

2024 年度 試験研究助成 一覧

<インドネシア>

No	大学名 University	研究テーマ Project Title	研究者 Researcher
1	インドネシア大学	Repurposing AC LED bulb waste into functional solar-powered DC LED bulb (交流LED電球の廃棄物の、機能的な太陽電池式直流LED電球への再利用)	Ir. Chairul Hudaya S.T., M.Eng., Ph.D., IPM
2	UNIVERSTIAS INDONESIA	Development of composite polymer hydrogen pressure vessel for mobility purpose (モビリティ用高分子複合水素圧力容器の開発)	Prof. Dr. Yudan Whulanza S.T., M.Sc.
1	バンドン工科大学	Rational Design of Green Catalysts for the Utilization of CH ₄ and CO ₂ as Liquid Fuel of Methanol (CH ₄ と CO ₂ をメタノール液体燃料として利用するためのグリーン触媒の合理設計)	Muhammad Haris Mahyuddin
2	INSTITUT TEKNOLOGI BANDUNG	Process Integration of CO ₂ Nanobubble Contactor System and Microalgal Photobioreactor to Enhance the Decarbonization (脱炭酸を促進するCO ₂ ナノバブルコンタクターシステムと微細藻類光バイオリアクターのプロセス統合)	Elvi Restiawaty
1	ボゴール農業大学 INSTITUT PERTANIAN BOGOR	Optimum composition of fly ash bottom ash (FABA) and organic materials in passive treatment of acid mine drainage (酸性鉱山廃水の受動的処理における飛灰と焼却主灰(FABA)と有機物の最適組成)	Irdika Mansur
2		Long-term habitat management of Varanus komodoensis on Flores Island (フローレス島におけるコモドオオトカゲの長期生息地管理)	Angga Irfandi Yudistira
3		Monitoring Mangroves, Waterbirds and reptiles of Pulau Rambut Wildlife Sanctuary, five years after oil spill (原油流出から5年後のランブト島の野生生物保護区のマングローブ、水鳥、爬虫類の生態調査)	Ani Mardiasuti
4		Combination of reject coal biochar and chicken manure as rice commodity rice plants soil amelioration in Karawang Regency (カラワン県における石炭バイオ炭と鶏糞堆肥の組合せによる水稻の土壌改良)	Arief Hartono
5		Maximizing the adsorption of micronutrients Fe Mn Cu Zn in biochar-based slow-release compound fertilizer (バイオ炭ベースの緩効性化成肥料における微量栄養素 Fe Mn Cu Znの最大吸着量)	Dr. Ir. Iskandar

<マレーシア>

No	大学名 University	研究テーマ Project Title	研究者 Researcher
1	サラワク 大学 UNIVERSITI MALAYSIA SARAWAK	Solar-powered organic waste dehydrators for better food waste management (食品廃棄物管理向上を目的とした太陽電池式有機廃棄物脱水機)	Siti Nor Ain Binti Musa
2		Performance of kraft press paper in transformers with the presence of multi walled carbon nanotube (MWCNT) based on palm oil methyl ester (POME) (パーム油メチルエステル(POME)を基とした多層カーボンナノチューブ(MWCNT)存在下の変圧器におけるクラフトプレス紙の性能)	Nutul Izzati Binti Hashim
3		Enhancing energy efficiency through adaptive iterative learning control with PI (PID 制御を用いた適応的の反復学習によるエネルギー効率向上)	Ts Dr Maimum Huja Husin
4		Development of index for indoor occupational environmental stress assessment in SMES industry (中小企業における室内作業環境ストレス評価指標の開発)	Mohd Azrin Bin Mohd Said
5		From sago pith to bioplastics: Study on mechanical and thermophysical properties (サゴ椰子の髄からバイオプラスチック: 機械的及び熱物理的特性に関する研究)	Dr Mahshuri Yusof
6		Assessing the tribological characteristics of used motor oil from local automotive workshops (自動車整備工場から排出される使用済み自動車オイルの摩擦学的特性評価)	Ts. Dr Aidil Azli Bin Alias
7		Feasibility study of Archimedes wind turbine in Sarawak Borneo (ボルネオ島サラワクにおけるアルキメデス型風力タービンの事業性評価)	Hishammudin Afifi bn Huspi

FINAL REPORT

**OSAKA GAS FOUNDATION OF
INTERNATIONAL CULTURAL EXCHANGE
Year 2024/2025**

**REPURPOSING WASTE AC LED BULBS INTO
FUNCTIONAL SOLAR-POWERED DC LED BULBS**

**Principal Investigator:
CHAIRUL HUDAYA, Ph.D.**

**Department of Interdisciplinary Engineering
Faculty of Engineering**



**UNIVERSITAS INDONESIA
DEPOK
2025**

RESEARCH PROPOSAL SUMMARY

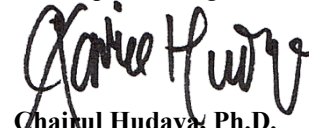
1. Research Project Title	:	Repurposing AC LED Bulb Waste Into Functional Solar-Powered DC LED Bulb
2. Principal Investigator	:	
a. Name	:	Chairul Hudaya, Ph.D.
b. Rank/Status	:	Assistant Professor
c. Main Field of Specialization	:	Electrical Power Engineering
d. Department	:	Interdisciplinary Engineering
e. Faculty	:	Engineering
3. Summary of Research Project	:	In 2023, global electronic waste reached 59.4 million tons, with over 10 billion LED bulbs sold annually. In Indonesia, 60 million LED bulbs are discarded yearly, highlighting a critical need for sustainable e-waste management. This study focuses on repurposing AC LED light bulb waste into functional solar-powered DC LED bulb by identifying common failure modes, recircuiting for conversion, and rigorous testing to ensure the safety aspects. Furthermore, a universal circuit design standard is proposed to facilitate easier conversion in the future, encouraging manufacturers to adopt more modular designs. The converted LED lights can be integrated with solar panels or battery storage, offering sustainable outdoor and street lighting solutions. This approach reduces e-waste and promotes sustainable energy solutions, especially in off-grid areas, contributing to environmental sustainability in Indonesia and beyond.
4. Field of Research	:	Sustainable Energy, Green Technology, Global Environmental Problem
5. Relevant SDGs	:	Affordable and Clean Energy (7), Industry, Innovation, and Infrastructure (9), Climate Action (13)
6. Research Location	:	Department of Interdisciplinary Engineering, Faculty of Engineering – Universitas Indonesia
7. Time of Research Project	:	12 Months
8. Requested Budget	:	US \$6,000

Depok, 29 September 2025

Recommended by
Vice Dean of Academic, Research and
Student Affairs

Prof. Dr. Ir. Yanuar, M.Eng., M.Sc.
NIP. 196001121987031003

Principal Investigator


Chairul Hudaya, Ph.D.
NUP. 040903027

Approved
Dean of Faculty of Engineering, Universitas Indonesia

Prof. Kemas Ridwan Kurniawan, S.T., M.Sc., Ph.D.
NIP. 197101281995121001

FINAL REPORT

**OSAKA GAS FOUNDATION OF
INTERNATIONAL
CULTURAL EXCHANGE
Year 2024/2025**

**DEVELOPMENT OF COMPOSITE POLYMER HYDROGEN PRESSURE VESSEL
FOR MOBILITY PURPOSE**

Principal Investigator:

**Prof. Yudan Whulanza
Department of Mechanical Engineering
Faculty of Engineering**



UNIVERSITAS INDONESIA

DEPOK

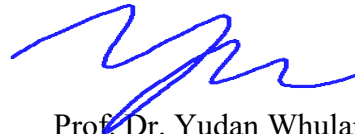
2025

SUMMARY OF RESEARCH PROPOSAL

No	Nama		
1	Research Project Titel	:	Development of Composite Polymer Hydrogen Vessel for Mobility Purposes
2	Principal Investigator Name Rank/Status Main Field of Specialization Department Faculty	: : : : :	Yudan Whulanza Professor Advanced Material and Manufacture Mechanical Engineering Engineering
3	Summary of Research Project	:	This research aims to develop Composite Overwrapped Pressure Vessels (COPV) using natural rubber liners to enhance hydrogen storage safety.
4	Field of Research.	:	Energy and Manufacturing
5	Relevant SDGs	:	SDG 7; SDG 9; SDG 12
6	Research Location	:	University of Indonesia, National Research & Innovation Agency, Indonesian Rubber Institute
7	Time of Research Project	:	1 year
8	Requested Budget	:	USD \$6000

Depok, 30 September 2025

Principal Investigator



Prof. Dr. Yudan Whulanza
NUP. 0408050280

Research Report

Osaka Gas Foundation of International Cultural Exchange

(OGFICE)



Research Title

**Rational Design of Green Catalysts for the
Utilization of CH₄ and CO₂ as Liquid Fuel of
Methanol**

Principal Investigator:
Dr. Eng. Ir. Muhammad Haris Mahyuddin, S.T. M.Eng

Academic Unit

Research Division : Quantum and Nano Technology
Faculty/School : Faculty of Industrial Technology

INSTITUT TEKNOLOGI BANDUNG

November 2025

I. IDENTITY PAGE

1. Title : Rational Design of Green Catalysts for the Utilization of CH₄ and CO₂ as Liquid Fuel of Methanol
2. Relevance of Topic : Global environmental problems
3. Research Period : November 2024 – November 2025
- 4.1 Principal Investigator :
- a. Full Name : Dr. Eng. Ir. Muhammad Haris Mahyuddin, S.T., M.Eng.
- b. Academic Rank : III/c
- c. NIP : 119110035
- d. Current Position : Permanent Faculty Member
- e. Academic Unit : Faculty of Industrial Technology (FTI – ITB)
- f. Office Address/Phone/Fax/E-mail : Jl. Ganesha No. 10 Bandung 40132
022-2504424, mahyuddin133@itb.ac.id
- g. Home Address/Phone/Fax/E-mail : Jl. Simabrama No. 21, Kab. Bandung Barat
0857-0303-0409, mahyuddin133@itb.ac.id

4.2 Members of the Team :

No	Name and Academic Rank	Field of Experties	Institution	Alocation of Time	
				Hrs/week	Months
1.	Adhitya Gandaryus Saputro, Ph.D. (IV/a)	Catalysis Design	FTI	5	12
2.	Wibawa Hendra Saputera, Ph.D. (III/c)	Catalyst Fabrication	FTI	5	12
3.	Triati Dewi Kencana Wungu, Ph.D. (III/c)	Theoretical Physics	FMIPA	5	12

4.3 Research Assistants/Students (mention names when available):

No	Name	Department and NIM	Alocation of Time	
			Hrs/week	Months
1.	Hasna Afifah, M.Sc.	Engineering Physics/33319303	20	12
2.	Marleni Wirmas, M.Sc.	Engineering Physics/33322006	20	12

