflection and enhancing the invisibility of military assets. However, traditional RAM such as ferrite, graphite and ceramic face critical challenges including limited absorption bandwidth, poor thermal stability, mechanical brittleness and high density. These limitations restrict the application in harsh environment where lightweight, durable and thermal stability are essential. High entropy alloy (HEA) composed of multiple principal elements in nearly equi-atomic ratio offer a solution due to the superior thermal stability, corrosion resistance, mechanical strength and electromagnetic wave absorption properties. This study focused on the characterization of the FeCoNiAlBSi HEA as coating material using magnetic sputtering on the graphite substrate. Advance characterization methods is used in this study including scanning electron microscopy (SEM) and X-ray diffraction (XRD), are employed to examine the microstructure and crystal structure respectively. Vickers hardness test is used to test the mechanical properties, while differential scanning calorimetry is used to analyse the thermal stability of the HEA.

2 Problem statement

- Graphite has been used in RAM due to its resistance to corrosion and narrow absorption frequency of (2-12GHZ). However, this material showed reduce efficiency at harsh environment condition which required by stealth application. This limits the efficiency of the RAM that to be effective across a larger spectrum of modern radar systems.
- At high altitude, thermal stability of graphite tend to degrade and phase transition will occur at around 400°C to 500°C which leading to a mass loss and surface porosity.
- At harsh environment condition, graphite tend to loss its structural stability due to low thermal expansion and also lead to embrittlement.

Figure 1 : F-117 Nighthawk Aircraft incorporates Stealth technology to avoid radar detection.

Figure 2 : Void and cracks phenomena in stealth coating on F22 [1].

3 Objectives

- To fabricate and characterize FeCoNiAlBSi high entropy alloy as coating material on graphite as substatrate using magnetic sputtering.
- To evaluate the thermal stability of FeCoNiAlBSi HEA as coating material at extreme temperature conditions typically up to 200–1100 °C.
- To compare the durability of uncoated graphite and coated graphite with FeCoNiAlBSi HEA as coating material by assessing the hardness property.

4 Methodology

Fabrication of FeCoNiAlBSi HEA powder by mechanical alloying

Compaction and sintering of the produced FeCoNiAlBSi HEA

Coating of FeCoNiAlBSi HEA on the graphite substrate using magnetic sputtering

5 Results & Findings

i. Crystal structure of FeCoNiAlBSi HEA before and after mechanical alloying process

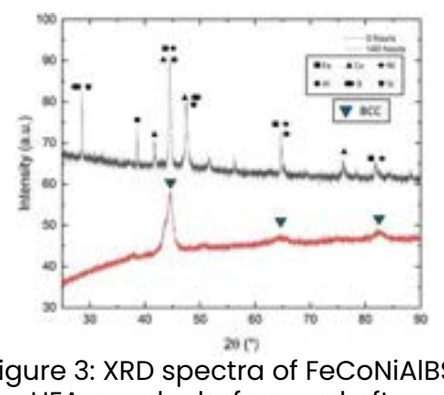

Figure 3: XRD spectra of FeCoNiAlBSi HEA powder before and after alloying at 140H

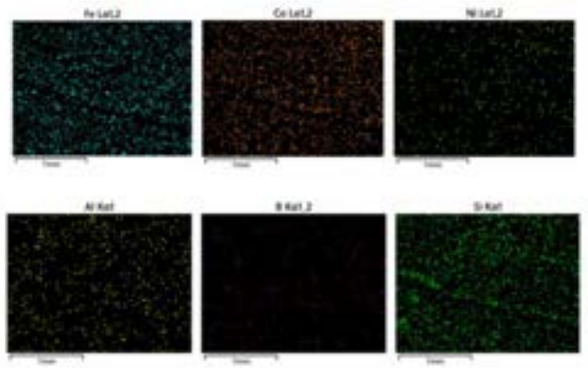

Figure 4: EDS mapping of FeCoNiAlBSi HEA powder after alloying at 140H

ii. Hardness test of graphite after coating with FeCoNiAlBSi HEA

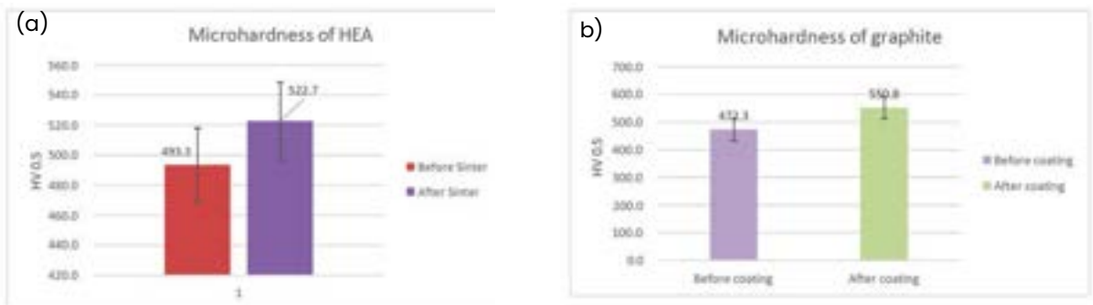

Figure 5 : (a) Microhardness test of FeCoNiAlBSi HEA powder before and after sintering at 900C and (b) microhardness of graphite before and after coating

iii. Thermal stability of graphite after coating with FeCoNiAlBSi HEA

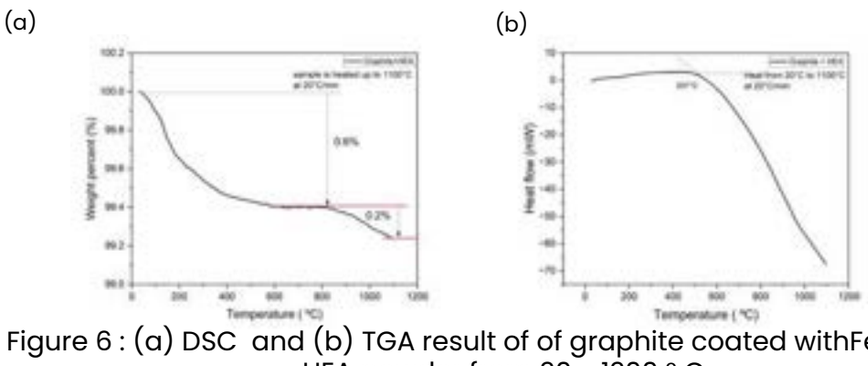

Figure 6 : (a) DSC and (b) TGA result of of graphite coated withFeCoNiAlBSi HEA powder from 20 - 1200 ° C.

6 Conclusion

- The fabrication of FeCoNiAlBSi HEA powder was successfully conducted. Formation of solid solution BCC phase was observed after 140 hours of milling time.
- The graphite was successfully coated with HEA at 30 minutes by magnetic sputtering.
- Thermal stability shows that the coated material does not significant weight loss and also having exothermic process which indicate stability of coated graphite at high temperature.
- 30 minutes of coating shows the improvement in hardness which is 17% compared to uncoated graphite.
- HEA coating successfully enhance the hardness and thermal stability making it ideal for radar absorbing material for stealth application

7 Acknowledgement

- The authors would like to thanks KOE and IIUM for continuous support for the successful of this project.

References
[1] Rogoway, T. (2019). These images of an F-22 Raptor's crumbling radar absorbent skin are fascinating. *The Drive: The War Zone*.

TAWHIDIC EPISTEMOLOGY LEADING THE WAY · UMMATIC EXCELLENCE LEADING THE WORLD
KHALĪFAH · AMĀNAH · IQRA' · RAHMATAN LIL-ĀLAMĪN
KULLIYYAH OF ENGINEERING
RESEARCH, INNOVATION & COMMERCIALISATION
KERICE 2025

IDENTIFYING AND RANKING KEY CAUSES OF CONSTRUCTION DELAYS: STAKEHOLDERS PERSPECTIVE BASED ON QUANTITATIVE APPROACH.

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Department of Civil Engineering, Kulliyyah of Engineering, International Islamic University Malaysia

1 Abstract

Construction delays remain a significant challenge worldwide including in the Malaysian construction industry. **Construction delays** often result **in increased costs, reduced productivity, and strained stakeholder relationships, ultimately affecting the industry's reputation**. To address this issue, quantitative methods are commonly used to identify and rank the most frequent key causes of delays. This study adopts a **quantitative approach to identify, evaluate, and rank the key causes of time delays in the construction projects**. Data were collected **through a structured questionnaire,** which underwent a validity check before being distributed to industry professionals. The **responses were analyzed using the Relative Importance Index (RII)** to determine the most critical key causes of delays in Malaysian construction projects, based on the perspectives of various project stakeholders. The findings offer valuable insights for **policymakers, industry stakeholders**, **practitioners, and researchers seeking to enhance construction sector performance**, particularly in **minimizing and mitigating project delays.**

2 Problem statement

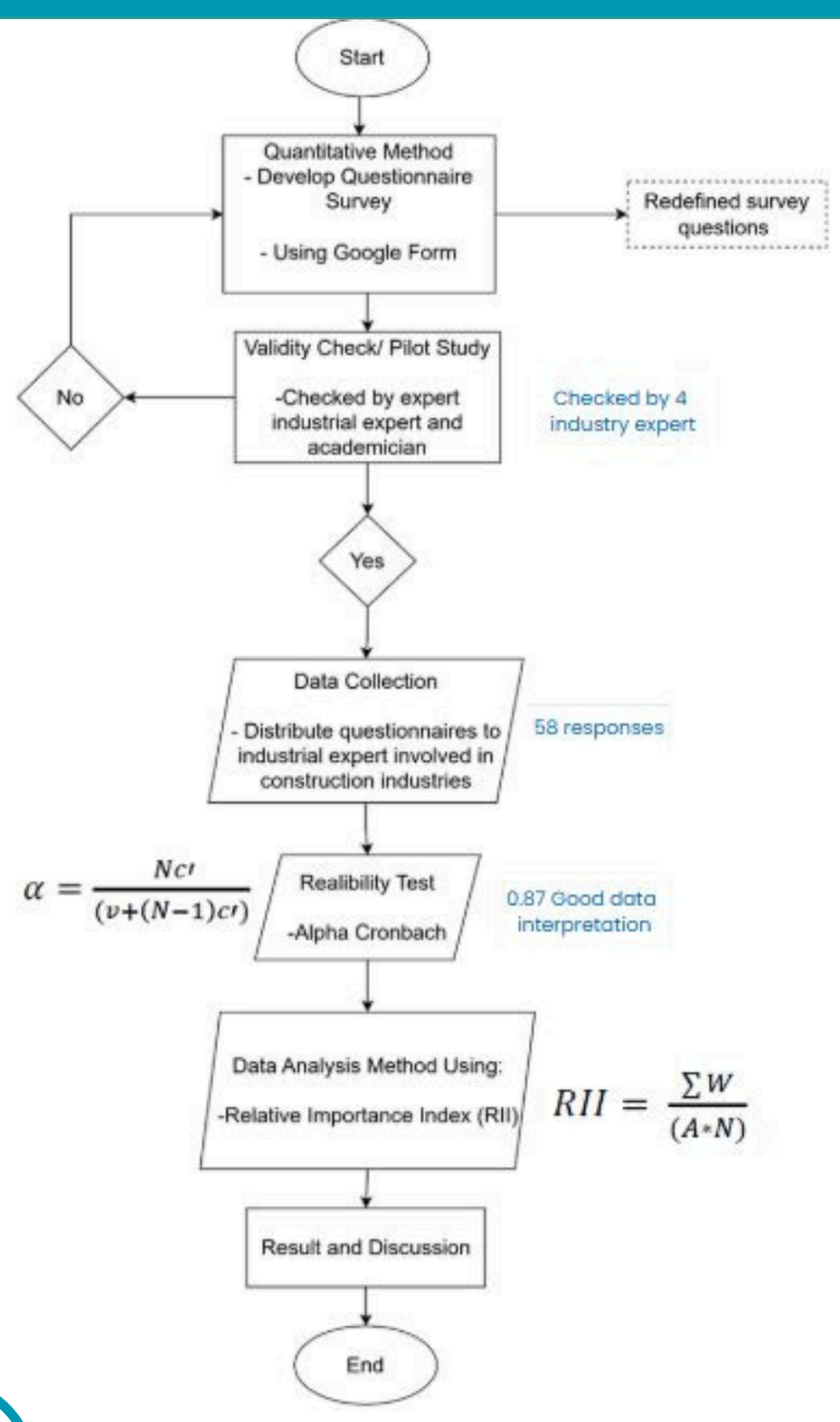
Construction activities are a major driver of the global economy, contributing significantly to gross domestic product (GDP) and employment worldwide. Large-scale construction projects play a vital role in societal development **[1–2]**. Delays in construction can be defined as time overruns the inability to meet the scheduled time, resulting in late completion **[3].** This issue has been widely researched particularly in public and private sector projects across low- and middle-income countries where meeting project timelines can also enhance a country's social reputation by fulfilling public needs **[4]**. Despite efforts to deliver projects on time within budget and at acceptable quality standards, many construction projects still experience delays, cost overruns, and amendments **[5]**. To address this, the current study considers the perspectives of key stakeholder groups such as clients, consultants, and contractors to develop a comprehensive understanding of the key causes of construction delays. The finding offers valuable insights for policymakers, industry stakeholders, practitioners, and researchers aiming to enhance the performance of the construction sector, particularly in Malaysia. By systematically identifying and ranking key causes of delay through a quantitative approach, the study contributes to a clearer understanding of scheduling challenges and supports the development of practical and effective mitigation strategies.

3 Objectives

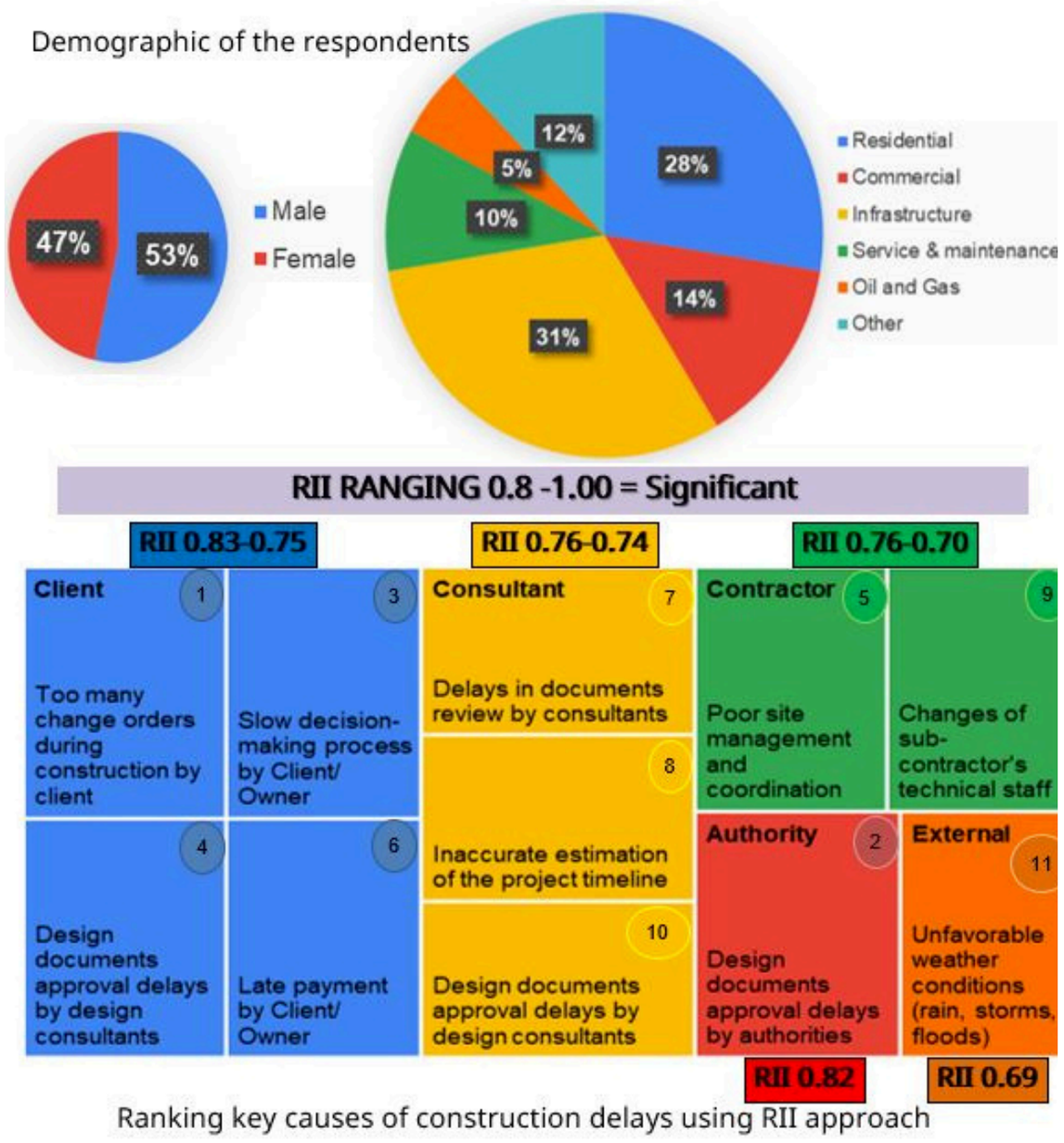
i To **identify the key causes** of **time delay** in construction projects using **quantitative approach.**

ii To **evaluate and rank the key causes of time delay** in construction projects using **quantitative approach.**

4 Methodology



5 Results & Findings



Ranking key causes of construction delays using RII approach

6 Conclusion

This study **identifies the 11 key causes of construction delays** involving clients, consultants, contractors, and external parties through a **quantitative approach**. Using the **Relative Importance Index (RII**), with values ranging from **0.83 to 0.75**, the results highlight frequent client change orders and slow decision-making during construction as major contributors to project delays. These findings provide valuable insights for improving planning and scheduling. Encouraging timely decision-making by clients can play a key role in minimizing delays and enhancing project timelines.

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3. Agyekum-Mensah G., Knight A.D. (2017) The professionals perspective on the causes of project delay in the construction industry, Engineering, Construction and Architectural Management 24 (5) (2017) 828–841.
4. Sepasgozar, S.M.E. (2019) Delay causes and emerging digital tools: a novel model of delay analysis, including integrated project delivery and PMBOK. Buildings.
5. Kavuma A, Ock J, Jang H (2019) Factors influencing time and cost overruns on freeform construction projects. KSCE Journal of Civil Engineering 23(4):1442-1450, https://doi.org/10.1007/s12205-019-0447-x

DEVELOPMENT OF A LOW-COST AND EASILY FABRICATED MOLECULARLY IMPRINTED POLYMER (MIP)-BASED SENSOR FOR SULFAMETHOXAZOLE (SMX) ANTIBIOTIC DETECTION

Amanatuzzakiah Abdul Halim [1]* ,Muhammad Azri Rafiq Mohd Rasyidi[1] ,Nik Ilham Zulaikha Nik Mohd Zamri[1],Rosminazuin Ab. Rahim[2],Aliza Aini Md Ralib[2]

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[2] *bDepartment of Electrical and Computer Engineering, Kulliyyah of Engineering, International Islamic University Malaysia*

1 Abstract

Sulfamethoxazole (SMX) is a commonly used veterinary antibiotic, and its overuse can lead to residue accumulation in dairy products. Such residues pose significant public health risks, including allergic reactions and the emergence of antibiotic-resistant bacteria. This study aimed to develop a selective and sensitive electrochemical sensor for detecting SMX residues using a molecularly imprinted polymer (MIP)-based screen-printed carbon electrode (SPCE) platform. The proposed MIP/SPCE sensor features a simple, rapid, and low-cost fabrication process. MIP was synthesized via bulk polymerization and characterized using SEM and FTIR, while the sensor was fabricated with inexpensive carbon paste on a cheap polyethylene terephthalate (PET) substrate. A limit of detection (LOD) of 0.12 µM and a limit of quantification (LOQ) of 0.38 µM were obtained using differential pulse voltammetry. These results confirm the sensor's ability to detect SMX at the maximum residue limit (MRL) of 0.4 µM, as defined by the European Union Regulation (1990) and Malaysian FoodRegulation (1985).

2 Problem statement

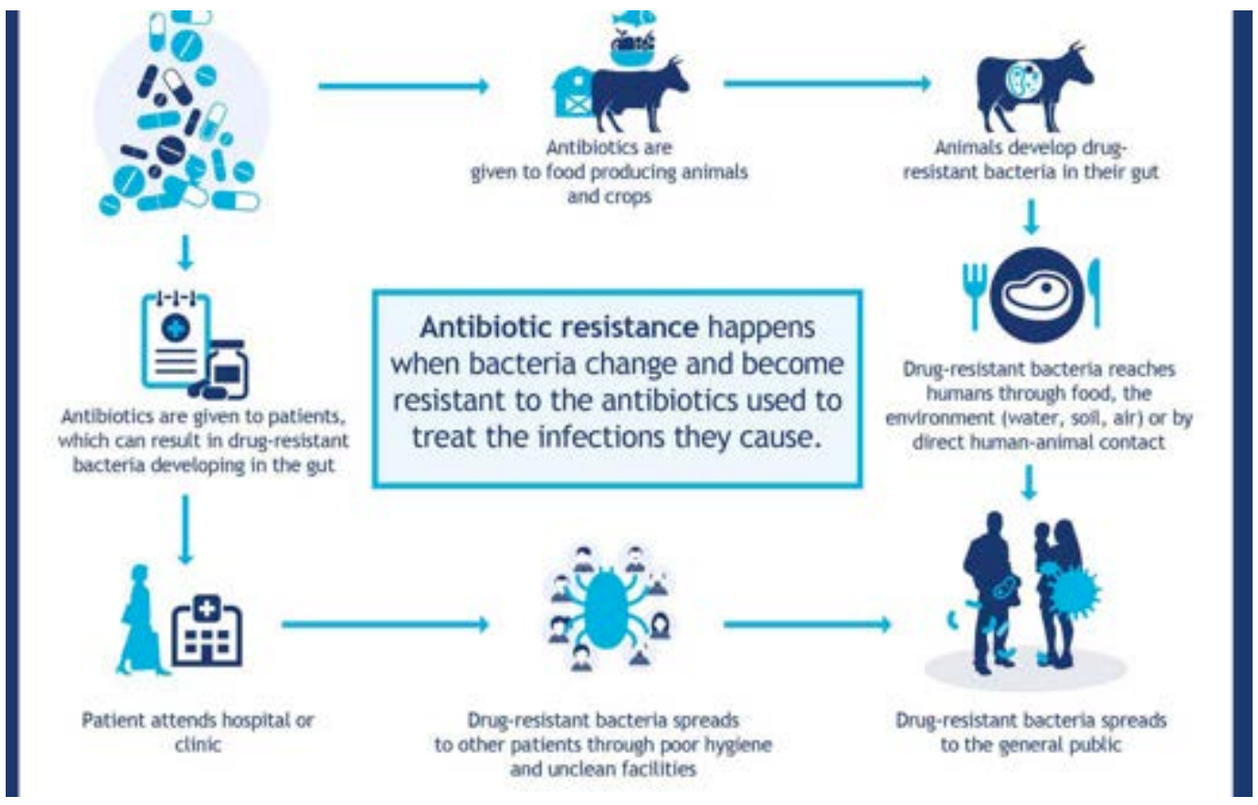
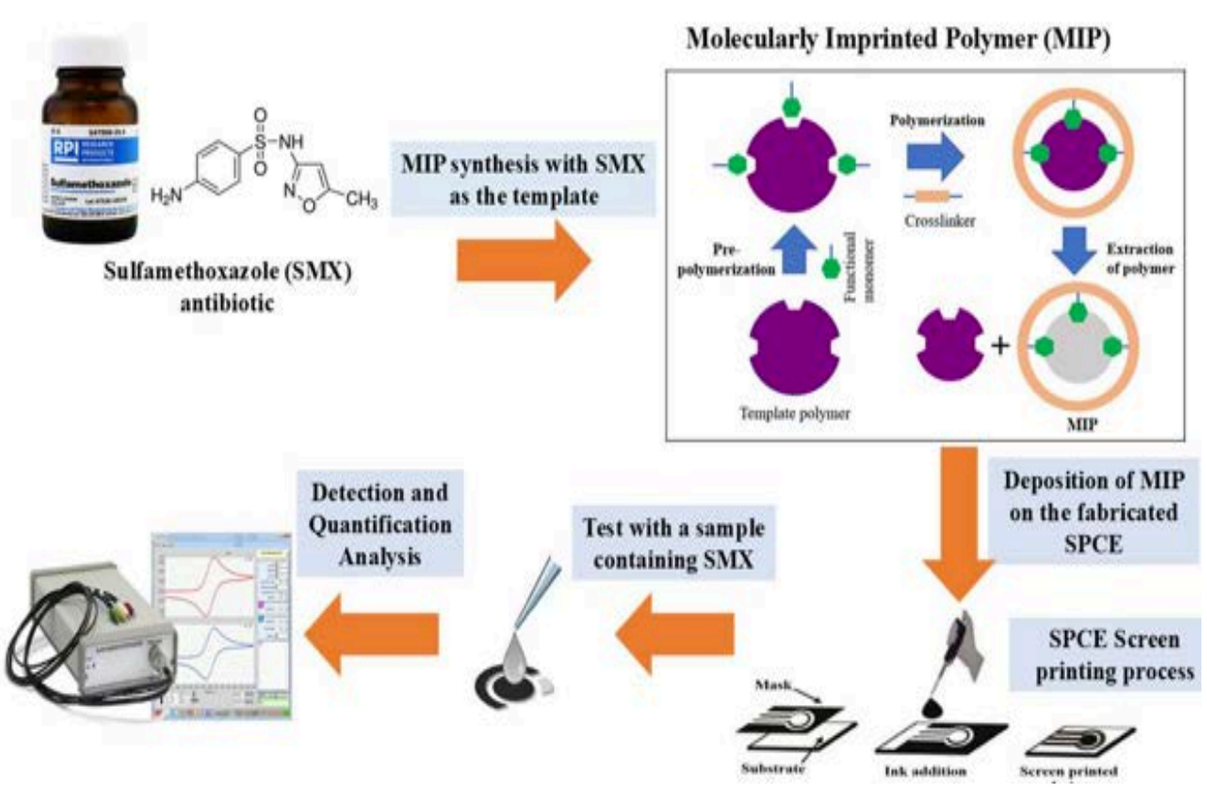


Figure 1 : Infographic illustrating the spread of antibiotic resistance

3 Methodology



4 Result

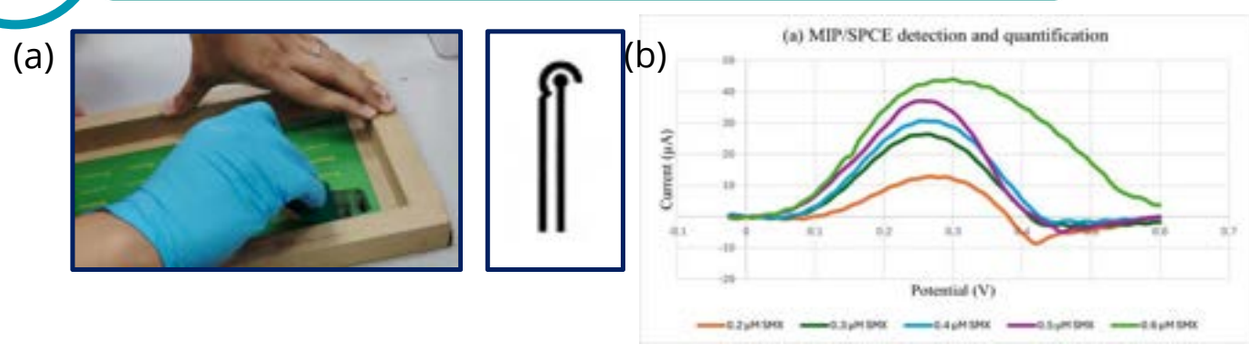


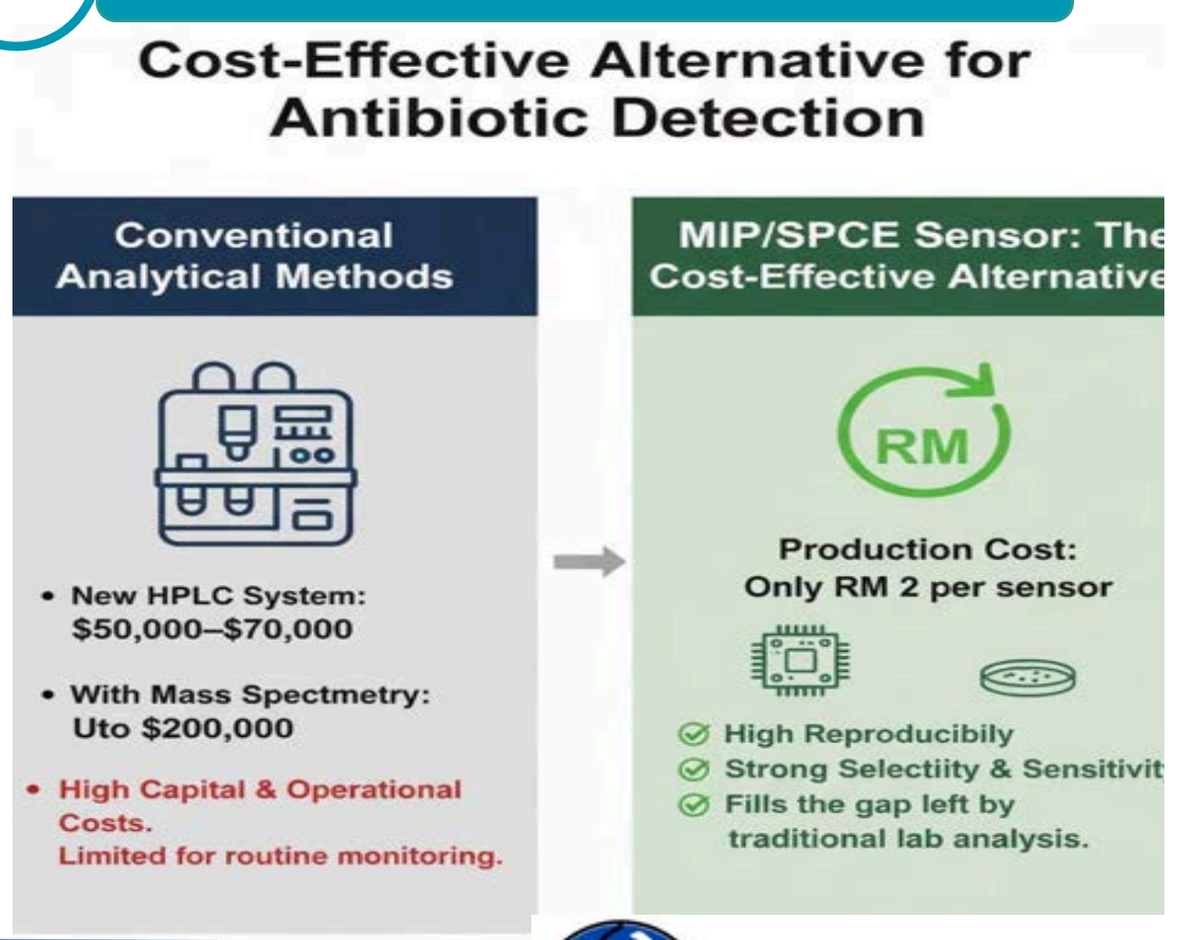
Figure 2: (a) Screen print process using stencil onto PET (b) DPV measurement

Characteristic of the calibration plot	MIP/SPCE (This work)	MIP/PGE (Özkorucuklu et al., 2008)	MIP/CPE (Sadeghi et al, 2013)	MIP/Gold electrode (Turco et al., 2015)
Analyte	SMX	SMX	SDZ	SDM
Linear range (µM)	0.1 – 0.6	0.025 – 0.75	0.2 – 1	0.15 - 3.7
Limit of detection (LOD) (µM)	0.12	0.36	0.13	70
Limit of quantification (LOQ) (µM)	0.38	1.2	-	-

Table 1 : Comparison of sensor 's performance

5 Target Market

6 Economic Analysis



BPMERU
Bioprocess & Molecular Engineering Research Unit

Flagship Project

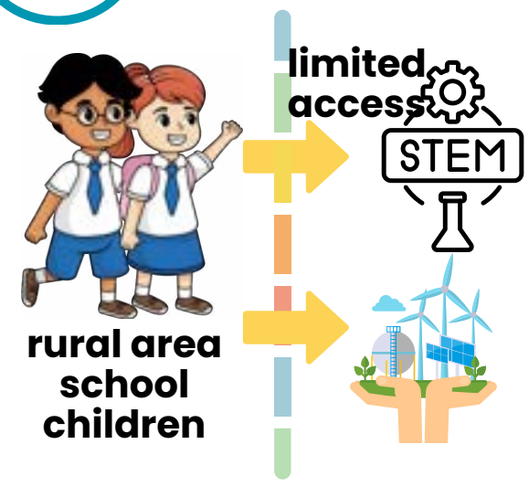
STEAM FOR SUSTAINABILITY: EMPOWERING SCHOOL CHILDREN THROUGH RENEWABLE ENERGY & TECHNOLOGY

Siti Hajar Yusoff, Nur Shahida Midi*, Sarah Yasmin Mohamad, Faridah Abd Rahman
International Islamic University Malaysia

1 Abstract

This project empowers rural students of Sekolah Kebangsaan Pasir Panjang, Selangor through STEAM-based modules that integrate Science, Technology, Engineering, Arts, and Mathematics that introduce renewable energy and sustainability concepts. The modules feature engaging, hands-on learning activities, such as Water Wheel Quest (Science), Pinwheel Challenge (Technology), Drain-piped Challenge (Engineering), Candle-powered Rotating Lamp (Art) and Cypher Quest (Math). Each module is carefully designed to match the students' age and level of understanding, while making complex concepts easy to grasp. Beyond knowledge transfer, the initiative fosters energy literacy, critical thinking, and problem-solving skills, inspiring students to view themselves as future innovators in green technology. This project demonstrates the collaboration between the academia (IIUM), industry (F&N) and community (SK Pasir Panjang) in bridging educational gaps faced by rural schools while promoting environmental awareness and digital literacy. Ultimately, it contributes to nurturing a generation of leaders prepared to drive sustainable solutions for humanity.

2 Problem statement



Underprivileged rural school children face limited access to STEAM education due to inadequate resources, lack of trained teachers, and minimal exposure to hands-on learning. This gap widens the inequality between rural and urban students, restricting their creativity, problem-solving skills, and future opportunities in a knowledge-driven economy.

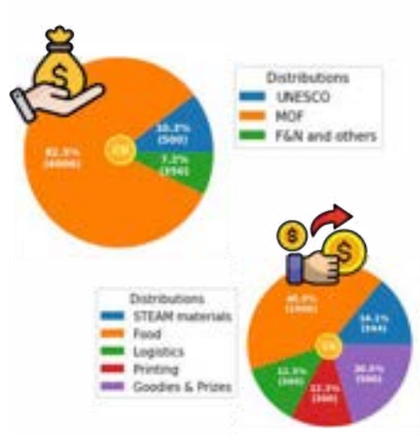
3 Objectives

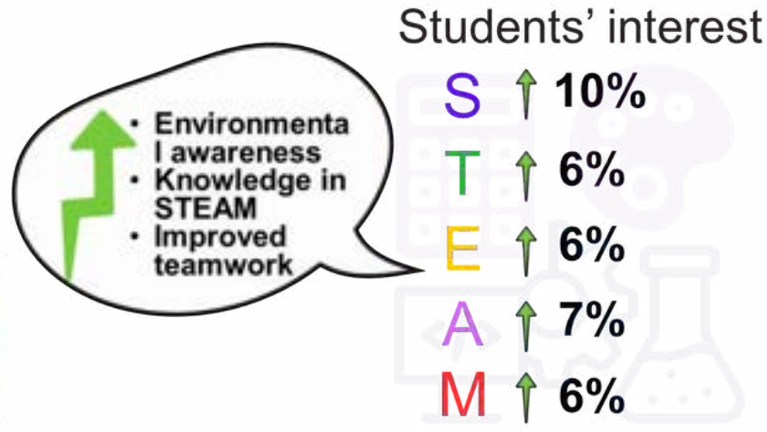
- To introduce concepts of renewable energy and sustainability to 12-year-old rural students through the STEAM (Science, Technology, Engineering, Arts, Mathematics) approach.
- To provide hands-on and interactive learning activities that spark curiosity, creativity, and problem-solving skills.
- To cultivate students' long-term interest and engagement in STEAM-related subjects.

4 Methodology

Assessment:
A pre- and post-program survey was conducted to assess students' interest and participation, where they rated their interest levels in the subject before and after the activities.

5 Results & Findings





6 Conclusion

This project shows how integrating STEAM education with renewable energy themes can effectively empower rural students, fostering both environmental awareness and problem-solving skills. By uniting academia, industry, and community support, the initiative not only bridges educational gaps but also nurtures future leaders who are capable of advancing sustainable solutions for society and humanity.