5. Approved budget : Rp. 93.450.000

Head of Academic Unit
Dean of Faculty of Industrial Technology



Prof. Ir. Tirto Prakoso, S.T., M.Eng., Ph.D.
NIP. 196907261995031002

Bandung, 30 October 2025
Principal Investigator



Dr.Eng. Muhammad Haris Mahyuddin, S.T., M.Eng.
Nopeg. 119110035

I. EXECUTIVE SUMMARY

1. **TITLE OF RESEARCH** : Rational Design of Green Catalysts for the Utilization of CH₄ and CO₂ as Liquid Fuel of Methanol
2. **HEAD OF RESEARCH TEAM** : Dr. Muhammad Haris Mahyuddin
3. **TEAM MEMBERS** : Dr. Adhitya Gandaryus Saputro
Dr. Wibawa Hendra Saputera
Dr. Triati Dewi Kencana Wungu
4. **OFFICIAL ADDRESS** : Jl. Ganesha No. 10 Bandung 40132, West Java, Indonesia

5. **EXTENDED ABSTRACT** :

[Study #1] The selective conversion of methane to methanol using metal-doped TiO₂ catalysts presents a promising strategy for efficient methane utilization. Understanding how different metal dopants influence catalytic activity is essential for optimizing reaction pathways. Here, we employ density functional theory (DFT) calculations combined with the climbing-image nudged elastic band (CI-NEB) method to investigate methane-to-methanol conversion on anatase TiO₂(101), where a surface Ti atom is substituted by a single Cr, Fe, or Co atom. Using H₂O₂ as the oxidant, we analyze the energetic and mechanistic differences in active site formation, methane activation, and methanol synthesis across the three catalysts. While each dopant introduces distinct effects on reaction energetics and intermediate stabilization, subtle variations in electronic structure play a decisive role in shaping catalytic behavior. Cr-TiO₂(101) exhibits highly exothermic H₂O₂ decomposition, but the resulting stability of CrO site significantly hinders methane activation by raising the C–H bond scission barrier. In contrast, Fe-TiO₂(101) shows a more controlled H₂O₂ decomposition process and the lowest activation energy for methane activation, although its more stable methyl radical may limit methanol formation efficiency. Microkinetic simulations further reveal that Fe-TiO₂ achieves a favorable balance between reactivity and stability, leading to enhanced turnover characteristics compared to its Cr- and Co-based counterparts. This study provides key insights into catalyst design strategies for optimizing active site formation, methane oxidation, and product selectivity.

[Study #2] PdZn alloys have been used as catalysts in various hydrogenation reactions, where Pd and Zn atoms exhibit a significant role in binding hydrogen and CO₂ molecules, respectively. In this work, we utilize density functional theory (DFT) calculations to investigate the catalytic performance and reaction mechanism of CO₂ hydrogenation to formic acid on a small, unsupported Pd₅Zn subnanocluster. Two reaction pathways are examined, i.e., the formate (HCOO) and carboxyl (COOH) routes. In the initial stage of CO₂ and H₂ adsorption, the molecules are strongly adsorbed, characterized by significant orbital hybridization between the H, C, and O atoms of H₂ and CO₂ molecules with the Pd and Zn sites of the cluster, suggesting an activated and well-suited condition for the subsequent hydrogenation process. The preferred adsorption of all intermediates in the elementary reactions is investigated. Overall, intermediates in the formate pathway exhibit more stable adsorption and lower activation energies than those in the carboxyl pathway, making it the favorable route. These findings provide insights into designing efficient catalysts by utilizing subnanometer clusters to promote the formation of appropriate reaction intermediates.

[Study #3] The adsorption and dissociation of hydrogen molecules are essential for various hydrogenation reactions and utilization in hydrogen storage. Herein, by utilizing Density Functional Theory (DFT), we introduce Zn atoms to a Pd subnanometer

cluster to investigate H₂ dissociation. Two cluster models with ZrO₂ support are considered, namely Pd₄Zn/ZrO₂ and Pd₃Zn₂/ZrO₂. We find that H₂ molecule strongly adsorbed on the Pd clusters, where Pd₃Zn/ZrO₂ gives slightly lower adsorption energy. Both configurations were found to facilitate the H₂ dissociation into two H atoms thermodynamically, which takes place on top of Pd atoms with activation barriers of 0.63 and 0.67 eV on the Pd₄Zn/ZrO₂ and Pd₃Zn₂/ZrO₂, respectively. Overall, this study provides new insights into the effect of cluster forms of Pd-based catalyst on the reaction mechanism of H₂ dissociation.

6. LIST OF RESEARCH OUTPUT

No.	Authors	Title	Journal/ Proceeding	Status
1	Afifah, H.; Nuruzzahran, M.A.; Mahyuddin, M.H.; Saputro, A.G.; Shukri, G.; Dipojono, H.K.	Metal-Specific Effects of Cr-, Fe-, and Co-TiO ₂ (101) in Catalytic Methane-to- Methanol Conversion	Journal	To be submitted
2	Wirmas, M.; Mahyuddin, M.H.; Agusta, M.K.; Dipojono, H.K.	Theoretical Study of CO ₂ Hydrogenation to HCOOH on Subnanometer PdZn Cluster	Proceeding <i>Journal of Physics: Conference Series</i>	Accepted
3	Wirmas, M.; Mahyuddin, M.H.; Agusta, M.K.; Dipojono, H.K.	DFT Study of H ₂ Adsorption and Dissociation on Supported PdZn Clusters	Proceeding <i>Journal of Physics: Conference Series, 2025, 2980, 012035</i>	Published (link)

Research Report

Osaka Gas Foundation of International Cultural Exchange

(OGFICE)



Research Title

**PROCESS INTEGRATION OF CO₂
NANOBUBBLE CONTACTOR SYSTEM AND
MICROALGAL PHOTOBIOREACTOR TO**

Principal Investigator:

Ir. Elvi Restiawaty, S.T., P.D.Eng., Ph.D., I.P.M.

Academic Unit

Research Division : Department of Chemical Engineering

Faculty/School : Faculty of Industrial Technology

INSTITUT TEKNOLOGI BANDUNG

November 2025

I. IDENTITY PAGE

1. Title : Process Integration of CO₂ Nanobubble Contactor System and Microalgal Photobioreactor to Enhance The Decarbonization
2. Topic : Global environmental problems
3. Research Period : November 2024 – November 2025
- 4.1. Principal Investigator :
- a. Full Name : Ir. Elvi Restiawaty, S.T., P.D.Eng., Ph.D., I.P.M.
- b. Academic Rank : Associate Professor
- c. NIP : 197507272010122001
- d. Current Position : Head of the Research Laboratory of Bioenergy and Chemurgy Engineering
- e. Academic Unit : Faculty of Industrial Technology
- f. Office Address/Phone/Fax/E-mail : Jl. Ganesa 10 Bandung / +62 22 2500989 / e.restiawaty@itb.ac.id
- g. Home Address/Phone/Fax/E-mail : Calistha Dago Residence No.12 / +62 857 20202202 / erestiawaty@gmail.com

4.2 Members of the Team:

No	Name and Academic Rank	Field of Expertise	Institution	Allocation of Time	
				Hrs/week	Months
1	Prof. Dr. Ir. Yogi Wibisono Budhi, S.T., M.T., I.P.M.	Chemical engineering process intensification	Bandung Institute of Technology	10	10

4.3 Research Assistants/Students (mention names when available):

No	Name	Departement and NIM	Alocation of Time	
			Hrs/week	Months
1	Muhammad Fadhlullah	Chemical Engineering, 33023304	40	10
2	Abidzar Akman	Chemical Engineering, 33023006	20	10
3	Adam Muhammad Syach	Chemical Engineering, 23024010	30	10
4	Khalfan Tavi Rizki Bochari	Bioenergy and Chemurgy Engineering, 14521014	20	10
5	Kenan Ramadhan Aryoaji	As research assistance	10	6

5. Approved budget : US\$ 5,616.34 (Rp 93,450,000.00)



Prof. Ir. Tirto Prakoso, S.T., M.Eng., Ph.D.
NIP. 196907261995031002

Bandung, November 3rd, 2025
Principal Investigator


Ir. Elvi Restiawaty, S.T., P.D.Eng., Ph.D.
NIP. 197507272010122001

I. EXECUTIVE SUMMARY

1. **TITLE OF RESEARCH** : Process Integration of CO₂ Nanobubble Contactor System and Microalgal Photobioreactor to Enhance The Decarbonization
2. **HEAD OF RESEARCH TEAM** : Ir. Elvi Restiawaty, S.T., P.D.Eng., Ph.D., I.P.M.
3. **TEAM MEMBERS** : Prof. Dr. Ir. Yogi Wibisono Budhi, S.T., M.T., I.P.M.
Muhammad Fadhlullah, Abidzar Akman, Adam
Muhammad Syach, Khalfan Tavi Rizki Bochari, Kenan
Ramadhan Aryoaji
4. **OFFICIAL ADDRESS** : Jl. Ganesa No. 10, Bandung

5. **EXTENDED ABSTRACT** :
Rapid technological and industrial growth is intensifying carbon dioxide (CO₂) emissions and organic-rich wastewater generation, aggravating global warming and environmental burdens. Microalgae provide a dual-benefit route to abate inorganic and organic carbon while generating valuable biomass; however, their performance is frequently constrained by inadequate CO₂ gas-liquid mass transfer. This study investigates an integrated strategy that couples CO₂ delivered as nanobubbles with mixotrophic cultivation of *Nannochloropsis oculata* to enhance carbon fixation, steer product profiles toward fuel-relevant fractions, and demonstrate early scalability. CO₂ nanobubbles were produced using diffusers with graded pore sizes and characterized to confirm persistent, stable populations, most notably with smaller-pore diffusers (≥ 50 nm), which extended CO₂ residence time in the culture medium. Relative to conventional aeration, nanobubble-enriched operation increased biomass productivity to as high as $0.41 \text{ g}\cdot\text{L}^{-1}\cdot\text{day}^{-1}$ and CO₂ fixation to $0.80 \text{ g}\cdot\text{L}^{-1}\cdot\text{day}^{-1}$. Under mixotrophic conditions using tofu-processing wastewater as an auxiliary organic-carbon source and blue-light illumination for photo regulation, *N. oculata* exhibited elevated lipid accumulation and a shift in fatty-acid distribution toward C14–C16 chains that are advantageous for diesel-range biofuels. Bio-hydrocarbon formation via the Fatty Acid Photodecarboxylase (FAP) pathway was verified, yielding heptadecane up to 6.47% of total lipids. Nitrogen limitation further increased total lipid content but suppressed hydrocarbon production, revealing a nutrient-management trade-off between bulk lipid storage and direct hydrocarbon synthesis. Preliminary scale-up in a 3-L prototype photobioreactor (2-L working volume) confirmed feasibility while indicating optimization needs, including mapping pore size and gas flow to mass-transfer coefficients and energy use, tuning light spectra and duty cycles to maximize FAP-mediated hydrocarbon yields, and staging nitrogen supply to decouple growth, lipid accumulation, and hydrocarbon formation. Collectively, the results demonstrate that integrating CO₂ nanobubble delivery with mixotrophic cultivation and targeted blue-light exposure can overcome mass-transfer bottlenecks, valorize wastewater, and advance fuel-oriented bioproduct profiles in *N. oculata*. The approach offers a promising pathway for scalable, sustainable biofuel production and carbon mitigation, warranting extended runs and techno-economic and life-cycle assessments to quantify performance, costs, and environmental benefits at larger scales.
6. **LIST OF RESEARCH OUTPUT** : Presentation at the 28th Regional Symposium on Chemical Engineering (RSCE) October 2024, Presentation at the Soehadi Reksowardojo International Seminar on Chemical Process Engineering (STKSR) October 2025, Paper that could be published in international journal of Q1 (*drafting*), and a 3 L bioreactor prototype .