7 Acknowledgement

This project is supported by Ministry of Finance (MoF) under the Komuniti@UniMADANI Programme 2025 : STEM for Sustainability: Empowering School Children Through Renewable Energy and Technology - K@UMADANI25-006-0006

TOUCH2READ: EMPOWERING STEM LITERACY THROUGH BRAILLE & TACTILE INNOVATION

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Suhaily Mokhtar[1] , Nor Farah Huda Abd Halim[1] , Shafie Kamaruddin [1] , Nur Azam Abdullah[1]
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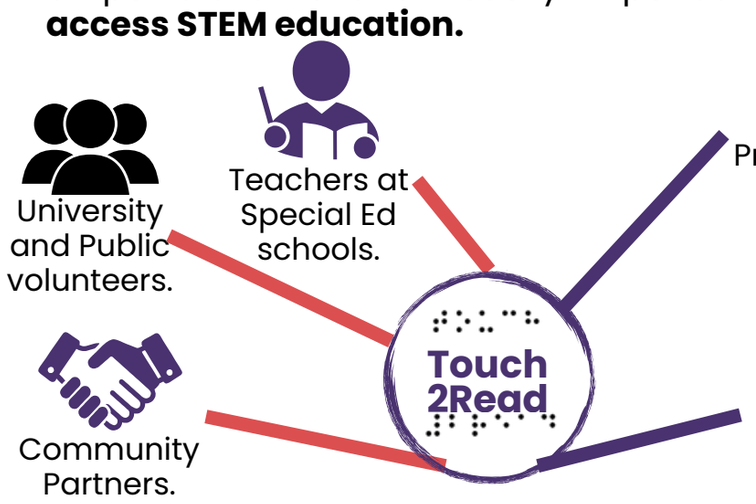
1 Abstract

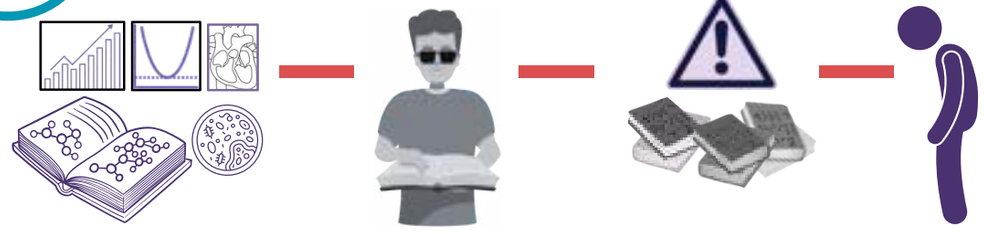
Touch2Read is a **community-driven initiative** that empowers blind and visually impaired (BVI) students to **access STEM education.**



Since BVI students **rely on touch** (Fig. 1), using Braille for text and tactile diagrams for graphics, science, and mathematics concepts, Touch2Read is dedicated to **developing learning resources that open access to STEM education.**

Fig. 1: BVI reading through touch

2 Problem statement



STEM Education relies heavily on diagrams, graphs and visual information

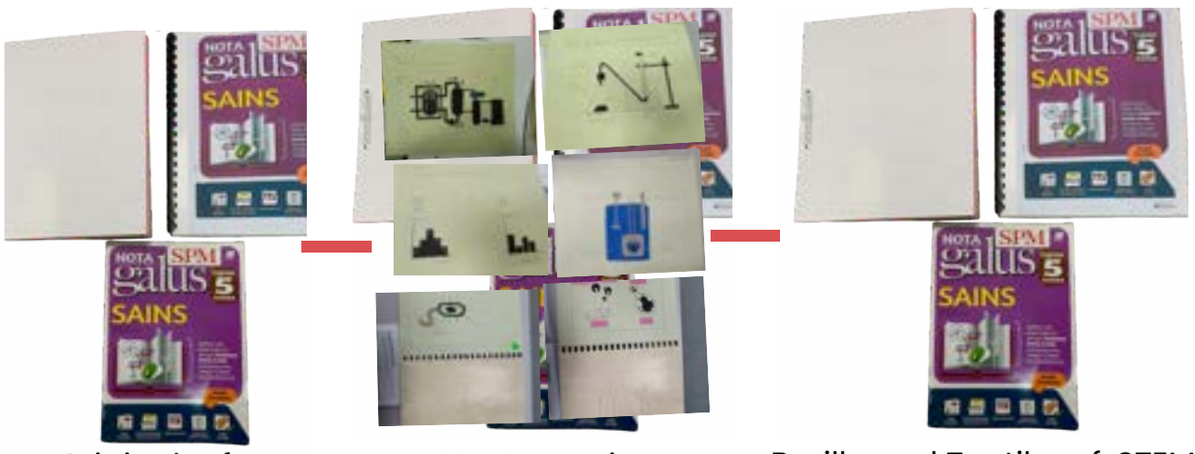
For BVI students, these are **inaccessible** unless converted into **Braille** *(raised dots)* and **Tactile** *(raised lines/ textures)*

The scarcity of learning resources for BVI

Leaves BVI learners at a disadvantage during national exam while teachers face heavy workload in preparing them

3 Objectives

Touch2Read aims to empower BVI students in STEM education by developing and providing accessible Braille and tactile learning resources through community collaboration and volunteer engagement.



Original ref. STEM book

Mastercopies (sample of students' work)

Braille and Tactile ref. STEM book (eg. page 12)

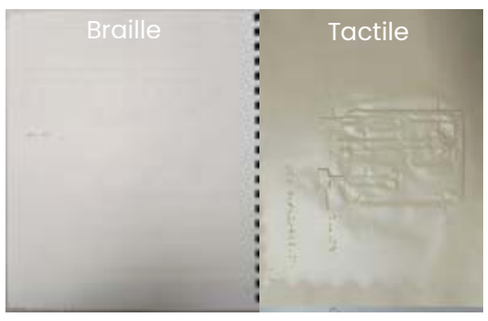


Fig. 2: Process of making a Braille and Tactile book

4 Methodology

Collaboration with SMK Pendidikan Khas Setapak, KL Braille Resources and community partners (Fig. 3)

Volunteer Training: IIUM students learn how BVI students read using braille and tactile graphics (Fig. 4)

Adapting STEM content into braille text and tactile mastercopies (Fig. 5)

Fig 3 : Profiling at school braille

Fig 4 : IIUM students learned braille

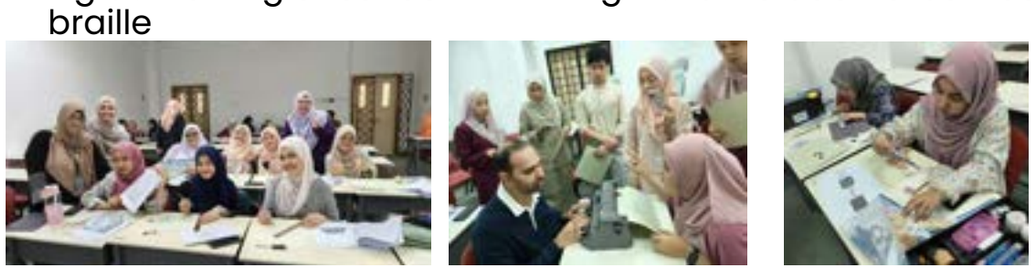


Fig 5 : IIUM students converted STEM images into tactile mastercopies

5 Achievement

Fig 6: Awareness activities on inclusive STEM education at the Touch2Read showcase

6 Conclusion

Touch2Read promotes inclusive education through community, volunteerism, and innovation. It offers accessible resources for BVI learners, supports teachers, and raises awareness of how students read by touch. By uniting learners, educators, and partners, it fosters empathy, service, and understanding—working toward an education system where **NO LEARNER IS LEFT BEHIND!**

For support, collaboration, or more info, contact: touch2read@iium.edu.my

AMTECH
Advanced Manufacturing and Materials Technology Research Unit

JOM BELAJAR TENAGA SOLAR: EMPOWERING COMMUNITIES THROUGH HANDS-ON RENEWABLE ENERGY EDUCATION

Muhammad Faris Asyraf Rosdi[1], Anuar Fazli Ubaidillah, Mohd Shahrin Abu Hanifah[1]*, Mohd Fahmi Hussin[1], Nur Shahida Midi[1], Siti Hajar Yusoff[1], Suriza Ahmad Zabidi[1], Ahmad Fathi Zainazlan[2]

[1]Department of Electrical and Computer Engineering,

[2]Solar Timur Sdn Bhd

1 Abstract

The "Jom Belajar Tenaga Solar" program was initiated to promote renewable energy (RE) awareness and STEM learning among underserved communities in Selayang, namely Kampung Selayang Indah and Apartment Julia. Conducted in collaboration with local NGOs, the program combined introductory sessions on electricity, RE, and solar technology with hands-on activities. Adults engaged with the EduSolar Kit, simulating real solar PV systems, while school students explored solar concepts using STEM kits such as solar cars and fans. The program successfully enhanced community awareness, inspired student interest in STEM, and supported Malaysia's transition towards sustainable energy.

2 Problem statement

- Low awareness of renewable energy and its benefits among the community
- Need for practical exposure to solar energy applications

3 Objectives

- Raise awareness of renewable energy and its benefits
- Provide hands-on exposure to solar applications
- Inspire future interest in green technology & STEM

4 Implementation Approach

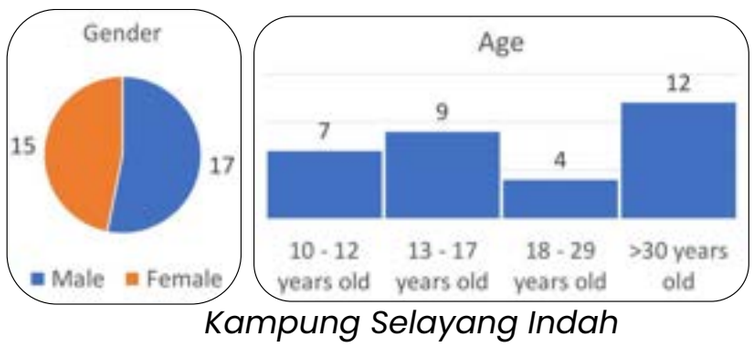
Knowledge Sharing: Introduction to renewable energy and solar energy.

Organized by lecturers and students from the Department of Electrical and Computer Engineering, IIUM.

Hands-on DIY: Participants assembled solar kits (adults) and STEM kits (children).

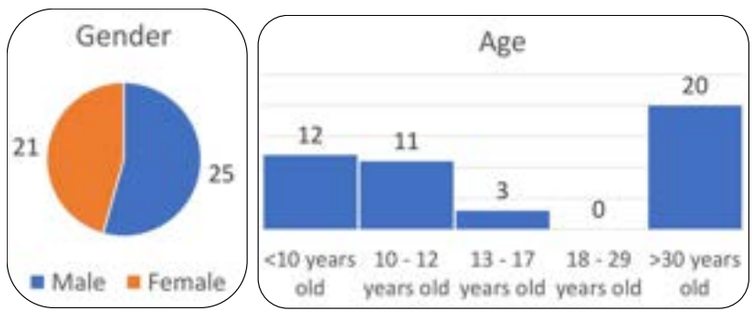
Demonstration: Working principle solar photovoltaic system using EduSolar Kit.

5 Outcome and Impacts



Kampung Selayang Indah

Apartment Julia BBS



Kampung Gombak Utara

- Active participation from all age groups
- Greater awareness of renewable energy & its applications
- Hands-on skills from solar kit assembly
- Stronger university–community connections
- Positive feedback: relevant, engaging & fun activities

6 Conclusion

This program enhanced community awareness and provided practical exposure to renewable energy. Future initiatives may include expanding to other residential areas, introducing more advanced kits, and fostering continuous collaboration between academia, industry, and community to promote sustainable energy practices.

7 Acknowledgement

This project was sponsored by Yayasan Taqwa under Knowledge Transfer and Empowerment Program Grant (KTP25-008-0008) and collaborated with NGO Ikram Selayang and Solar Timur Sdn Bhd

Malik, S. A., & Ayop, A. R. (2020). Solar energy technology: Knowledge, awareness, and acceptance of B40 households in one district of Malaysia towards government initiatives. *Technology in Society*, *63*, 101416.

PHARMASIM AI

Qistina Faqihah Binti Abdul Samat**, Fatimah Azzahrah Binti Razali, Muhammad Hafiz Shauqi Bin Mohd Yusri
International Islamic University Malaysia (IIUM)

1 Abstract

PharmaSim is an AI-powered web platform designed to accelerate early-stage drug evaluation in Malaysia's diverse population. The system integrates machine learning models to predict drug effectiveness, side effect risks, and overall success rates. A similarity scoring algorithm further compares new drug candidates with existing medicines using factors such as indication, treatment line, ingredient overlap, and dosage. Clinical features including ethnicity-aware predictions, oncology line escalation, and automated dosage unit conversion enhance practical usability for local healthcare settings. By providing virtual simulations before clinical testing, PharmaSim enables faster, safer, and more inclusive evaluation of drug candidates, reducing reliance on costly physical trials and offering scalability global applications.

2 Problem statement

In Malaysia, clinical trials are currently expensive, slow, and often lack adequate representation of the country's diverse ethnic groups. This creates a gap where drug evaluations may not accurately reflect creal-world patient responses, leading to risks of unsafe or less effective treatments. Therefore, there is a need for an alternative approach that reduces cost and time while ensuring inclusivity in drug response evaluation.

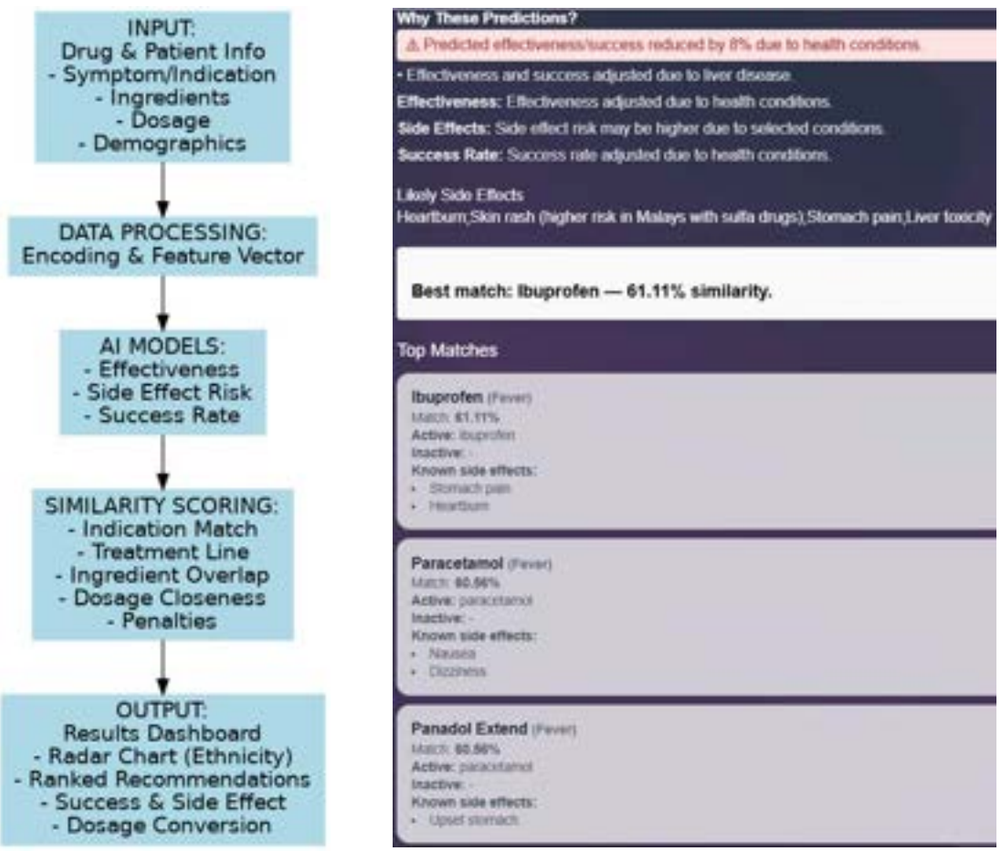
3 Objectives

The purpose of this study is to develop an AI-driven platform that can simulate drug responses virtually, providing a faster and more cost-effective alternative to traditional clinical trials. Specifically, the objectives are to predict drug effectiveness, safety, and overall success rates; to incorporate Malaysia's multi-ethnic diversity for more inclusive and reliable outcomes; and to support healthcare decision-making by delivering accessible and clinically relevant insights.

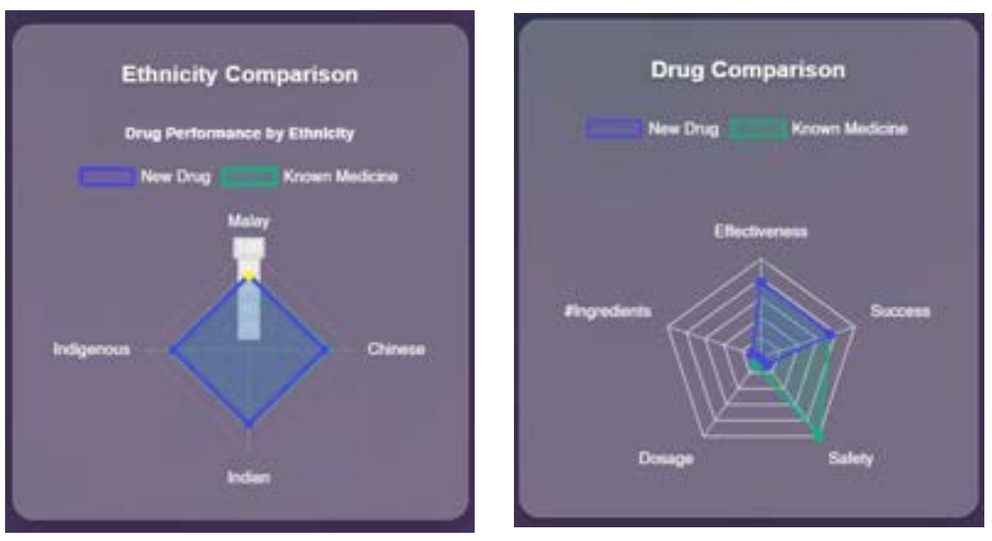
4 Methodology

This system uses three machine learning models stored as pickle files to predict a drug's effectiveness against symptoms, the probability of side effects, and its overall success rate. Patient and drug data are first converted into numerical feature vectors, which the models process to generate predictions that are clearly presented through radar charts and tables. A similarity scoring algorithm then compares new drugs with existing ones by considering indication matches, symptom group similarity, treatment line, ingredient overlap, and dosage closeness, while applying penalties for mismatches or cross-domain use. The system also includes clinical enhancements, such as mimicking oncology treatment steps by suggesting second-line drugs if no first-line option is found, adjusting predictions based on ethnicity.

4 Results & Findings



Findings & Results for the New Drug tested on PharmaSIM



New Drug performance across ethnicity

5 Conclusion

PharmaSim demonstrates the feasibility of using AI to accelerate drug evaluation in Malaysia's multi-ethnic population. The platform offers faster, cheaper, and safer simulations, helping researchers and health agencies identify promising candidates before clinical trials. While still in prototype stage, its combination of similarity scoring, ethnicity-aware predictions, and clinical workflow features provides a strong foundation of global healthcare systems.

6 Acknowledgement

We thank IIUM and the medical professionals who provided valuable feedback for this project.

AI-POWERED TACTILE IMAGES FOR THE VISUALLY IMPAIRED

Nurul Fariza Zulkurnain[1]*, Iqbal Hamdi Muhammad Asri[1]*, 'Atiah Abdullah Sidek[2], Shafie bin Kamaruddin[2], Suhaily Mokhtar[2]
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1 Abstract

This project introduces an AI-powered approach to transform visual images into tactile representations, enabling the visually impaired to access visual information through touch. The system utilizes image segmentation to separate distinct objects and applies unique textured patterns to each segment, generating touch-sensitive outputs that can be printed or embossed. By combining computer vision and pattern generation, the solution bridges the gap between sight and touch, supporting greater independence, accessibility, and inclusivity for visually impaired individuals in education, daily living, and creative expression.

2 Problem statement

Visually impaired individuals struggle to access visual information such as images, diagrams, and shapes. Existing tools like Braille and audio descriptions are limited, while tactile materials are often manually assembled (Figure 1), making them slow and costly to produce. This restricts learning, independence, and inclusivity. An innovative solution is needed to automatically convert images into tactile formats, allowing the visually impaired to "see" through touch.

Figure 1: Tactile being manually assembled

3 Objectives

1. To develop an AI-powered system that segments images into distinct objects for tactile representation.
2. To generate unique textured patterns that translate visual details into touchable formats.
3. To enhance accessibility and inclusivity for the visually impaired by enabling tactile exploration of visual content.

4 Methodology

1. **Input Image**: Collect or upload photo/diagram (RGB image).
2. **Pre-processing**: Resize, denoise, adjust contrast; convert to greyscale if needed.
3. **Image Segmentation**: Use an AI model (e.g., semantic/instance segmentation) to separate objects and regions.
4. **Feature Extraction**: Compute region properties (shape, edges, size, texture cues) to inform pattern choice.
5. **Pattern Assignment**: Map each segmented region to a distinct tactile pattern (e.g., dots, lines, waves) based on features and contrast.
6. **Pattern Refinement**: Adjust pattern scale, density, and boundary smoothing for tactile discrimination and printability.
7. **Layout & Emboss Preparation**: Combine patterns into final layout; add labels/anchors (if needed) and prepare file for embossing/3D printing/tactile printing.
8. **Output & User Testing**: Produce tactile print/embossed sheet; iterate with visually impaired users for usability and readability feedback.

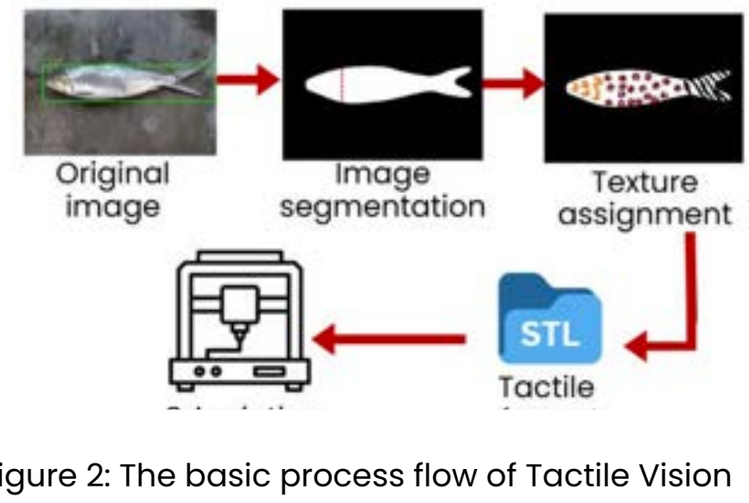

Figure 2: The basic process flow of Tactile Vision

4 Results & Findings

Progressive improvements were observed with model modifications and fine-tuning, though accuracy and IoU (Intersection over Union) remain low, highlighting the need for further optimization.

Initial Training (20 epochs, Simple U-Net):
- Training loss reduced from 3.7 → 2.3
- Validation loss reduced from 3.3 → 2.3
- Test Accuracy: 7.8%,
- Mean IoU: 2.2%

Figure 3: **Segmentation** input image and predicted mask by U-Net model

Figure 4: **Edge Detection** input and output of canny edge detection

5 Conclusion

The study demonstrates that accurate segmentation is critical for generating reliable tactile images, as mask errors directly affect edge detection quality. Although dataset imbalance remains a challenge, the integration of U-Net segmentation with lightweight OpenCV edge detection shows promising potential for efficient deployment. Future improvements in segmentation quality will further enhance accessibility and scalability of tactile image generation for the visually impaired.

6 Acknowledgement

The research team would like to express our sincere gratitude to the Ministry of Higher Education (MOHE), Malaysia, for providing financial support through the Social Research Fund (Year 2025).

PORTABLE CARIES DETECTION DEVICE FOR INCREASING ORAL HEALTH AWARENESS.

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International Islamic University Malaysia

1 Abstract

This paper presents a portable dental caries detection system powered by deep learning to enhance early screening and oral health awareness. The system integrates a YOLOv11 object detection model with both desktop software and a mobile application, enabling real-time detection and classification of caries based on ICDAS criteria: Healthy, Initial, Moderate, and Extensive. Dental images captured using an endoscopic camera are processed via OpenCV, while model training and evaluation were conducted on Google Colab using annotated datasets.

2 Problem statement

Current diagnostic methods often require specialized equipment and professional expertise, limiting early screening and timely intervention. This creates a need for a portable, real-time detection system that integrates advanced deep learning models with user-friendly desktop and mobile platforms to improve oral health awareness and facilitate early diagnosis based on standardized criteria.

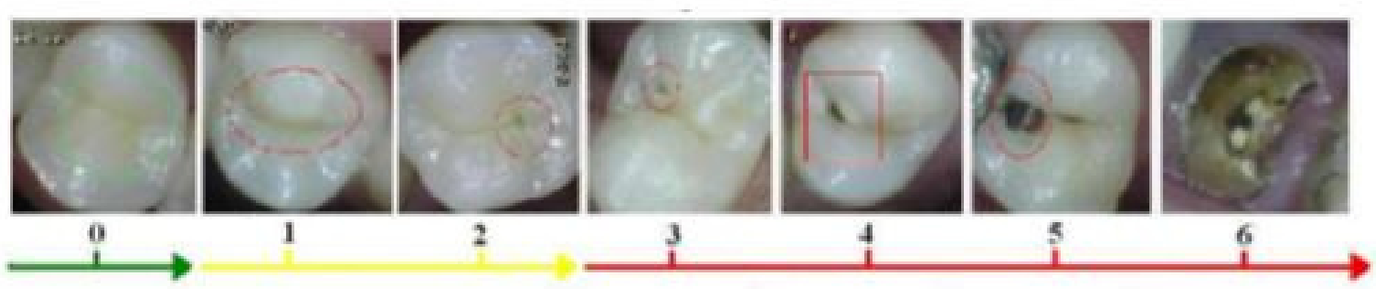
3 Objectives

1) To utilize dental endoscopic images for effective model training and evaluation using annotated datasets.

2) To develop a portable dental caries detection system that enables early screening and enhances oral health awareness.

3) To implement and compare deep learning object detection models (YOLOv11, Faster R-CNN, Detectron2, EfficientDet) for accurate classification of dental caries based on ICDAS criteria.

4 Methodology



ICDAS Classification

The primary hardware component is a USB-based endoscopic dental camera as shown in Figure 3, which is used to capture intraoral images of teeth. These images are transmitted to a processing unit where a trained deep learning model performs real-time object detection to identify and classify carious lesions. The model follows the International Caries Detection and Assessment System (ICDAS) criteria, categorizing teeth into four conditions: Healthy, Initial, Moderate, and Extensive.

The training and evaluation were conducted on Google Colab using GPU acceleration, which provided sufficient computational resources for deep learning experimentation. All models were initialized with pre-trained weights (e.g., COCO dataset) to leverage transfer learning, given the limited size of the dental dataset. This approach allowed the models to converge more quickly and perform better on low-resource data. Each model was trained using the annotated dataset

4 Results & Findings

Caries Class Distribution

The confusion matrix revealed that the Healthy and Extensive classes were predicted with high accuracy, showing minimal misclassification. However, the Initial and Moderate stages exhibited more confusion. Some Initial caries instances were misclassified as Moderate, and vice versa. This misclassification likely stems from the subtle differences between early and moderate lesions.

5 Conclusion

While the system performed reliably overall, limitations such as dataset imbalance, image quality variability, and label ambiguity were identified. These will be addressed in future work through the expansion of annotated datasets

DIGITAL DA'WAH: DEVELOPMENT OF DIGITAL APP WITH KG SG KERTAS COMMUNITY

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1 Abstract

In today's digital age, many students from the Asnaf community still face difficulties in learning tajwid due to limited access to qualified teachers, financial constraints, and lack of engaging learning methods. Although tajwid apps exist, they are often not suitable for their needs. This project aims to empower the Asnaf community in Kg. Sg, Kertas by training them to develop their own mobile application tailored for tajwid learning Through this initiative, the community, especially the younger generation, can learn tajwid in a more interactive and accessible way while gaining valuable digital skills and strengthening their connection to the Qur'an.

2 Problem statement

Although there are many digital resources for learning Islam, the Asnaf community still faces difficulties in learning tajwid effectively. They often lack access to qualified teachers, cannot afford paid classes, and have limited digital skills. Many existing tajwid apps are not suitable for their needs or language. As a result, they are becoming more disconnected from the Qur'an. A solution that combines religious learning with technology in a way that is simple, engaging and relevant to them is needed.

3 Objectives

Objectives of this program are as follows:

1. To assist Asnaf students in Kg. Sg. Kertas, Selangor in revising tajwid lessons through interactive, immersive, and engaging game-based learning.

2. To transfer knowledge on developing mobile digital applications to the Asnaf community in Kg. Sg. Kertas.

4 Methodology

This program was implemented in three main phases:

1. Pre-Program Assessment
A questionnaire was distributed to assess the participants' level of tajwid knowledge and their familiarity with mobile app development.

2.Mobile App Development Training
A 2-day hands-on workshop was conducted to teach participants how to build their own tajwid learning mobile app using MIT App Inventor.

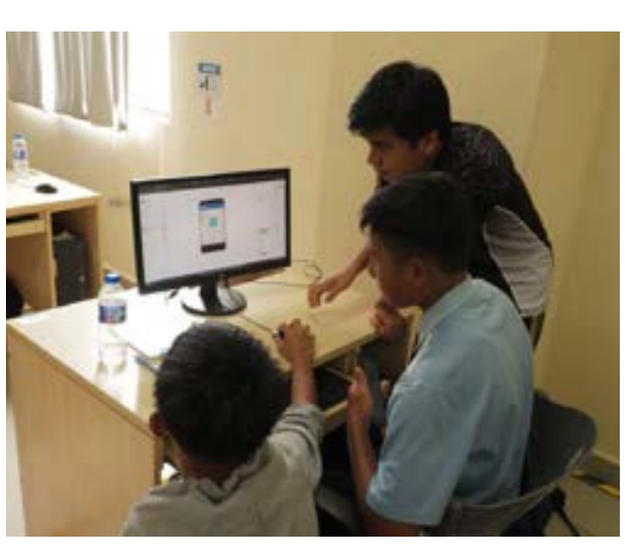
3.Fun Day with Tajweed
A 1-day interactive program was organized to help participants revise their tajwid knowledge and practice reading the Qur'an in a supportive and engaging environment.

5 Conclusion

This project successfully empowered the Asnaf community in Kg. Sg. Kertas with basic digital skills by introducing them to mobile app development for tajwid learning. Participants were not only exposed to interactive methods of revising their Qur'anic knowledge, but also took part in hand-on activities that strengthen their engagement with technology and the Qur'an. The "Fun Day with Tajweed" event further enriched their experience by providing a fun and supportive environment to practice and apply what they had learned. Overall, the program has shown that community-driven digital da'wah initiative can be both impactful and sustainable.

6 Acknowledgement

We would like to express our sincere gratitude to Yayasan Taqwa for supporting this project through the KTP-YT Grant.

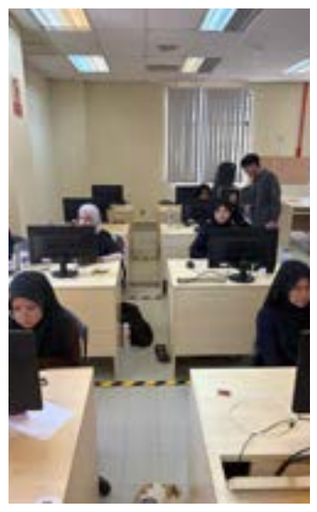










Integrated Design Project

FLOODSEEK: INTELLIGENT FLOOD PREDICTION FOR COMMUNITY SAFETY

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[2]Balai Bomba dan Penyelamat Alor Setar, Kedah

1 Abstract

Floods remain one of the most destructive natural hazards in Malaysia, causing recurrent loss of life, economic disruption, and community displacement. This work presents FloodSeek, an intelligent flood prediction and monitoring system developed to enhance community preparedness and safety. The system integrates government open weather data with IoT-based water level information from Public Info Banjir into a mobile application, ensuring accessibility for end-users. A Naive Bayes classifier was implemented to analyze rainfall intensity, temperature variation, and official weather warnings, generating location-specific alerts categorized into Safe, Flood Alert, and Flood Danger. Simulation testing with datasets from MetMalaysia and Public Info Banjir achieved approximately 90% prediction accuracy, with reliable real-time notifications delivered to both users and emergency responders. Developed through academia–community collaboration, FloodSeek demonstrates how the integration of machine learning, open data, and mobile technology can provide a scalable and socially impactful early warning system, contributing to improved disaster resilience in flood-prone regions.

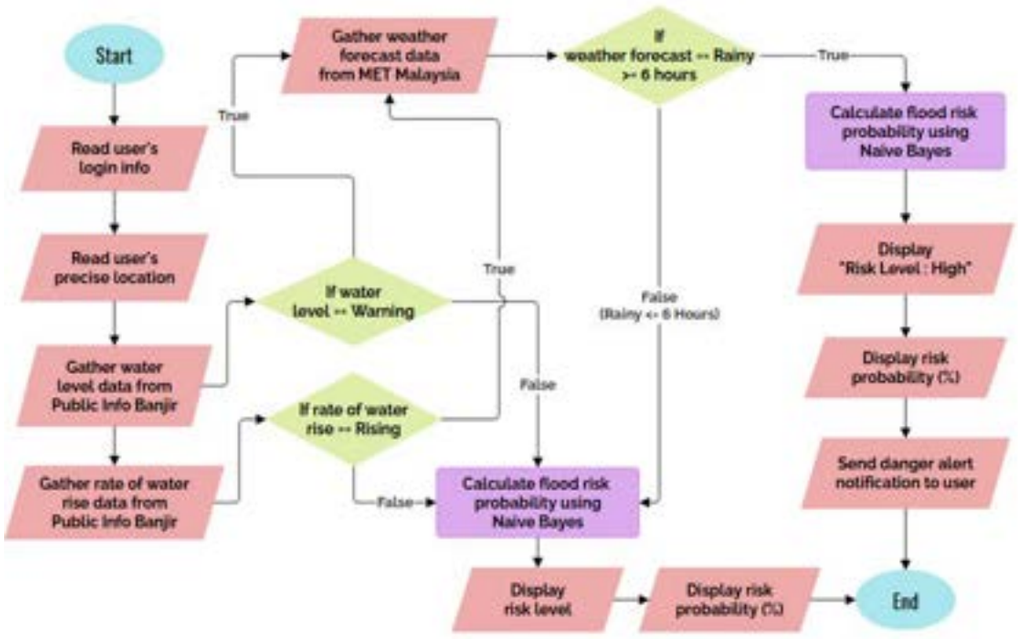
2 Problem statement

- Although water level detection systems and weather forecasting technologies are available, their integration and precision remain limited, leading to insufficient accuracy in predicting flood events.
- The lack of advanced predictive models that combine hydrological data with localized environmental factors reduces the effectiveness of early warning systems, leaving flood prone communities especially those in rural areas vulnerable.

3 Objectives

- To develop and validate an integrated prediction model that fuses water level detection and weather forecasting data with machine learning techniques to enhance the accuracy and reliability of flood prediction.
- To design, implement, and evaluate an efficient early warning framework that ensures timely dissemination of flood risk information to vulnerable communities for improved preparedness and response.

4 Methodology



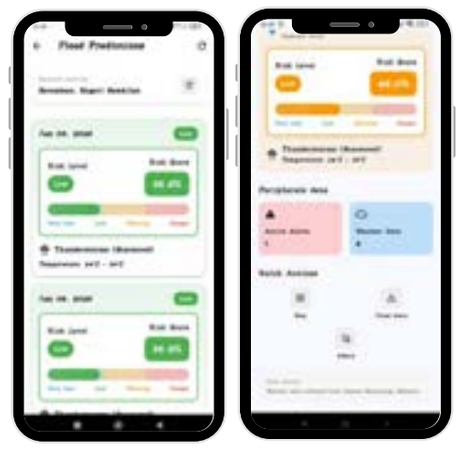
1. Frontend Layer:
- Secure login system using Firebase for personalized experience.
- Uses the Geolocator plugin to get the user's GPS coordinates to center the map, retrieve weather and flood data, and display real-time condition indicators on specific locations.
- Colour-coded risk levels (Blue, Green, Orange, Red) for quick flood risk evaluation.
- Users can set preferred alert types and thresholds for flood warnings

2. Backend Layer:
- API calls from two reliable sources (MET Malaysia & Public Info Banjir) to obtain real-time water level and weather forecast data.
- Mapping API to display danger zones.
- Uses set thresholds and machine learning model (Naive Bayes) to analyse data and calculate flood probability.

3. Data Processing & Output:
- Real-time analysis combining water level data, weather forecasts (for the subsequent 6 hours), and precise location.
- Indicates flood risk levels using distinct colour codes for clear interpretation.
- Triggers alert (Push notifications):
- Sends prompt alerts to notify users of any flood risk.

5 Results & Findings

Achieved Specifications
1. Frontend Framework: Flutter
2. Backend Stack: Firebase
3. Database: Firestore
4. Third-party APIs used: Google Maps, Public Info Banjir, and MET Malaysia
5. Authentication: Firebase Authentication
6. Hosting & Deployment: Google Play Store and Apple App Store
7. Screen Sizes Supported: Mobile: 360x640 (minimum), responsive up to 1440x3040



System Validation
1. **Location:** Peninsular Malaysia.
2. **Samples**: 4 weeks, 5 locations.
3. **Metrics Evaluated:** Water level, Weather conditions, Alert system, Flood prediction
4. **Findings:**
- Water & weather data received from Public Info Banjir & MET Malaysia within 1 min.
- Alerts displayed within 1 min.
- Flood predictions available up to 3 days in advance. Prediction accuracy: ~90% (Naive Bayes).

6 Conclusion

Integration of open government data + real-time IoT monitoring is effective for early flood warning.

Naive Bayes classifier achieved ~90% accuracy in predicting flood risks.

Provides reliable, timely, and location-specific alerts for communities.

FloodSeek shows how accessible technology improves disaster preparedness.

7 Acknowledgement

We would like to thank the staff of Balai Bomba dan Penyelamat Alor Setar for their valuable suggestions during the app development

1Kumar, V., Azamathulla, H. M., Sharma, K. V., Mehta, D. J., & Maharaj, K. T. (2023). The state of the art in deep learning applications, challenges, and future prospects: A comprehensive review of flood forecasting and management. Sustainability, 15(13), 10543.

STRUTT: EXOSKELETON ASSISTIVE DEVICE

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1 Abstract

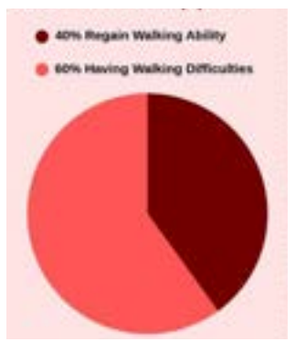
Stroke leaves nearly 60% of survivors with walking difficulties even after physiotherapy. Home-based rehab is often ineffective due to poor adherence, limited feedback, and high fall risks.

To address these challenges, we developed STRUTT (Smart Therapeutic Robotic Unit for Transformative Therapy), an intelligent exoskeleton assistive device designed for safe, adaptive, and home-based gait rehabilitation. STRUTT integrates motion tracking sensors to guide lower-limb movement, delivers real-time feedback to reduce fall risk, and employs IoT connectivity to allow clinicians to remotely monitor progress.

By reducing hospital visits and supporting underserved communities, STRUTT makes stroke recovery more accessible, effective, and independent.

2 Problem statement

Around 60% of stroke survivors still face walking difficulties after physiotherapy (Belda Louis, 2011). Home-based rehabilitation often fails due to poor adherence, irregular therapy, limited real-time feedback, and fall risks from poor joint control, leading to delayed recovery and reduced gait improvement.