The Osaka Gas Foundation of International Cultural Exchange (OGFICE)

Research Grant FY 2024/2025

Final Report

**Optimum Composition of Fly Ash Bottom Ash
(FABA) and Organic Materials in Passive Treatment
of Acid Mine Drainage**

1. Dr. Irdika Mansur, MFor.Sc.

Faculty of Forestry and Environmental IPB University

2. Armaiki Yusmur, M.Si

PPLH IPB

3. Muhamad Hadid Husada, S.Si

Natural Resources Management – IPB University



Submitted to:

Center for Environmental Research

IPB University

for

The Osaka Gas Foundation of International Cultural Exchange (OGFICE)

December 2025

General Information

Title : Optimum Composition of Fly Ash Bottom Ash (FABA) and Organic Materials in Passive Treatment of Acid Mine Drainage

Researchers:

- 1 Name : *Dr. Irdika Mansur, MFor.Sc*
Institution : *Faculty of Forest and Environment- IPB*
Address of institution : *Jalan Ulin, Kampus IPB Darmaga, Bogor 16680, telephone number 0251- 8621677, E-mail: fahutan@apps.ipb.ac.id*
- 2 Name : *Armaiki Yusmur, M.Si*
Institution : *PPLH IPB*
Address of institution : *Jalan Lingkar Akademik Kampus IPB Darmaga, Bogor, Jawa Barat 16680 [0251\) 8621262](tel:02518621262), pplh_ipb@indo.net.id*
- 3 Name : *Muhamad Hadid Husada, M.Si*
Institution : *Natural Resources Management – IPB University*
Address of institution : *Baranangsiang, Kecamatan Bogor Tengah, Kota Bogor, Jawa Barat 1612, 082157647968.*

Center for Environmental Research,
IPB University,

Director



Dr. Yudi Setiawan, SP., M.Env.Sc

Bogor, 1 December 2025

Principal Investigator,



Digitally signed by:
Irdika Mansur

Date: 1 Des 2025 21:27:02 WIB
Verify at design.ipb.ac.id

Dr. Irdika Mansur, MFor.Sc

Executive Summary

The 34-day water quality monitoring program shows that the application of Floating Geo FABA technology has a significant impact on increasing the pH of acid mine drainage (AMD), especially during the initial stages of use. The data indicate that the pH at the inlet remained stable in the range of 3–3.5, reflecting highly acidic water conditions. In contrast, the outlet pH increased sharply during the first two weeks, reaching the range of 6–8, confirming the initial effectiveness of FABA material in the neutralization process.

Although daily fluctuations occurred, the overall trend of increasing pH at the outlet remained consistent and significantly higher than the inlet. However, this effectiveness gradually decreased after the third week, as indicated by the outlet pH dropping to the range of 4–5. This decline suggests a reduction in the reactive capacity of FABA over time due to material saturation.

Overall, Floating Geo FABA has proven to be an efficient solution for increasing AMD pH during the early application phase, with strong potential as a pre-treatment technology. However, regular maintenance or replacement of the material is required to maintain long-term effectiveness.

The Osaka Gas Foundation of International Cultural Exchange (OGFICE)
Research Grant FY 2024/2025

Final Report

Long-Term Habitat Management of *Varanus komodoensis* on Flores Island

1. Angga Irfandi Yudistira

IPB University

2. Lilik Budi Prasetyo

IPB University



Submitted to:

Center for Environmental Research

IPB University

for

The Osaka Gas Foundation of International Cultural Exchange (OGFICE)

November 2025

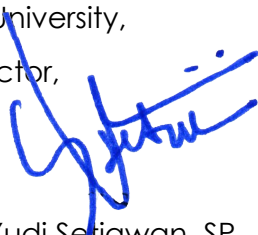
General Information

Title : Long-Term Habitat Management of *Varanus komodoensis*
on Flores Island

Researchers:

- 1 Name : Angga Irfandi Yudistira, S.Si.
Institution : IPB University
Address of institution : Jl Dramaga, Kampus IPB Dramaga Bogor, Post code: 16680,
Tel. +62 251 8622642, E-mail: ask@apps.ipb.ac.id
- 2 Name : Prof. Dr. Ir. Lilik Budi Prasetyo, M.Sc.
Institution : IPB University
Address of institution : Jl Dramaga, Kampus IPB Dramaga Bogor, Post code: 16680,
Tel. +62 251 8622642, E-mail: ask@apps.ipb.ac.id

Center for Environmental Research,
IPB University,
Director,



Dr. Yudi Seriawan, SP., M.Env.Sc

Bogor, 11 November 2025

Principal Investigator,



Angga Irfandi Yudistira, S.Si.

Executive Summary

Komodo dragons (*Varanus komodoensis*) are the largest lizard species in the world, with only a few in Indonesia. While much of the global attention and conservation efforts have focused on populations within Komodo National Park, Flores Island supports the largest landmass of its remaining habitat outside the park. The conservation condition in Flores differs from those of Komodo, Rinca, Padar, Gili Motang, and Gili Dasami Islands due to the existence of both conservation and non-conservation areas, diverse landscapes, and land use changes caused by humans. These characteristics make Flores ecologically important and irreplaceable for sustaining genetically and ecologically distinct populations of Komodo dragons. This study aims to evaluate the sustainability of Komodo dragon habitats in Flores using Landsat 7/ETM+ imagery from 2000 to 2020, which then became the basis for the Patch-generating Land Use Simulation (PLUS) model until 2050 based on two analysed scenarios, namely the business as usual (BAU) scenario and the optimistic scenario. The year 2050 was chosen as the final baseline in this study to correspond with the timeline of Indonesia's Long-term Strategy for Low Carbon and Climate Resilience. The results of this model will then be analysed for landscape quality by evaluating and integrating them using four landscape indices (i.e., land cover, number of patches, effective mesh size, and like adjacencies).

The results of this study show that habitat fragmentation is still a major problem despite the increase in habitat area in both scenarios. Concerns about population isolation and decreased genetic exchange arise due to the large number of small patches and low spatial connectivity on Flores Island, especially in non-conservation areas. Although the optimistic scenario offers better outcomes for landscape cohesion, particularly for savanna and mangrove habitats, monsoon forests remain spatially disjointed.

The study highlights the problem of fragmented habitats for Komodo dragons on Flores. Improving connectivity and maintaining genetic exchange is crucial, particularly in non-conservation areas. The study suggests that conservation efforts should concentrate on landscape cohesion and the ecological integrity of all habitats, particularly monsoon forests.

Final Report

Title:

Monitoring Mangroves, Waterbirds and Reptiles of Pulau Rambut Wildlife Sanctuary, Five Years After Oil Spill

1. Ani Mardiasuti

Department of Forest Resources Conservation and Ecotourism
Faculty of Forestry and Environment, IPB University

2. Yeni Aryati Mulyani

Department of Forest Resources Conservation and Ecotourism
Faculty of Forestry and Environment, IPB University

3. Mirza Dikari Kusri

Department of Forest Resources Conservation and Ecotourism
Faculty of Forestry and Environment, IPB University



Submitted to:

Center for Environmental Research
IPB University
for

The Osaka Gas Foundation of International Cultural Exchange (OGFICE)
December 2025

General Information

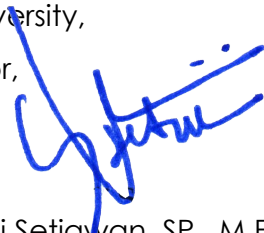
Title : **Monitoring Mangroves, Waterbirds and Reptiles of Pulau Rambut Wildlife Sanctuary, Five Years After Oil Spill**

Researchers:

- 1 Name : Ani Mardiasuti
Institution : Department of Forest Resources Conservation, Faculty of Forestry and Environment, IPB University, Darmaga Campus, Bogor 16880, Indonesia
Address of institution : Babakan, Dramaga, Bogor Regency, West Java 16680, (0251) 8621947, 0251-8621947, dkshe@apps.ipb.ac.id
- 2 Name : Yeni Aryati Mulyani
Institution : Department of Forest Resources Conservation, Faculty of Forestry and Environment, IPB University, Darmaga Campus, Bogor 16880, Indonesia
Address of institution : Babakan, Dramaga, Bogor Regency, West Java 16680, (0251) 8621947, 0251-8621947, dkshe@apps.ipb.ac.id
- 3 Name : Mirza Dikari Kusri
Institution : Department of Forest Resources Conservation, Faculty of Forestry and Environment, IPB University, Darmaga Campus, Bogor 16880, Indonesia
Address of institution : Babakan, Dramaga, Bogor Regency, West Java 16680, (0251) 8621947, 0251-8621947, dkshe@apps.ipb.ac.id

Bogor, 01 December 2025

Center for Environmental Research,
IPB University,
Director,



Dr. Yudi Setiawan, SP., M.Env.Sc

Principal Investigator,



Prof. Dr. Ir. Ani Mardiasuti, M.Sc.

EXECUTIVE SUMMARY

Pulau Rambut Wildlife Sanctuary, a 25-hectare island in Jakarta Bay, experienced a major oil spill in mid-July 2019, threatening its status as the only wildlife sanctuary and Ramsar Site in the region and its critical role as habitat for waterbirds and other fauna. This research project evaluated the long-term ecological impacts five years post-spill, focusing on mangrove forests, waterbird populations, and reptile communities. The study was conducted over 14 months from November 2024 to December 2025, employing satellite image analysis (SPOT-6 and SPOT-7), ground surveys, drone-based mapping, concentration counts of waterbirds, and Visual Encounter Surveys for reptiles, covering both breeding (December 2024–June 2025) and non-breeding seasons (July–August 2025).

Mangrove Assessment: Satellite imagery analysis revealed relatively stable island-wide mangrove coverage (18.80 ha in 2019 vs. 18.84 ha in 2021), but localized impacts were severe. The northern section most affected by the spill showed 12% mangrove cover reduction, with a 0.8-hectare bare area in the northeast representing complete forest loss. Species-specific responses varied significantly: *Rhizophora mucronata* (the tallest species critical for Milky Stork nesting) suffered 15% mortality and 15% stress, *Rhizophora stylosa* showed 80% survival with 8% mortality, and *Ceriops tagal* exhibited the highest resilience with 85% survival and only 5% mortality. Mangrove Health Index assessment across 13 plots averaged 50.72% (moderate health), with canopy cover ranging from 13.37% to 88.32%. Natural seedling regeneration occurred at densities 40% lower in impacted areas compared to reference zones, indicating slow recovery requiring an estimated 15-25 years without active intervention.

Waterbird Population: Monitoring documented 11,920 individuals from 17 species across the study period, with 9,250 individuals recorded during the breeding season (January–June 2025). The February peak of 2,724 individuals indicates partial recovery from the immediate post-spill crash (1,500-2,000 birds) but remains approximately 22% below pre-spill baseline levels (~3,500 birds). Community composition showed strong dominance by Little Black Cormorant (35.08%) and Black-crowned Night Heron (35.00%), species utilizing medium-height trees that survived better than taller species. The endangered Milky Stork maintained 18 active nests representing Java's entire breeding population, though constrained by reduced availability of tall *R. mucronata* nesting trees. Analysis of 347 documented nests revealed 89% occurred in healthy trees, 11% in stressed trees, and none in dead trees, confirming direct linkage between tree condition and habitat suitability. The breeding season extended unusually through June 2025 due to prolonged rainfall (142 mm in June versus typical <50 mm), demonstrating climate sensitivity. Two juvenile Milky Storks were fitted with GPS devices, revealing 10-25 km ranging patterns and concentration of feeding activity in coastal fish ponds (45-50% of locations) and tidal mudflats (30-35%), emphasizing the need for landscape-level conservation beyond the island.

Reptile Population: Visual Encounter Surveys documented 392 encounters with Water Monitors (*Varanus salvator*), estimating a population of approximately 98 individuals at 0.72 individuals/ha density. This represents a dramatic 76% decline from pre-spill conditions (386 individuals at 8.57 ind/ha in 2018), reversing a 17-year trend of population growth. Age structure analysis revealed severe demographic imbalance with senesced adults comprising 47.4%, prime adults 35.2%, and juveniles only 17.3%—an inverted pyramid indicating recruitment failure. Spatial distribution showed concentration in coastal and edge habitats (51% of observations) rather than interior forest (9.44%), with activity hotspots correlating with waterbird nesting zones and waste accumulation areas. Health assessments documented concerning indicators including severe ocular pathologies,

physical injuries suggesting intense intraspecific combat, and fecal evidence of plastic ingestion (styrofoam, synthetic fibers, nylon) in 25% of analyzed samples. Five additional reptile species were documented including Reticulated Python and Gold-ringed Cat Snake, both functioning as waterbird predators.

Ecosystem-Level Impacts: The study reveals cascading trophic effects from mangrove degradation through waterbird populations to apex predators. The mangrove-waterbird linkage is direct: 15% mortality of *R. mucronata* translates to proportional loss of Milky Stork nesting habitat. The waterbird-reptile linkage operates through bottom-up effects: reduced waterbird populations (22% below baseline) and nesting activity (347 nests versus higher historical levels) decrease prey availability for Water Monitors, driving the 76% population decline. The inverted age structure suggests recruitment failure perpetuates decline even as adult mortality reduces population size. Multiple stressors operate synergistically: oil spill legacy effects, chronic plastic pollution, reduced prey availability, and habitat degradation combine to suppress recovery across trophic levels.

Conservation Significance: This study provides the first comprehensive scientific assessment of long-term oil spill impacts on a tropical island ecosystem, demonstrating that substantial ecological consequences persist five years post-incident. Pulau Rambut's status as Jakarta Bay's sole wildlife sanctuary, Indonesia's only Ramsar Site in the region, and Java's only Milky Stork breeding location elevates the urgency of addressing documented impacts. The research delivered direct benefits to BKSDA Jakarta through actionable baseline data, trained eight university students (two BSc, six MSc) in conservation science, supported the local community of Untung Jawa Island through research-related economic activity, and generated two scientific manuscripts accepted for presentation at the 6th International Conference on Bioscience plus contributions to the National Herpetology meeting. The findings emphasize the urgent need for active restoration measures including targeted mangrove replanting in the 0.8-ha bare area and degraded zones, plastic pollution mitigation, and landscape-level habitat protection to facilitate ecosystem recovery and ensure long-term conservation of this irreplaceable biodiversity refuge.

The Osaka Gas Foundation of International Cultural Exchange (OGFICE)

Research Grant FY 2024/2025

Final Report

**Combination of Reject Coal Biochar and Chicken Manure as Soil Ameliorant to
Improve Soil Properties of Rice Field Soil in Karawang**

1. Prof. Dr. Ir Arief Hartono, M.Sc.Agr.

IPB UNIVERSITY

2. Muhammad Ramadhan Fauzi Sulistiono, S.P.

IPB UNIVERSITY



Submitted to:

Center for Environmental Research

IPB University

for

The Osaka Gas Foundation of International Cultural Exchange (OGFICE)

December 2025

General Information

Title : Combination of Reject Coal Biochar and Chicken Manure as Soil Ameliorant to Improve Soil Properties of Rice Field Soil in Karawang.

Researchers:

- 1 Name : *Prof. Dr. Ir. Arief Hartono, M.Sc. Agr.*
Institution : *IPB University*
Address of institution : *Department of Soil Science and Land Resource. Faculty of Agriculture. Jl. Meranti Kampus IPB Darmaga, Bogor Regency, West Java, Indonesia.*
- 2 Name : *Muhammad Ramadhan Fauzi Sulistiono. S.P.*
Institution : *IPB University*
Address of institution : *Department of Soil Science and Land Resource. Faculty of Agriculture. Jl. Meranti Kampus IPB Darmaga, Bogor Regency, West Java, Indonesia.*

Center for Environmental Research,
IPB University,
Director,

Dr. Yudi Setiawan, SP., M.Env.Sc



Bogor, 1 December 2025

Principal Investigator,



Prof. Dr. Ir. Arief Hartono, M.Sc. Agr.

EXECUTIVE SUMMARY

The continuous increase in coal production each year has contributed to an increase in the amount of reject coal, which is the fraction of coal that is rejected and becomes mining industry waste and is generally not utilized. The long-term accumulation of reject coal poses environmental challenges, while scientific studies on its use as a soil conditioner are still limited. To date, there has been no research specifically developed on reject coal processed through pyrolysis into biochar, then combined with chicken manure, for application to rice fields in Karawang as an effort to increase rice productivity and sustainable mining waste management. This study aims to determine the optimal dosage of a combination of 70% reject coal biochar and 30% chicken manure on rice growth and yield, as well as to compare the effectiveness of regular reject coal (RCP) with reject coal biochar (RCBP) at five dosage levels (0, 5, 10, 20, and 40 t/ha). The study used a split-plot design, with the type of soil conditioner as the main plot (RCP and RCBP) and the dosage as the subplot. Observations were made during the vegetative phase (plant height, number of tillers), generative phase (number of panicles, panicle length, weight of 1000 grains), and yield (GKP and GKG per hectare). Data were analyzed using ANOVA and Tukey's post hoc test at a significance level of 5%.

The results showed that RCBP produced a higher plant response than RCP, especially in generative parameters such as the number of filled grains, total grains, number of panicles, and 1000-grain weight. Doses of 20 t/ha and 40 t/ha produced the best vegetative growth, with a dose of 40 t/ha producing the highest plant height (90.1 cm at 7 MST) and the highest GKG (6.576 t/ha), exceeding national productivity. However, the 20 t/ha dose was considered the most efficient because it significantly increased growth and yield with lower inputs compared to the 40 t/ha dose.

A dose of 20 t/ha is recommended as the optimal dose for RCBP application in rice fields, while a dose of 40 t/ha can be applied if the main objective is to maximize yield. The use of reject coal as biochar has been proven to be a sustainable approach that can increase rice productivity while reducing the environmental burden of mining waste.

The Osaka Gas Foundation of International Cultural Exchange (OGFICE)

Research Grant FY 2024/2025

Final Report

MAXIMIZING THE ADSORPTION OF MICRONUTRIENTS Fe Mn Cu Zn IN BIOCHAR-BASED SLOW-RELEASE COMPOUND FERTILIZERS

1. Prof. Dr Ir Iskandar/ IPB University
2. Dr Ir Darmawan, MSc/IPB University
3. Dr Ir Dyah Tjahyandari, M.Appl.Sc/IPB University
4. Afritedy Limin, SP, MSc, PhD/PT. Great Giant Pineapple



Submitted to:

Center for Environmental Research

IPB University

for

The Osaka Gas Foundation of International Cultural Exchange (OGFICE)

December 2025

General Information

Title : Maximizing the adsorption of micronutrients Fe Mn Cu Zn in biochar-based slow-release compound fertilizers

Researchers:

1. Name : Prof. Dr Ir Iskandar

Institution : IPB University

Address of institution : Department of Soil Science and Land Resource, Faculty of Agriculture, Kampus IPB Dramaga, Bogor 16680

Phone: 0251-8629360

E-mail: soil_dept@apps.ipb.ac.id

2. Name : Dr Ir Darmawan, MSc

Institution : IPB University

Address of institution : Department of Soil Science and Land Resource, Faculty of Agriculture, Kampus IPB Dramaga, Bogor 16680

Phone: 0251-8629360

E-mail: soil_dept@apps.ipb.ac.id

3. Name : Dr Ir Dyah Tjahyandari Suryaningtyas, M.App.Sc

Institution : IPB University

Address of institution : Department of Soil Science and Land Resource, Faculty of Agriculture, Kampus IPB Dramaga, Bogor 16680

Phone: 0251-8629360

E-mail: soil_dept@apps.ipb.ac.id

4. Name : Atfritedy Limin, SP, MSc, PhD

Institution : PT. Great Giant Pineapple

Address of institution : Jl. Terbanggi Besar KM. 77, Terbanggi Besar, Kec. Terbanggi Besar, Kabupaten Lampung Tengah, Lampung 34163

Phone: (0725) 2102111

Bogor, 1 Desember 2025

Center for Environmental Research,
IPB University,
Director,



Dr. Yudi Setiawan, SP., M.Env.Sc

Principal Investigator,



Prof. Dr Ir Iskandar

Executive Summary

Peat and acid upland soils are quite widespread in Indonesia and have been partially utilized for agricultural cultivation. Plants growing on these soils often show symptoms of micronutrient deficiency. This occurs because these soils contain low amounts of micronutrients. Deficiency of one or more micronutrients can cause severe depression in growth, yield and crop quality. To overcome this micronutrient deficiency, the soil needs to be fertilized with controlled-release compound fertilizers to avoid loss of these elements due to leaching or being washed away by erosion. Controlled-release fertilizers can be made using porous materials, either inorganic material such as zeolite mineral or organic such as biochar. The use of biochar is more recommended because biochar is made by utilizing organic waste from harvest or other easily available organic materials. Biochar is more stable than compost, so it can last longer in the soil as organic carbon. The main problem in making biochar-based controlled-release compound fertilizer is how to maximize the absorption of micronutrients such as Fe Mn Cu Zn into the biochar pores. Although these elements have the same valence, these ions have different affinities and diameters which can cause competition between ions in entering and occupying the pore holes of biochar. Therefore, the purpose of this study is to find a way to maximize the absorption of Fe Mn Cu Zn ions into biochar holes made of chopped bamboo and test it using pak choy. Farmers and plantation owners are the target beneficiaries so that their plants can grow well and have maximum productivity. The trial was conducted in the green house and laboratory of Department of Soil Science and Land Resource, IPB University. The results of this study indicate that bamboo biochar can absorb individual Fe, Mn, Cu, and Zn in the order Cu (10.39-11.24%) > Zn (8.50-9.94) = Mn (8.68-9.49%) > Fe (4.65-6.33%). However, this ability is lower when bamboo biochar absorbs micronutrients from a mixed solution containing a combination of Fe, Mn, Cu, and Zn. Sorption of micronutrients from a solution containing a mixture of Fe, Mn, Cu and Zn with different concentrations by bamboo biochar shows that for Mn, Cu and Zn the amount absorbed depends on the concentration, while for Fe the amount absorbed is relatively constant. A mixture of single biochar-micro fertilizer (a mixture of biochar-Fe, biochar-Mn, biochar-Cu and biochar-Zn) produced better growth of pak choy compared to compound biochar-micro fertilizer (biochar-Fe-Mn-Cu-Zn), with the best results obtained in treatment P6, namely a single biochar-micro mixture with a dose of 200%.