3 Objectives

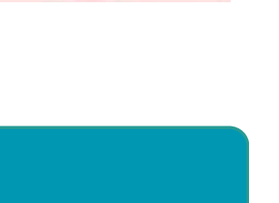
This study aims to develop an AI- and IoT-powered lower-limb exoskeleton to support stroke survivors in regaining mobility through safe home-based rehabilitation. The key objectives are to:

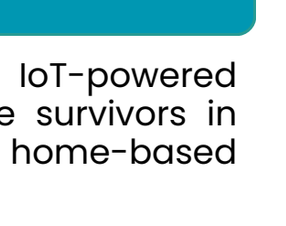
1. Design an adaptive exoskeleton with real-time motion sensing and AI-enabled gait assistance.
2. Implement IoT connectivity for clinician monitoring, progress tracking, and remote feedback.
3. Ensure safety through ergonomic design, validated structural strength, and fall-prevention features.

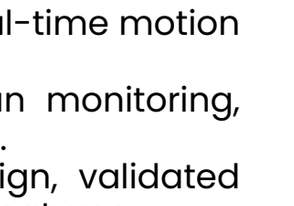
4 Methodology

STRUTT integrates motion sensing, smart actuation, structural validation, and IoT connectivity for safe home-based rehabilitation.

1. **Sensors:** MPU6050 IMU, potentiometers, and load cells track gait, tilt, and joint movement.
2. **Actuator**: A 100 W DC motor powers joint support and the foldable seat with vibration feedback for correction.
3. **Structure**: The A335 Chrome Moly frame was FEA validated with a safety factor of 7.16 under loads up to 1236 N.
4. **IoT Connectivity**: ESP32 streams real-time data to a cloud dashboard for clinician monitoring of steps, tilt, and gait trends.

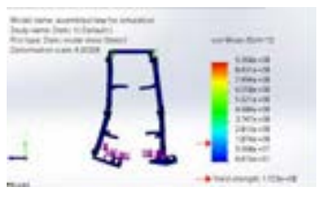


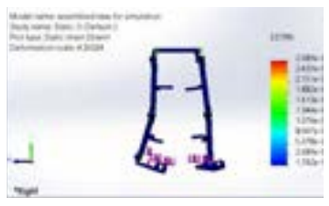


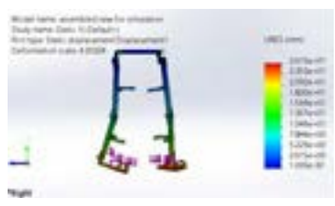


4 Results & Findings

1. Structural Safety → Withstood 1236 N load with FEA-validated Safety Factor = 7.16.

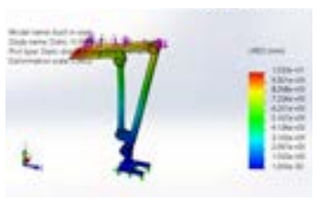


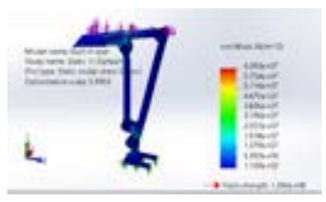




2. Torque Output → Femur: 61.8 Nm, Tibia: 54.9 Nm, sufficient for assisted gait.

3. Seat Mechanism → Deploys smoothly in ≤5s, supports up to 70 kg.



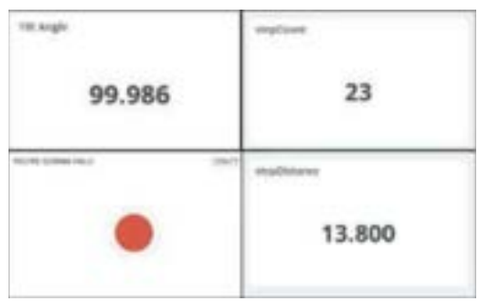


4. Step Tracking → Detected 15 steps/30s via MPU6050 with high accuracy.

5. Tilt Detection → Unsafe tilt (>±70°) corrected with <100 ms vibration alert.

6. Battery Runtime → 4 hours continuous use (819.2 Wh).

7. IoT Dashboard → Live sync (<1s latency) for step count, gait trend, and session data.



Steps were accurately detected using flexion above 55° and extension below 15°. The MPU6050 triggered fall alerts at 70° tilt, while the Arduino Cloud dashboard displayed real-time progress with a 1-second refresh.

5 Conclusion

STRUTT proved to be structurally safe, functionally effective, and clinically relevant. These findings highlight STRUTT's potential to provide safe, adaptive, and home-based gait rehabilitation, reducing reliance on hospital visits while improving recovery consistency. Importantly, it positions STRUTT as a scalable innovation that addresses the rehabilitation gap in rural and underserved communities, advancing the field of accessible stroke therapy.

6 Acknowledgement

We thank Ir. Ts. Dr. Norhafana Binti Mohamed for her guidance, Tulips Resources for proposing system architecture improvements, and Dr. Luqman for clinical insights to enhance user benefits. Appreciation also goes to the Kulliyyah of Engineering, IIUM, for facilities and support.

FLOOD RESISTANT FISH CAGE

Nik Muhammad Azfar Bin Nasroddin, Mohamad Amil Bin Mohd Yusof, Mu'adz Bin Suhaimi, Harrez Zafwan Daniel, Fakhrur Razee Bin Abd Samad, Ir. Ts. Dr. Norhafana Binti Mohamed
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1 Abstract

This project aims to design a flood-resistant fish cage to help fish farmers reduce losses during floods. The main problems include strong currents, drifting debris, and sudden water level changes that damage traditional cages. The proposed solution uses a rolling barrier to block debris, an electric winch to adjust the cage position, and sensors to monitor water level and distance from the riverbank. Controlled by an ESP32 with IoT features, the system can alert farmers and adjust automatically. A scaled-down prototype was tested and showed good results in maintaining cage safety and reducing manual work.

2 Problem statement

Aquaculture operations along the Pahang River are critically vulnerable to seasonal floods, as evidenced by RM 1.4 million in losses in 2021, due to the structural inadequacy of current cage systems against specific flood impacts like debris damage, anchor failure, and beaching. This recurring vulnerability creates a significant gap between the current state of frequent financial loss and operational disruption and the desired state of resilient, sustainable fish farming. The problem, therefore, is the lack of flood-adapted aquaculture designs, which jeopardizes the long-term viability of local operations and necessitates the development of reinforced solutions to minimize damages and secure community livelihoods.

3 Objectives

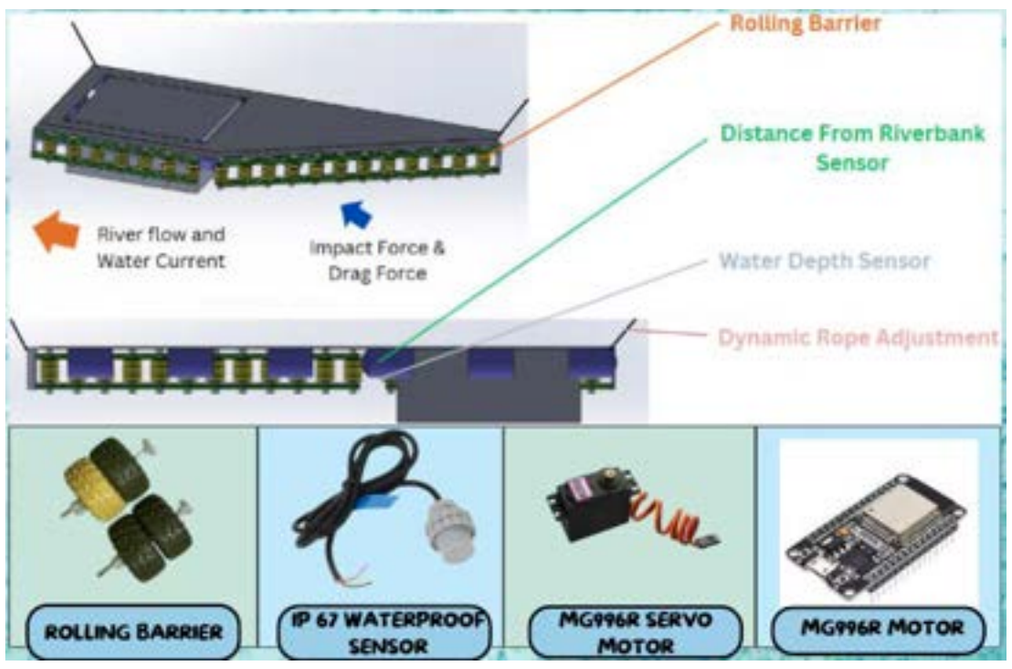
1. To investigate the causes of fish cage failure during flood.
2. To design an adaptive anchoring mechanism capable of withstanding strong currents and sudden water level fluctuations.
3. To develop a debris-resistant cage structure that minimizes damage from impacts.

4 Methodology

The methodology began by conducting interviews with local fish farmers in Temerloh to establish key design requirements. Based on this, a CAD model was developed integrating both mechanical and smart components, followed by a design analysis calculating drag force, impact force, rope tension, and winch torque. A 1:20 scale prototype was then constructed, featuring a rolling barrier made from plastic rollers and rubber tires to deflect debris, an ESP32 microcontroller with IP67-rated ultrasonic sensors for water level monitoring, and a servo-driven rope adjustment mechanism for automatic anchor line control. The system was equipped with IoT connectivity via MQTT to a HiveMQ server for real-time data and manual override capability. Finally, the prototype was rigorously tested under simulated flood conditions with dynamic water levels and debris impacts to evaluate its performance.

4 Results & Findings

The flood-resistant fish cage prototype was tested successfully at a smaller scale. The system was able to detect water depth and distance from the riverbank using ultrasonic sensors. The winch system adjusted the rope automatically to keep the cage at a safe distance (20–35 cm) during different water levels. The rolling barrier also worked well in deflecting floating debris by rotating smoothly upon impact, protecting the cage structure. Data from the sensors were sent to a mobile app through the IoT system, allowing remote monitoring. Overall, the system met all targets and showed that it can help fish farmers reduce flood damage with less manual work.



5 Conclusion

The prototype of the flood-resistant fish cage proved effective in reducing risks of being damaged during flood. It can remotely monitor water level, automatically adjust rope length, and protect against debris using a rolling barrier. With real-time alerts through IoT, this system can help fish farmers reduce damage. The design can be long term solution and ready to be improved for full-scale use.

6 Acknowledgement

We extend our sincere gratitude to our project supervisor, Ir. Ts. Dr. Norhafana Binti Mohamed, for her invaluable guidance and unwavering support throughout this project. We also wish to acknowledge the tremendous hard work and dedication of our entire team, whose collaborative efforts were essential to its successful completion. This achievement is a result of this shared commitment.

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DESIGN OF ASSISTIVE PROTOTYPE FOR PEDIATRIC PATIENT WITH SEVERE PTOSIS

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1 Abstract

Ptosis, a drooping of the upper eyelid, can obstruct vision and significantly affect children's daily lives. Current ptosis eyewear often faces issues of poor fit and comfort, noticeable designs that impact confidence, and limited access due to cost and customization. In collaboration with Sultan Ahmad Shah Medical Centre (SASMEC IIUM), this project aims to develop a safe and lightweight pediatric ptosis crutch via a 3D printing method that directly addresses these challenges. By utilising precise facial measurements and expert clinical feedback, the design prioritises accurate sizing, enhanced comfort for extended wear, and a child-friendly, affordable solution.

2 Problem statement

1. Fit and Comfort	2. Aesthetics & Social Impact	3. Cost & Accessibility
Current ptosis eyewear often doesn't fit well for children, causing discomfort, slippage, and irritation	Visible crutches or props may affect a child's confidence and draw unwanted attention	Customized devices are expensive, not widely available, and require frequent adjustments

Figure 1: Ptosis patient

Figure 2: Example of an existing ptosis crutch in the market

3 Objectives

- To design a custom ptosis crutch based on children's facial measurement
- To ensure lightweight, durable, and skin-friendly materials for safe long-term wear
- To develop a 3D-printed, low-cost, and child-friendly ptosis eyewear

4 Methodology

Measure Get child's eye and face measurements from doctor.

Design Create custom crutch in *SolidWorks*

Choose Material Thermoplastic polyurethane (TPU)

3D Print Print the design and attach to glasses.

Test Fit Ensure comfort, good function, and easy maintenance at low cost.

Finish the prototype Finishing the prototype, and deliver to the patient

4 Results & Findings

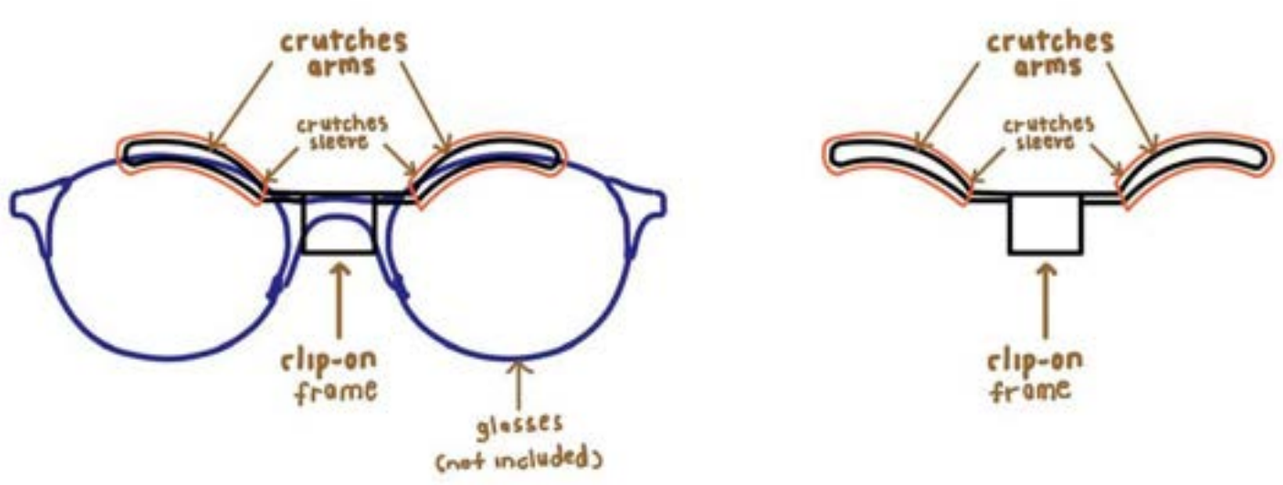

Figure 3 : Design of our ptosis crutch

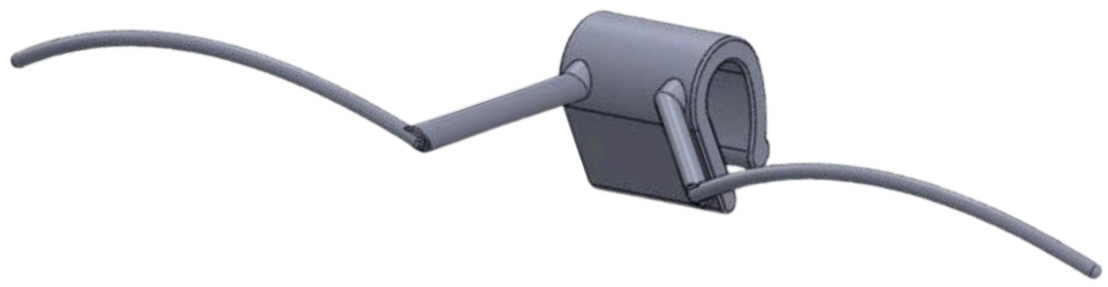

Figure 4: 3D drawing design of our crutch by using TPU material

Key Features

Clip-on design	Easily attaches to existing glasses (no need for custom frames).
Crutches arms & sleeves	Provide gentle lift to support drooping eyelids.
3D printed	Allows customization, low-cost production, and quick prototyping.
Ergonomic design	Smooth curves and lightweight structure for comfort.
Child-friendly look	Less clinical appearance with colour options.

5 Conclusion

This project developed a lightweight, adjustable ptosis crutch specially tailored for children. Designed from precise facial measurements and 3D-printed with durable, skin-safe, and recyclable materials, the device ensures comfort, affordability, and sustainability. With added colour options and a less clinical appearance, it offers a child-friendly, non-surgical solution to support vision and improve daily quality of life.

6 Acknowledgement

We sincerely thank Adik Cinta and her parents for permitting this study, and our gratitude to Industrial Lab, Kulliyyah of Engineering, IIUM, for resources and facilities. Special thanks also to SASMEC for their invaluable support in realizing the ptosis eyewear crutch project.

BRAILLEASE: AN INNOVATIVE ASSISTIVE WRITING TOOL FOR ACCESIBLE TACTILE LITERACY

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[1]*Department of Manufacturing and Materials Engineering, Kulliyyah of Engineering, International Islamic University Malaysia*

1 Abstract

BrailleEase is a simple yet transformative tool that makes Braille writing more accessible for the blind and visually impaired. Unlike conventional Braille tools that require confusing reverse writing and use impractical styluses, BrailleEase introduces a direct writing slate with an ergonomic stylus designed for comfort, accuracy, and ease of use.

2 Problem statement

Current Braille writing tool (Braille) requires users to write in reverse (mirrored writing), which is confusing and error-prone for beginner. The styluses are also often uncomfortable, slippery and easily lost, especially problematic for visually impaired users.

Fig. 1: Hands-on experience session with conventional Braille slate and stylus

(a) Text appears reversed ("daer 2 hcuot") with raised dots on the back and visible puncture holes on the front

(b) Flipped side of the paper, displaying the correct text orientation ("touch 2 read") with raised dots for tactile reading

Fig. 2: Braille output from current mode of writing using Braillet

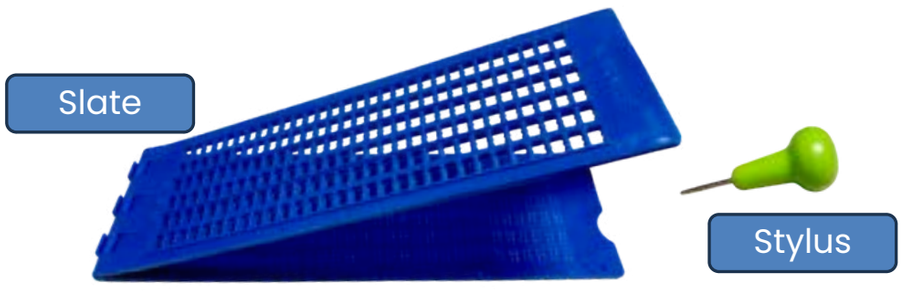


Fig. 3: Current braille writing tool – Braillet (Braille slate and stylus)

3 Objectives

- To design an improved Braille slate and stylus that enables direct Braille writing without mirrored orientation
- To enhance the stylus with ergonomic features, better grip for user comfort

4 Methodology

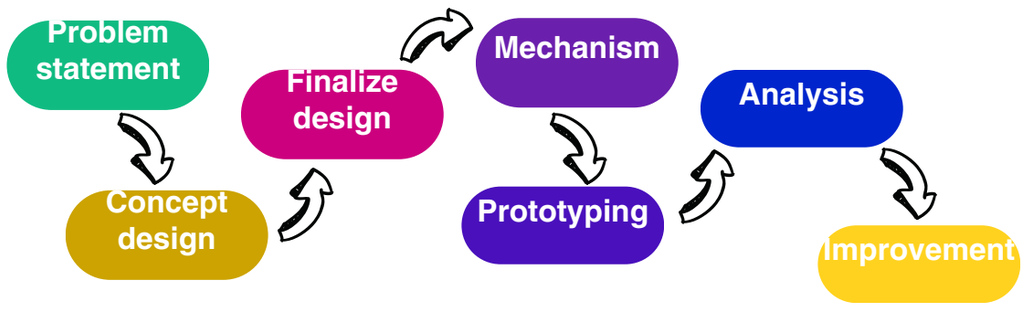


Fig. 4: Design and development workflow BrailleEase

5 Results & Findings

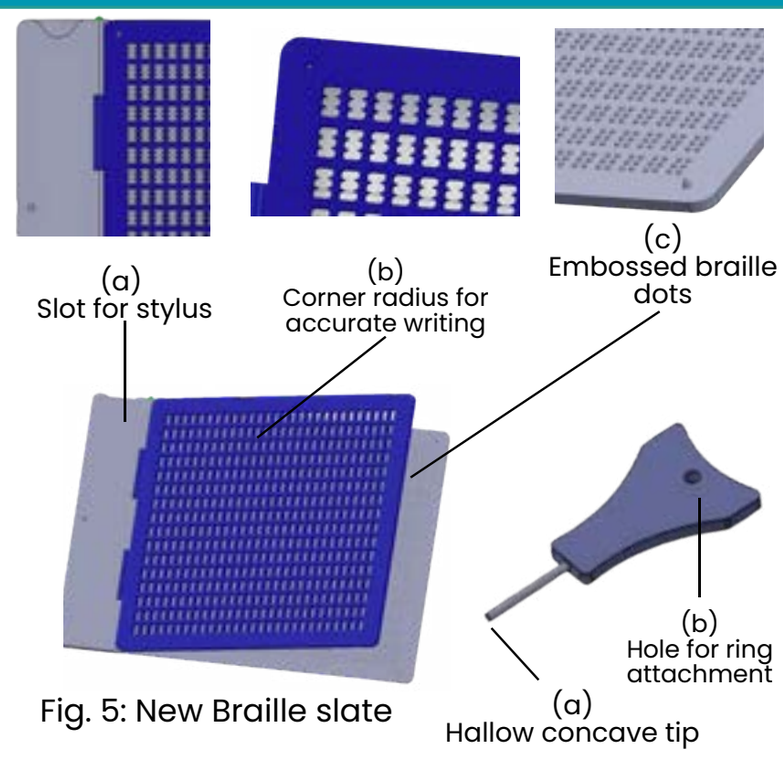


Fig. 5: New Braille slate

Fig. 6: New Braille stylus

Key Features:

- Direct dot-alignment design that eliminates mirrored writing
- Integrated stylus storage slot on the slate
- Stylus attached with a safety string to prevent loss

Benefits / impact:

- Simplifies Braille writing and reduces learning errors
- Prevents stylus loss, especially for visually impaired users
- Supports literacy in low-resource and inclusive education settings

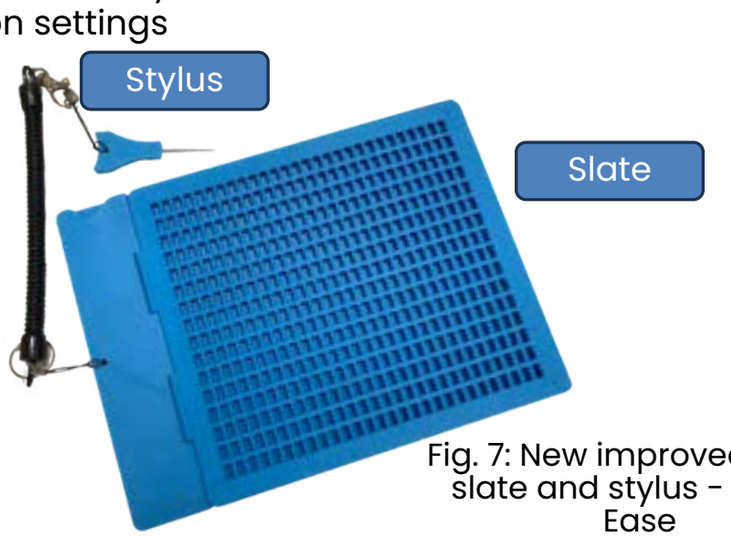


Fig. 7: New improved Braille slate and stylus - Braille Ease

6 Conclusion

BrailleEase is designed as an affordable, alternative solution for inclusive education. It is intended for non-profit use and can be adopted by schools, NGOs and community programs supporting blind and visually impaired learners – both in Malaysia and internationally.

7 Achievement

Kulliyyah of ENGINEERING for sustainable FUTURE

KL BRAILLE RESOURCES

AMTech Advanced Manufacturing and Materials Technology Research Unit

MUTECH: ENABLING VOICES, ENSURING SAFETY FOR THE DEAF

Harmi Hazwan Arifi Bin Harmi Thamri*, Haikal Khusairi Bin Ahmad, Muhammad Aidil Syazril Bin Khairul Anuar, Khairun Nazmi Bin Razian, Nik Arief Irfan Bin Ab Rahman, Anis Nurashikin Nordin
Department of Electrical and Computer Engineering, Kulliyah of Engineering, International Islamic University Malaysia (IIUM)

1 Abstract

Individuals with speech disabilities, particularly those who are mute, often face significant challenges in communicating effectively during emergency situations. Traditional methods of seeking help, such as making phone calls or verbally alerting others, are not accessible to them. This communication barrier can delay assistance and potentially endanger their safety. To address this issue, the MUTECH project was developed as a mobile application designed specifically to assist mute individuals in emergency contexts. The application provides essential features such as sending instant emergency alerts to family members and displaying image-based icons to indicate danger. Additionally, the system integrates a "Help" sound function to capture the attention of nearby people when immediate support is needed. The main objective of this project is to create a practical and user-friendly solution that empowers mute individuals to seek help quickly and effectively. By bridging the communication gap in critical moments, MUTECH contributes not only to personal safety but also to inclusivity and accessibility in emergency response systems.

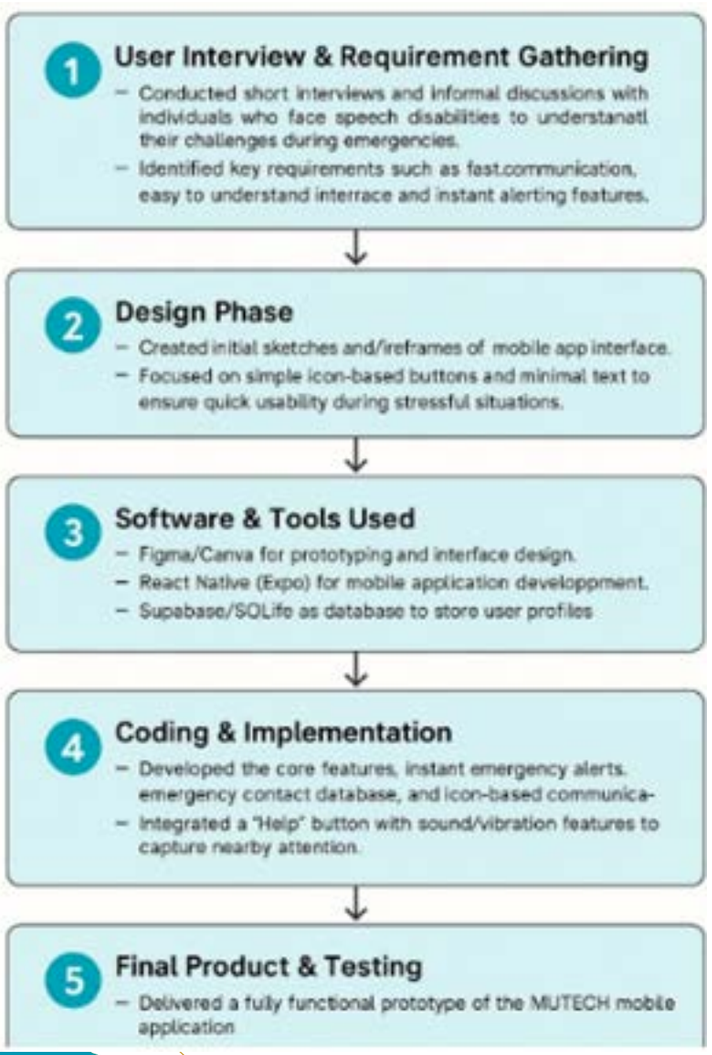
2 Problem statement

- Mute individuals face significant barriers when seeking help during emergencies.
- Rely on sign language, which is not widely understood by the general public.
- Results in delays in receiving timely help.

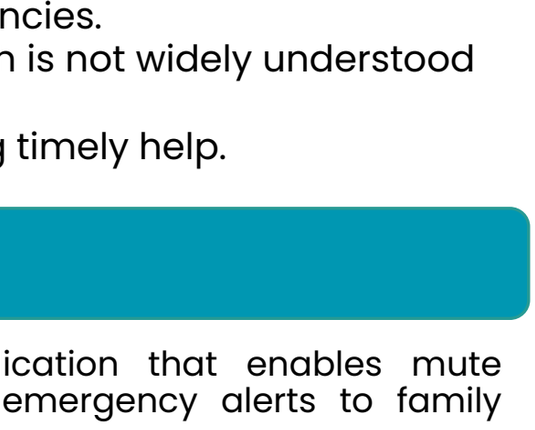
3 Objectives

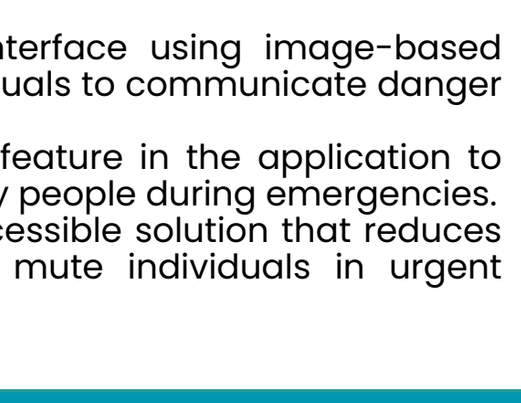
1. To develop a mobile application that enables mute individuals to send instant emergency alerts to family members.
2. To design a user-friendly interface using image-based icons that allows mute individuals to communicate danger effectively.
3. To integrate a "Help" sound feature in the application to attract the attention of nearby people during emergencies.
4. To provide a reliable and accessible solution that reduces communication barriers for mute individuals in urgent situations.

4 Methodology



Interview session with a deaf person at PDK Hulu Kelang

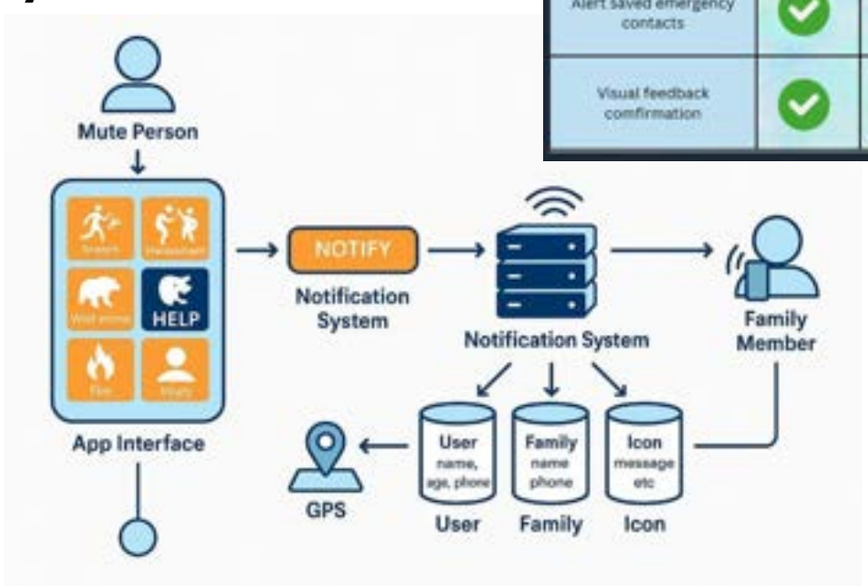




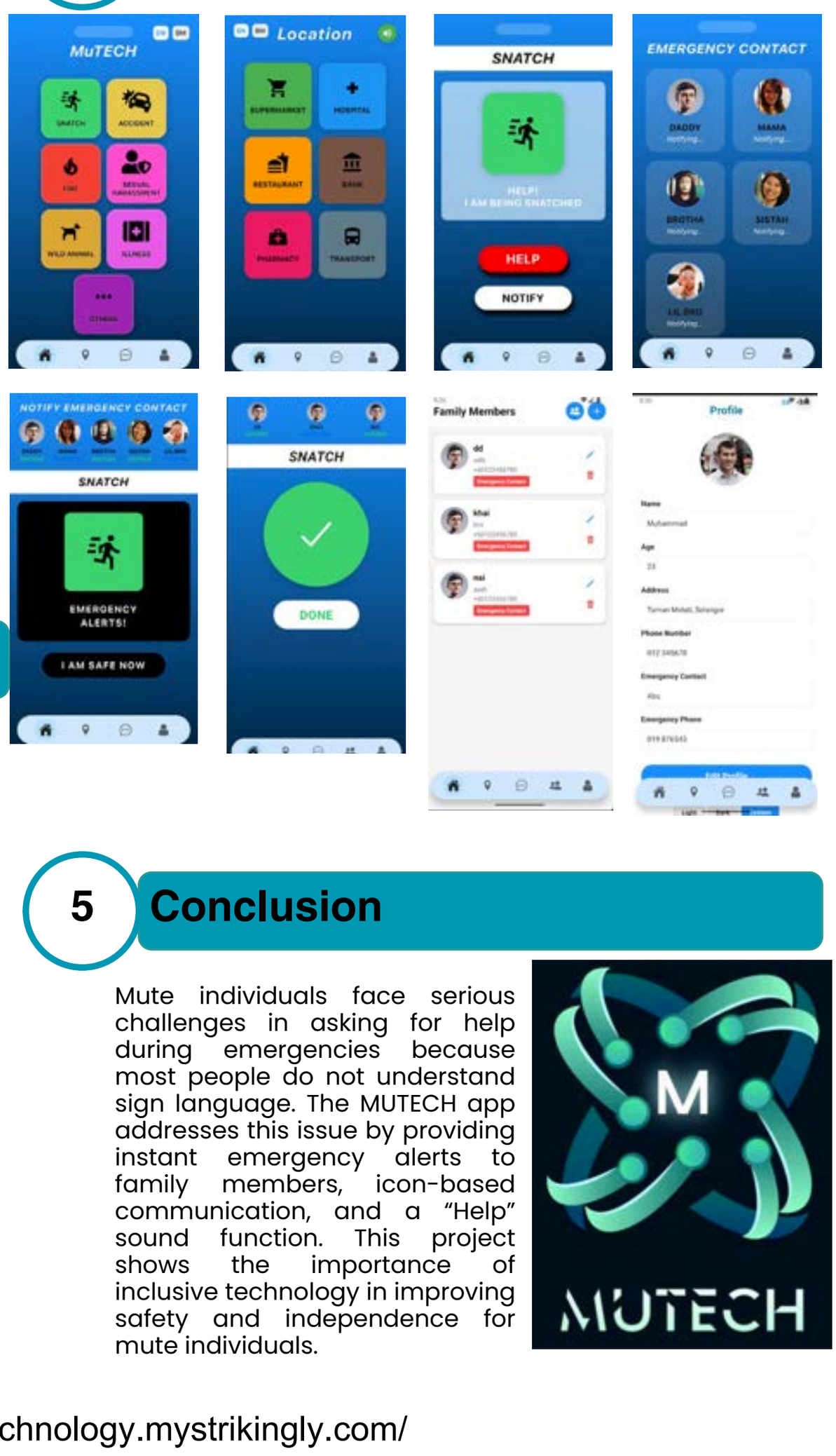
Benchmarking

FEATURES	MuTECH	AccesSOS	ICE	Be My Eyes
Alert surroundings (sound)	✓	✗	✗	✓
Alert saved emergency contacts	✓	✗	✓	✗
Visual feedback comfirmation	✓	✓	✗	✓

System Architecture



4 Results & Findings



5 Conclusion

Mute individuals face serious challenges in asking for help during emergencies because most people do not understand sign language. The MUTECH app addresses this issue by providing instant emergency alerts to family members, icon-based communication, and a "Help" sound function. This project shows the importance of inclusive technology in improving safety and independence for mute individuals.

https://mutech-technology.mystrikingly.com/

Postgraduate Project

PERFORMANCE OF PASSIVATED BACKGATED GRAPHENE FIELD EFFECT TRANSISTOR FOR RADIATION ENVIRONMENT

Muhammad Hazim Bin Ahmad Guzali, Nur Idayu Binti Ayob*, Zuraida Binti Ahmad, Aliza Aini Binti Md. Ralib @ Md Raghib
International Islamic University Malaysia and MIMOS

1 Abstract

This study explores the impact of electron beam radiation on passivated back-gated Graphene Field-Effect Transistors (GFETs) using Silvaco TCAD simulations. A GFET model with a 0.6 µm channel length and 0.1 nm thickness was optimized for ideal ambipolar behavior. To enhance radiation hardness, three passivation materials—SiO_2, Si_3N_4, and Al_2O_3—were tested under radiation doses of 50, 100, and 200 kGy. Results show that all passivated GFETs retained ambipolar characteristics, with SiO_2-passivated devices demonstrating the best radiation tolerance and highest conductivity. In contrast, Si_3N_4 and Al_2O_3 exhibited performance degradation due to hole trapping effects.

2 Problem statement

Simulating Graphene Field-Effect Transistors (GFETs) in Silvaco TCAD is challenging due to the lack of built-in graphene material, requiring manual definition. Additionally, there is no comparative simulation study on the effectiveness of different passivation materials (Si_3N_4, SiO_2, Al_2O_3) in protecting back-gated GFETs from radiation damage. The use of TCAD tools to model radiation effects on such structures remains largely unexplored, highlighting the need for simulation-based validation before fabrication.

3 Objectives

1. To develop a theoretical back-gated GFET model with a passivation layer for radiation environment.
2. To validate the developed back-gated GFETs with passivation layers of different materials under different doses of high-energy electron beam.
3. To evaluate the electrical performance of back-gated GFETs with different materials of passivation layer after the exposure of high energy electron beam radiation through simulation.

4 Methodology

This study utilises a simulation-based approach to investigate the performance of an optimised back-gated GFET with a passivation layer in an electron beam radiation exposure. The methodology of this study involves the development of a physical device model using the Silvaco TCAD simulation tool. The simulation workflow comprises the design of GFET models, optimisation of device performance and the implementation of a radiation module into the GFET model to evaluate the device performance under varying dosages of electron beam radiation exposure.

4 Results & Findings

Figure 1 shows the transfer curves of GFETs with different passivation materials and a non-passivated GFET at 200 kGy. Differences in drain current (ID) appear from VG = -10 V and become more noticeable beyond VG = +10 V, especially after VG = 10 V. The reduced ID in passivated GFETs (SiO_2, Al_2O_3, and Si_3N_4) compared to the non-passivated one may be due to ionization effects, creating hole traps between the passivation layer and the graphene channel.

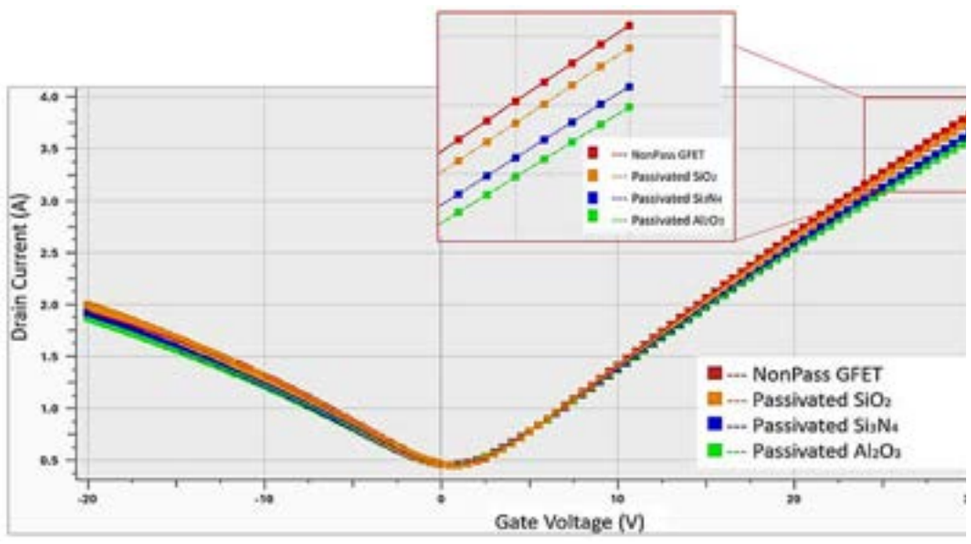
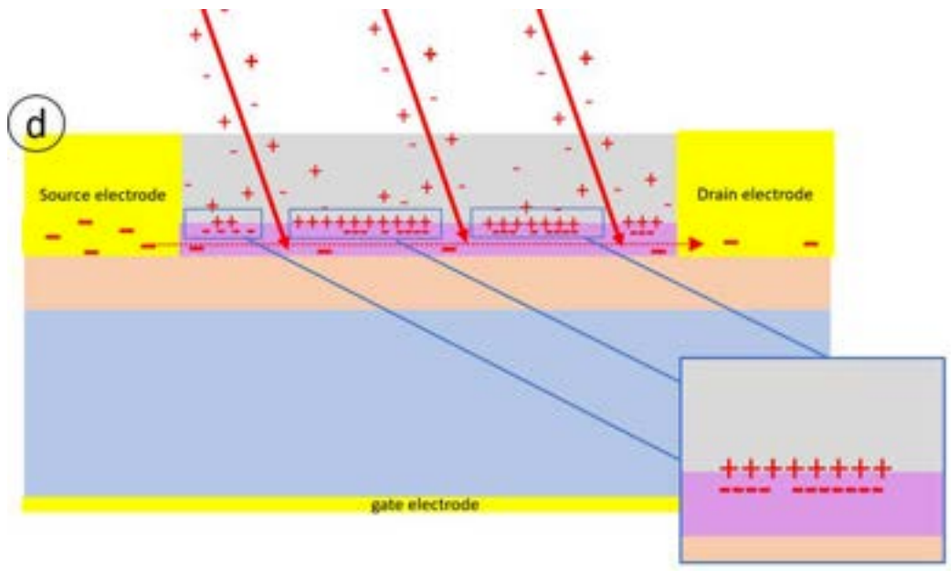


Figure 2 shows a parasitic field from the holes trap scatter the mobility of electron in the channel by attracting the electrons towards the trapped holes. Ultimately, the trapped holes played an important role in degrading the electron mobility and promoting current leakage



5 Conclusion

Simulation-based comparison of passivation materials suggests that SiO_2 offers superior radiation shielding for graphene channels compared to Al_2O_3 and Si_3N_4. This is likely due to its lower density of dangling bonds, resulting in fewer trapped holes and reduced radiation damage.

6 Acknowledgement

The authors would like to sincere gratitude to MIMOS Berhad for providing access to the Silvaco TCAD, which was used as the primary simulation tool in this study. This work was supported by the Fundamental Research Grant Scheme (FRGS) (Grant No. FRGS22-258-0867) under the Ministry of Higher Education Malaysia.

Alexandrou, K. (2016). *Ionizing Radiation Effects on Graphene Based Field Effects Transistors*. [Ph. D Dissertation, Columbia University].

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Schwank, J. R., Shaneyfelt, M. R., Fleetwood, D. M., Felix, J. A., Dodd, P. E., Paillet, P., & Ferlet-Cavrois, Vé. (2008). Radiation Effects in MOS Oxides. *IEEE Transactions on Nuclear Science*, *55*(4), 1833–1853.

DESIGN AND EVALUATION OF A WHEELCHAIR TIPPER FOR ACCESSIBLE DENTAL TREATMENT

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[1]*Department of Mechatronics Engineering, Kulliyyah of Engineering, International Islamic University Malaysia*
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[3]*Advanced Automation Section, Smart Manufacturing Centre, SIRIM Berhad*

1 Abstract

The growing number of wheelchair users contrasts with limited access to dental care, supported by only eight special care dentistry clinics in Malaysia. This study introduces a wheelchair tipper that enables treatment without patient transfer. Tested with ten healthy male subjects and validated through Finite Element Analysis (FEA), the design demonstrated stability under a 1226.25 N load (subject and wheelchair). Comfort evaluation identified 30° and 45° recline as most preferred. The innovation enhances accessibility and comfort, with future work focusing on broader participant groups and design refinement.

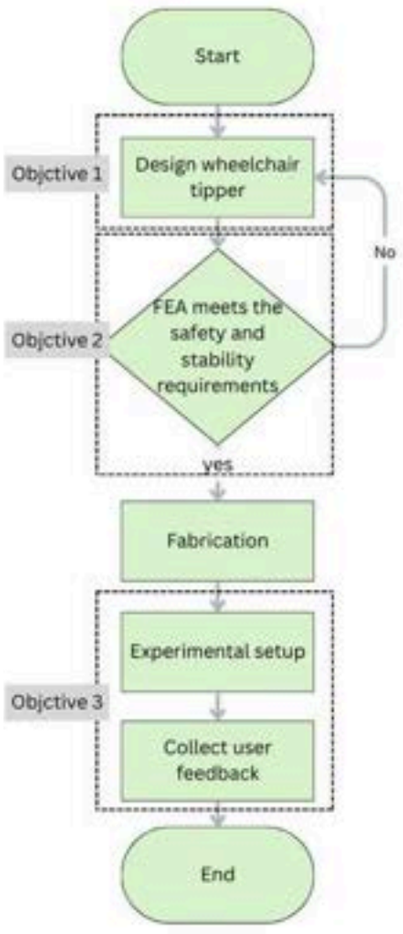
2 Problem statement

Wheelchair users face difficulties accessing dental care due to unsafe and inconvenient transfers to dental chairs. Existing solutions are limited, and lack often lack comfort, leading to patient discomfort and increased caregiver strain.

3 Objectives

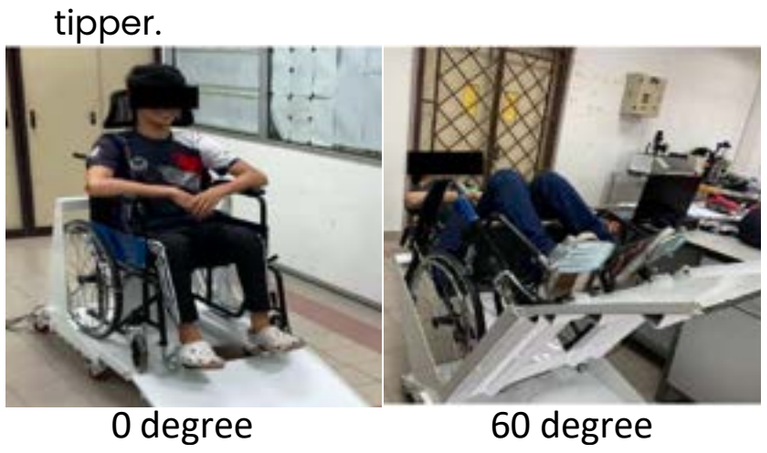
- To design a wheelchair tipper for dental treatment.
- To validate stability with FEA.
- To evaluate comfort of the tipper via verbal questionnaire.

4 Methodology



Project Flowchart

- A wheelchair tipper was designed using CAD modeling, guided by literature specifying a maximum tilt of 60°, wheelchair dimensions, and safety features for dental applications.
- Stability was evaluated using Finite Element Analysis (FEA) with a 1226.25 N load.
- Comfort was assessed through verbal questionnaires during subject testing at different tilt angles (0°, 30°, 45° and 60°) and overall comfort while using the tipper.

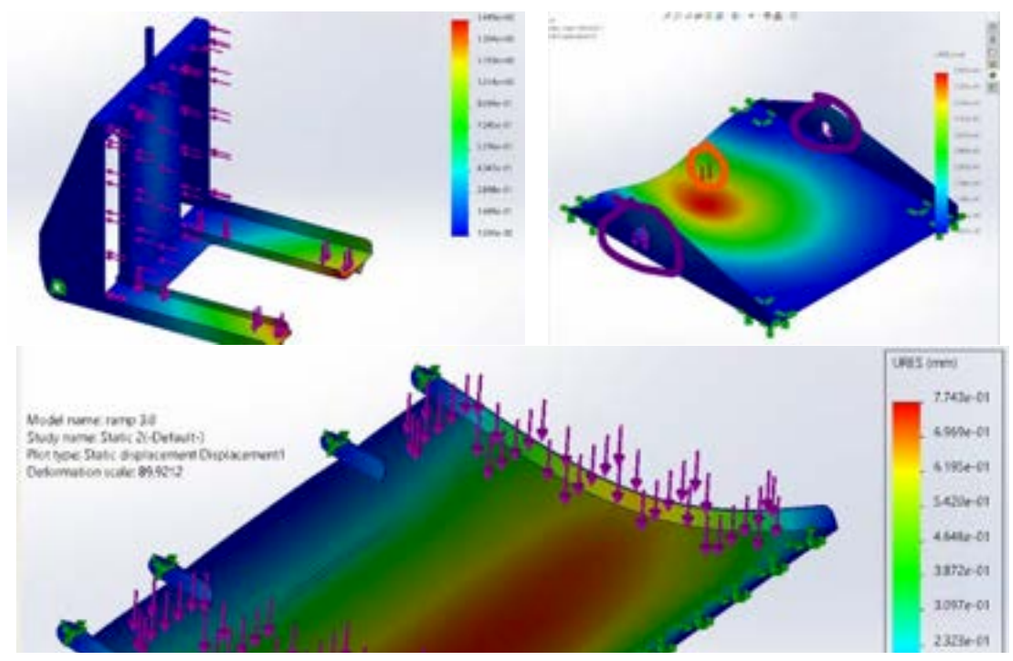


0 degree 60 degree

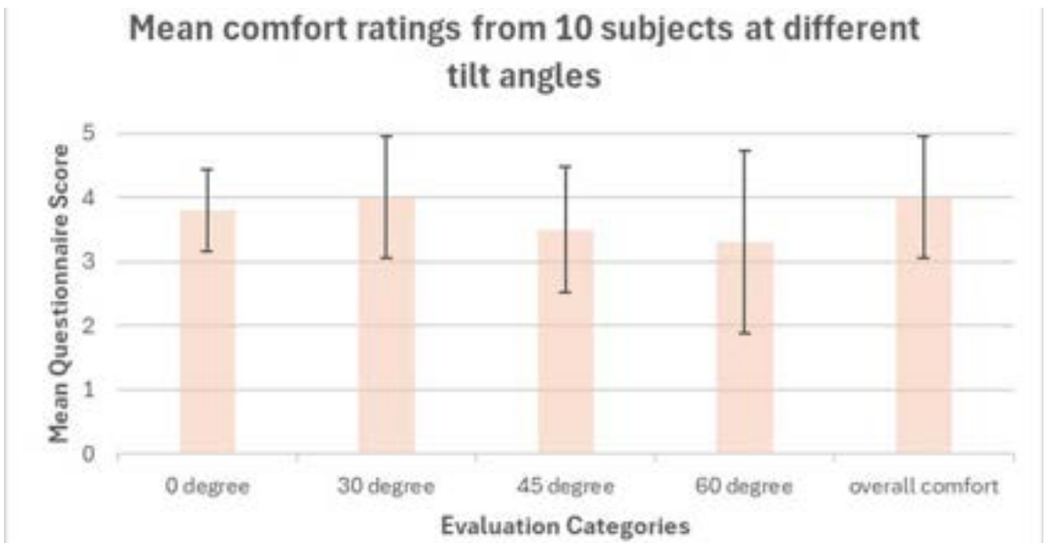
Experimental setup showing a participant in the wheelchair tipper at 0 and 60 degrees

5 Results & Findings

The CAD-designed wheelchair tipper was fabricated according to specifications, achieving a maximum tilt of 60° with stable operation. The design accommodates standard wheelchairs, with overall dimensions of 1480 mm × 725 mm × 725 mm when the ramp is open. A locking mechanism was incorporated to enhance safety, confirming feasibility for dental applications.



FEA of the tipper components shows a maximum displacement of approximately 0.73 mm. The stress distribution was uniform, with no localized areas of high stress observed on any surface or corner. The overall deformation remained within safe limits.



Comfort ratings were highest at 30°, followed by 0° and 45°, while 60° was least preferred. Moderate recline angles (30°–45°) were generally rated most comfortable.

6 Conclusion

- A wheelchair tipper that tilt up to 60° was designed, fabricated and tested.
- The 60° recline angle was reported as the least preferred.
- Future Recommendations:
  - Improve ergonomics and test with wheelchair users.

7 Ethics and Intellectual Property

- Research Ethics : IREC 22-109
- Copyright ID : LY2024W03321

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SUSTAINABLE SUPPLY CHAIN OF KELULUT HONEY SMES: BRIDGING ACADEMIA, INDUSTRY AND COMMUNITY

Raudoh Helmi, *Adibah Amir
International Islamic University Malaysia

1 Abstract

A Selangor-based kelulut honey SME producing 500 kg annually struggled with inconsistent quality, stock imbalances, and delayed fulfilment. A Fishbone (Ishikawa) analysis traced these issues to gaps in workforce skills, the absence of clear standard operating procedures (SOPs), weak inventory management, and limited quality control practices. Zero-cost solutions were introduced, including FIFO inventory flow to balance stock rotation, one page SOP to standardize all operations and basic QC logs to monitor consistency. These interventions reduced post-harvest losses by more than half, cut product returns to below 1%, and improved on-time fulfilment to over 95%. Beyond operational gains, kelulut honey holds global significance as a natural superfood with medicinal value, while stingless bees play a vital role in biodiversity and food security. This case aligns with SDGs 8 (Decent Work & Economic Growth), 12 (Responsible Consumption & Production), and 15 (Life on Land), demonstrating how simple, cost-free practices from academia collaboration can generate meaningful and sustainable impact.

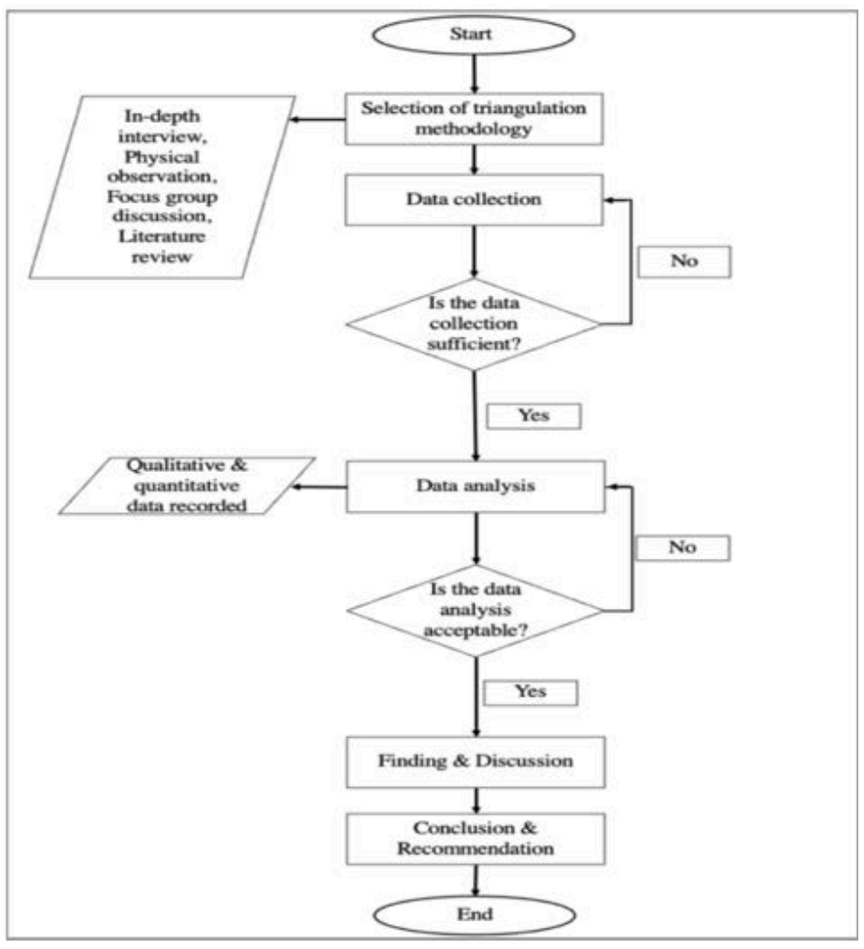
2 Problem statement

Demand for kelulut honey in Malaysia is growing, yet SMEs struggle to deliver consistent quality and reliable supply because kelulut honey naturally has high moisture (25–35%), making it prone to fermentation and quality drift during storage and handling. For standardization, Malaysia introduced MS2683:2017 to guide kelulut honey quality such as in moisture determination and limits, but SME compliance is uneven due to gaps in equipment, SOPs, and inventory discipline. Studies on SMEs specifically flag inadequate storage, processing limits, and manual inventory as recurring constraints. To fulfill this gap, there is a need for low-cost, process-based interventions that SMEs can adopt without capital outlay and with support through collaboration with academia.

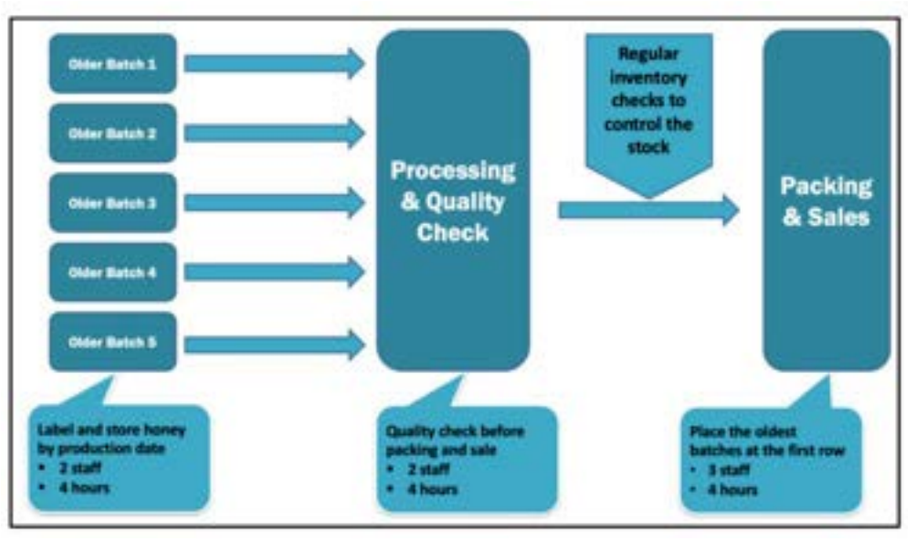
3 Objectives

The primary objective of this research is to analyze the supply chain inefficiencies faced by a Selangor-based kelulut honey SME and to propose zero-cost, sustainable interventions.

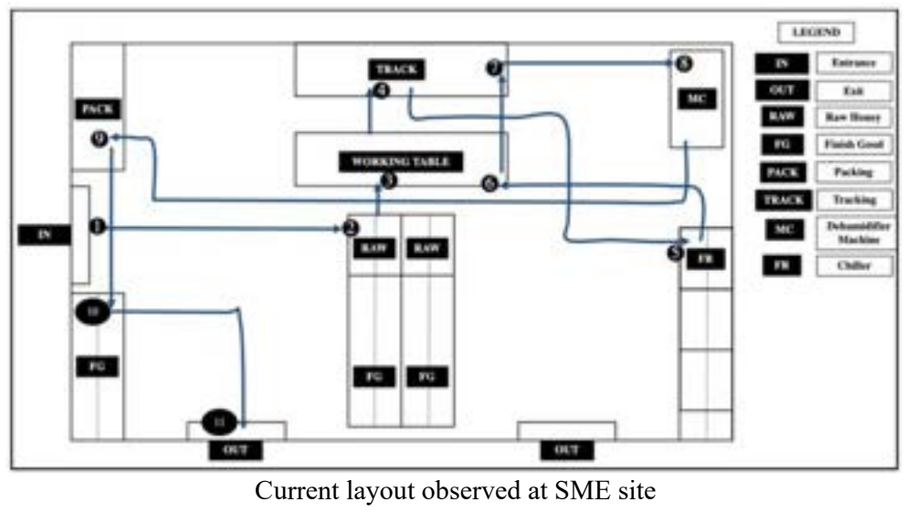
4 Methodology



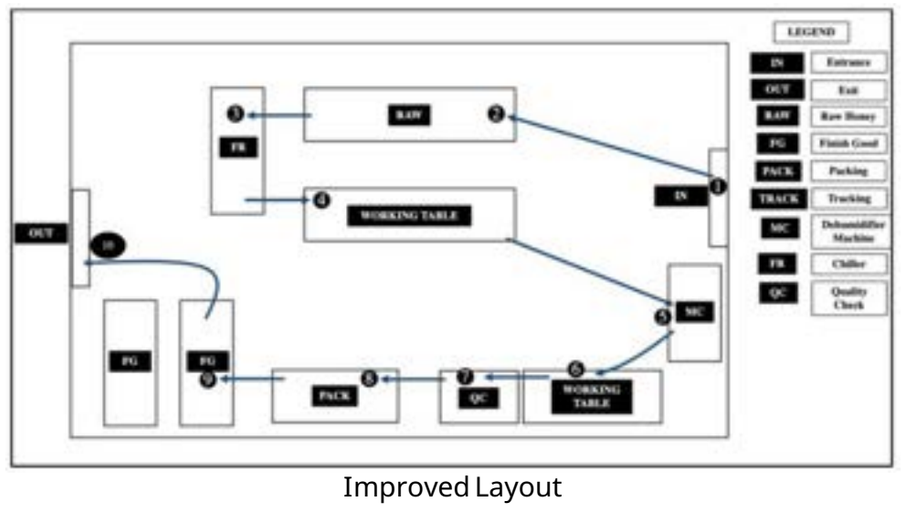
5 Results & Findings



Manpower allocation and working hours following the FIFO



Current layout observed at SME site



Improved Layout

6 Conclusion

This study highlights how academia–industry–community collaboration can transform simple, zero-cost practices into meaningful solutions that cut waste, improve reliability, and build customer trust. Beyond business gains, the initiative aligns with SDGs 8, 12, and 15, showing how sustainable enterprise practices with kelulut honey contribute to human health, biodiversity, and long-term resilience for humanity.

7 Acknowledgement

Authors are thankful to IIUM and My Madu Iqra PLT for facilitating the study.

FROM WASTE TO STRENGTH: ENHANCING 3D PRINTED POLYETHYLENE TEREPHTHALATE GLYCOL (PETG) WITH RICE HUSK (RH) REINFORCEMENT

Hajar Naemah binti Sohif, Wan Muhammad Zulfadli bin Wan Sulaiman, Dr Hanisah binti Manshor
International Islamic University of Malaysia (IIUM)

1 Abstract

This research unveils a sustainable breakthrough by transforming agricultural waste into high-performance materials. The blending of Polyethylene Terephthalate Glycol (PETG) with rice husk (RH), an abundant byproduct, was explored to create a novel composite 3D printing filament. This work addresses the dual challenge of improving PETG's mechanical properties and promoting eco-friendly manufacturing. Novel composite filaments with various RH content (0wt.%-10wt.%) were developed and tested for their mechanical properties. The findings reveal a clear optimal blend where the addition of 6 wt% RH significantly enhances the material's key properties. This optimal composition delivers a smoother surface finish (4.05 Ra), increased hardness (22.63 HV), and superior tensile strength (50.9142 MPa) compared to pure PETG (9.86 Ra, 10.9 HV, 40.8522 MPa). This peak performance is achieved by balancing the fiber-matrix interaction, beyond which properties decline. Further increase of RH leads to a stronger fiber-fiber bond, which weakens the interfacial bond of fiber-matrix. A weak interfacial bond between the fiber and matrix results in inefficient load transfer, thereby decreasing the sample's mechanical properties. This study successfully demonstrates that rice husk waste can be transformed into a valuable reinforcing agent for 3D printing. 94 wt.% PETG/6 wt.% RH composite offers a superior, sustainable alternative to conventional filaments, balancing enhanced performance with environmental responsibility.

2 Problem Statements

- PETG filament → **limited** stiffness, heat resistance, and sustainability.
- Rice husk → sustainable reinforcement strategy **BUT** challenges in **dispersion, bonding, and property balance**.

3 Objectives

- To measure the surface roughness of 3D printed composite parts by optimizing the fiber-matrix interface through the incorporation of rice husk filler into PETG.
- To investigate the effect of rice husk (RH) filler on the hardness and tensile strength of a PETG-based 3D printing filament.

4 Methodology

Preparation of rice husk powder (90 µm)

Sample name (PETG(%)/ RH(%))	Weight of RH (g)	Weight of PETG (g)
100/0	0	500
98/2	10	490
94/6	30	470
90/10	50	450

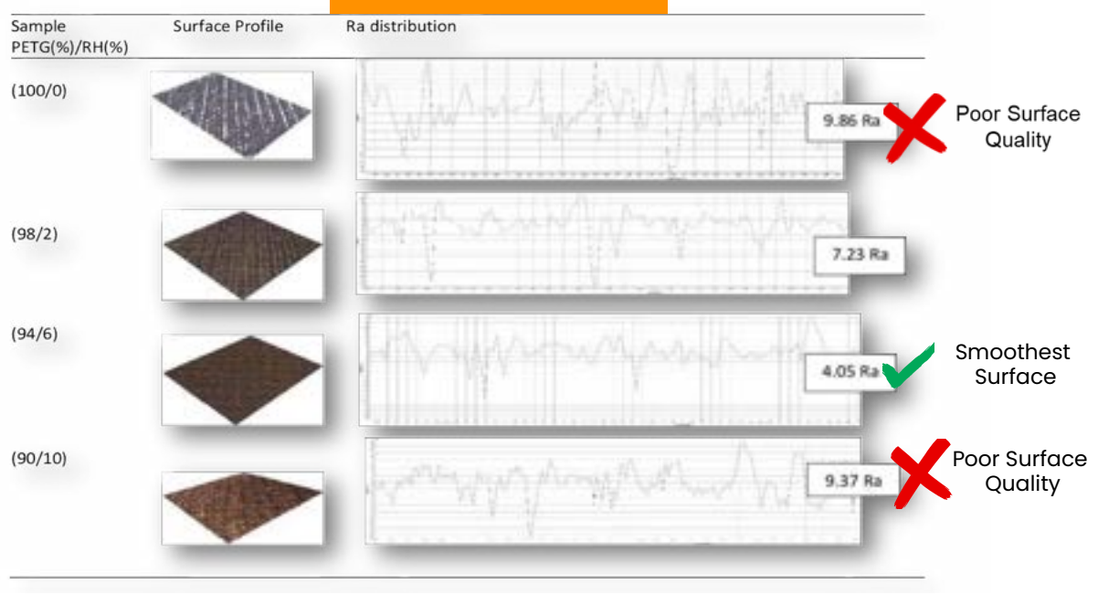
Formulation and fabrication of PETG/RH filament

Printing of samples

CHARACTERIZATION
- Smooth surface?
- Hardness increase?
- Tensile strength improve?

5 Results & Findings

Surface Roughness



- *RH **improves** surface and aesthetic value.*
  Reason: Particles fill micro-voids, promote uniform crystallization, and stabilize melt flow
- *But, beyond optimal value (>6 wt% RH), surface roughness ↑.*
  Reason: Excessive RH accumulation (protruding) near the filament's surface

Hardness

- ↑ [t]RH, ↑ hardness
  Reason: Enhancement in lignocellulose fiber strength ☒ improves the properties
- Beyond optimal value (>6 wt% RH), ↓ hardness.

Tensile Strength

- ↑ [t]RH, ↑ tensile strength
  Reason: RH was uniformly dispersed in the PETG matrix. RH restricts polymer chain mobility & promote efficient stress transfer between the matrix and the filler ☒ improve load-bearing capacity and stiffness
- Beyond optimal value (>6 wt% RH), ↓ tensile strength

6 Conclusion

- RH powder into PETG shown a promising result in **good printability, mechanically enhanced**, and **eco-friendly** filament for 3D printing.
- **94 wt.% PETG/6 wt.% RH** is the optimal loading. Beyond optimal value : poor dispersion, weak interfacial bonding, and reduced mechanical properties.

FUTURE?

Consumer Goods *(household, packaging, etc)*

Automotive *(lightweight parts, covers etc)*

Healthcare Prototypes *(not implant, disposable items, etc)*

7 Acknowledgement

Kulliyyah of Engineering (KOE) Lab

DESIGNING A COMPATIBILIZED TPU/PE-G-MA/PP BLEND FOR NEXT GENERATION 3D PRINTED FILAMENT

Hajar Naemah binti Sohif[1], Dr Hanisah binti Manshor[1]*, Assoc. Prof. Dr. Maziati Akmal binti Mohd Hatta[1], Assoc. Prof. Ts. Dr. Mohd Shaiful bin Sahab[2]
[1] *International Islamic University of Malaysia (IIUM)*
[2] *Universiti Kebangsaan Malaysia (UKM)*

1 Abstract

This study addresses the incompatibility of thermoplastic polyurethane (TPU) and polypropylene (PP) to generate reusable, 3D-printed medical devices, reducing single-use plastic waste. TPU/PP blends were melt-mixed at different ratios (90/10, 80/20, 70/30) with a compatibilizer, polyethylene-graft-maleic anhydride (PE-g-MA), 1-5 wt%. Scanning Electron Microscopy (SEM) revealed that uncompatibilized blends had poorly dispersed TPU particles in the PP matrix. Adding PE-g-MA significantly improved blend homogeneity, reducing phase separation. Fourier-transform infrared spectroscopy (FTIR) analysis confirmed enhanced compatibility, evidenced by an increased ester carbonyl (C=O) peak near 1735 cm^{-1} and a decrease in anhydride groups. The most optimal formulation is the TPU30/PP70 blend with 3 wt% PE-g-MA. This research demonstrates that PE-g-MA successfully compatibilizes immiscible TPU/PP blends. These findings enable the development of advanced, sterilizable materials for fused deposition modeling (FDM) 3D printing in healthcare, promoting sustainability through reusable medical tools.

2 Problem Statements

Current: Single-use, Disposable, Wasteful

Future: Durable, Reusable, Sustainable

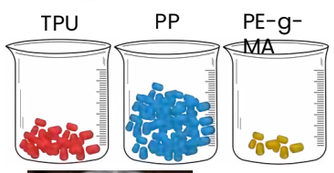
The **immiscibility** of TPU/PP blend

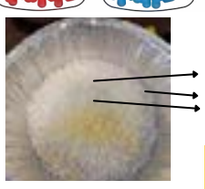
PLASTIC WASTE GENERATION

3 Objectives

- To determine the optimal weight percentage of PE-g-MA compatibilizer with varied ratios of TPU/PP that maximizes the morphological homogeneity of the blend.
- To evaluate the enhancement of chemical compatibility in TPU/PP blends with the addition of PE-g-MA as a compatibilizer.

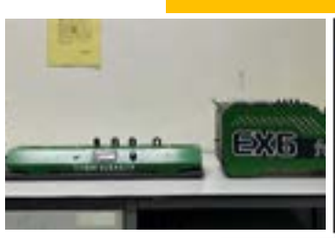
4 Methodology



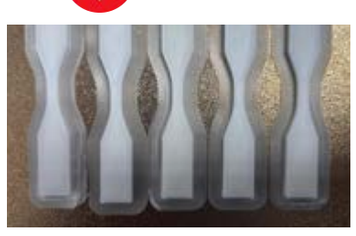


FORMULATION

FABRICATION



Nominal Diameter: 1.75 mm
Acceptable Tolerance: ±0.05 mm (industry standard)



3D PRINTING

CHARACTERIZATIONS

SEM

Smooth matrix, minimal voids and well-dispersed granules?
(GOOD MISCIBILITY)

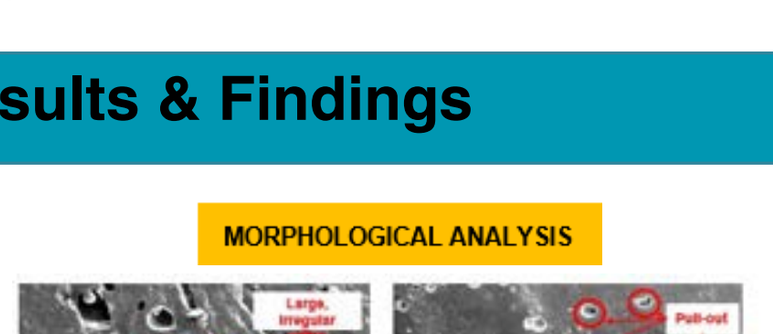
FTIR

Ester C=O ↑ + anhydride ↓ ?
(GOOD COMPATIBILITY)

5 Results & Findings

MORPHOLOGICAL ANALYSIS

FUNCTIONAL GROUP ANALYSIS



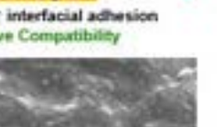
DUE TO

PE-g-MA = BRIDGE

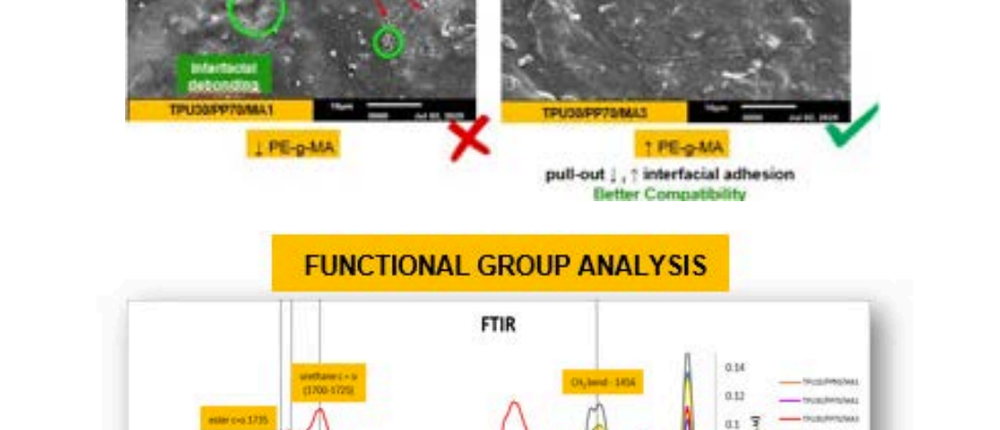
$-CH_2-CH_2-CH_2-[C=O]O[C=O]-CH_2-CH_2-$

MA with TPU – OH/N-H

PE & PP – same backbone



PROVEN BY



6 Conclusion

- PE-g-MA **enables** reactive compatibilization of TPU/PP Miscible blend
- **TPU30/PP70/MA3** – high interfacial compatibility (SEM & FTIR) ⊠ optimal ratio

FUTURE?

Medical devices – *Safe, Sterilizable and Sustainable*

7 Acknowledgement

Kulliyyah of Engineering (KOE) Lab, IIUM & CESPRO Lab, UKM

AMSERU

SCREENING FOR MACROCYCLIC LEAD COMPOUNDS AGAINST DNA REGULATING KINASE

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Department of Chemical Engineering and Sustainability, International Islamic University Malaysia (IIUM)

1 Abstract

Macrocyclic compounds, defined by rings of 12 or more atoms, represent a promising but underexplored space in drug discovery. Their conformational rigidity enables them to engage complex biological targets, making them attractive for therapeutic design. In this study, a cheminformatic pipeline was applied to a library of 28,888 macrocycles to explore and extract meaningful structural insights. Molecular descriptors were computed and analyzed using Principal Component Analysis (PCA) and K-means clustering, allowing reduction of data dimensionality and grouping of structurally similar compounds. This analysis revealed clustered patterns in ring size, molecular weight, polarity, and heteroatom distribution, while PCA biplots highlighted densely populated chemotypes and underexplored regions of chemical space. The insights are particularly relevant for targeting mutated breast cancer type 1 susceptibility protein (BRCA1), a missense tumor suppressor protein that could cause genomic instability and cancer progression. This macrocycles –screening framework supports rational compound selection for protein–ligand binding studies, accelerating drug discovery pipelines.

2 Problem statement

- DNA repair relies on **BRCA1**, a key protein that fixes double-strand DNA breaks.
- Mutated BRCA1 often performs faulty repair, leading to **genomic instability** and cancer progression.
- Strategy: Block mutated BRCA1 to stop faulty DNA repair and shift repair to other pathways.
- **Macrocyclic compounds** are ideal candidates due to:
  1. Conformational Rigidity
  2. High Stability
  3. Strong binding specificity to complex biological proteins
- Screening of ~28,888 macrocycles requires **cheminformatics approaches** for classification and prioritization.

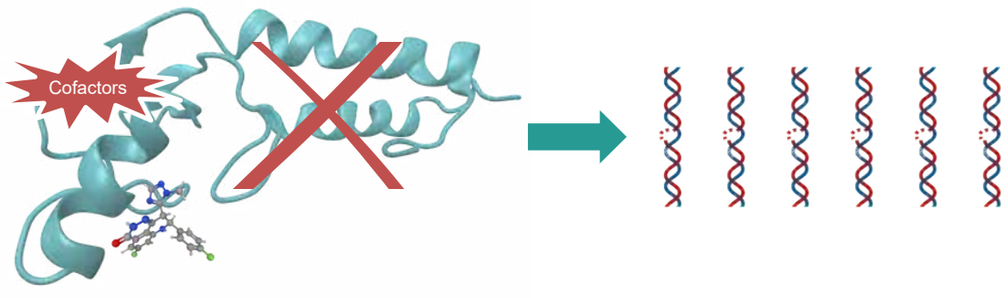


Figure 1. Putative macrocyclic inhibitors block mutated BRCA1–cofactor binding (left), preventing faulty DNA repair. This forces reliance on alternative repair (e.g., PARP1), leading to DNA damage accumulation, genomic instability, and apoptosis (right).