RINGKASAN LAPORAN AKHIR
GERAN PENYELIDIKAN OSAKA GAS
END OF OSAKA GAS
GRANT REPORT SUMMARY

A. Tajuk Projek <i>Project Title</i>	: Solar Power Organic Waste Dehydrators for Better Food Waste Management
Ketua Penyelidik <i>Project Leader</i>	: Siti Nor Ain Musa
Fakulti/Institut <i>Faculty/Institute</i>	: Engineering
Ahli Kumpulan Penyelidik <i>Research Team Members</i>	: Nur Syuhada Ahmad Zauzi
B. Tarikh Geran Diluluskan <i>Grant Approval Date</i>	: 1 Januari 2025
Tempoh Projek <i>Project Duration</i>	: 12 bulan
Peruntukan Yg. Diluluskan <i>Budget Approved</i>	: RM10,000.00
Perbelanjaan Terkini <i>Expenditure To-Date</i>	: RM4,155.00
C. Pencapaian Keseluruhan <i>Overall Achievement</i> Huraikan pencapaian berbanding objektif, hipotesis serta permasalahan asal yang diselidiki.. <i>Describe the achievements in relation to the original objectives, hypothesis and research problems.</i> This research project has accomplished all the primary objectives outlined: Objective 1 (Design): An innovative integrated organic waste dehydrator system was successfully designed. The project resulted in the development of an integrated organic waste dehydrator system. While the initial hypothesis suggested that a standard blade shape would be sufficient, preliminary laboratory work identified performance limitations when processing high-moisture waste. To overcome these challenges, a revised blade configuration was developed. This design utilizes a combination of centrifugal force and mechanical shearing to better handle varied waste consistencies. The final configuration couples high-efficiency mechanical grinding:	

incorporating a static outer grind ring, a spinning base plate, and twin impellers; with a forced-convection thermal dehydration system. This integration allows the entire process to be contained within a single, compact countertop unit.

Future work will involve the use of Computational Fluid Dynamics (CFD) to further analyze and optimize the system's internal airflow and grinding efficiency.

Objective 2 (Fabrication & Pilot Testing): A functional benchtop prototype was fabricated using a hybrid manufacturing approach, combining CNC metal machining with Fused Deposition Modeling (FDM) 3D printing (utilizing high-temperature PETG and wear-resistant Nylon). (Figure 1)



Figure 1 Proof of Concept of the latest design

While the original intent was to construct a full-scale model using final production materials, resource constraints led to the development of this scaled-down prototype to focus on proof-of-concept testing.

Pilot testing was conducted using four representative food waste categories; cabbage, chicken skin, cooked rice, and mixed waste. These tests were designed to evaluate heat and humidity transfer. Specifically, the impact of particle size reduction (comparing ground vs. unground samples) on water removal rates was analyzed at drying temperatures of 40°C and 65°C.

Results of the integrated system yielded the following results within a 12 to 24-hour processing window:

i. Volume Reduction: 80–85%

ii. Mass Reduction: 75–80%

The process successfully stabilized putrescible waste into a drier byproduct.

D. Pencapaian Utama

Key Findings

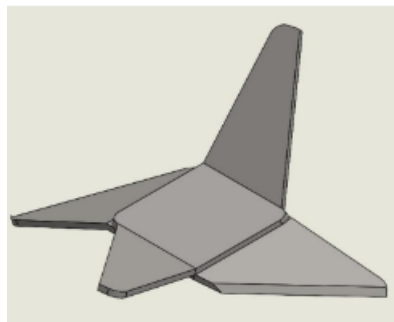
1. Blade Geometry and Size Reduction (Grinding Mechanics)

Two distinct grinding blade configurations were evaluated during the pilot runs to investigate how shear efficiency influences subsequent waste heat transfer:

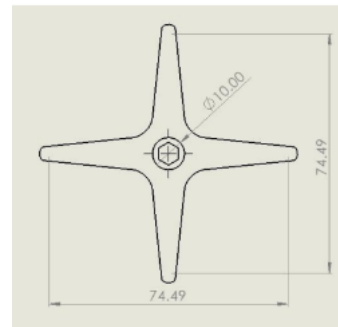
Type 1 Blade (Flat Blade Design): A standard flat blade with slightly upturned tips. This blade generates moderate shear force, reducing mixed waste to a median particle size.

Type 2 Blade (Dual-Plane Curved Blade): A multi-focus curved blade featuring a serrated aerofoil profile. This design generates exceptionally high shear forces and a forced axial flow, yielding a significantly finer median particle size under identical grinding parameters (a 30-second intermittent run-stop cycle).

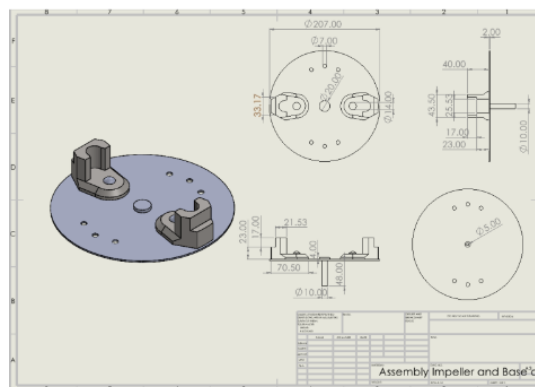
Particle size reduction using the Type 2 Blade dramatically increases the specific surface area per unit volume. According to Fourier's law of heat conduction and Fick's laws of diffusion, this expanded specific surface area directly accelerates convective heat transfer into the particles and the outward diffusion of moisture. For high-fiber waste such as chicken skin and bone, using the Type 2 Blade increased the drying rate by 25% compared to the Type 1 Blade during the initial constant-rate drying period.



Type 1



Type 2



Final Blade Design

2. Drying Kinetics by Food Waste Type

The physical and chemical properties of different food wastes significantly influence their dehydration kinetics at 40°C and 65°C.

- i. Vegetable Waste (Cabbage): Characterized by a very high initial moisture content (92%). Grinding effectively ruptures the cellulosic plant cell walls, converting bound water into free water. Ground cabbage dried 40% faster than unground cabbage during the early stages of the process.
- ii. Protein & Fat Waste (Chicken Skin & Bones): The rubbery, oily texture of chicken skin severely restricts water diffusion. Grinding breaks down the fibrous collagen network and releases lipids, which allows water molecules to escape to the surface much faster. The drying kinetics of ground chicken skin improved by 35% compared to the unground control.
- iii. Sticky Starchy Waste (Cooked Rice): Exhibited a highly notable anomalous behavior. Unlike cabbage and chicken skin, ground rice dried slower than unground rice. This is due to starch gelatinization during wet grinding, which causes the rice particles to stick together and form dense clumps (clumping). These compact clumps block convective airflow pathways and reduce the effective exposed surface area, thereby slowing down internal water diffusion. Conversely, unground rice maintains micro-air gaps between individual grains, allowing heat to circulate far more efficiently.

E, Hasil Penyelidikan *Deliverables*

Sila tandakan item yang berkaitan pada senarai berikut:

Please tick the relevant items below:

	Item	Bilangan/Number
	Kertas teknikal/bersiri dalaman <i>Internal technical/serial papers</i>	
	Tesis/disertasi pelajar sarjana muda <i>Undergraduates' student's thesis/dissertation</i>	2
	Tesis pelajar PhD <i>Student's PhD thesis</i>	
	Kertas persidangan tempatan <i>Local conference papers</i>	
	Kertas persidangan antarabangsa <i>International conference papers</i>	
	Makalah dalam jurnal tempatan <i>Local journal papers</i>	
	Makalah dalam jurnal antarabangsa <i>International journal papers</i>	
	Monograf atau buku <i>Book/monograph</i>	

Lain-lain/others (sila nyatakan/please specify)

1. Final Year Project Thesis

Sila senaraikan maklumat (pengarang, tahun, tajuk, jurnal/penerbit, jilid, halaman) bagi penerbitan/tesis yang dihasilkan (jika ada).

Please specify the publications (authors, year, title, journal/publisher, volume, page nos.) (if any)

1. Title: Force convection Solar Dryer for Moisture Removal of Food Waste

Tahun: 2025 (FYP1&2)

Pengarang: Feliia Ratchell Anak Bennet

2. Title: Development of an Integrated Dry-Grinding and Dehydration System for On-Site Food waste Management

Tahun: 2026 (FYP 1)

Pengarang: Alistrair Bryan anak Anthony Glees

F. Pengecaman Output
Output Identification

Sila tandakan penerangan yang berkaitan pada senarai berikut:

Please tick the relevant description as given below:

☐	Suatu sumbangan besar kepada bidang ilmu yang berkaitan <i>A major contribution to knowledge (new knowledge) in the respective discipline</i>
☐	Suatu sumbangan kecil tetapi bermakna kepada bidang ilmu yang berkaitan <i>A minor but important contribution to knowledge in the respective discipline</i>
☐	Suatu sumbangan besar kepada teknologi/ciptaan/algoritma dalam bidang yang berkaitan <i>A major contribution to technology/invention/algorithm or a tangible product</i>
☐	Suatu sumbangan kecil tetapi bermakna kepada teknologi/ciptaan/algoritma berkaitan <i>A minor but important contribution to relevant technology/invention/algorithm</i>
☐	Terdapat potensi yang baik untuk kajian lanjutan ke arah pemasaran <i>There is a good potential for further R & D and commercialization</i>
☐	Suatu sumbangan besar kepada kerangka polisi pengurusan/garis panduan <i>A major contribution to management policy framework/guidelines (in relevant areas)</i>
☐	Suatu sumbangan kecil tetapi bermakna kepada kerangka polisi pengurusan/garis panduan <i>A minor contribution to management policy framework/guidelines (in relevant areas)</i>
☐	Sesuai untuk dijadikan bahan pengajaran/case study atau bahan latihan <i>The finding is suitable for use as a complementary teaching/training material (a case study)</i>
☐	Suatu output yang baik dan berpotensi untuk memenangi hadiah penyelidikan <i>A quality output that has a potential for winning a research award</i>
☐	Suatu bahan yang baik/sesuai untuk hebahan atau pameran <i>A good/suitable material for showcasing/publicizing/exhibition</i>

Lain-lain/Others (Sila nyatakan/Please specify): Tiada

G. Sinopsis Hasil Penyelidikan bagi Tujuan Promosi

Synopsis for Promotional Purposes

(Beri huraian ringkas yang tidak melebihi 400 perkataan dan dalam bahasa yang mudah, bagi maksud hebahan hasil penyelidikan ini melalui media massa dan 'Unimas Research Update')

(Please provide a synopsis not exceeding 400 words, in a not-too-technical language, for the purpose of promoting this research findings through the mass media and Unimas Research Update).

Managing Waste at the Source: A Proof-of-Concept for Malaysian Eateries/ Pasar Mala/ Food Festival

Food waste is an escalating challenge in Malaysia, particularly at high-traffic locations like "pasar malam", food festivals, and "pasar basah". To address this, a research supported by the Osaka Gas Foundation of International Cultural Exchange (OGFICE), has developed a proof-of-concept prototype for a compact, integrated organic waste dehydrator.

The project specifically targets the organic waste commonly generated in Malaysian eateries and food courts. Reaching this proof-of-concept stage required overcoming significant engineering hurdles. Initial designs faced multiple issues, as the "stickiness" and high moisture content of typical local food scraps were not initially accounted for, leading to processing difficulties. These challenges led to a revised design featuring a specialized blade and grinding system capable of handling varied and high-moisture organic matter more effectively.

The system functions by grinding scraps; such as vegetable remains and leftovers, into fine particles. This increases the surface area, allowing moisture to evaporate more efficiently through a forced-convection heating process. A key finding of this fundamental research is its potential for energy efficiency; testing showed that drying waste at a lower temperature of 40°C is more efficient than high-heat methods, while still effectively stabilizing the waste. This low power demand suggests the system could eventually be adapted for solar-powered use in outdoor settings like night markets.

In laboratory settings, the prototype demonstrated a volume reduction of approximately 80% and a mass reduction of 75% within 16 to 24 hours. The process transforms perishable waste into a drier and less odor waste that can be repurposed as a soil conditioner.

While there is still a long road ahead before this design is refined enough for actual prototype production, these findings provide a vital foundation. By proving the feasibility of decentralized waste processing, this research moves us a step closer to a cleaner, more sustainable "zero-waste" future for Malaysia's vibrant food culture.

Catatan Penting/Important Notes

Penyelidik diminta mengemukakan kepada Pusat Penyelidikan:

- Borang ini dalam kedua-dua bentuk bercetak dan elektronik
- Researchers are required to submit to the Research Centre:*
- *This form in both hard- and soft-copies*


Siti Nor Ain Musa
Lecturer
Mechanical & Manufacturing Engineering
Faculty of Engineering
UNIVERSITI MALAYSIA SARAWAK

2026/5/16

.....
Tandatangan (Penyelidik Utama)
Signature (Principal Researcher)

.....
Tarikh
Date



RINGKASAN LAPORAN AKHIR
GERAN PENYELIDIKAN OSAKA GAS
END OF OSAKA GAS
GRANT REPORT SUMMARY

A. Tajuk Projek <i>Project Title</i>	: Performance of Kraft presspaper in transformers with the presence of Multi Walled Carbon Nanotube (MWCNT) based on Palm Oil Methyl Ester (POME)
Ketua Penyelidik <i>Project Leader</i>	: Nurul 'Izzati binti Hashim
Fakulti/Institut <i>Faculty/Institute</i>	: Faculty of Engineering
Ahli Kumpulan Penyelidik <i>Research Team Members</i>	: PM Ir Ts Dr Yanuar Zulardiansyah Arief Dr Sharifah Masniah binti Wan Masra Dr Asrani bin Lit Ts. Shirley anak Rufus Puan Nazreen bt Junaidi Dr Mohamad Syazwan Zafwan bin Mohamad Suffian
B. Tarikh Geran Diluluskan <i>Grant Approval Date</i>	: 05 November 2024
Tempoh Projek <i>Project Duration</i>	: 01 January 2025 – 31 December 2025 1 Year
Peruntukan Yg. Diluluskan <i>Budget Approved</i>	: RM 10,000.00
Perbelanjaan Terkini <i>Expenditure To-Date</i>	: RM 9970.00

C. Pencapaian Keseluruhan / Overall Achievement

Huraikan pencapaian berbanding objektif, hipotesis serta permasalahan asal yang diselidiki.

Describe the achievements in relation to the original objectives, hypothesis and research problems.

The project successfully addressed the research problem of improving the performance and sustainability of transformer solid insulation when operating with alternative biodegradable insulating liquids. The study investigated the behavior of Kraft presspaper impregnated in Palm Oil Methyl Ester (POME) with the presence of Multi-Walled Carbon Nanotubes (MWCNT), which was hypothesized to enhance ageing characteristics and extend insulation lifespan.

All planned experimental works were completed, including accelerated ageing, physicochemical analysis (FTIR, FESEM and TGA), mechanical testing (tensile strength) and electrical breakdown testing (ACBDV).

The objectives were achieved as follows.

- i. The chemical and structural behavior of the insulation material was characterized using FTIR, FESEM and TGA analyses, allowing the ageing degradation mechanism to be identified.
- ii. Mechanical performance was evaluated through tensile strength measurements, confirming that the presspaper retained acceptable structural integrity after impregnation and ageing.
- iii. Electrical performance was assessed using AC breakdown voltage testing, demonstrating stable dielectric withstand capability under new and aged conditions.

Overall, the experimental results support the initial hypothesis that the incorporation of MWCNT-modified POME does not degrade the insulation performance and shows potential to improve ageing behavior. Therefore, the study successfully answered the research questions related to electrical properties, mechanical strength variation and ageing behavior of Kraft presspaper in alternative insulating. The findings indicate that the proposed insulation system is a feasible and environmentally sustainable alternative for transformer applications. In addition, one research paper from this project was presented at TENCON 2025 (November 2025).

D. Pencapaian Utama /Key Findings

- i. The physicochemical analyses revealed that ageing caused progressive degradation of cellulose structure; however, the presence of MWCNT-modified POME influenced the degradation rate and improved thermal stability behavior.
- ii. Mechanical testing showed that tensile strength decreased with ageing as expected for cellulose insulation, but the reduction remained within acceptable limits, indicating that the alternative liquid insulation did not accelerate mechanical deterioration.
- iii. Electrical testing demonstrated that the ACBDV remained stable across ageing duration, confirming that dielectric performance was maintained.

Overall, the combined results indicate that the POME-MWCNT insulation system can preserve dielectric reliability while maintaining mechanical integrity and improving thermal stability characteristics. These findings suggest strong potential for the material to be applied as a sustainable transformer insulation system.

E. Hasil Penyelidikan / Deliverables

Sila tandakan item yang berkaitan pada senarai berikut:

Please tick the relevant items below:

	Item	Bilangan/Number
	Kertas teknikal/bersiri dalaman <i>Internal technical/serial papers</i>	
	Tesis/disertasi pelajar sarjana <i>Student's Masters thesis/dissertation</i>	
	Tesis pelajar PhD <i>Student's PhD thesis</i>	
/	Kertas persidangan tempatan <i>Local conference papers</i>	1
	Kertas persidangan antarabangsa <i>International conference papers</i>	
	Makalah dalam jurnal tempatan <i>Local journal papers</i>	
	Makalah dalam jurnal antarabangsa <i>International journal papers</i>	
	Monograf atau buku <i>Book/monograph</i>	

Lain-lain/others (sila nyatakan/*please specify*)

Sila senaraikan maklumat (pengarang, tahun, tajuk, jurnal/penerbit, jilid, halaman) bagi penerbitan/tesis yang dihasilkan (jika ada).

Please specify the publications (authors, year, title, journal/publisher, volume, page nos.) (if any)

N. ' . Hashim, S. M. b. W. Masra, S. Rufus, N. b. Junaidi, Y. Arief and N. E. B. A. Hassan, "Performance of Transformer Insulation Paper in the Presence of Multi Walled Carbon Nanotube (MWCNT) in Palm Oil Methyl Ester (POME)," TENCON 2025 - 2025 IEEE Region 10 Conference (TENCON), Kota Kinabalu, Malaysia, 2025, pp. 1608-1612, doi: 10.1109/TENCON66050.2025.11375221.

F. Pengecaman Output / Output Identification

Sila tandakan penerangan yang berkaitan pada senarai berikut:

Please tick the relevant description as given below:

	Suatu sumbangan besar kepada bidang ilmu yang berkaitan <i>A major contribution to knowledge (new knowledge) in the respective discipline</i>
/	Suatu sumbangan kecil tetapi bermakna kepada bidang ilmu yang berkaitan <i>A minor but important contribution to knowledge in the respective discipline</i>
	Suatu sumbangan besar kepada teknologi/ciptaan/algoritma dalam bidang yang berkaitan <i>A major contribution to technology/invention/algorithm or a tangible product</i>
/	Suatu sumbangan kecil tetapi bermakna kepada teknologi/ciptaan/algoritma berkaitan <i>A minor but important contribution to relevant technology/invention/algorithm</i>

/	Terdapat potensi yang baik untuk kajian lanjutan ke arah pemasaran <i>There is a good potential for further R & D and commercialization</i>
	Suatu sumbangan besar kepada kerangka polisi pengurusan/garis panduan <i>A major contribution to management policy framework/guidelines (in relevant areas)</i>
	Suatu sumbangan kecil tetapi bermakna kepada kerangka polisi pengurusan/garis panduan <i>A minor contribution to management policy framework/guidelines (in relevant areas)</i>
	Sesuai untuk dijadikan bahan pengajaran/case study atau bahan latihan <i>The finding is suitable for use as a complementary teaching/training material (a case study)</i>
	Suatu output yang baik dan berpotensi untuk memenangi hadiah penyelidikan <i>A quality output that has a potential for winning a research award</i>
/	Suatu bahan yang baik/sesuai untuk hebahan atau pameran <i>A good/suitable material for showcasing/publicizing/exhibition</i>

Lain-lain/Others (Sila nyatakan/Please specify)

G. Sinopsis Hasil Penyelidikan bagi Tujuan Promosi

Synopsis for Promotional Purposes

(Beri huraian ringkas yang tidak melebihi 400 perkataan dan dalam bahasa yang mudah, bagi maksud hebahan hasil penyelidikan ini melalui media massa dan 'Unimas Research Update')

(Please provide a synopsis not exceeding 400 words, in a not-too-technical language, for the purpose of promoting this research findings through the mass media and Unimas Research Update).