3 Objectives

- Apply **K-means clustering** to group macrocycles based on structural descriptors.
  - Optimal cluster number determined via **Elbow Method** and **Silhouette Score.**
- Use PCA to reduce 11 descriptors → 2D space for visualization.
- Identify promising macrocyclic leads for BRCA1 studies by **highlight structurally diverse clusters** with potential for BRCA1 inhibition.

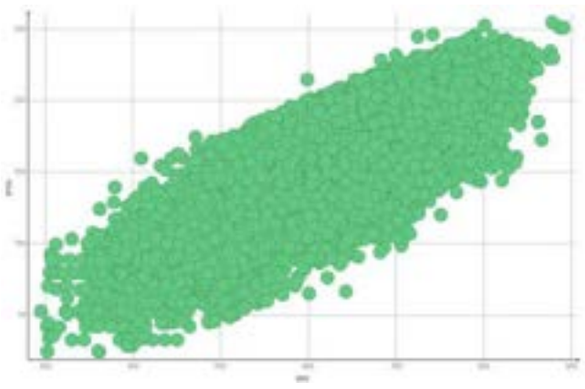
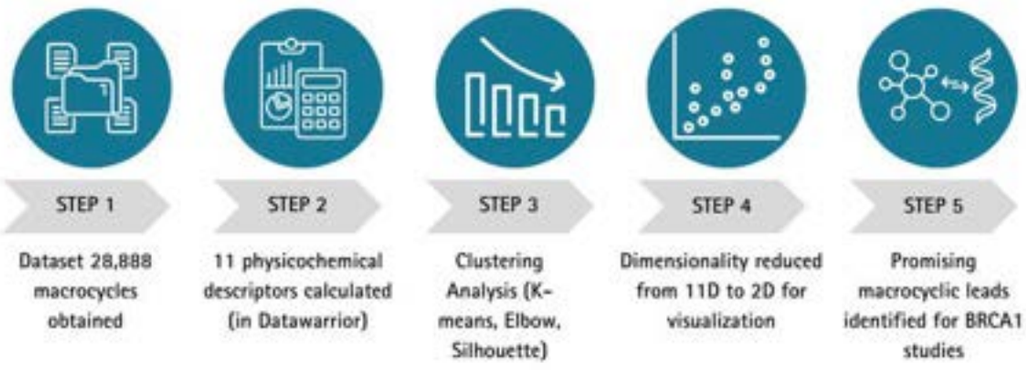


Figure 2. Scatter plot of 28,888 macrocyclic compounds, showing molecular weight (MW, x-axis) against topological polar surface area (tPSA, y-axis)

4 Methodology



5 Results & Findings

Cluster Validation

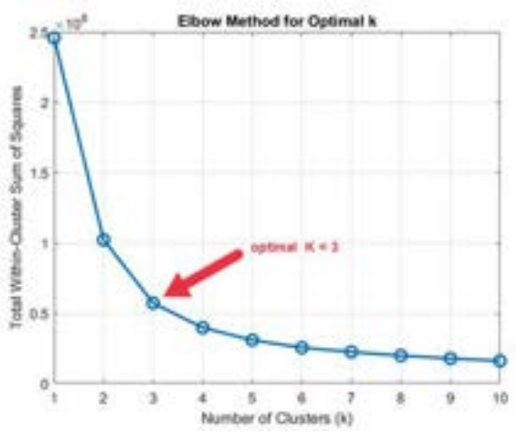


Figure 3. **Elbow Plot** – Optimal number of clusters (**k = 3**)

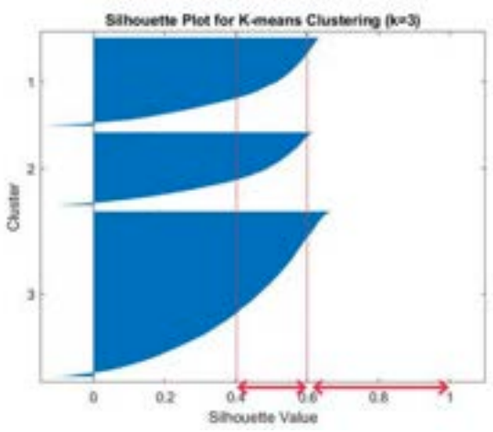


Figure 4. **Silhouette Plot** – Confirms **3 well-defined clusters** with limited misclassification

Cluster Visualization

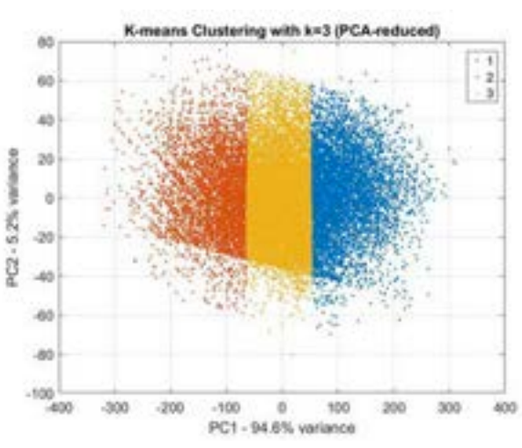


Figure 5. **PCA Scatter Plot** – Dimensionality reduction of 28,888 macrocycles
- PC1 = 94.6%, PC2 = 5.2% (**99.8% variance explained**)
- Clear separation into 3 clusters, preserving structural diversity

Representative Macrocycles

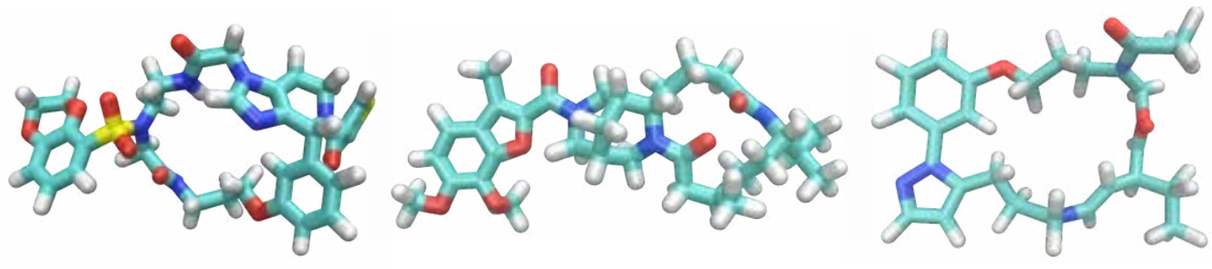


Figure 6. Representative macrocycles from clusters 1, 2, and 3, respectively.

6 Conclusion

- Cheminformatic analysis grouped ~28,888 macrocycles into three well-defined clusters, with PCA confirming 99.8% variance explained and clear structural separation.
- These clusters provide a structured framework for selecting promising macrocyclic leads for BRCA1 inhibition studies.

7 Acknowledgement

This work was supported by the Ministry of Higher Education Malaysia under the Fundamental Research Grant Scheme (FRGS22-281-0890).
Special thanks to ChemBridge Corporation for providing the macrocyclic compound databases.

BPMERU

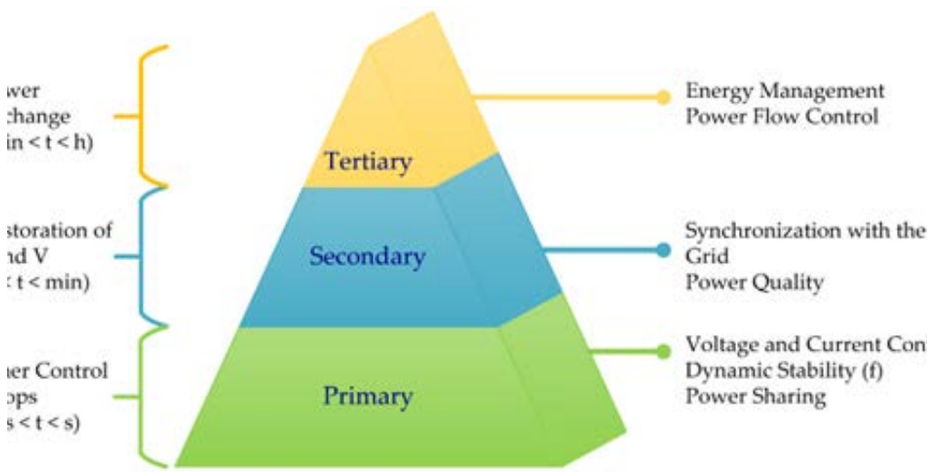
DECISION OPTIMIZATION OF ANN-DRIVEN EMS VIA RISK MITIGATION STRATEGIES

Kamal Akashah Che Kamaruddin & Assoc. Prof. Ts. Dr. Siti Hajar Yusof *
International Islamic University Malaysia (IIUM)

1 Background

Energy Management Systems (EMS) are important for optimizing performance and reducing costs in Hybrid Renewable Energy Systems (HRES)

Major Challenges:
a. Uncertainties & fluctuations nature of the system
b. Presence of multiple dispatchable and non-dispatchable energy sources requires sophisticated decision-making tools
c. Traditional EMS lacks robustness when considering risks and uncertainties
d. Integration of Peer-2-Peer (P2P) technology in HRES



Tertiary Control Level: focuses on the long-term optimization such as power scheduling / economic dispatch / system constraints / power exchanges

Some implemented EMS strategies			
RBC	FLC	MPC	ANN
"if then" logic	fuzzy rules	mathematical	human brain

2 Problem statement

a. Intermittent generation from Renewable Energy Sources (RES) and dispatchable units complicate stable operation
b. Grid-connected HRES involve complex coordination of multiple energy sources
c. Existing tertiary control method often do not integrate risk mitigation effectively in terms of reliability, cost-effectiveness and economic

3 Objectives

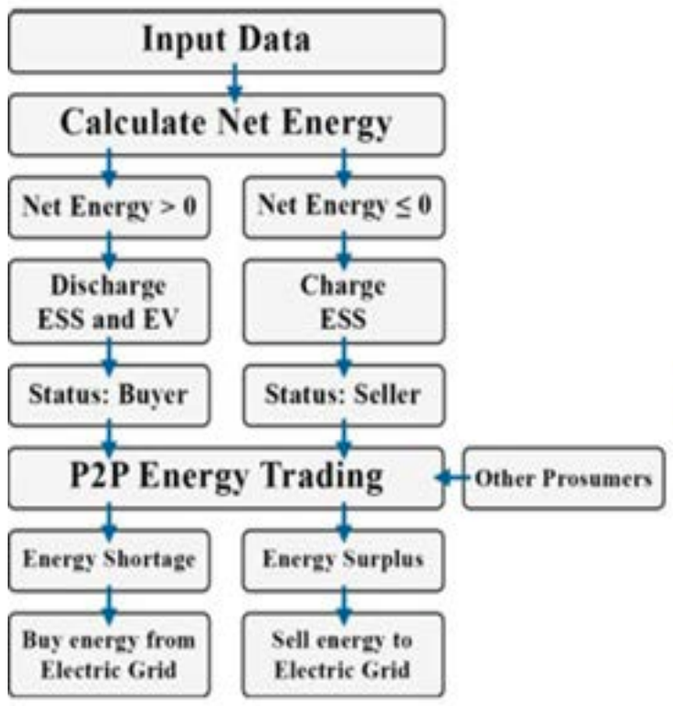
a. To compare the existing EMS strategies with the proposed ANN-based EMS
b. To develop ANN-based decision optimization model for EMS that improves prediction and control of energy consumption patterns
c. To evaluate the performance of the proposed ANN-based EMS optimization in terms of energy efficiency improvements and cost savings

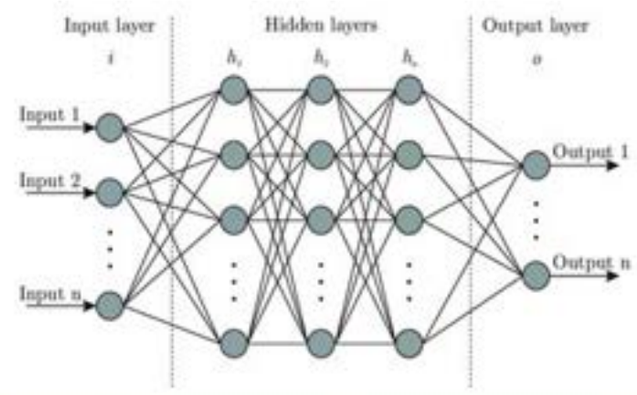
P. A. Cárdenas, M. Martínez, M. G. Molina, and P. E. Mercado, "Development of Control Techniques for AC Microgrids: A Critical Assessment," *Sustainability 2023, Vol. 15, Page 15195*, vol. 15, no. 21, p. 15195, Oct. 2023, doi: 10.3390/SU152115195

M. Yavuz and O. C. Kivanc, "Optimization of a Cluster-Based Energy Management System Using Deep Reinforcement Learning Without Affecting Prosumer Comfort: V2X Technologies and Peer-to-Peer Energy Trading," *IEEE Access*, vol. 12, pp. 31551–31575, 2024, doi: 10.1109/ACCESS.2024.3370922.

4 Methodology

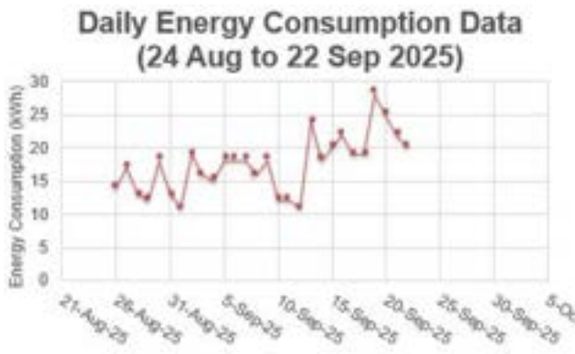
- Data collection: historical & real-time data on energy consumption, RES, load demand, weather data
- ANN model development: Design & Training of ANN
- Decision Optimization: Develop optimization algorithms incorporating ANN predictions to determine optimal control actions
- Risk mitigation: implement risk assesments techniques
- Simulation / Testing / Performance Evaluation

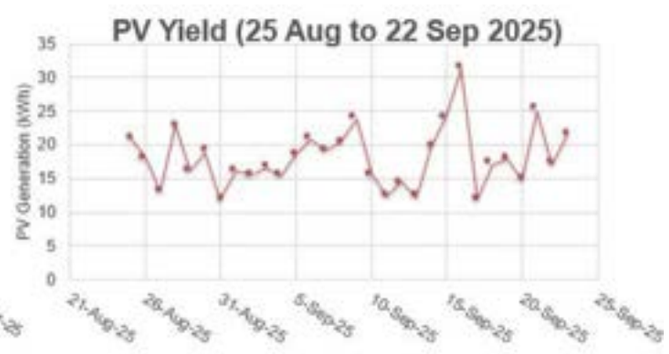


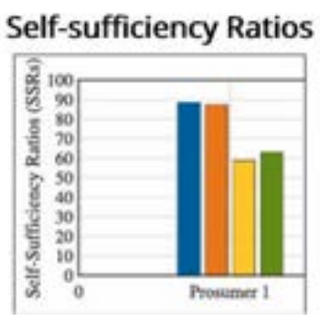


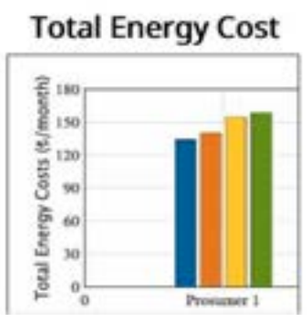
Likelyhood	Consequences				
	Insignificant: Risk is easily mitigated by normal day to day process	Minor: Delays up to 10% of Schedule, Additional cost up to 10% of Budget	Moderate: Delays up to 30% of Schedule, Additional cost up to 30% of Budget	Major: Delays up to 50% of Schedule, Additional cost up to 50% of Budget	Catastrophic: Project abandoned
Certain >90% chance	High	High	Extreme	Extreme	Extreme
Likely 50% - 90% chance	Moderate	High	High	Extreme	Extreme
Moderate 10% - 50% chance	Low	Moderate	High	Extreme	Extreme
Unlikely 3% - 10% chance	Low	Low	Moderate	High	Extreme
Rare <3% chance	Low	Low	Moderate	High	High

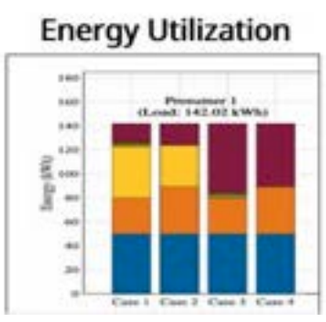
5 Expected Results & Findings











Self-sufficiency Ratios

$$SSR^n = 1 - \sum_{t=1}^{T_{simulation}} \frac{E^n_{grid,buying}}{E^n_{load}}$$

6 Conclusions

- This research highlights the practicality of ANN-driven and risk mitigation strategies for applications in smart grids, microgrids, and complex energy
- The integrated approach combining ANN with risk mitigation strategies is expected to enhance EMS performance by improving decision optimization under uncertainty (the SSR > 90%~)
- Future work may focus on the scalability, computational efficiency, and real-time implementation challenges

INKJET-PRINTED PEDOT:PSS-BASED TEXTILE ELECTRODE FOR HEALTHCARE APPLICATION

Nabila Hamzah*, Amelia Wong Azman, Zuraida Ahmad & Nur'aishah Ahmad Shahrim
Kulliyyah of Engineering, International Islamic University Malaysia

1 Abstract

The adoption of PEDOT:PSS has garnered increasing attention in electronic textiles applications due to their commercial availability, biocompatibility, tunable conductivity, and ease of processing capabilities as alternatives to the disposable Ag/AgCl electrodes. Nevertheless, improving their conductivity and long-term stability while preserving mechanical properties poses significant challenges. Here, we have developed a mass-producible conductive ink that includes PEDOT:PSS, silver nanoparticles (AgNPs), and various additives that ensure stable dispersion and can be inkjet-printed onto cotton fabric with strong adhesion. The good adhesion of the ink on cotton fabric was confirmed by analyzing the FTIR spectra. The results show that the formulated ink in this study provides improved resistance in measurement. Inkjet-printed PEDOT:PSS-based textiles offer promising properties for future electronic textiles in healthcare, featuring improved conductivity, reusable, and biocompatible electrodes.

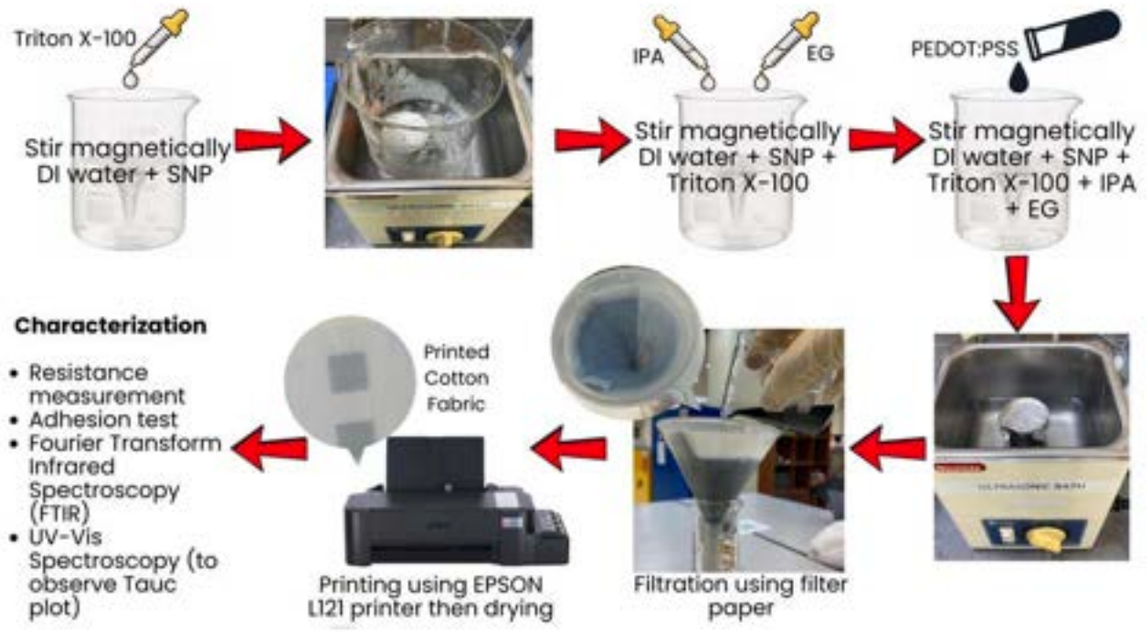
2 Problem statement

The application of PEDOT:PSS alone as textile electrodes presents certain constraints, such as its high solubility in aqueous environments and the degradation of the conductive properties of the textiles [1]. Besides, the textile electrodes face electrical performance degradation after multiple washing cycles which are prone to wear abrasion, bending of the coated materials, stretching and twisting during the cycle, resulting in reusability and durability challenges for conductive textiles [2,3]. This is due to poor adherence of conductive coating to the textile's surface, leading to flaking off of the coating from the textile's surface [3].

3 Objectives

1. To design a printable and mass-producible conductive ink composed of PEDOT:PSS, silver nanoparticles (AgNPs), and other additives with uniform ink distribution and good adhesion on cotton fabric.
2. To evaluate resistance for both dip-coated and inkjet-printed cotton fabric as the first proof of the conductivity of textile electrodes.

4 Methodology



4 Results & Findings

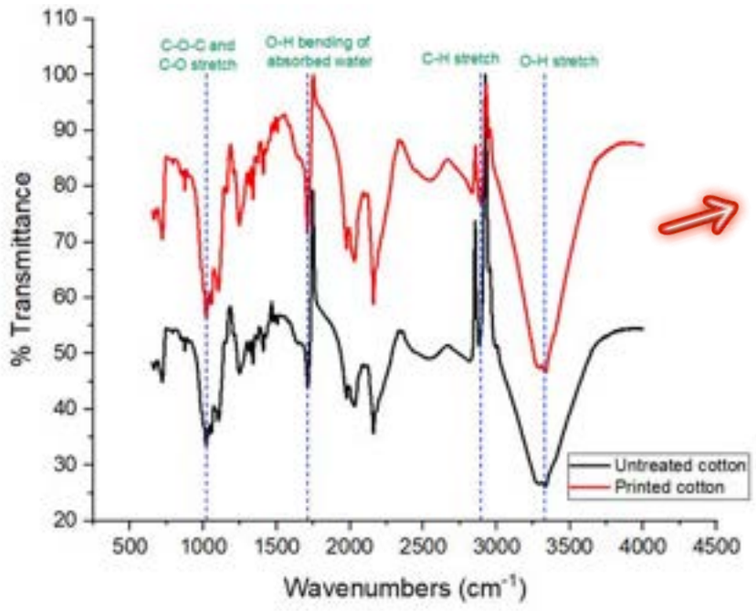


Fig. 1 FTIR Spectra

The untreated cotton has lower transmittance than printed cotton, across the range.

Successfully tunes the surface chemistry of cotton, increasing its hydrophobicity and stability

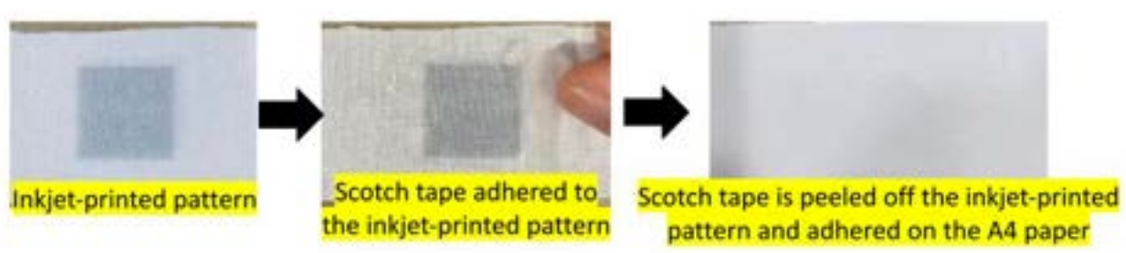


Fig 2. Good adhesion on fabric

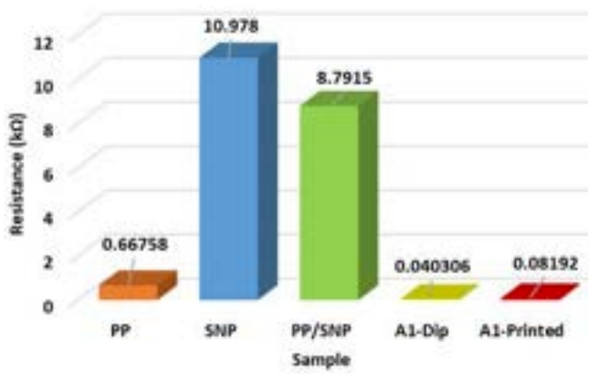


Fig 3. Resistance of dip-coated and printed samples

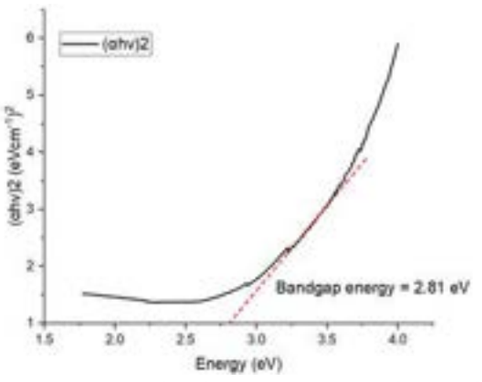


Fig 4. Tauc Plot for PEDOT:PSS-based conductive ink

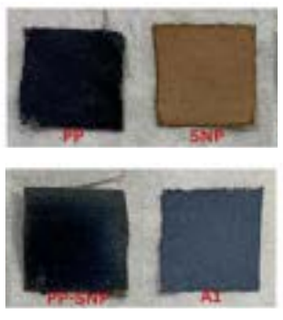


Fig 5. Dip-coated cotton fabric samples

A1 sample shows uniform ink distribution on the fabric and no brittleness after being cured at 130°C

Fig 6. Stable dispersion - No sedimentation after being left for 20 days and less agglomeration

5 Conclusion

In this study, the formulation was effectively developed into a printable ink through the inkjet printing process, demonstrating significant potential for scalable and mass production of wearable electrodes. The enhanced resistance observed, alongside satisfactory ink distribution on fabric and ink stability even after 20 days, underscores the potential of these composites for future electronic textiles in healthcare, featuring improved conductivity as well as reusable and biocompatible electrodes.

6 Acknowledgement

Supported by Ministry of Education through Fundamental Research Grant Scheme (FRGS/1/2023/TK09/UIAM/01/1)

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[3] Vidhya, C. M., Maithani, Y., & Singh, J. P. (2023). Recent Advances and Challenges in Textile Electrodes for Wearable Biopotential Signal Monitoring: A Comprehensive Review. Biosensors, 13(7), 679.

DEVELOPMENT OF INKJET-PRINTED PET-BASED RESISTIVE TACTILE FORCE SENSOR FOR WEARABLE ELECTRONICS

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[2]Department of Mechatronics Engineering, Kulliyyah of Engineering, IIUM,
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1 Abstract

Accurate force and pressure measurement is vital in human motion sensing and rehabilitation. Commercial resistive tactile force sensors, or force sensitive resistors (FSRs) are widely used but lack flexibility and adaptability for more personalized devices. This work presents a flexible PET-based resistive tactile force sensor that consists of a silver electrode, graphene piezoresistive layer, acrylic spacer and PET substrate. The sensor was optimized using finite element simulation, to determine the optimum height of gap spacer and electrode ratio (width of electrode/gap between electrodes) for high sensitivity. The optimum design of the sensor was fabricated using inkjet printing of silver ink for the electrode layer onto PET substrate, and drop casting of graphene ink for the piezoresistive layer on a similar PET substrate. The sensor was measured using dynamic mechanical analysis (DMA) to determine sensitivity, stability, and response/recovery time. The simulation revealed that an electrode ratio of 0.67 and gap spacer height of 0.02 mm yielded the highest sensitivity. Measurement using DMA showed a nonlinear response with a fractional resistance change of 0.35, saturation at 6.44 N, and fast response/recovery times (164.04 ms/161.54 ms). The sensor also demonstrated stable output over 100 load cycles at 1 Hz. These results highlight the potential of the proposed PET-based resistive tactile force sensor for wearable and rehabilitation applications.

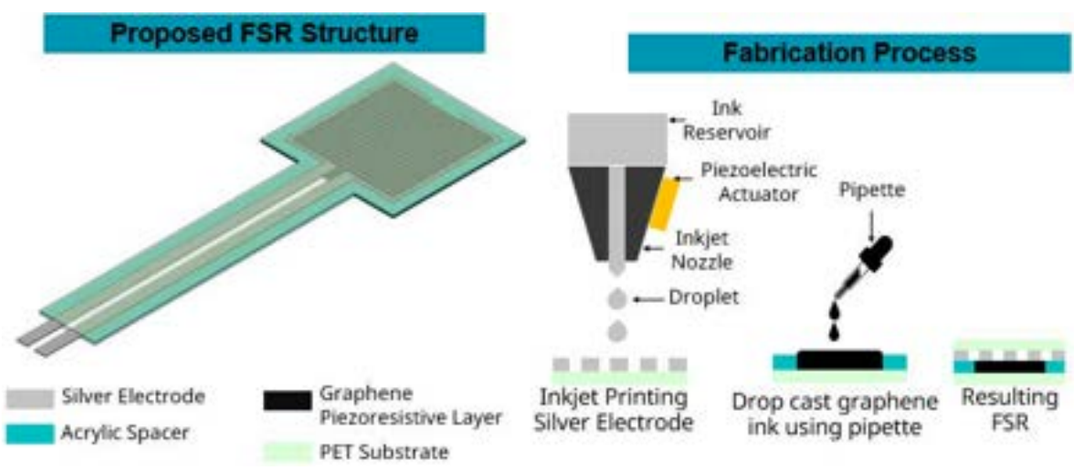
2 Problem statement

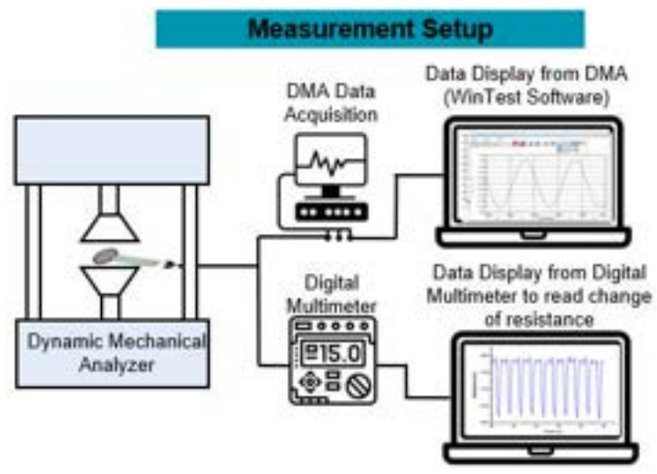
Current commercial force sensitive resistors (FSRs) lack flexibility and adaptability for more personalized sensing. Hence, custom-made sensors can provide tailor-made parameters for personalized sensing.

3 Objectives

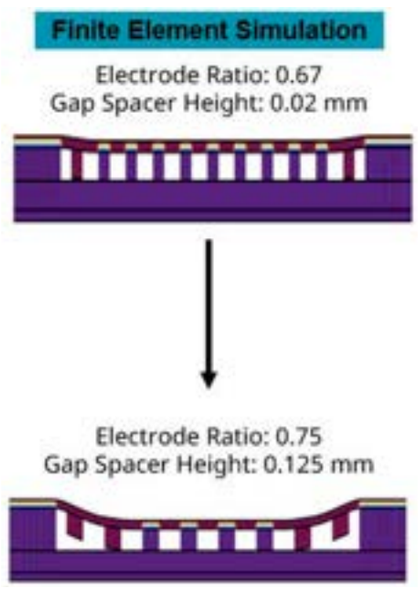
- To obtain the optimum design of FSR using finite element simulation
- To fabricate the FSR using inkjet printing
- To measure the performance of FSR in terms of sensitivity, stability and response time

4 Methodology



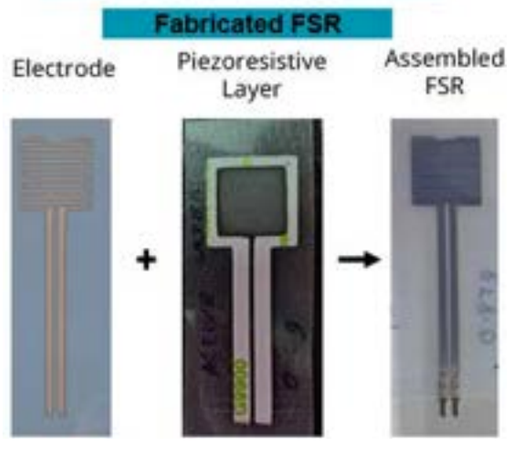


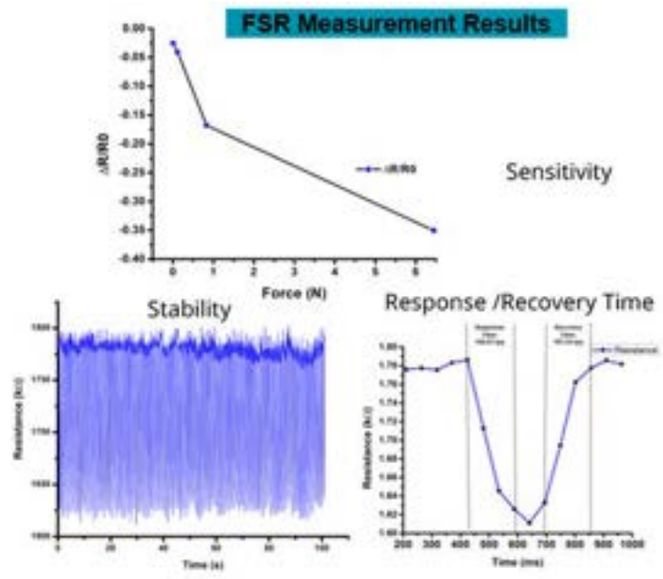
5 Results & Findings



Optimum FSR design Parameters

Electrode Ratio	0.67
Gap Spacer Height (mm)	0.02





6 Conclusion

The fabricated FSR has an optimized design that can be used for pressure sensing in wearable electronics.

7 Acknowledgement

The authors would like to thank all the team members of Department of Semiconductor Additive Technology & Printed Electronics, Semiconductor R&D Division, MIMOS Berhad for their guidance. This research work was funded by Fundamental Research Grant Scheme (FRGS) research project FRGS24-341-0950 (FRGS/1/2024/TK07/UIAM/03/1).

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VLSI & MEMS RESEARCH UNIT

FROM RIVERBED TO RESILIENCE: SUSTAINABLE MORTAR INNOVATION AT IIUM FOR HUMANITY

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1 Abstract

The Pusu River at IIUM faces excessive sedimentation from upstream land clearing, requiring dredging to restore river health. Conventional disposal of dredged sediment (DS) creates environmental burdens, while carbon fiber reinforced polymer (CFRP) waste from industries poses additional sustainability challenges. This research explores the combined use of DS as a sand substitute and milled CFRP wastes as fiber reinforcement in mortar to enhance mechanical and microstructural performance. By repurposing locally sourced waste, the project contributes to circular economy practices, sustainable construction, and river rehabilitation.

2 Problem statement

River pollution has afflicted the Pusu River and its tributaries, which pass through the Gombak campus of IIUM. Hence, dredging of sediment becomes necessary to maintain navigable waterways and prevent flooding.

Reusing the dredged sediment (DS) would :

i. provide a sustainable **waste management**

ii. viable **alternative** for declining natural aggregate.

Additionally, the incorporation of milled CFRP waste can offer mechanical reinforcement to compensate for the material limitations of DS. While previous studies have examined the reuse of DS, the **combined effect** of it and milled CFRP waste in cement-based materials has not been sufficiently explored.

IIUM river filled with silt

Milled CFRP wastes

3 Objectives

Objective 1: To characterise river sand, dredged sediment, & CFRP wastes
Objective 2: To evaluate the mechanical performance of the mortar
Objective 3: To correlate the microstructural analysis with mechanical performance

4 Methodology

Collection of DS

Characterisation of DS (XRF, XRD & SEM-EDS)

Treatment of DS (sieving & calcination)

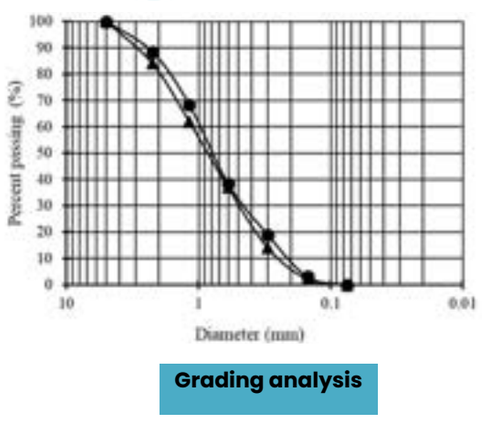
Preparation of specimen

Mortar mixing

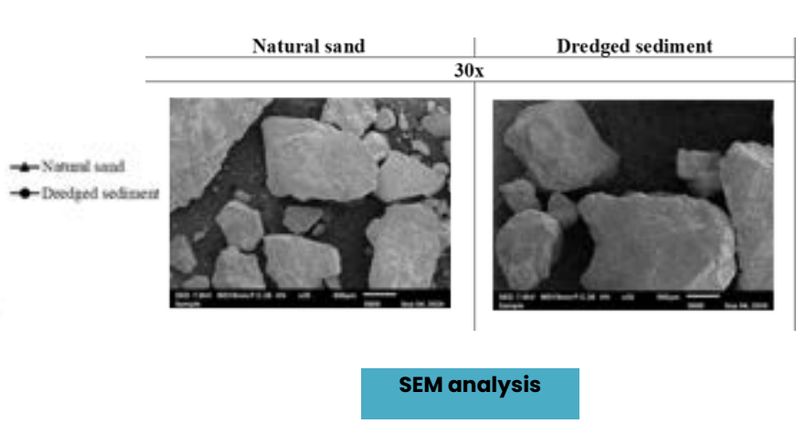
Casting & curing

Testing & Evaluation

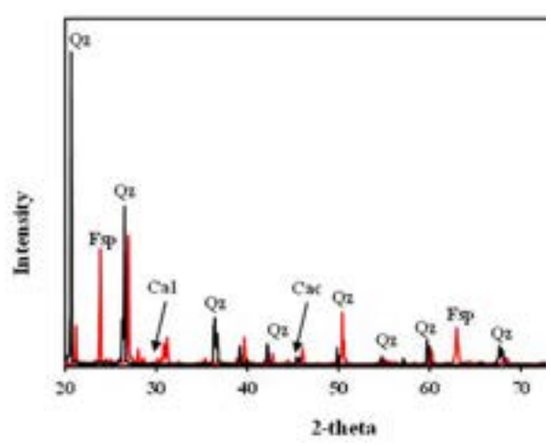
4 Results & Findings



Grading analysis



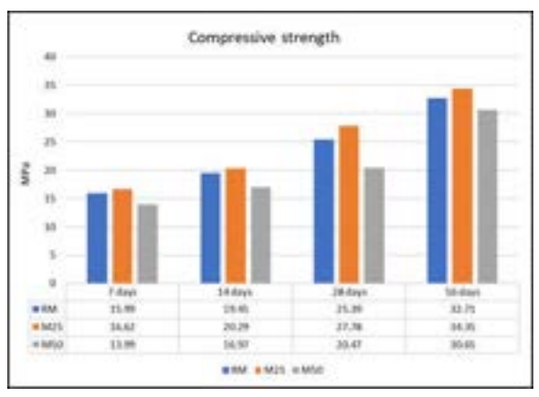
SEM analysis



XRD analysis

	Percentage (%)	
	14.4	14.3
	65.12	64.54
	2.52	2.39
	0.22	0.235
	16.4	16.9
	0.70	0.734
Cu	-	0.111
	0.21	0.256
	0.43	0.460

XRF analysis



- 25% replacement (M25) **outperfomed** reference mortar (RM) due to benefits from **filler effect** and **particle packing**.
- 50% Replacement (M50) **underperformed** compared to RM, especially at early ages due to **increased water demand** from higher fines and clays in DS.

Tawhidic Lens: Guided by **khilafah** (stewardship of earth), **mizan** (balance in nature), and **maslahah** (benefit for humanity), this research transforms **DS** and **CFRP waste** through scientific treatment and testing into **sustainable mortar**—showing how faith and science unite to protect nature and serve people.

5 Conclusion

From characterization of DS, it is found **feasible** as sand substitute with the **necessary treatment processes**. However, higher replacement resulted in lower mortar performance. Thus, addition of **milled CFRP waste** is expected to address this issue.

6 Acknowledgement

The authors would like to acknowledge and thank the support provided by the International Islamic University Engineering Merit Scholarship 2023.

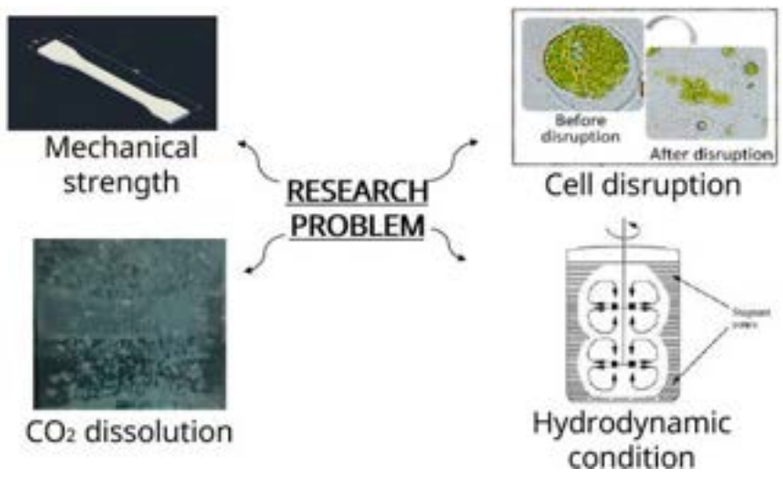
Design and Fabrication of Carbon Dioxide Microbubble Dissolver Plate for Microalgae Cultivation Application

Nurul Atiqah Binti Zahari, Assoc. Prof. Dr. Farah Binti Ahmad, Assoc. Prof. Dr. Maziati Akmal Mohd Harttar @ Mohd Hatta, Assoc. Prof. Ir. Dr. Azlin Suhaida Binti Azmi, Assoc. Prof. Ir. Dr. Fathilah Binti Ali
International Islamic University Malaysia (IIUM)

1 Abstract

Carbon dioxide (CO_2) emissions from industry and fossil fuels drive climate change, underscoring the need for effective carbon capture. Microalgae cultivation offers a sustainable solution by converting CO_2 into biomass, but conventional photobioreactor (PBR) aeration suffers from poor gas transfer, energy loss, and inefficiency. This study integrates a phase-inverted PVDF membrane with a CO_2 microbubble dissolver plate in a 5 L tubular PBR. PETG was identified as the most durable plate material (35.37 MPa, no leakage), while membrane fabrication optimized for immersion time, bath temperature, and thickness produced 7.38 nm pores and ~0.2 cm bubbles. The integrated system enhanced CO_2 dissolution and was validated through cultivation, showing improved microalgal growth and productivity. This approach offers a promising, energy-efficient method for CO_2 transfer with potential for biomass production and carbon capture.

2 Problem statement



3 Objectives

1. To evaluate the mechanical strength of 3D-printed microbubble dissolver plates (PC, PETG, ASA).
2. To optimize PVDF membrane fabrication (solvent, bath temperature, thickness) for minimal bubble size, high tensile strength, and zero leakage.
3. To assess CO_2 mass transfer efficiency of the integrated dissolver–PVDF system in a 5 L tubular PBR.
4. To validate the system as an aeration method through microalgae cultivation.

4 Methodology

Design & Fabrication
- CAD-based design of CO_2 microbubble dissolver plate
- 3D printing with selected materials (PC, ASA, PETG)
- Mechanical strength validation (UTM)

Membrane Fabrication
- PVDF membranes via phase inversion
- Optimized parameters: immersion time, bath temperature, thickness
- Characterization (XRD, SEM, FTIR, swelling)

System Integration & Testing
- Integration with 5 L tubular PBR
- Gas mass transfer (kLa, CO_2 dissolution efficiency)
- Reusability & leakage testing

Microalgae Cultivation & Validation
- Cultivation with 5% CO_2 sparging
- Biomass (OD, CDW), pH, lipid yield
- Overall system performance validation

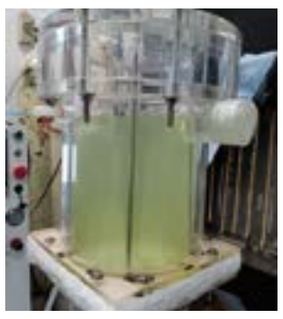


Figure 3.1: Integration of membrane-microbubble dissolver for microalgae cultivation

4 Results & Findings

1. CO_2 Microbubble Dissolver Plate

Figure 4.1: Design of CO_2 Microbubble Dissolver Plate

Figure 4.2: Bar chart of tensile strength (Mpa) of 3D printer material

2. PVDF membrane

Optimized PVDF Membrane Fabrication
- Phase inversion method; varied coagulation bath time, temperature, and thickness.
- Optimum condition: **20 °C bath, 2 h immersion, 350 µm**

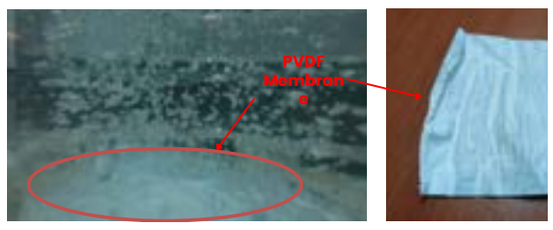


Figure 4.3: Microbubbles produce by PVDF membrane

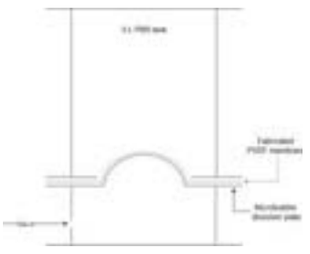


Figure 4.4: Schematic diagram of membrane-microbubble plate in PBR

Parameter	Result
Tensile strength	9.81 MPa
Average pore size	7.3775 nm
Contact angle	90.72 ± 3.91
Leaking test	No leaking

Figure 4.5: Morphology of membrane (SEM)
uniform pore distribution, confirming consistent morphology.

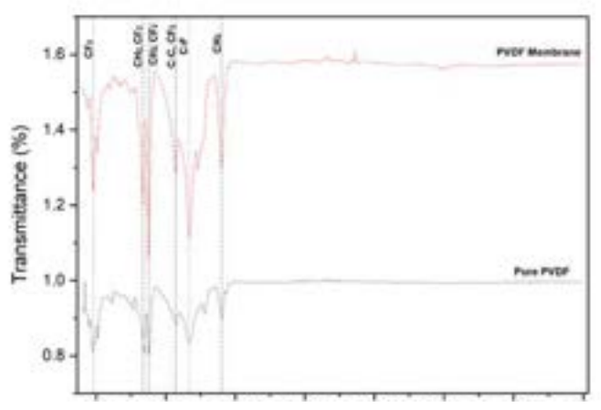


Figure 4.6: Functional group analysis (FTIR)
Presence of characteristic PVDF functional groups→ Confirms PVDF polymer integrity and composition

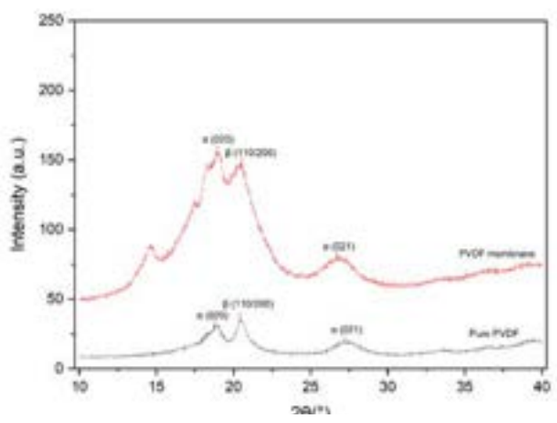


Figure 4.7: Crystal structure analysis (XRD)
α-phase PVDF dominant → high chemical resistance & mechanical robustness.

3. Microalgae cultivation

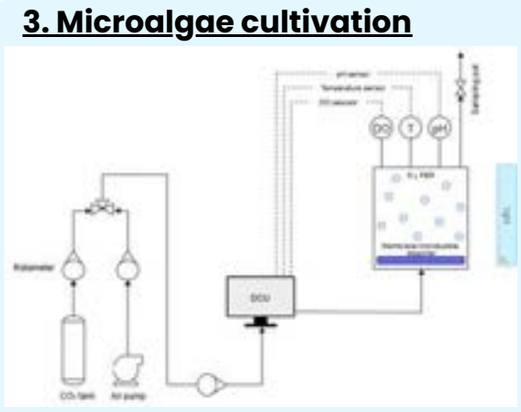


Figure 4.8: Schematic diagram of the system

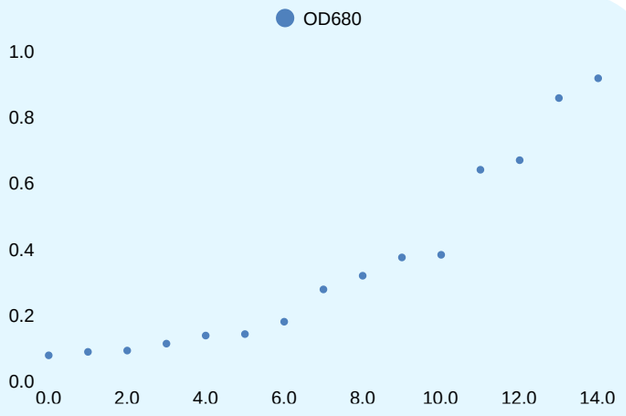


Figure 4.9: Growth curve of microalgae over 14 days

5 Conclusion

- PETG exhibited the highest tensile strength
- The optimized fabrication parameters for the membrane achieved minimum bubble size, maximum tensile strength, and zero leakage.
- The integrated CO_2 microbubble system improved dissolution efficiency and supported higher microalgae biomass productivity

SUSTAINABLE MACHINING OF CFRP : EVALUATION OF TOOL WEAR AND SURFACE QUALITY UNDER VARIABLE CUTTING CONDITIONS

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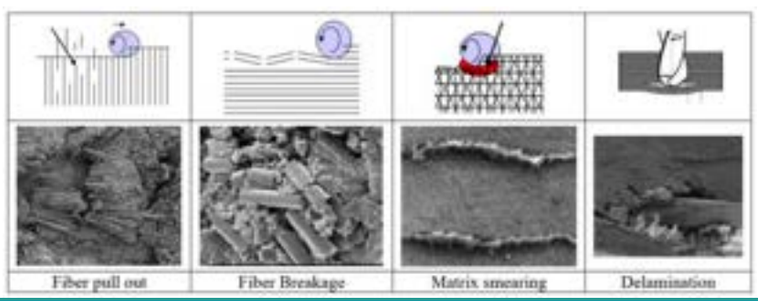
1 Abstract

CFRP is desirable for its strength-to-weight ratio properties, therefore extensively applied in aircraft and automotive. However, machining CFRP presents difficulties due to its anisotropic and inhomogeneous nature. The abrasive carbon fibers, when machined at high cutting speeds, causes significant wear on the cutting tool's edge, leading to visible rounding and flank wear. As the CFRP is made of carbon fiber impregnated in matrix resin, it is advisable to process the CFRP beneath the glass transitional temperature (Tg) of the polymer to avoid defects such as matrix smearing and fiber pull-out, which occur when the polymer softens and fails to hold the fibers together. Therefore, alternative machining strategies are necessary to enhance CFRP machinability. This study examines the impact of cutting speeds and conditions on tool wear and surface quality during CFRP milling. Experiments were conducted at high (170 m/min) and low (130 m/min) machining speeds, with a constant feed rate (2100 mm/min), under dry and chilled air conditions. Results indicate that milling CFRP at 170 m/min in chilled air measured the highest tool wear (110 mm), 25.5% higher than other cutting parameters. This increase in tool wear is attributed to the elevated stress on the cooled machined surface experienced by the cutting tool during high-speed machining. Milling in dry condition produced the highest Sa of 5.015 µm, 27% higher than in chilled air, due to the heat generated from the friction during the milling process.

2 Problem statement

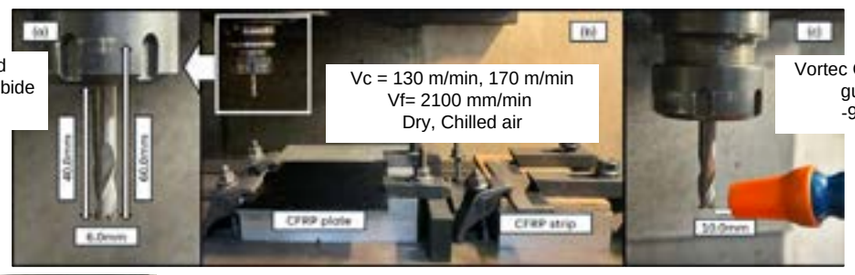
- Abrasive of CFRP causes abrasion on the cutting edge of uncoated tungsten carbide during milling process
- High machining = high heat generated
- CFRP must be processed below the glass transitional temperature (Tg)
- Milling beyond the Tg can degrade the polymer matrix, leads to occurrence of surface damages



3 Objectives

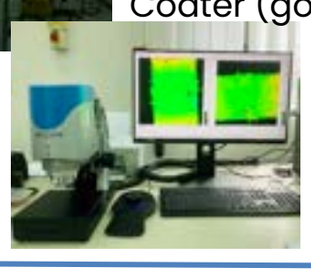
- To evaluate the effects of cutting conditions on the progression of tool wear and wear mechanism of uncoated tungsten carbide tool
- To investigate the effects of cutting conditions on the surface roughness and the surface damage of the CFRP

4 Methodology



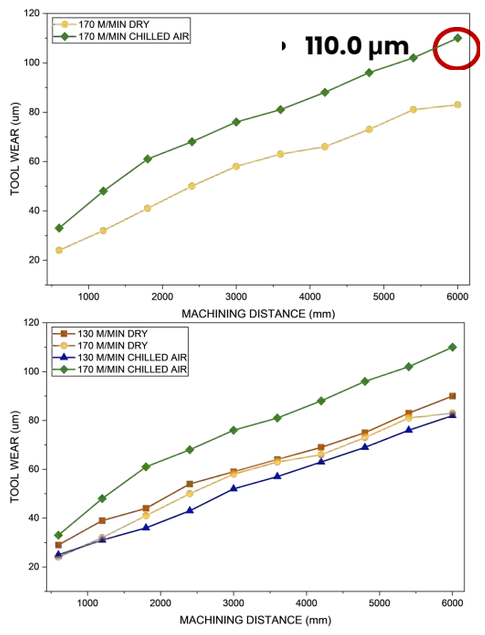
Dino-lite Premier digital microscope
DinoCapture 2.0 software
Interval : Every 400 mm machining distance

Jeols JSM-5600 Schottky Field Emission scanning electron microscope with EDS
x50 - x5000
Surface conductivity : Quorum SC7620 Sputter Coater (gold palladium)

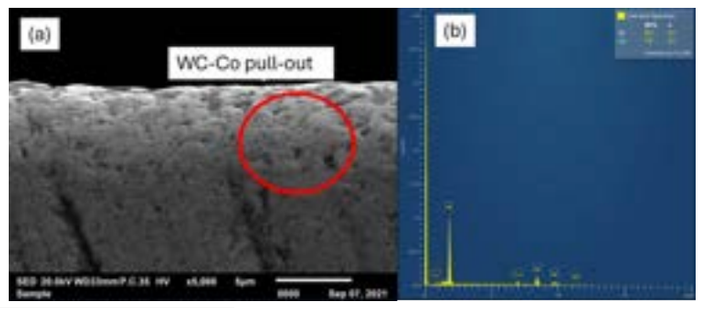


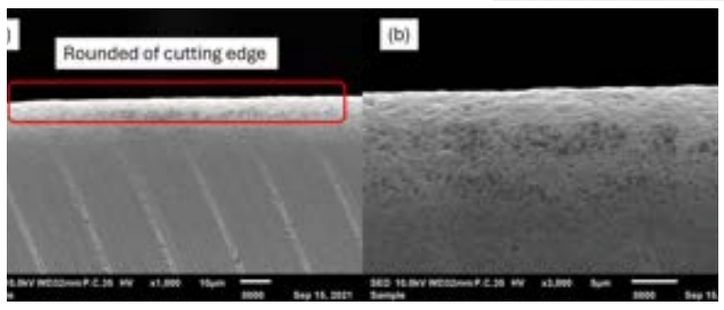
Alicona Infinite SL 3D profiler
Sampling length : 4mm
Cut of length : 800 µm [ISO 4288]
Lateral resolution : 8.39 µm
Vertical resolution : 1.98 µm

5 Results & Findings

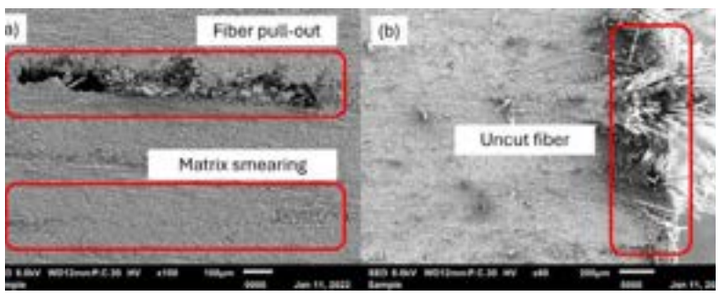


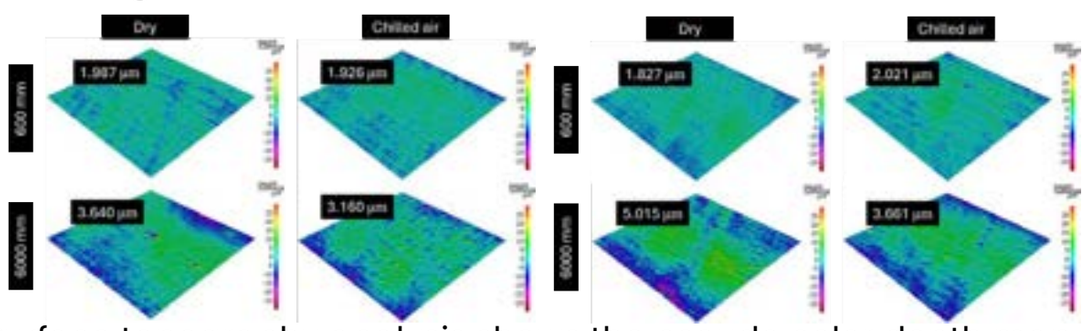
- Increasing of wear along the machining distance caused by the increasing of contact between the cutting edge and work surface along the machining distance
- Alternate heating and chilling cycles subjected on the cutting zone - fracture dominant removal mechanism
- Accumulation of dust-like chips on the cutting edge increases friction on the cutting zone
- Absence of coolant in flushing the fine chips of CFRP
- Abrasiveness of CFRP causing constant abrasion onto the cutting tool edge causing WC-Co pull out





- Rounded of cutting edge as the wear mechanism caused by the constant interaction between sharp edge of cutting tool and workpiece
- Softens of matrix resin has weakens the bond between laminate causing fiber pull out and matrix smearing
- Rounded of the cutting tool edge ineffectively removing the CFRP





- Surface topography analysis shows the pseudo color depth map that supports the value of Sa
- Represents the surface irregularities formed on the CFRP machined surface

6 Conclusion

The alternating heating and cooling cycle has subjected the cutting tool to thermal fatigue that resulted in brittle cutting edge. The pseudo-color depth map of the machined surface evidently supports the high Sa values and confirms the assistance of the surface topography and the areal surface roughness in understanding materials with anisotropic and inhomogeneity properties, such as CFRP.

7 Acknowledgement

A special gratitude to the supervisors and staffs of production lab, metrology lab, metallography lab and workshop in Kulliyyah of Engineering, IIUM. Their assistances and guidance are deeply appreciated.

ELECTROSPUN POLY (VINYL ALCOHOL) (PVA)/POLYCAPROLACTONE (PCL) NANOFIBERS FOR EFFICIENT FILTRATION

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[1]*Department of Manufacturing and Materials Engineering, International Islamic University Malaysia, Gombak, 53100, Kuala Lumpur, Malaysia*
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1 Abstract

The widespread use of synthetic facemasks has raised concerns about plastic pollution, highlighting the need for biodegradable alternatives. This study developed electrospun nanofiber filter media from polyvinyl alcohol (PVA, 15 wt%) blended with varying polycaprolactone (PCL, 4,6,8 wt%) using a single-needle electrospinning setup. FTIR confirmed hydrogen bonding between PVA and PCL, indicating good miscibility. Higher PCL content increased solution viscosity and fiber diameter. The 4 wt% PCL blend produced the finest, most uniform fibers (~427 nm) with the highest tensile strength (3.16 MPa) and elongation (0.63 mm/mm). Filtration tests showed low particle penetration (<0.05%) but a relatively high pressure drop at 95 L/min flowrate. Overall, PVA–PCL electrospun nanofibers demonstrate strong potential as biodegradable facemask filters with promising filtration performance.

2 Problem statement

Blending PVA and PCL is difficult due to their contrasting polarities, leading to immiscibility, poor interfacial adhesion, phase separation, and non-uniform fiber morphology. These issues compromise the mechanical strength and filtration efficiency of electrospun nanofibers.

Acetic acid is introduced as a compatibilizing solvent, enabling co-dissolution of PVA and PCL.

This approach aims **to develop uniform, mechanically stable, and efficient biodegradable PVA/PCL nanofiber filters as a novel filtering media** for facemask applications.

3 Objectives

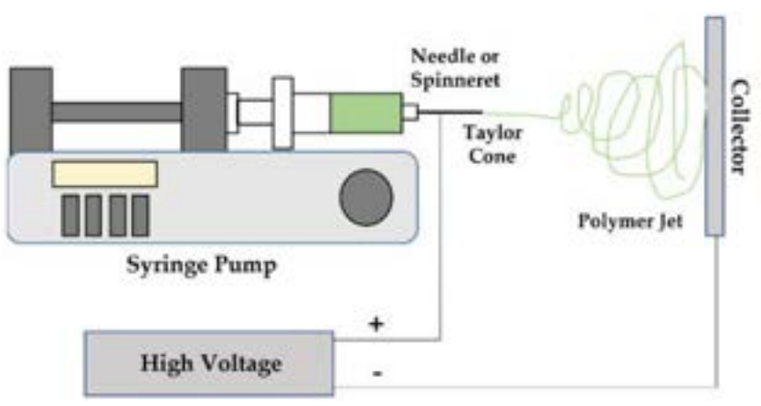

Figure 1: Schematic diagram of electrospinning setup

Machine parameters	Value
voltage	17 kV
current	0.3 mA
nozzle size	18 G
flow rate	1.5 ml/h
temperature	23±0.5 °C

Table 1: Machine parameters

4 Results & Findings

Table 1: Viscosity of all samples

	Composition PCL (wt%)	Composition PCL (wt%)	Viscosity (mPa.s)
F1	15	4	426
F2	15	6	447
F3	15	8	430

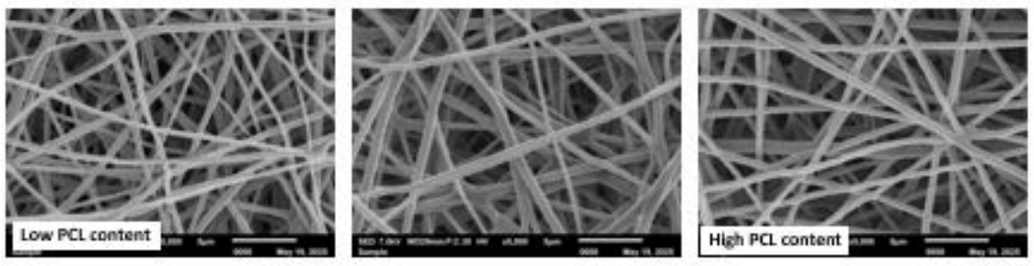

Figure 2: SEM micrographs of samples at 5 µm magnification

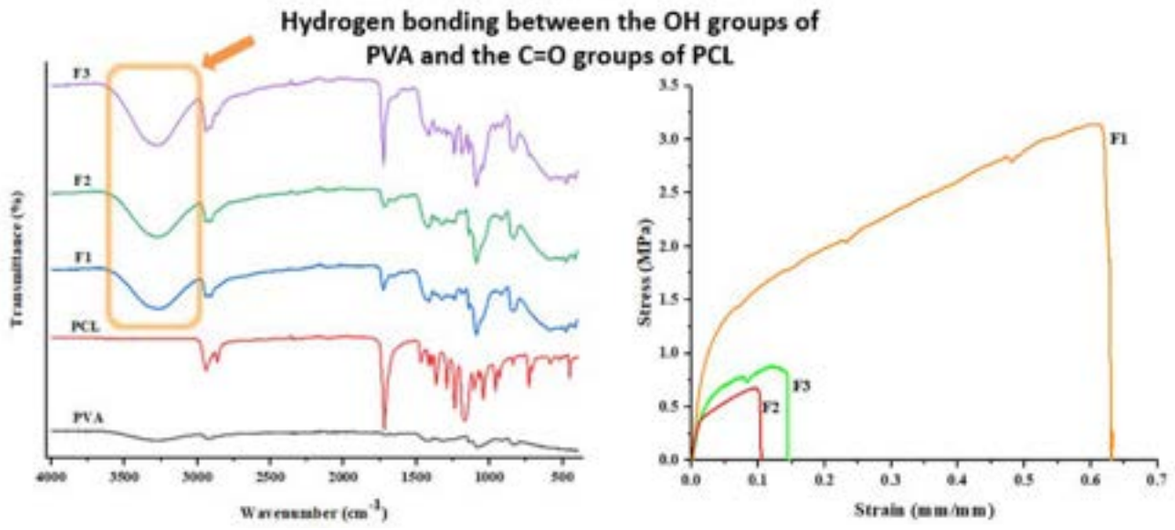

Figure 3: FTIR spectra

Figure 4: Tensile stress-strain curve

Table 3: Tensile properties of all samples

	Tensile strength (MPa)	Elongation at break (mm)	Young's Modulus (MPa)
F1	3.16	0.63	60.36
F2	1.40	0.104	44.44
F3	1.77	0.145	38.88

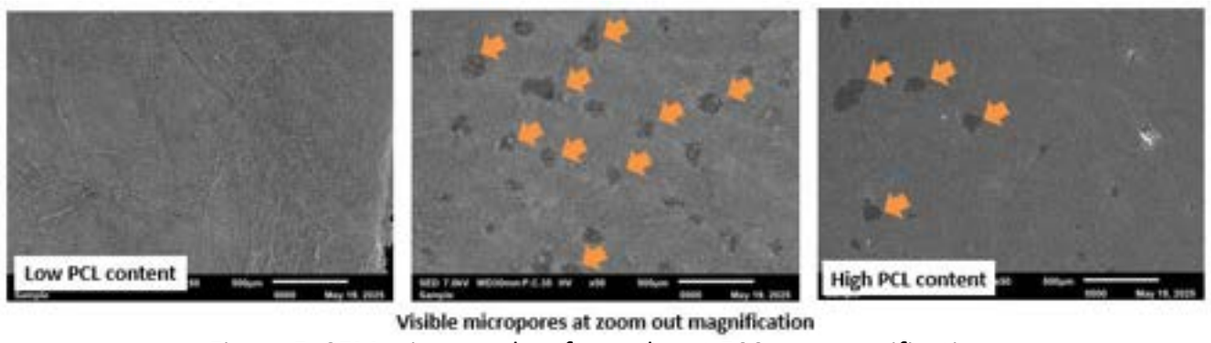

Figure 5: SEM micrographs of samples at 500 µm magnification

Table 4: The filtration performance

	Penetration (%)	Particle Filtration Efficiency (%)	Filter resistance (mmH2O)
F1	0.055	99.95	153.20
F2	0.643	99.34	109.05
F3	0.075	99.93	153.95

5 Conclusion

Successful fabrication: Electrospun PVA/PCL nanofibers with uniform, bead-free morphology.

Compatibilization: FTIR confirmed acetic acid enhances miscibility via hydrogen bonding.

Effect of PCL: Higher PCL → larger fiber diameter; smaller fibers → higher FE but greater pressure drop.

Optimum formulation: Formulation 2 offers the best trade-off between filtration efficiency, structure, and breathability.

Future directions & Commercialization:

Test biodegradation efficiency and antimicrobial integration.

Industry collaboration for scale-up and real-world testing.

Explore commercial adoption in eco-friendly facemask production.

6 Acknowledgement

This research was funded by a grant from Ministry of Higher Education of Malaysia (FRGS/1/2022/TK09/UIAM/02/2).

OPTIMIZATION AND ADSORPTION STUDIES OF LEAD REMOVAL USING MODIFIED MACROPHYTE BIO-ADS0RBENT

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1 Abstract

Lead in wastewater is a major concern due to its toxicity and persistence. Conventional treatments like chemical precipitation and membrane filtration are costly and may cause secondary pollution. This study explores Azolla macrophyte, an aquatic plant, as a low-cost and eco-friendly bio-adsorbent for lead removal. Azolla was pre-treated in hydrochloric acid, enhancing its surface area and activate functional groups especially hydroxyl and carboxyl groups. Its lignocellulosic structure supports high adsorption ability through complexation and ion exchange. Using a 2-Level Factorial Design, the result shows the best conditions were at pH 10, 250 ppm initial lead concentration, and 10 minutes contact time, achieving 93.69% removal of lead . High regression value represents that adsorption process followed the Freundlich isotherm model with value R = 0.8593 with maximum adsorption capacity of Azolla was 239.47mg/g, indicating multilayer adsorption on heterogeneous surfaces. Results show Azolla is a promising material for sustainable wastewater treatment.

2 Problem statement

- Toxic waste poses health and environment risk.
- Limitations on conventional methods as they might causes secondary pollutants.
- Major gaps in understanding and optimizing macrophytes interactions with heavy metals.

3 Objectives

- To optimize lead removal by controlling pH, initial concentration, and contact time.
- To investigate lead ion adsorption isotherm on macrophyte-based using isotherm model comparisons.

4 Methodology

Synthesis of adsorbent (Azolla Macrophyte)

Azolla macrophyte was dried in the oven under 105°C for 2 hours → Crushed and sieved the dried Azolla until the particle is 1-2mm in size

Before

the Azolla was treated with 0.1M HCl for five hours to optimize its adsorption properties → after 5 hours, thoroughly washed with distilled water, and dried in a shaded environment

Pre-treatment

Drying process after pre-treatment

BATCH ADSORPTION AND ISOTHERM EXPERIMENT

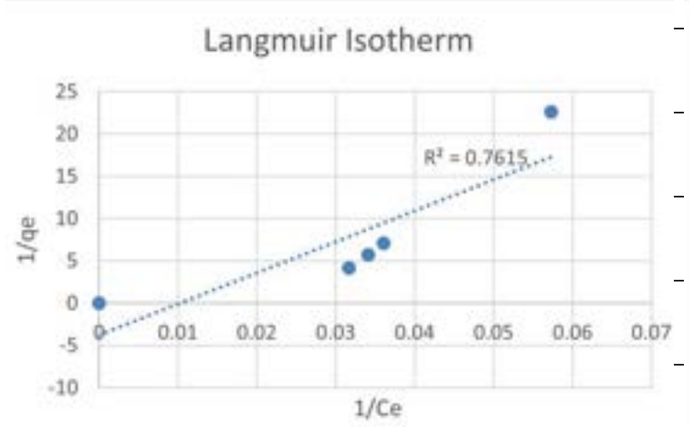
Experiments were signed by DX under 2-level factorial design → Lead solution were prepared with different initial concentration (100,175,250ppm) → pH adjustment by NaOH and HCl (pH 4,7 and 10) → 0.3g of Azolla was added to the conical flask containing lead solution

the mixture was stirred using a laboratory shaker at constant speed of 200rpm until a pre-determined time (10,40,70min) → Samples were extracted and the absorbance was measured using UV-Vis spectorphotometer → Adsorption isotherm was investigated using Langmuir a Freundlich models under optim conditions (150,450,550,750pp

5 Results & Findings

Batch adsorption of Azolla

Run	Factor1 pH	Factor 2 Initial Lead Conc (ppm)	Factor 3 Contact Time (min)	Result
1	10.00	250.00	70.00	90.54412
2	4.00	250.00	70.00	52.76471
3	10.00	100.00	70.00	84.59559
4	10.00	100.00	10.00	85.03676
5	4.00	100.00	70.00	78.67647
6	7.00	175.00	40.00	90.54622
7	4.00	250.00	10.00	58.22059



(a) (b)

Fig 1: a)Graph and linearized equation of a) Langmuir isotherm;1/qe versus 1/Ce and b) Freundlich isotherm; 1/qe versus 1/Ce

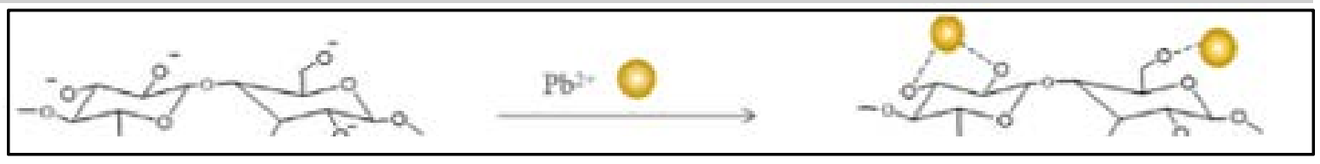


Fig 2: Adsorption mechanism

6 Conclusion

This study proved that Azolla is an effective and low-cost natural bio-adsorbent for removing lead from wastewater, achieving the highest removal efficiency of 93.69% at pH 10, 250 ppm lead concentration, and 10 minutes contact time. The adsorption process followed the Freundlich isotherm with an R^2 value of 0.8593, indicating multi-layer adsorption on Azolla's surface. Overall, these findings highlight Azolla's strong potential as an eco-friendly solution for cleaner water and a sustainable approach to wastewater treatment.

7 Acknowledgement

I am grateful to my supervisors Dr Nik Rashida and Prof Saedi Jami for their guidance, IIUM for the facilities, my friends for their support, and my family for their love and prayers throughout this study.

STAR DETECTION AND CENTROIDING ALGORITHM FOR LUNAR NAVIGATION

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1 Abstract

This study presents an enhanced centroiding algorithm designed to improve robustness and accuracy in the presence of noise. The method incorporates thresholding and intensity-weighted centroid calculations, optimized through testing on synthetic star images affected by Salt-and-Pepper and Gaussian noise. Validation is conducted via affine transformation and star matching with a known star catalogue. The results show accurate detection by visual validation and the detected stars are within 1 to 3 pixels Euclidean distances from the actual stars input. The proposed method demonstrates high accuracy and strong noise resilience, compared to benchmark methods, making it suitable for future lunar missions.

2 Problem statement

The growing demand for reliable star-based navigation. On the Moon, bright regolith reflections and radiation noise can degrade star centroiding performance. There's uncertainty whether the detections are genuine stars or false positives.

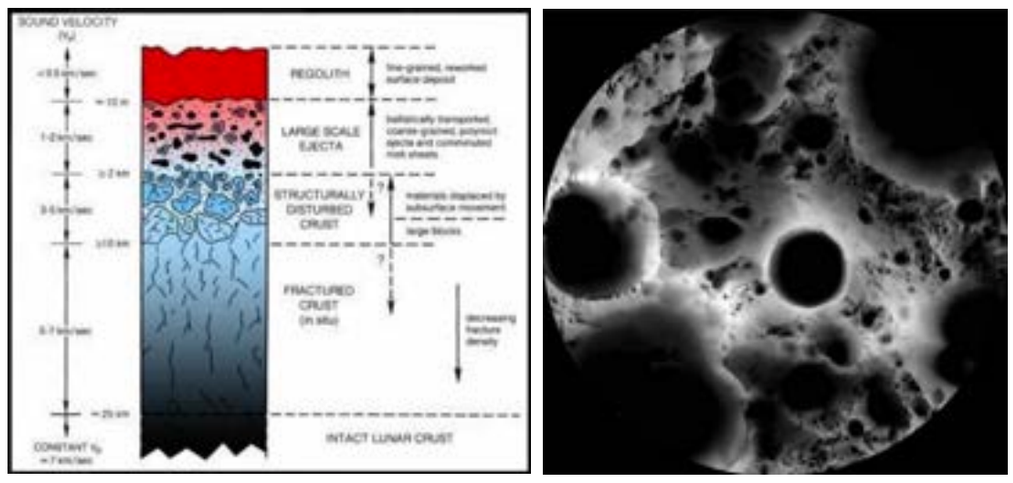

Figure 1: Lunar regolith and solar reflection

3 Objectives

This research aims to improve the robustness of the star centroiding algorithm for lunar mission.