Electricity reaches our homes and industries through transformers, which rely on insulation materials to operate safely. Traditionally, transformers use petroleum-based mineral oil together with paper insulation. While effective, this conventional system is not environmentally friendly and its ageing process can shorten transformer lifespan, leading to costly maintenance and replacement.

This research explored a greener alternative by combining natural palm-based oil (Palm Oil Methyl Ester, POME) with a very small amount of advanced Nano-material known as Multi-Walled Carbon Nanotubes (MWCNT). The study focused on how this eco-friendly liquid interacts with transformer insulation paper (Kraft presspaper), especially when exposed to long operating temperatures that simulate real service conditions.

A series of laboratory tests were carried out to evaluate electrical strength, mechanical durability and thermal stability before and after ageing. The results showed that the modified palm-based insulation system was able to maintain stable electrical performance while preserving the strength of the insulation paper. In addition, the material demonstrated improved resistance to heat-related degradation, which is one of the main causes of transformer failure.

These findings indicate that biodegradable insulating liquids enhanced with nanotechnology have strong potential to replace conventional petroleum-based insulation systems in the future. The adoption of such materials could reduce environmental impact, improve equipment reliability and extend transformer service life, ultimately lowering maintenance costs for utility providers.

This research supports sustainable energy development by promoting the use of renewable resources derived from palm oil while integrating advanced nanotechnology for better performance. The outcomes contribute to ongoing efforts in developing safer and more environmentally responsible electrical infrastructure.

Catatan Penting/Important Notes

Penyelidik diminta mengemukakan kepada Pusat Penyelidikan:

- Borang ini dalam kedua-dua bentuk bercetak dan elektronik
Researchers are required to submit to the Research Centre:
- *This form in both hard- and soft-copies*



.....
Tandatangan (Penyelidik Utama)
Signature (Principal Researcher)

19 Feb 2026

.....
Tarikh
Date



RINGKASAN LAPORAN AKHIR
GERAN PENYELIDIKAN OSAKA GAS
END OF OSAKA GAS
GRANT REPORT SUMMARY

A. Tajuk Projek <i>Project Title</i>	: Enhancing Energy Efficiency through Adaptive Iterative Learning Control with PI
Ketua Penyelidik <i>Project Leader</i>	: Ts Dr Maimun Huja Husin
Fakulti/Institut <i>Faculty/Institute</i>	: Faculty of Engineering, University Malaysia Sarawak, 94300 Kota Samarahan, Sarawak
Ahli Kumpulan Penyelidik <i>Research Team Members</i>	: Ts Dr Mohamad Faizrizwan Bin Mohd Sabri Ts Dr Shamsiah Binti Suhaili Ts Assoc. Prof. Dr Rohana Binti Sapawi
B. Tarikh Geran Diluluskan <i>Grant Approval Date</i>	: 5 th Nov 2024
Tempoh Projek <i>Project Duration</i>	: 1 st Jan 2025 – 31 st Dec 2025
Peruntukan Yg. Diluluskan <i>Budget Approved</i>	: RM10 000
Perbelanjaan Terkini <i>Expenditure To-Date</i>	: RM5,687.62 (penyata dari UHSB) RM2,700.00 (belum dibayar untuk ENCON2026)
C. Pencapaian Keseluruhan <i>Overall Achievement</i>	Huraikan pencapaian berbanding objektif, hipotesis serta permasalahan asal yang diselidiki.. <i>Describe the achievements in relation to the original objectives, hypothesis and research problems.</i> The project successfully met its original research problems, validated all three hypotheses, and achieved all stated objectives.

	Research Problem 1: Conventional PI controllers struggle to handle nonlinearities, fluctuating influent loads, and regulatory tightening in activated sludge systems (based on Benchmark Simulation Model no.1 (BSM1)) Achievement: Successful integration of Iterative Learning Control (ILC) with PI-based ABAC within the BSM1 environment. Demonstrated improved tracking of DO and SNH trajectories under dry, rain, and storm influent scenarios. Research Problem 2: Aeration accounts for up to 67% of WWTP energy consumption; traditional DO control often increases energy use to ensure compliance. Achievement: Quantifiable reduction in oxygen transfer coefficient demand and lower aeration energy index while maintaining effluent quality limits. Research Problem 3: Limited research on practical ILC applications in wastewater treatment. Achievement: Developed a MATLAB/Simulink-based ILC–PI ABAC implementation framework. Produced validated comparative performance results against standard BSM1 PI controller and conventional PI ABAC controller Hypothesis (a): ILC + PI ABAC improves effluent quality and reduces energy consumption compared to traditional PI. Achievement: ✓ Improved nitrogen removal performance ✓ Lower SNH peaks during dynamic influent conditions ✓ Reduced aeration energy index Hypothesis (b): ILC + PI ABAC improves adaptability to fluctuating influent conditions. Achievement: ✓ Improved regulatory compliance stability across evaluation periods Hypothesis (c): ILC + PI ABAC yields cost savings via energy reduction. Achievement: ✓ Reduced aeration operational cost (simulated energy index reduction) Objective 1: To evaluate the impact of integrating Iterative Learning Control (ILC) with PI ABAC on effluent quality parameters in the activated sludge process of wastewater treatment plants, compared to traditional PI controllers.
--	---

	Achievement: The integrated ILC–PI ABAC controller demonstrated improved effluent quality performance, achieving lower ammonium (SNH) and total nitrogen (N_{tot}) concentrations compared to the conventional PI controller within the BSM1 platform. Objective 2: To investigate the effectiveness of the combined use of ILC and PI ABAC in enhancing the adaptability of wastewater treatment plant operations to fluctuating influent conditions, assessing its influence on effluent quality performance and compliance with regulatory standards. Achievement: The proposed controller showed enhanced adaptability under dry, rain, and storm influent weathers. Objective 3: To assess the economic feasibility and cost-effectiveness of implementing ILC with PI ABAC in terms of energy savings for aeration processes, comparing these savings with the operational costs associated with traditional PI control strategies in wastewater treatment plant operations. Achievement: Simulation results indicated reduced aeration energy demand relative to the conventional PI strategy, demonstrating improved energy-effluent trade-off performance and indicating strong potential for operational cost savings in wastewater treatment plants.
--	---

D. Pencapaian Utama *Key Findings*

The integration of ILC with PI ABAC significantly improves the energy–effluent quality trade-off, achieving stable regulatory compliance with reduced aeration energy consumption compared to the conventional PI strategy within the BSM1.

E, Hasil Penyelidikan *Deliverables*

Sila tandakan item yang berkaitan pada senarai berikut:

Please tick the relevant items below:

	Item	Bilangan/Number
	Kertas teknikal/bersiri dalaman <i>Internal technical/serial papers</i>	
	Tesis/disertasi pelajar sarjana <i>Student's Masters thesis/dissertation</i>	
	Tesis pelajar PhD <i>Student's PhD thesis</i>	
✓	Kertas persidangan tempatan <i>Local conference papers</i>	2
	Kertas persidangan antarabangsa <i>International conference papers</i>	

	Makalah dalam jurnal tempatan <i>Local journal papers</i>	
	Makalah dalam jurnal antarabangsa <i>International journal papers</i>	
	Monograf atau buku <i>Book/monograph</i>	

Lain-lain/others (sila nyatakan/*please specify*)

Sila senaraikan maklumat (pengarang, tahun, tajuk, jurnal/penerbit, jilid, halaman) bagi penerbitan/tesis yang dihasilkan (jika ada).

Please specify the publications (authors, year, title, journal/publisher, volume, page nos.) (if any)

F. Pengecaman Output Output Identification

Sila tandakan penerangan yang berkaitan pada senarai berikut:

Please tick the relevant description as given below:

	Suatu sumbangan besar kepada bidang ilmu yang berkaitan <i>A major contribution to knowledge (new knowledge) in the respective discipline</i>
✓	Suatu sumbangan kecil tetapi bermakna kepada bidang ilmu yang berkaitan <i>A minor but important contribution to knowledge in the respective discipline</i>
	Suatu sumbangan besar kepada teknologi/ciptaan/algoritma dalam bidang yang berkaitan <i>A major contribution to technology/invention/algorithm or a tangible product</i>
	Suatu sumbangan kecil tetapi bermakna kepada teknologi/ciptaan/algoritma berkaitan <i>A minor but important contribution to relevant technology/invention/algorithm</i>
	Terdapat potensi yang baik untuk kajian lanjutan ke arah pemasaran <i>There is a good potential for further R & D and commercialization</i>
	Suatu sumbangan besar kepada kerangka polisi pengurusan/garis panduan <i>A major contribution to management policy framework/guidelines (in relevant areas)</i>
	Suatu sumbangan kecil tetapi bermakna kepada kerangka polisi pengurusan/garis panduan <i>A minor contribution to management policy framework/guidelines (in relevant areas)</i>
	Sesuai untuk dijadikan bahan pengajaran/ <i>case study</i> atau bahan latihan <i>The finding is suitable for use as a complementary teaching/training material (a case study)</i>
	Suatu output yang baik dan berpotensi untuk memenangi hadiah penyelidikan <i>A quality output that has a potential for winning a research award</i>
	Suatu bahan yang baik/sesuai untuk hebahan atau pameran

A good/suitable material for showcasing/publicizing/exhibition

Lain-lain/Others (Sila nyatakan/Please specify)

G. Sinopsis Hasil Penyelidikan bagi Tujuan Promosi

Synopsis for Promotional Purposes

(Beri huraian ringkas yang tidak melebihi 400 perkataan dan dalam bahasa yang mudah, bagi maksud hebahan hasil penyelidikan ini melalui media massa dan 'Unimas Research Update')

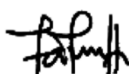
(Please provide a synopsis not exceeding 400 words, in a not-too-technical language, for the purpose of promoting this research findings through the mass media and Unimas Research Update).

Wastewater treatment plants play a critical role in protecting rivers, public health, and the environment. However, treating wastewater, especially during the aeration process, consumes a large amount of electricity. In fact, aeration can account for more than half of a plant's total energy use. Improving energy efficiency while maintaining high water quality standards is therefore a major challenge for plant operators. This research introduces a more adaptive control approach to improve the performance of the activated sludge process, the core biological treatment stage in most wastewater treatment plants. The study combines two techniques: Iterative Learning Control, which enables the system to learn from past operating data, and Proportional Integral Ammonium based Aeration Control, which adjusts aeration based on ammonium levels rather than relying solely on dissolved oxygen measurements. Using the widely recognized Benchmark Simulation Model no. 1 (BSM1) for simulation and validation, the proposed method was compared against the conventional proportional integral control strategy commonly used in treatment plants. The results show that the new integrated approach improves effluent quality, particularly in controlling ammonium and total nitrogen, while reducing the energy required for aeration. Importantly, the system also demonstrated better adaptability under different operating conditions, including fluctuating influent loads caused by dry weather, rainfall, and storm events. This means the treatment plant can respond more effectively to sudden changes in wastewater characteristics without compromising environmental compliance. Overall, the study highlights a practical solution that can enhance energy efficiency and environmental performance in wastewater treatment plants. By leveraging data driven learning and intelligent control strategies, this research contributes to more sustainable water management practices and supports national and global goals for environmental protection and energy conservation. The findings offer strong potential for real world implementation.