1. To formulate an enhanced centroiding algorithm for improved star position estimation.
2. To investigate the impact of lunar environmental factors.
3. To validate the proposed algorithm by comparing the detected star positions with known star catalogue.

4 Methodology

The methods start with capturing the real star images with image sensor, threshold the image then calculate its centroid. For validation, the detected stars are then compared with the established star catalogue to evaluate its centroid accuracy and robustness.

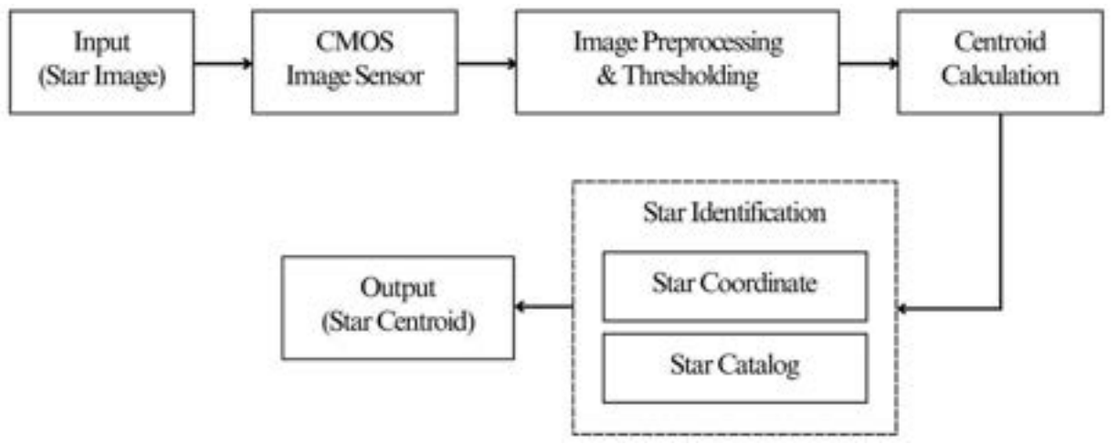

Figure 2: Block diagram of the proposed algorithm

Star Camera Prototype

For the testing, we used Sony IMX219 using Raspberry Pi Camera Module v2 NoIR as the CMOS sensor to capture the star images.

4 Results & Findings

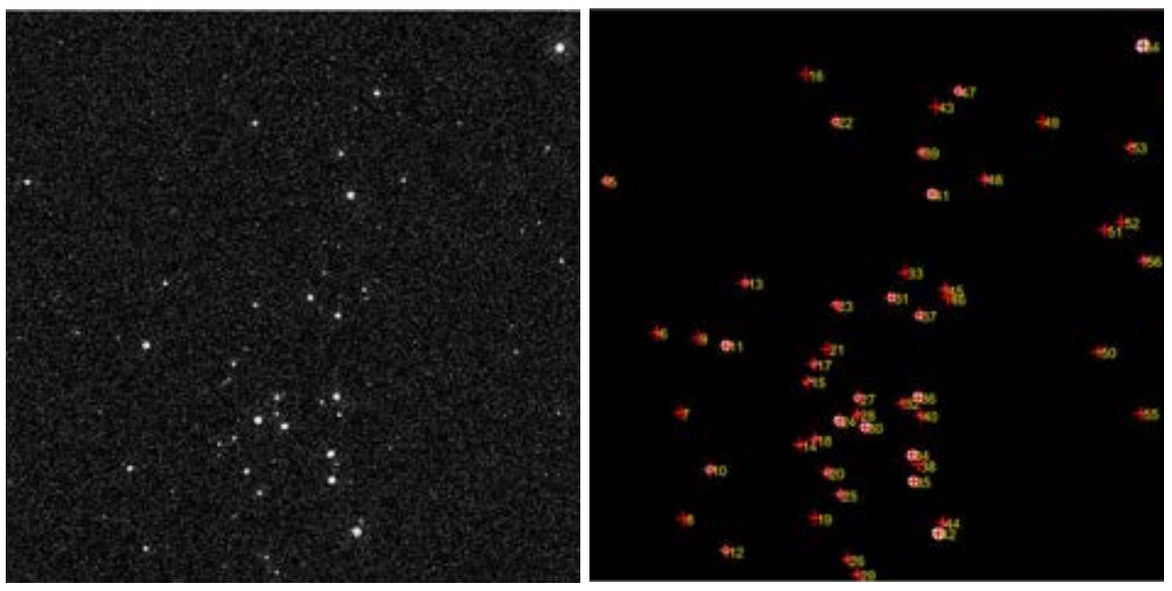

Figure 3: Real star image under noisy environment and centroid of the star

This testing is to ensure that the algorithm can actually detect real stars and their coordinates.

Table 1: Star detected coordinates and its star ID (selected data)

Star #	Pixel Coordinate	RA-coordinate (°)	Dec-coordinate (°)	HIP	Error (°)
8	251.59, 258.72	184.7594	25.0345	60087	0.0706
10	310.98, 351.60	185.308	24.9883	60260	0.0541

5 Conclusion

This study presented an enhanced centroiding algorithm for star detection and attitude determination. A test using a real star image captured through the star camera was conducted. The angular distance error of matched stars remained below 0.1° demonstrates the method's potential for integration into future lunar exploration missions.

6 Acknowledgement

This research was supported by the IIUM Sponsored Research Fund SPI24-224-0224, IIUM Fundamental Research Grant Scheme (FRGS) code number FRGS/1/2024/TK07/UIAM/02/1 and KHAIR Award by Center for Postgraduate Studies (CPS) IIUM.

ENHANCING BIOHYDROGEN YIELD THROUGH ENZYMATIC PRETREATMENT OF PALM OIL MILL EFFLUENT USING ANAEROBIC DARK FERMENTATION PROCESS

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1 Abstract

Anaerobic dark fermentation of wastewater is a sustainable way to produce biohydrogen, but slow hydrolysis limits the process. This study examined enzymatic pre-treatment of palm oil mill effluent (POME) using a mixture of cellulase, xylanase, amylase, and protease produced at the Kulliyyah of Engineering, IIUM. The experiments were conducted in batch mode with 350 mL working volume in 500 mL glass fermenters. The enzyme pretreatment shortened the hydrolysis of the POME, resulting in about 3 times higher gas yield compared to that of the control. The gas contained up to 68.3% hydrogen. Enzymatic pre-treatment of POME with a mix of enzymes improved hydrogen yield and made the fermentation process faster.

2 Problem Statement

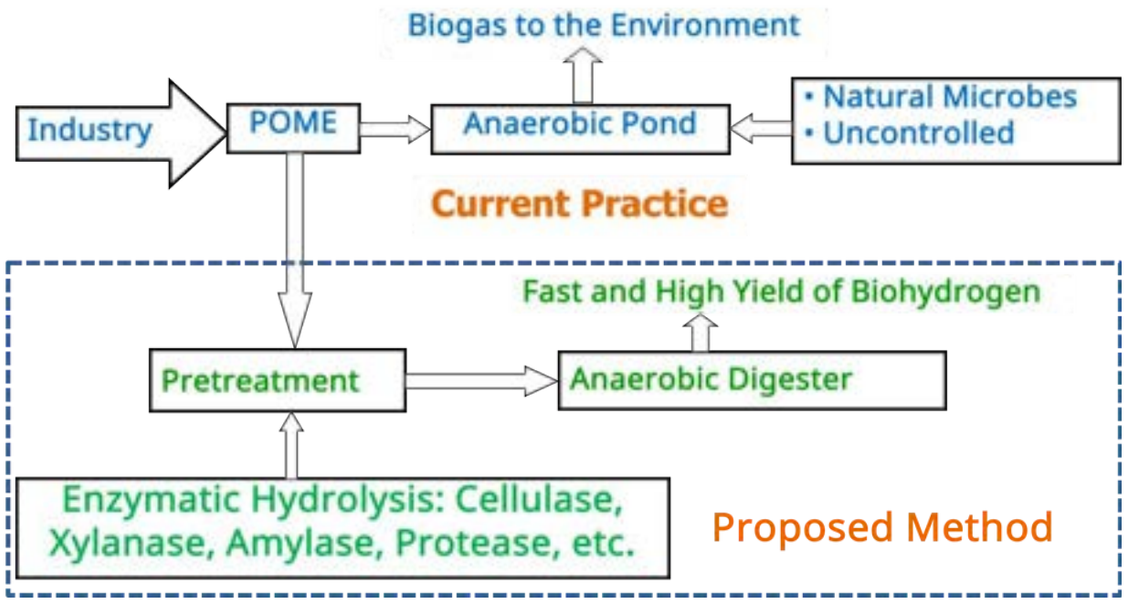
The palm oil industries are searching for efficient effluent treatment systems, while increasing global demand for renewable energy has made hydrogen a potential alternative to fossil fuels. Dark fermentation of palm oil mill effluent (POME) has the potential to reduce high pollution load from POME and produce biohydrogen at the same time. However, one of the main challenges of anaerobic dark fermentation of POME is long treatment time, which is often limited by low hydrogen yield. Industries often treat POME in open anaerobic ponds. These ponds release methane into the air. Methane traps about 21 times more heat than carbon dioxide and promotes global warming. Producing biohydrogen from POME through dark fermentation would reduce methane release and also lower water pollution.

3 Objectives

The primary objective of this research was to evaluate the potential of a cocktail of enzymes (produced at KOE) in reducing the overall time of the anaerobic dark fermentation process and increasing biohydrogen yield from POME.

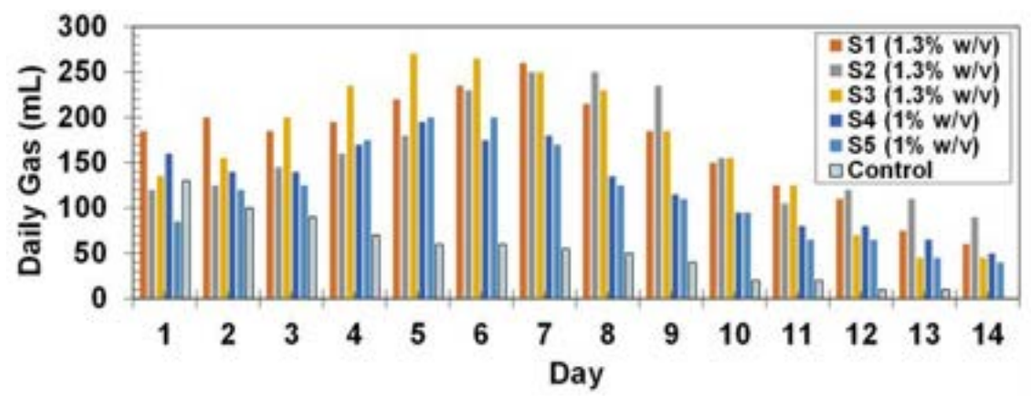
4 Methodology

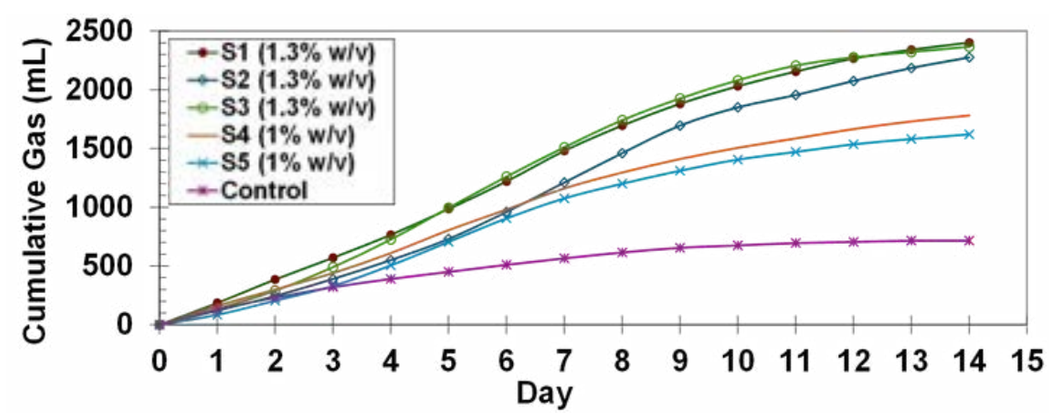
POME was pretreated with 1% and 1.3% w/v enzyme blend (cellulase, xylanase, protease, amylase) and fermented in 500 mL Duran bottles under anaerobic dark conditions. Gas yield was measured by the water displacement method, and composition was analysed by gas chromatography.



5 Results & Findings

The daily gas production from the raw POME (control) decreased with time. The maximum daily biohydrogen production with enzymes was observed within 6-8 days, indicating that the enzymes helped hydrolyse more solids. Gas from control stopped by 9 days whereas it stopped for other samples at about 14 days.





6 Conclusions

Pre-treatment of POME using a mixture of locally produced enzymes helps improve the hydrolysis process and reduce the time required by the anaerobic dark fermentation process to produce biohydrogen from the wastewater. Application of the enzymes also increased the yield of biohydrogen by about 3 times that of the control.

7 Acknowledgement

The authors would like to express their gratitude to the academic and technical staff of IIUM for their support in conducting this research work.

HEAT DEFICIENCY EFFECT ON SOLAR PANEL PERFORMANCE AND COOLING SYSTEMS

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1 Abstract

The study examines how heat accumulation degrades the performance of photovoltaic (PV) panels in hot climates. A MATLAB/Simulink model was developed and validated with experimental data to predict PV behavior under varying solar irradiance and temperature. An active water-based evaporative cooling system was tested, showing that uncooled panels reached over 65 °C, causing significant efficiency loss. With cooling, surface temperature dropped by an average of 23 °C, leading to a ~40% increase in power output and an overall efficiency of 16.88%. The cooling system proved most effective during peak irradiance, when thermal stress was highest.

2 Problem statement

PV modules absorb much of the incoming solar radiation as heat, leading to overheating that reduces efficiency, lowers power output, and accelerates material degradation. This challenge is especially severe in hot climates with strong solar radiation, making effective cooling solutions essential to sustain performance, boost energy generation, and ensure long-term system reliability.

3 Objectives

The study aims to increase solar power gains by applying an efficient active cooling system to lower PV panel operating temperatures, thereby improving electrical performance, maximizing energy output, and extending module durability in high-temperature environments.

1. Identify the effect of the heat on the solar panels in terms of performance.
2. Propose an enhanced model to achieve the required efficiency.
3. Evaluate and benchmark the performance of the proposed model.

4 Methodology

This study employs a quantitative, simulation-based approach to evaluate PV panel performance with an active evaporative cooling system. Using a JKM400M-72HL-V module, a MATLAB/Simulink model was developed under Atbara City (Sudan) conditions on February 22, 2025. The model integrates solar irradiance, heat transfer, and PV temperature–efficiency relations, comparing uncooled and cooled scenarios. Performance is measured by temperature reduction, power gain, and electrical efficiency.

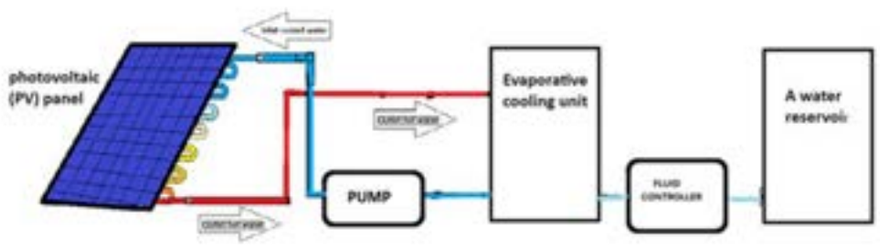
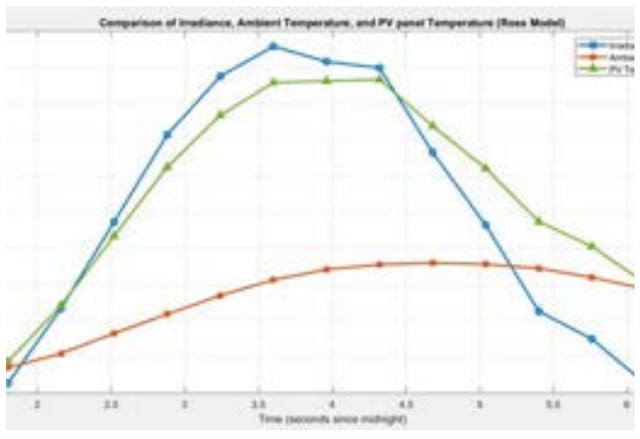


Figure 1 Design of the proposed cooling system model for PV Panels

4 Results & Findings

The MATLAB/Simulink simulation evaluated PV performance in Atbara City (Sudan) under cooled and uncooled conditions.
PV Temperature Reduction:
Uncooled panels reached 67 °C during peak irradiance, Figure 2 (left).
With cooling, panel temperatures were maintained between 22–30 °C, with differences exceeding 35 °C at mid day, Figure 3 (right).



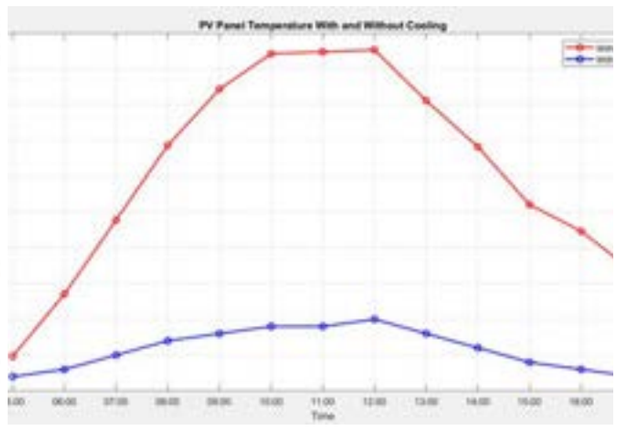


Figure 2 (left) PV panel temperature rises with increasing solar irradiance and ambient heat.
Figure 3 (right) Cooled PV panel stayed at 22–30 °C (>35 °C reduction).

Power Output Gain:
Without cooling: 239–287 W (peak hours), daily total 1,553 W.
With cooling: 345–387 W (peak hours), daily total 2,235 W.
Net improvement: +43.8% power generation.
Gains were most significant from 09:00–13:00, minimal in early morning/late afternoon (Figure 4).
Electrical efficiency Gain:
electrical efficiency saw a similar enhancement, culminating in an overall efficiency of 16.88%.

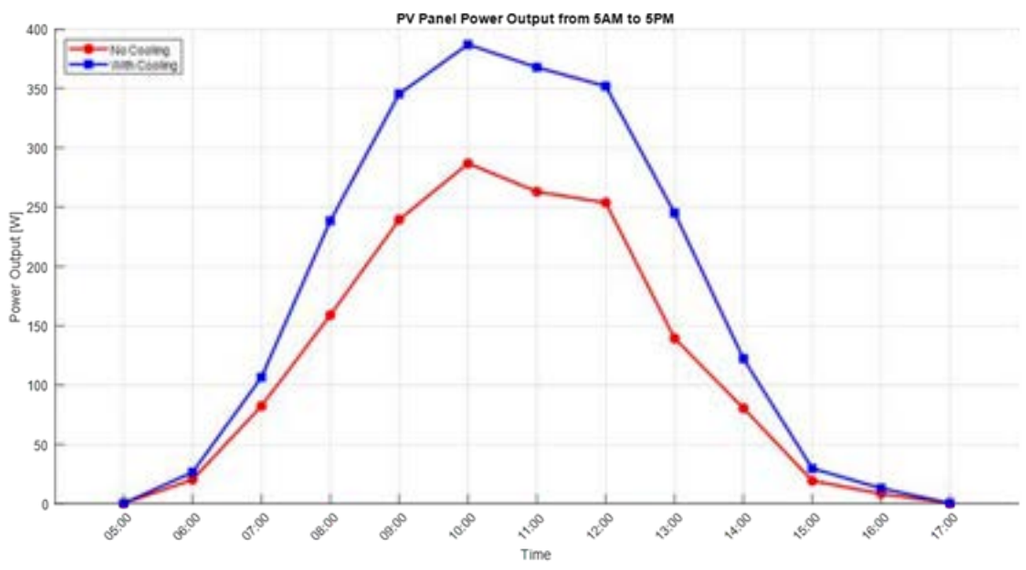


Figure 4 illustrates the power output of photovoltaic panels with and without cooling between 05:00 and 17:00.

5 Conclusion

The study shows that active water-based cooling reduces PV panel temperature by 20–23°C during peak irradiance, leading to a 43.8% power gain and 16.88% overall efficiency. Cooling was most effective under maximum heat stress, underscoring the importance of thermal management in solar systems.

VARIABLE-LENGTH CONTINUUM ROBOT DEPLOYABLE IN COMPLEX ENVIRONMENTS

Osama Rifaat Abdulrahman Aldaghir [1], Md Raisuddin Khan[1], Azhar Bin Mohd Ibrahim[1]

[1]*Department of Mechatronics Engineering, Kulliyyah of Engineering, International Islamic University Malaysia*

1 Abstract

This research presents a modular, variable-length continuum robot designed for high-degree-of-freedom manipulation in challenging, constrained environments. It's a solution for tasks in tight spaces, such as inside complex machinery, under collapsed debris, or during minimally invasive surgery, where traditional fixed-length robots can not be used. The robot's innovation lies in its segmental architecture, which utilizes ball-and-socket joints to achieve customizable length. Localized control segments with motors manage a set of passive segments, providing exceptional dexterity. A continuous, hollow central channel can deliver essential supplies in disaster areas or house inspection cameras. This project offers a practical, scalable, and versatile robotic platform with strategic importance for both humanitarian aid and industrial development.

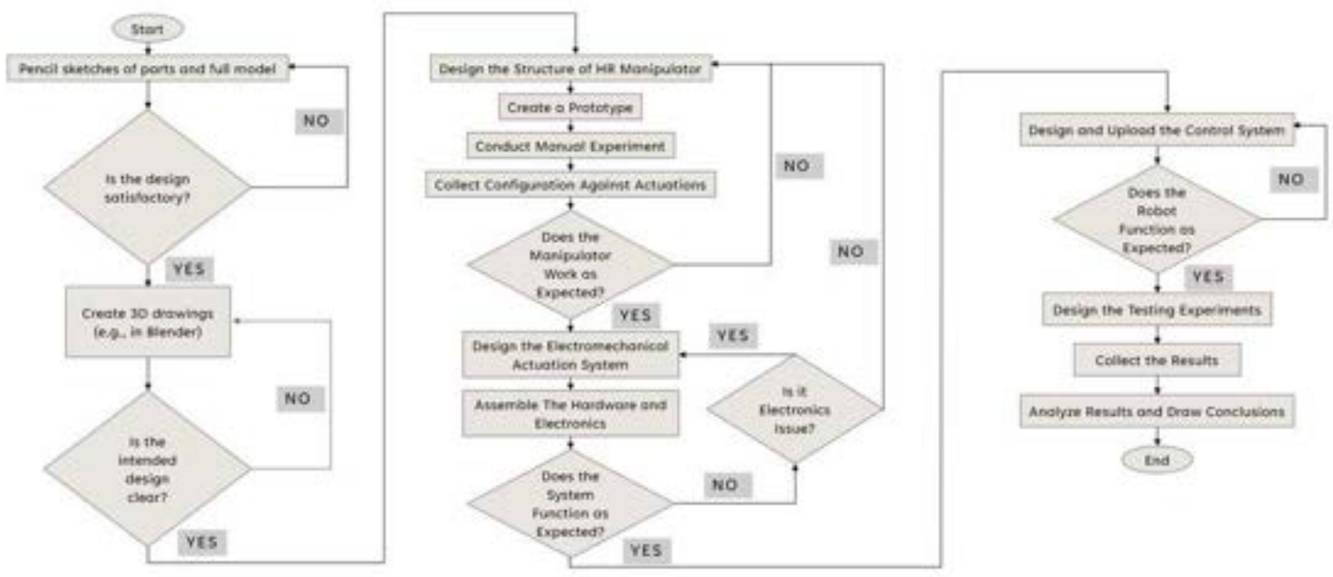
2 Problem statement

Traditional robots lack the versatility to navigate complex and unstructured narrow spaces, constrained environments, and perform a variety of functions, such as delivering aid. The limited degrees of freedom of the fixed-length robots restrict their use in crucial applications, such as humanitarian relief under rubble and industrial maintenance within tight, unstructured spaces. The main goal of this research is to develop a modular continuum robot with high dexterity to address these challenges.

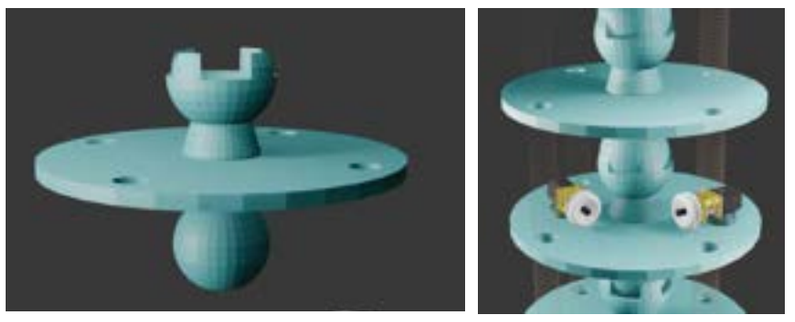
3 Objectives

- To design a modular robot with variable length and dexterity for navigating inside unstructured, narrow passages
- To develop a control system for enhanced maneuverability in tight spaces.
- To create a prototype to test the robot's performance.

4 Methodology



5 Results & Findings



(a) (b)

Figure 1: Model of The Continuum Robot (a) Single Segment Model (b) An Assembly of Segments with Springs

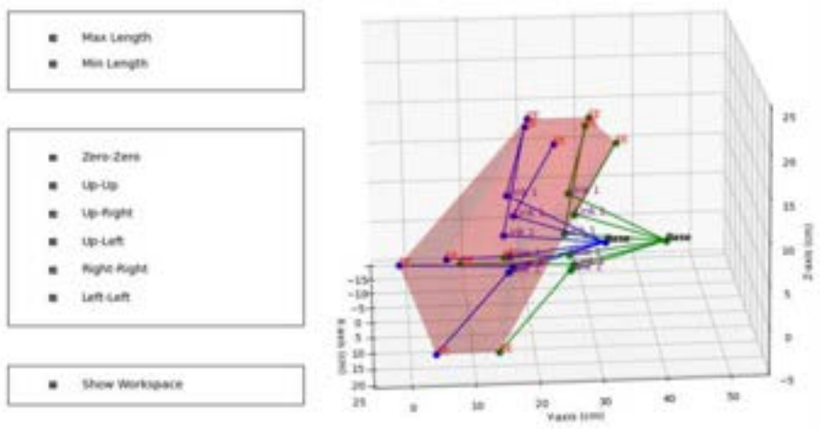


Figure 2: 3D Visualization of the Manipulator's Measured Workspace.

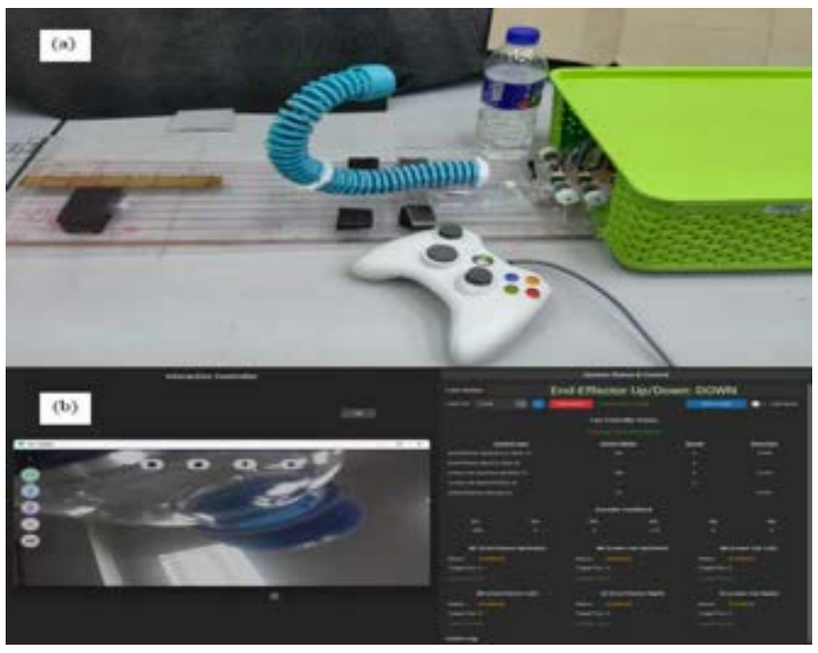


Figure 3: Task-Oriented Monitoring Experiment. (a) The Manipulator Prototype with a camera attached at the free-end framing a Target Water Bottle. (b) The Operator's Combined View, Showing the Live Camera Feed Cast to the PC Alongside the Diagnostic GUI.

6 Conclusion

We present a novel, cost-effective variable-length hyper-redundant robot concept with modular segments with a multi-purpose hollow core. This design offers a versatile solution for unstructured, narrow spaces in an industrial setup and cluttered environments under rubble.

7 Acknowledgement

The authors sincerely acknowledge the support of the Autonomous Systems Laboratory for helping with space and components for this project.

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Wang, C., Xie, H., & Yang, H. (2023). An iterative path-following method for hyper-redundant snake-like manipulator with joint limits. Industrial Robot.

A GREEN ROUTE TO TUNABLE SILICA NANOPARTICLES VIA BIOSURFACTANTS

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1 Abstract

Hydrophobic therapeutic agents and bioactive molecules hold significant promise in healthcare and biotechnology, yet their translation into commercial products is often restricted by poor solubility, stability, and bioavailability To address these challenges, we developed a sustainable one-step in-situ immobilization method to synthesize biosurfactant-modified silica nanoparticles (BS-SiNPs) as delivery vehicles. By incorporating natural biosurfactants (rhamnolipids and saponins) into the silica matrix during sol-gel synthesis; tunable, highly stable, and biocompatible nanoparticles were produced. Structural and functional characterization using SEM, TEM, FTIR, and Zetasizer confirmed spherical BS-SiNPs with integrated biosurfactant functionalities. Process optimization using one-factor-at-a-time (OFAT) and Box-Behnken Design of Experiments (DOE) enabled precise control of particle size (300–900 nm) and improved dispersibility. Beyond the laboratory, this green nanocarrier platform offers a scalable strategy for enhancing the delivery of hydrophobic biomolecules. Although biosurfactants are relatively premium inputs, their biodegradability, regulatory acceptance, performance and strong consumer preference for "natural" ingredients make the technology highly attractive for commercialization. This positions BS-SiNPs as a potential solution for pharmaceuticals, cosmeceuticals, and functional foods, where value-added formulations and eco-friendly branding justify higher price points and strengthen competitiveness in the global nanotechnology market.

2 Problem statement & Objectives

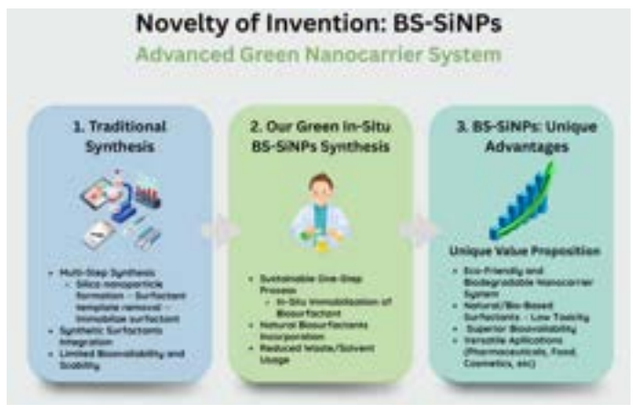
- Poor Solubility of Hydrophobic Drugs
- Toxicity and Non-Biodegradable of Synthetic Surfactants
- Stability and Leaching Issue of Multi-Steps Nanocarriers
- Poor Control of Particle Size and Dispersibility

1. To synthesize one-step in-situ immobilized biosurfactant-modified silica nanoparticles (BS-SiNPs) via a modified sol-gel method as nanocarriers for hydrophobic drugs.
2. To characterize the physicochemical properties of the synthesized BS-SiNPs.
3. To optimize synthesis parameters using OFAT and Box-Behnken DOE for precise size control and improved dispersibility.

3 Commercial Value & Market Potential

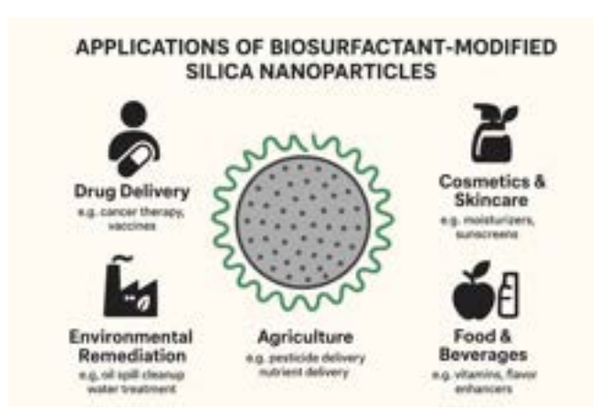
Price comparison by manufacturer

Manufacturer	Product Example	Price (Approx.)	Price per Gram (Approx.)
US Research Nanomaterials Inc.	Silicon Dioxide (SiO2) Nanopowder (99+%, 20-30 nm)	$35 for 25g	$1.40/g
		$65 for 100g	$0.65/g
Sigma-Aldrich	Silica nanoparticles, mesoporous, (200nm)	$340 for 1g	$340/g
		$1,150 for 5g	$230/g
Steen Chemicals	High Surface area Silica nanoparticles (40-50 nm)	$181 for 1g	$181/g
		$714 for 5g	$142.80/g
General Engineering & Research	Silica Nanoparticles, Powder (100nm)	$125 for 1g	$125/g
		$300 for 10g	$30/g



Target Groups:
1. Academia & R&D UM NANOCEN, UKM IMEN, UPM, SIRIM/AMREC
2. Industry / Manufacturers Pharma (Novugen, generics), Cosmeceuticals, Nutraceutical OEMs
3. Community / End Users Healthcare providers, consumers, NGOs, regulators

Potential Malaysian Partner/Collaborators:
- NanoMalaysia Berhad, MNIG (Malaysia Nanotechnology Industrial Group), Nanopac (M) Sdn Bhd , NanoLifeQuest Sdn Bhd, Novugen Pharma, Pharmaniaga



4 Methodology

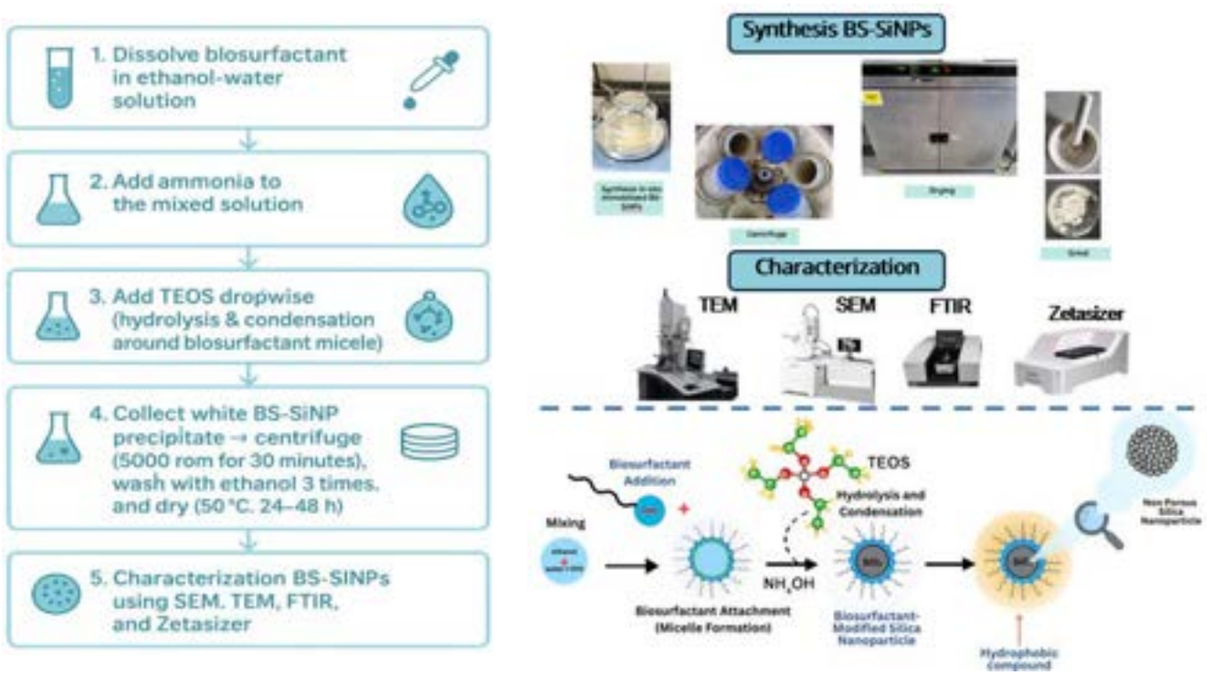


Figure 1: A schematic diagram of the in-situ immobilized biosurfactant-modified silica nanoparticles.

5 Results & Findings

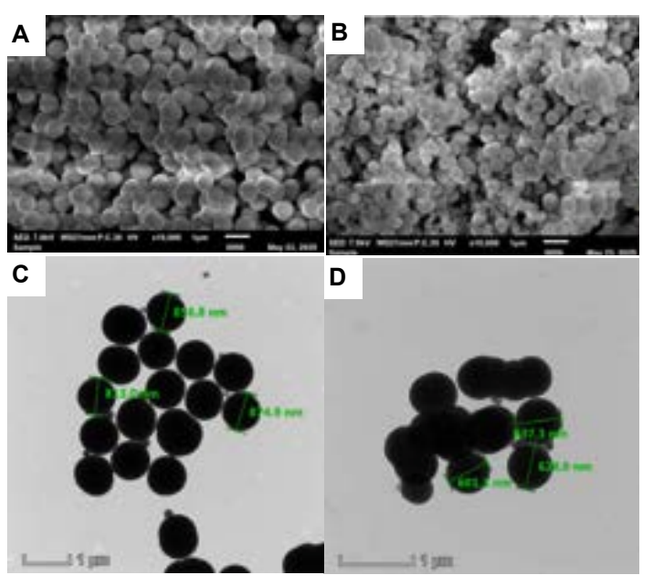


Figure 2: SEM (A, B) and TEM (C, D) images of biosurfactant modified-silica nanoparticles (BS-SiNPs) for different biosurfactant; rhamnolipid (A, C) and saponin (B, D).

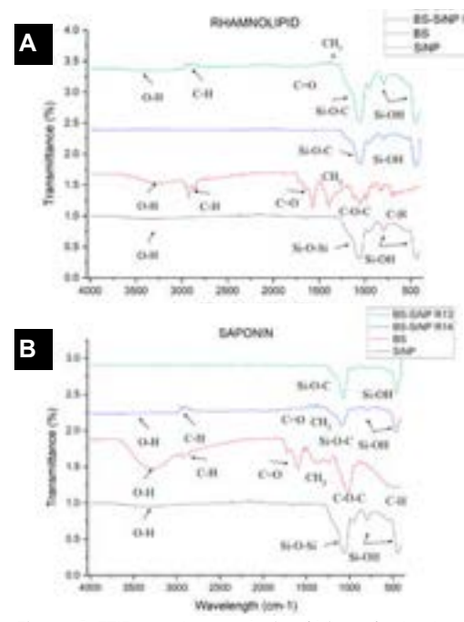


Figure 3: FTIR spectra analysis of biosurfactant modified-silica nanoparticles (BS-SiNPs) for different biosurfactant; rhamnolipid (A) and saponin (B).

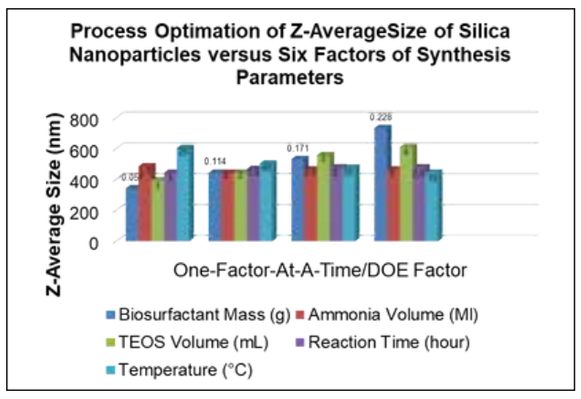


Figure 4: A graph representation of Z-Average size of biosurfactant modified-silica nanoparticles (BS-SiNPs) versus 6 factors of One-Factor-At-A-Time/DOE Factor.

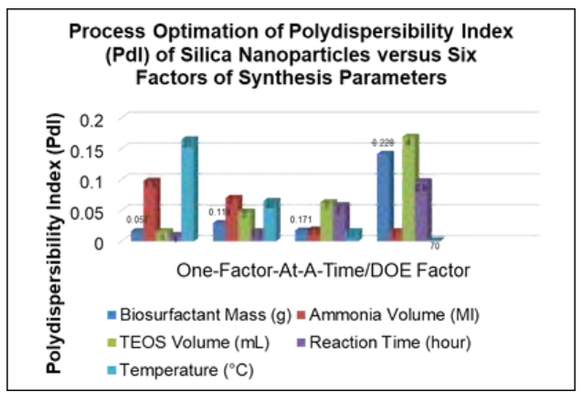


Figure 5: A graph representation of polydispersibility index of biosurfactant modified-silica nanoparticles (BS-SiNPs) versus 6 factors of One-Factor-At-A-Time/DOE Factor.

6 Conclusion

A one-step green immobilization method was developed to synthesize biosurfactant-modified silica nanoparticles (BS-SiNPs) that are spherical, size-tunable (300–900 nm), and well-dispersed. The system offers a scalable, eco-friendly, and regulator-ready platform for stabilizing hydrophobic drugs, with strong commercial potential in pharmaceutical, cosmetic, and nutraceutical applications, while enhancing therapeutic efficacy and supporting "Sustainable Academia-Industry-Community Collaboration for Humanity" and SDG 3 (Good Health & Well-being).

7 Acknowledgement

The authors would like to thank to the Department of Chemical Engineering and Sustainability at the International Islamic University Malaysia (IIUM) and the Ministry of Higher Education (MOHE) for their support and funding through the Research Grant (FRGS23-309-0918).

SOLAR SPONGE: PVA-CHITOSAN/PANI HYDROGEL FOR ENHANCE SOLAR VAPOR GENERATION

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1 Abstract

Solar vapor generation (SVG) technology offers a promising solution to global water scarcity and pollution challenges. Current hydrogels for SVG have suboptimal photothermal efficiency due to poor solar absorption and large heat losses caused by the structure of the hydrogel. Conventional solar evaporation delivers low photothermal conversion efficiency of 30%–45% . This study explores the development of a novel polyvinyl alcohol-chitosan/polyaniline (PVA-CS/PANi) hydrogel, optimized for enhanced mechanical properties, solar thermal conversion, and water purification efficiency. The PVA-CS/APS-PANi-0.4 mol.% hydrogel exhibited remarkable mechanical stability, with a storage modulus increase of 12,000 Pa, and maintained long-term performance over multiple cycles. Its high light-absorption efficiency (96.4%) and evaporation rates of 3.08 kg $m^{-2}h^{-1}$ (1 sun) and 9.25 kg $m^{-2}h^{-1}$ (3 sun) highlight its scalability for practical SVG systems. This system effectively reduces primary ion concentrations (Na^{+}, Mg^{2+}, K^{+}, Ca^{2+}) in seawater by 2–3 orders of magnitude.

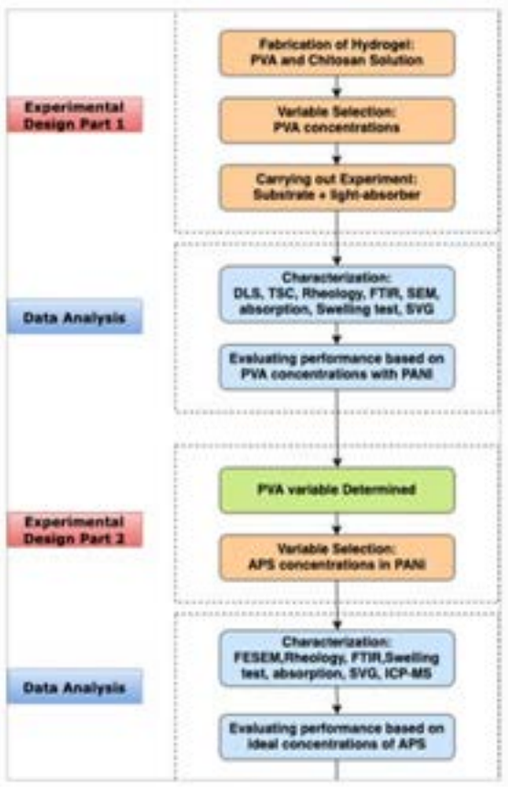
2 Problem statement

Current hydrogels exhibit limited photothermal efficiency (30–45%) due to poor solar absorption, ineffective heat localization, and significant energy losses. Single-component hydrogels further lack the balance of mechanical strength, porosity, biocompatibility, and photothermal responsiveness needed for scalable water evaporation applications. Addressing these drawbacks requires structural modification, functional group integration, and incorporation of photothermal materials.

3 Objectives

To investigate the effect of concentrations of APS with aniline as photothermal materials for PVA-Chitosan-Polyaniline hydrogel for SVG application.

4 Methodology



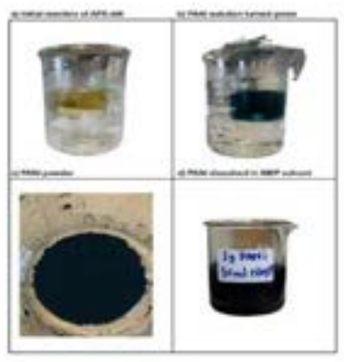


Fig. 1: The preparation of PANi powder: (a) Initial reaction of APS-AN mixture. (b) Mixture of PANi solution turned green. (c) Dried PANi powder after 12 hours drying. (d) PANi powder dissolved into NMP solvent

4 Results & Findings

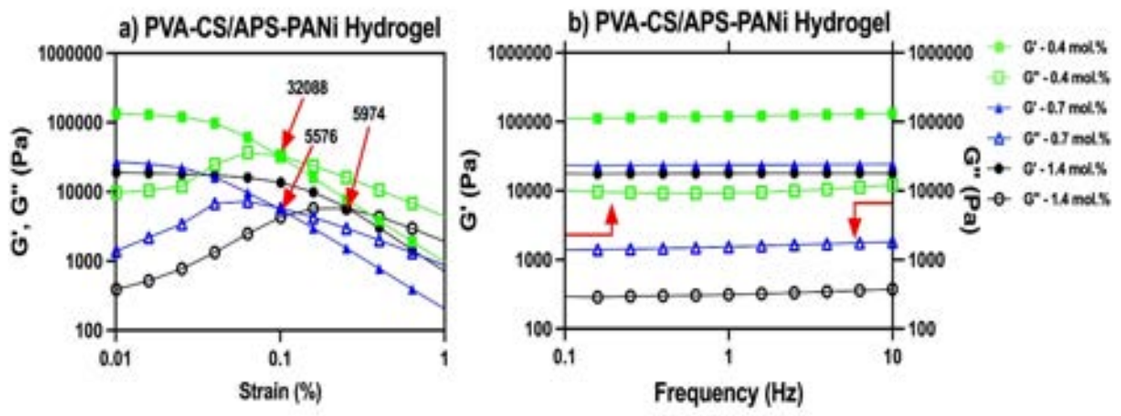


Fig. 2 : Rheology analysis for PVA-CS/APS-PANi with different concentrations of APS

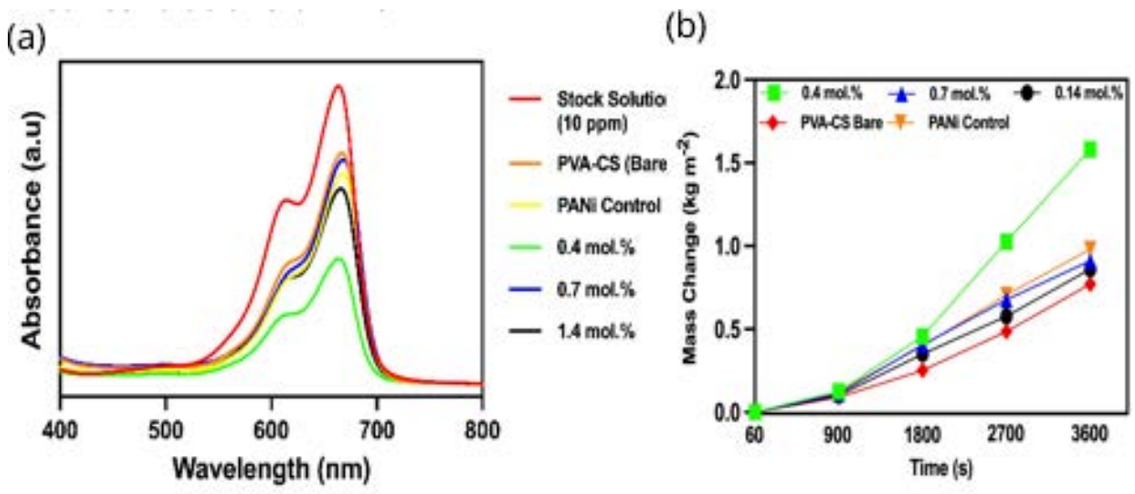


Fig. 3 (a) UV-Vis of absorption of methylene blue into hydrogels after 24 hr with different concentrations APS and (b) Mass PVA-CS/APS-PANi hydrogels during SVG.

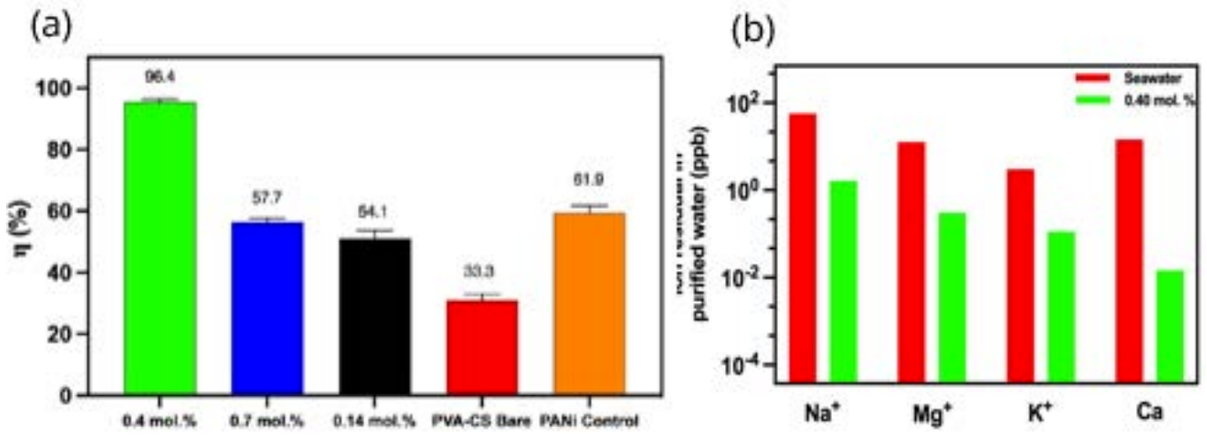


Fig. 4: (a) SVG efficiency of PVA-CS/PANi hydrogel as a function of different APS concentrations and (b) Primary ions concentration of seawater from Pantai Tapang before and after SVG.

5 Conclusion

The optimized hydrogel of PVA-CS/APS PANi-0.4 mol.% has demonstrated a high light absorption efficiency of 96.4%, alongside significant evaporation rates of 3.08 kg $m^{-2}h^{-1}$ under 1 sun irradiation and 9.25 kg $m^{-2}h^{-1}$ under 3 sun conditions. These results underscore the hydrogel's capability for effective water purification, positioning it as a viable solution for desalination processes. The purpose of this hydrogel is to maximize the SVG design and provide clean water.

6 Acknowledgement

This research work was funded by IIUM-UMP-UiTM Sustainable Research Collaboration Grant (SRCG20-044-0044) and FRGS 2022 (FRGS22-259-0868)

Serati, F., Mohd Zaki, S., Zulkifli, A. A., & Makhsin, S. R. (2025). Solar-Driven Water Purification: Advancing PVA-Chitosan/PANI Hydrogel to Enhance Solar Vapor Generation for Freshwater Treatment. *IIUM Engineering Journal*, *26*(1), 450–465.
Guo, Y., et al., Synergistic energy nanoconfinement and water activation in hydrogels for efficient solar water desalination. ACS nano, 2019. 13(7): p. 7913-7919.
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DESSICCATED COCONUT RESIDUE (DCR) AS A SUSTAINABLE BITUMEN MODIFIER

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1 Abstract

Agricultural waste as bitumen modifiers has gained attention due to the need for environmentally friendly road materials. The temperature sensitivity of conventional bitumen causes it to soften at high temperatures and stiffen at low temperatures, thereby causing rutting and cracking. This study investigates the use of desiccated coconut residue (DCR), as a sustainable bitumen modifier for PEN 60/70. DCR was oven-dried, ground at a high speed and added at replacement amounts of 5%, 10%, 15%, and 20%. ASTM guidelines were followed while performing penetration, softening point, and Dynamic Shear Rheometer (DSR) testing. The results demonstrated that 5% DCR improved rutting resistance in both treated and untreated samples, with G*/sin δ significantly increased from 2.61 Pa (control) to 5.99 Pa and 5.87 Pa, respectively. Overall, DCR shows great promise as a bio-based, sustainable modifier that improves bitumen qualities and encourages the use of agricultural waste.

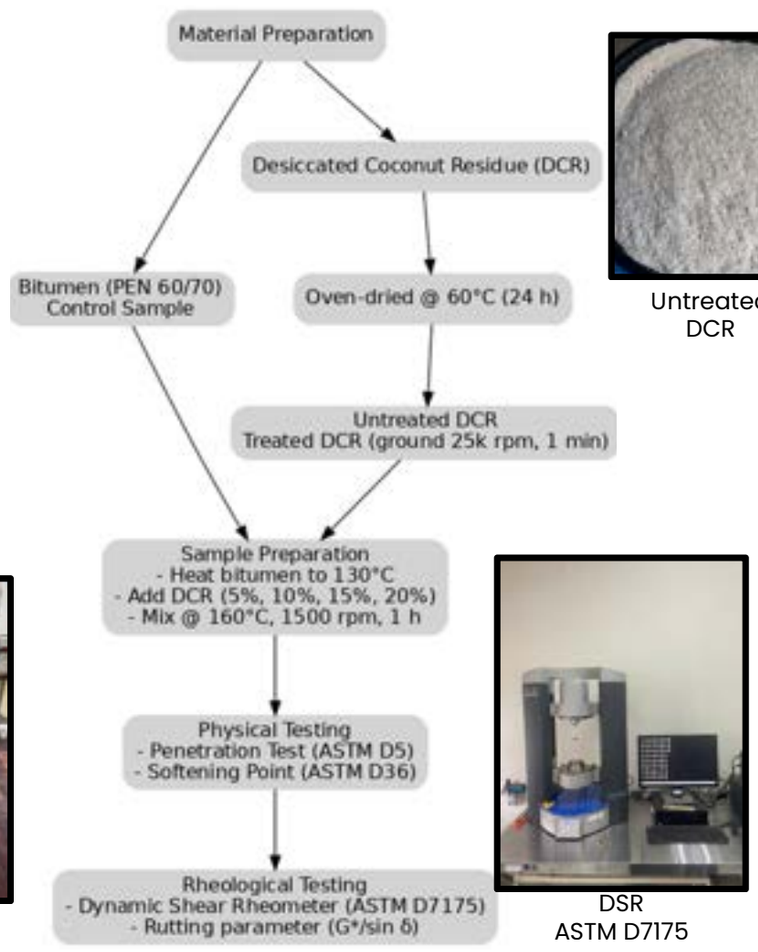
2 Problem Statement

Conventional bitumen is highly temperature-sensitive, softening at high temperatures and stiffening at low temperatures, which leads to rutting and cracking. With increasing traffic loads, Malaysian roads deteriorate faster, creating higher maintenance demands. While agricultural wastes like desiccated coconut residue (DCR) offer potential as sustainable modifiers, their natural crystallinity causes clumping and poor compatibility with bitumen. Addressing this challenge is crucial to enhance binder performance, durability, and the development of greener pavements.

3 Objectives

- To investigate the effects of different DCR replacement levels (5%, 10%, 15%, and 20%) on the physical and rheological properties of bitumen.
- To determine the optimum percentage of DCR replacement

4 Methodology



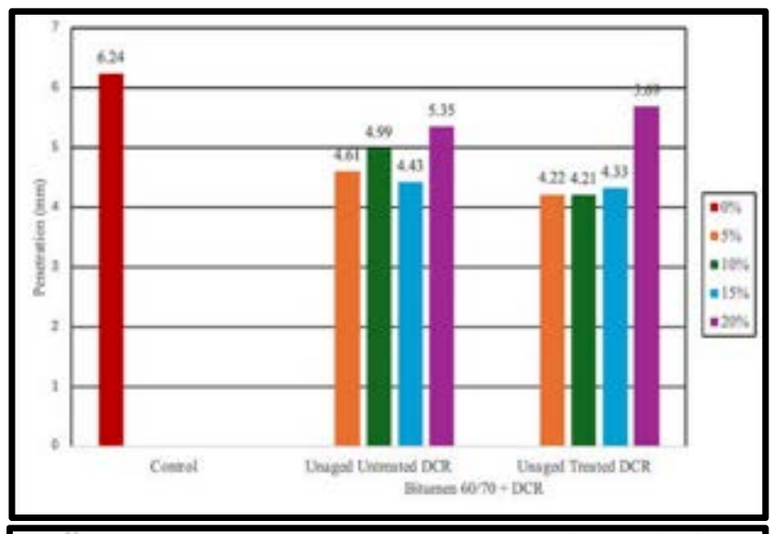

Untreated DCR


Penetration
ASTM D5


Ring and Ball
ASTM D36

DSR
ASTM D7175

5 Results & Findings



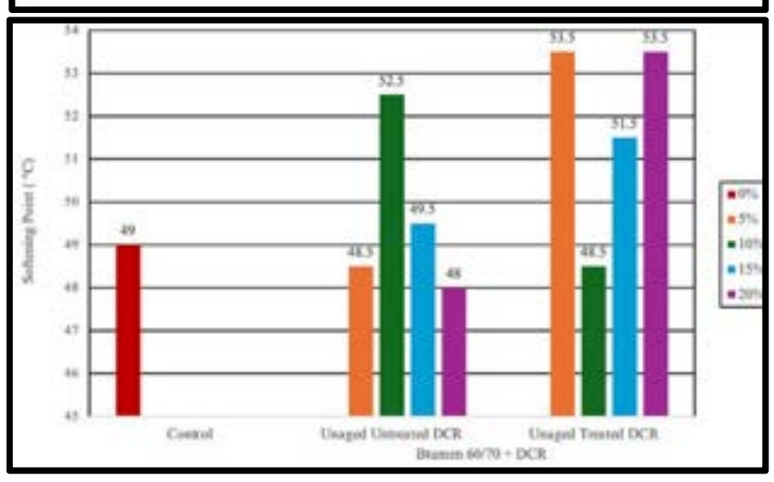


Table 1. DSR data for control and untreated DCR at 64°C

Asphalt binder sample	|G*| (Pa)	δ (°)	|G*| / sin (δ) (Pa)
Control sample	2.61	87.68	2.61
Untreated DCR 5%	5.96	83.79	5.99
Untreated DCR 10%	5.99	85.71	5.98
Untreated DCR 15%	5.11	86.96	5.11
Untreated DCR 20%	4.87	82.24	4.92

Table 2. DSR data for control and treated DCR at 64°C

Asphalt binder sample	|G*| (Pa)	δ (°)	|G*| / sin (δ) (Pa)
Control sample	2.61	87.68	2.61
Treated DCR 5%	5.85	85.64	5.87
Treated DCR 10%	5.47	86.07	5.48
Treated DCR 15%	5.25	84.52	5.27
Treated DCR 20%	5.06	82.39	5.11

Modified bitumen with 5–20% DCR showed higher G/sin δ than the control, indicating improved rutting resistance

6 Conclusion

This study evaluated the effects of varying DCR replacement levels (5%, 10%, 15%, and 20%) on the physical and rheological properties of bitumen. Results showed that DCR modification reduced penetration, increased binder stiffness, and improved softening point and rutting resistance compared to the control. Treated DCR provided more consistent improvements due to better dispersion, while the optimum performance was observed at 5% replacement, which delivered the highest rutting resistance (G*/sin δ) and enhanced thermal stability. These findings confirm that DCR can be effectively utilized as a sustainable bitumen modifier to improve binder performance.

7 Acknowledgement

The support provided by Fundamental Research Grant Scheme (FRGS) from Malaysian Ministry of Higher Education (MOHE) and Department of Civil Engineering, International Islamic University of Malaysia (IIUM) in the form of a research grant number FRGS/1/2023/TK02/UIAM/02/3 (Project ID: FRGS23-319-0928) for this study is highly appreciated.

A SUSTAINABLE FLEXIBLE WIDEBAND MICROSTRIP ANTENNA ON TPU SUBSTRATE FOR WEARABLE AND HUMAN-CENTRIC APPLICATIONS

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1 Abstract

This work presents a **sustainable and flexible wideband microstrip antenna** designed on a **Thermoplastic Polyurethane (TPU)** substrate. TPU is selected for its eco-friendly, durable, and flexible properties, making it a **sustainable alternative** to conventional rigid substrates. The antenna incorporates an inset slot feed to optimize the resonant frequency and a partial ground plane to achieve wide impedance bandwidth. Simulation results show that the antenna operates effectively between 7.5 and 10.2 GHz, achieving a 17.4% bandwidth improvement and improved return loss compared to conventional designs. Beyond technical performance, **the use of TPU ensures safety and comfort for wearable applications** such as healthcare monitoring, communication systems, and community-focused devices, without posing harm to users. This study demonstrates how **sustainable material innovation and advanced antenna design** can bridge academia, industry, and community needs, **supporting technologies that are high-performing, safe, and beneficial to humanity**.

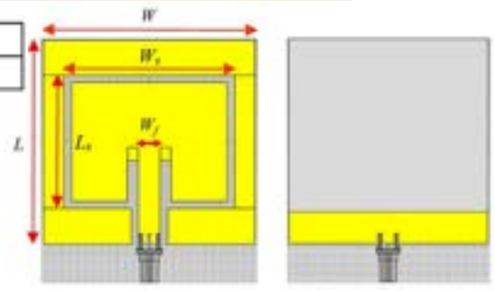
2 Problem statement

3 Objectives

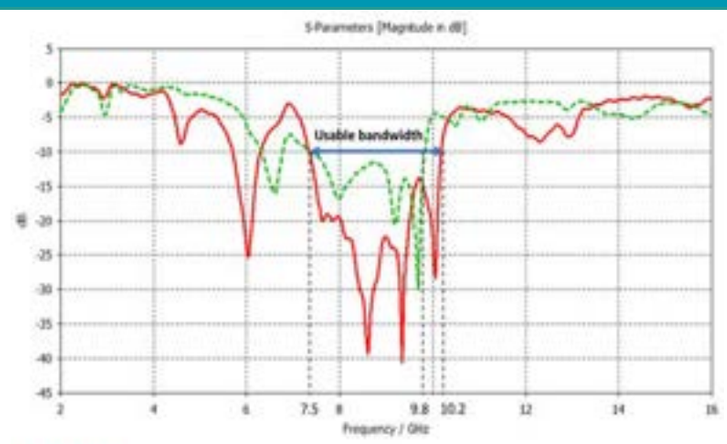
4 Methodology

Parameters	W	L	W_s	L_s	W_f
Dimensions (mm)	60	60	44.19	35.11	6.26

After optimization



4 Results & Findings



Before optimization

After optimization (inset slot feed and partial ground plane)

Parameters	Freq (GHz)	Before optimization	After optimization	% increase
S_{11} (dB)	8	-16.73	-20.14	20.38%
	8.5	-12.43	-31.22	151.17%
	9	-13.06	-22.42	71.67%
	9.5	-15.14	-20.08	32.63%
	10	-4.49	-21.50	378.8%
Bandwidth (MHz)		2300	2700	17.4%

Frequency (GHz)	Realized gain (dBi)	Directivity (dBi)
8	4.194	4.265
8.5	4.567	4.591
9	5.828	5.875
9.5	5.283	5.354
10	5.533	5.524

5 Conclusion

- A flexible wideband microstrip patch antenna was designed on a **2.5 mm TPU substrate** with dimensions of 60 × 60 mm², simulated using CST MWS.
- The integration of an **inset slot feed** and a **partial ground plane** improved the antenna's performance, achieving:
  i. Operating bandwidth from **7.5 to 10.2 GHz.**
  ii. **17.4% bandwidth enhancement** (400 MHz increase).
  iii. Improved return loss, realized gain, and directivity.
- **Sustainability contribution**: TPU is flexible, durable, and environmentally friendly, making it suitable for **safe wearable applications.**
- Human-centric impact: Potential use in **healthcare (SDG 3 & MySTIE Medical & Healthcare), communication and community-focused devices (SDG 7 & SDG 9),** aligning with sustainable academia–industry–community collaboration.
- Future work: evaluate antenna performance under various bending conditions and 3D fabrication.

6 Acknowledgement

- This research was supported by IIUM and MOHE through FRGS/1/2023/TK07/UIAM/02/1

EXPERIMENTAL AND NUMERICAL CHARACTERIZATION OF FLUTTER IN A WING SPAR USING MODAL AND WIND TUNNEL TESTING

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1 Abstract

Vibration and aeroelastic analyses are vital for ensuring the structural integrity of aircraft and UAV components. This study experimentally and numerically investigates a rib-and-spar wing box using Vibration Testing and wind tunnel flutter tests to determine natural frequencies, mode shapes, and flutter speed for different modelling fidelities.

2 Problem statement

- Vibrations, when uncontrolled, can lead to a dangerous aeroelastic phenomenon known as flutter, especially in UAV.
- Finite Element Analysis (FEA) accuracy depends on modeling fidelity (1D beam, 2D shell, 3D solid).
- Existing studies highlight theoretical strengths/weaknesses of each fidelity but often lack direct experimental validation.

3 Objectives

- Design a straight spar for flutter testing at the region of 20-25 m/s.
- Develop finite element models of the wing box using 1D beam, 2D shell, and 3D solid elements.
- Compare numerical predictions from each model with experimental results for modal and flutter behavior.

4 Methodology

Simulation Setup
- Modal Analysis: Natural frequencies & mode shapes using eigenvalue solution.
- Flutter Analysis: DLM aerodynamics + p-k method
- Flutter speed (Vf) at zero damping.

Experimental Setup
- Ground Vibration Test (GVT): Shaker excitation, laser vibrometer at 3 points.
- Wind Tunnel Test: Vibrometer + signal analyzer;
- Flutter = sustained oscillation growth

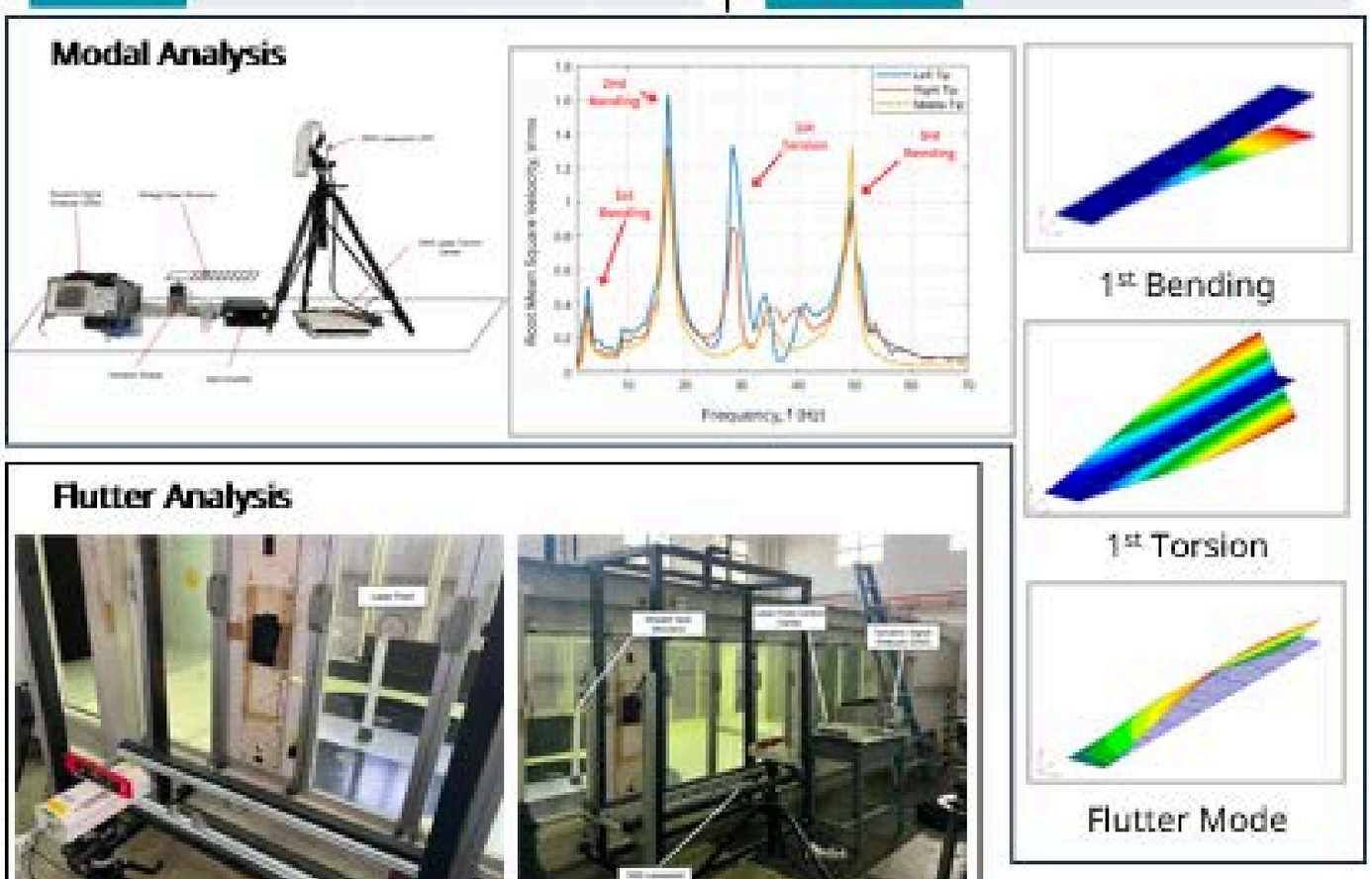
5 Results & Findings

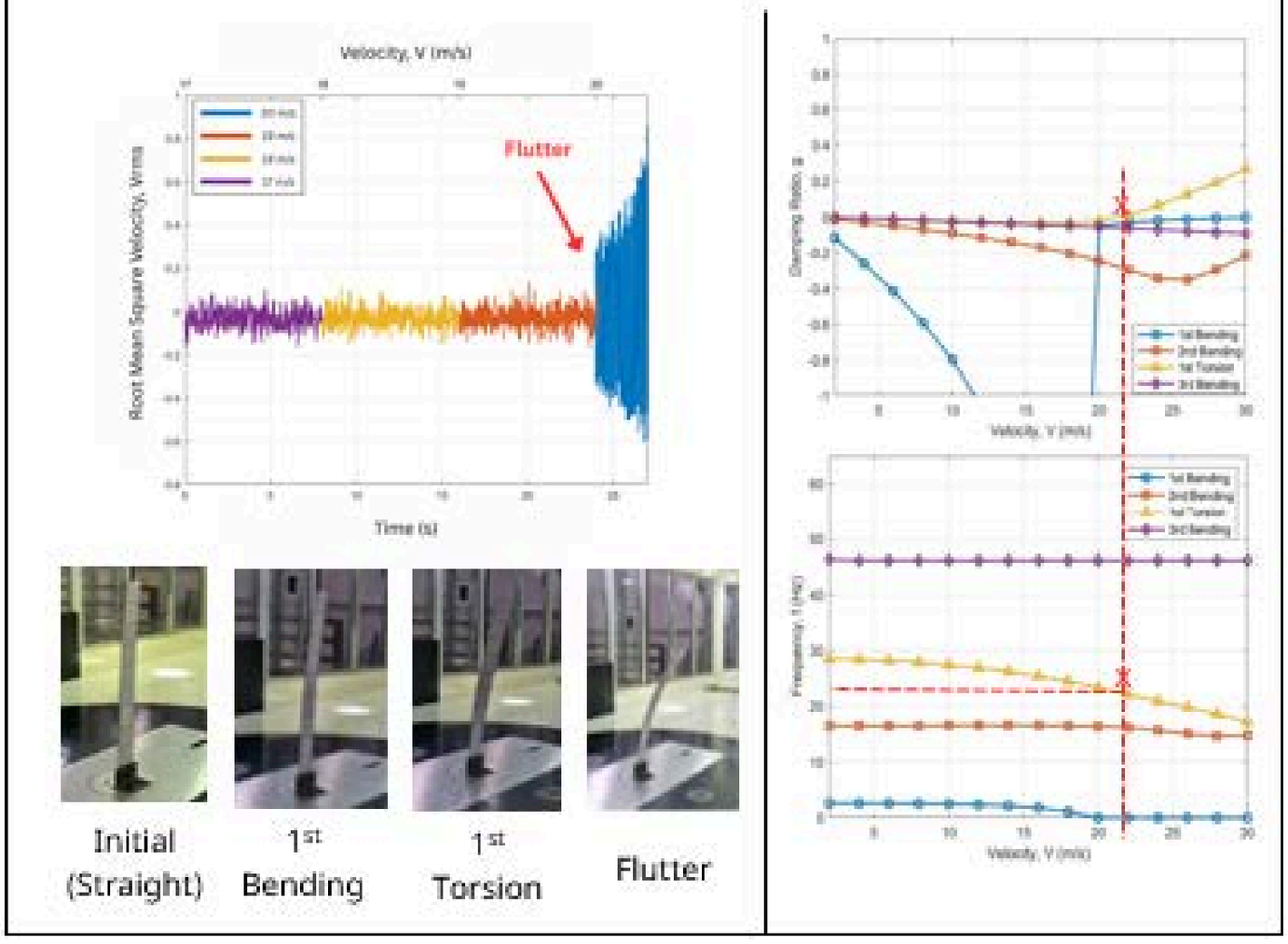
Modal Analysis

Mode	Experiment (Hz)	Beam (Hz)	Shell (Hz)	Solid (Hz)
1st Bending	2.98	2.66	2.70	2.69
2nd Bending	18.10	16.68	16.89	16.83
1st Torsion	29.20	28.55	30.01	31.25
3rd Bending	49.50	46.23	47.23	47.04

Flutter Analysis

	Flutter Speed (m/s)	Flutter Frequency (Hz)
Experimental	20.00	21.88
1D (Beam)	21.35	22.47
2D (Shell)	23.68	24.46
3D (Solid)	23.1	24.20





6 Conclusion

- Designed spar exhibit flutter behavior within the target velocity range of 20–25 m/s.
- Experimental findings closely matched simulation results, confirming the reliability of the test setup and structural model.
- 1D Beam Model: Best for flutter prediction, efficient for capturing global aeroelastic behavior.
- 2D Shell Model: Most accurate for modal analysis, particularly in bending modes.
- 3D Solid Model: Balanced option with moderate accuracy in both modal and flutter analyses, though computationally expensive.

Advancing Frontiers: Kulliyyah of Engineering Research, Innovation & Commercialisation Exhibition (KERICE 2025) brings together the diverse research outputs, innovations, and scholarly ideas from the Kulliyyah of Engineering, International Islamic University Malaysia.

With the theme “Sustainable Academia–Industry–Community Collaboration for Humanity”, KERICE 2025 provides a platform to promote quality research, foster exchange of ideas, and highlight the Kulliyyah’s research excellence. It also serves as a bridge between academia and industry, strengthening collaborations that translate knowledge into impactful solutions.

Since its establishment in 1994, the Kulliyyah of Engineering has aspired to be “A Global Centre of Innovative Engineering Education and Research with Values and Professional Ethics.” This publication reflects that vision and celebrates the spirit of innovation that drives engineering towards advancing frontiers for humanity.

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