Catatan Penting/Important Notes

Penyelidik diminta mengemukakan kepada Pusat Penyelidikan:

- Borang ini dalam kedua-dua bentuk bercetak dan elektronik
- Researchers are required to submit to the Research Centre:
- This form in both hard- and soft-copies



.....
Tandatangan (Penyelidik Utama)
Signature (Principal Researcher)

.....19 Feb 2026.....
Tarikh
Date



RINGKASAN LAPORAN AKHIR
GERAN PENYELIDIKAN OSAKA GAS
END OF OSAKA GAS
GRANT REPORT SUMMARY

A. Tajuk Projek <i>Project Title</i>	: Development of Index for Indoor Occupational Environmental Stress Assessment in SMEs Industry
Ketua Penyelidik <i>Project Leader</i>	: Ts. Mohd Azrin Mohd Said
Fakulti/Institut <i>Faculty/Institute</i>	: FACULTY OF ENGINEERING
Ahli Kumpulan Penyelidik <i>Research Team Members</i>	: 1. Associate Professor Ir. Dr Syed Tarmizi bin Syed Shazali 2. Professor Ir Dr Abdullah bin Hj Yassin 3. Dr Magdalene anak Andrew Munot 4. Ir. Ts. Dr Shirley anak Johnathan Tanjong 5. Dr Mohamad Syazwan Zafwan bin Mohamad Suffian 6. Dr Nor Kamaliana binti Khamis
B. Tarikh Geran Diluluskan <i>Grant Approval Date</i>	: 5 Nov 2024
Tempoh Projek <i>Project Duration</i>	: 1 year 1 January 2025 – 31 December 2025
Peruntukan Yg. Diluluskan <i>Budget Approved</i>	: RM 10,000.00
Perbelanjaan Terkini <i>Expenditure To-Date</i>	: RM9883.24 Balance From UHSB (RM116.76)
C. Pencapaian Keseluruhan Overall Achievement Huraikan pencapaian berbanding objektif, hipotesis serta permasalahan asal yang diselidiki.. <i>Describe the achievements in relation to the original objectives, hypothesis and research problems.</i>	

This study aimed to develop **novel occupational environmental indices** for SME factories through the establishment of the **Workplace Heat Stress Comfort Index (WHSCI)** and the **Indoor Environment Workplace Risk Assessment (IEWRA)** frameworks. The overall goal was to enhance smart safety, health, and environmental monitoring systems within SME industrial settings.

All objectives outlined in the proposal have been successfully achieved, as detailed below:

1) To identify key environmental stressors in indoor occupational settings within SMEs

This objective was achieved through comprehensive environmental measurements and field assessments conducted in selected SME factories. The study identified critical environmental stressors affecting workers' comfort and safety. These stressors formed the foundational variables for the development of both WHSCI and IEWRA models.

2) To develop comprehensive and standardized assessment frameworks tailored for SME industries

This objective was fulfilled through the development of two structured models:

- **WHSCI** – A predictive index model specifically designed to evaluate workplace heat stress comfort levels by integrating WBGT, thermal parameters, and workers' subjective comfort ratings.
- **IEWRA** – A comprehensive indoor environmental risk assessment framework incorporating IAQ, lighting, noise, and temperature factors, supported by a structured risk matrix for hazard classification.

Both frameworks were designed to be practical, measurable, and directly applicable within SME operational environments.

3) To validate the developed indices through empirical studies in diverse SME environments

Validation was successfully conducted through field data collection across multiple SME production and workshop settings. Statistical modelling and predictive analysis confirmed the robustness, reliability, and practical applicability of both WHSCI and IEWRA.

The validation results demonstrated significant correlations between objective environmental measurements and workers' perceived comfort and risk responses, confirming the scientific credibility of the developed indices.

4) To establish novel predictive index equations and develop an application (app) for smart workplace safety and health

Both studies successfully produced **novel predictive index equations**:

- A heat stress comfort prediction equation under WHSCI
- A workplace environmental risk prediction model under IEWRA

In addition, the foundational framework for a smart monitoring application has been established to facilitate data input, automated risk calculation, and workplace safety evaluation for SMEs. Further large-scale validation and user acceptance studies will strengthen its implementation at industry level.

In conclusion, all research objectives have been fully achieved through the successful development, validation, and preliminary implementation framework of the WHSCI and IEWRA models. These outputs provide data-driven, practical, and scalable tools to improve occupational environmental management, safety performance, and worker well-being within SME industries.

D. Pencapaian Utama **Key Findings**

1. Identification of Critical Environmental Stressors

The study confirmed that heat stress (WBGT), temperature, relative humidity, indoor air quality (IAQ), lighting intensity, and noise levels are the primary environmental factors influencing workers' comfort, safety, and productivity in SME factories.

2. Development of Novel Predictive Indices

Two predictive models were successfully developed:

- a. **Workplace Heat Stress Comfort Index (WHSCI)** for assessing thermal comfort and heat strain risk.
- b. **Indoor Environment Workplace Risk Assessment (IEWRA)** for evaluating overall indoor environmental hazards.

3. Validated and Industry-Applicable Models

Empirical validation across multiple SME environments demonstrated strong reliability and correlation between measured environmental data and workers' perceived comfort and risk levels.

4. Practical Tool for SMEs

The developed indices provide data-driven, easy-to-implement tools that support systematic monitoring, risk classification, and proactive workplace safety improvements.

5. Foundation for Smart Safety Application

The research established the basis for developing a smart application to automate environmental risk calculation and enhance occupational safety management in SMEs.

E, Hasil Penyelidikan **Deliverables**

Sila tandakan item yang berkaitan pada senarai berikut:

Please tick the relevant items below:

	Item	Bilangan/Number
	Kertas teknikal/bersiri dalaman <i>Internal technical/serial papers</i>	
	Tesis/disertasi pelajar sarjana <i>Student's Masters thesis/dissertation</i>	
	Tesis pelajar PhD <i>Student's PhD thesis</i>	
	Kertas persidangan tempatan <i>Local conference papers</i>	

	Kertas persidangan antarabangsa <i>International conference papers</i>	
✓	Makalah dalam jurnal tempatan <i>Local journal papers</i>	1
	Makalah dalam jurnal antarabangsa <i>International journal papers</i>	
	Monograf atau buku <i>Book/monograph</i>	

Lain-lain/others (sila nyatakan/please specify)

1. **Two Final year Report (Undergraduate Students)**
2. **Two Intellectual Property under RIEC UNIMAS and MyIPO**
3. **Two Bronze in Borneo InTEX 2025**
4. **1 Gold and 1 Silver in MIIX 2025**

Sila senaraikan maklumat (pengarang, tahun, tajuk, jurnal/penerbit, jilid, halaman) bagi penerbitan/tesis yang dihasilkan (jika ada).

Please specify the publications (authors, year, title, journal/publisher, volume, page nos.) (if any)

F. Pengecaman Output Output Identification

Sila tandakan penerangan yang berkaitan pada senarai berikut:

Please tick the relevant description as given below:

	Suatu sumbangan besar kepada bidang ilmu yang berkaitan <i>A major contribution to knowledge (new knowledge) in the respective discipline</i>
✓	Suatu sumbangan kecil tetapi bermakna kepada bidang ilmu yang berkaitan <i>A minor but important contribution to knowledge in the respective discipline</i>
	Suatu sumbangan besar kepada teknologi/ciptaan/algoritma dalam bidang yang berkaitan <i>A major contribution to technology/invention/algorithm or a tangible product</i>
✓	Suatu sumbangan kecil tetapi bermakna kepada teknologi/ciptaan/algoritma berkaitan <i>A minor but important contribution to relevant technology/invention/algorithm</i>
	Terdapat potensi yang baik untuk kajian lanjutan ke arah pemasaran <i>There is a good potential for further R & D and commercialization</i>
	Suatu sumbangan besar kepada kerangka polisi pengurusan/garis panduan <i>A major contribution to management policy framework/guidelines (in relevant areas)</i>
✓	Suatu sumbangan kecil tetapi bermakna kepada kerangka polisi pengurusan/garis panduan <i>A minor contribution to management policy framework/guidelines (in relevant areas)</i>
	Sesuai untuk dijadikan bahan pengajaran/case study atau bahan latihan <i>The finding is suitable for use as a complementary teaching/training material (a case study)</i>
✓	Suatu output yang baik dan berpotensi untuk memenangi hadiah penyelidikan <i>A quality output that has a potential for winning a research award</i>
	Suatu bahan yang baik/sesuai untuk hebahan atau pameran <i>A good/suitable material for showcasing/publicizing/exhibition</i>

Lain-lain/Others (Sila nyatakan/Please specify)

G. Sinopsis Hasil Penyelidikan bagi Tujuan Promosi

Synopsis for Promotional Purposes

(Beri huraian ringkas yang tidak melebihi 400 perkataan dan dalam bahasa yang mudah, bagi maksud hebahan hasil penyelidikan ini melalui media massa dan 'Unimas Research Update')

(Please provide a synopsis not exceeding 400 words, in a not-too-technical language, for the purpose of promoting this research findings through the mass media and Unimas Research Update).

Ensuring safe and comfortable working environments remains a major challenge for Small and Medium Enterprise (SME) factories, particularly in settings exposed to high heat, poor air quality, inadequate lighting, and excessive noise. To address these concerns, researchers at Universiti Malaysia Sarawak have developed two practical and industry-focused assessment tools: the Workplace Heat Stress Comfort Index (WHSCI) and the Indoor Environment Workplace Risk Assessment (IEWRA).

WHSCI is designed to evaluate and predict heat stress risks in factory environments by analysing temperature, humidity, radiant heat, and workers' comfort feedback. This enables employers to detect unsafe heat conditions early and implement preventive measures to protect workers' health and productivity.

IEWRA assesses overall indoor workplace conditions, including air quality, lighting intensity, noise levels, and temperature. It provides a clear risk classification system that helps SMEs identify hazards and prioritise workplace improvements effectively.

Both tools were tested in real SME factory settings and demonstrated strong reliability and practical applicability. The innovation has received national recognition, with IEWRA winning a Gold Medal and WHSCI receiving a Silver Medal at the Malaysia Invention & Innovation Expo 2025.

This research supports safer, healthier, and more sustainable workplaces within Malaysia's SME sector.

Catatan Penting/Important Notes

Penyelidik diminta mengemukakan kepada Pusat Penyelidikan:

- Borang ini dalam kedua-dua bentuk bercetak dan elektronik
- Researchers are required to submit to the Research Centre:*
- *This form in both hard- and soft-copies*



.....
Tandatangan (Penyelidik Utama)
Signature (Principal Researcher)

.....**20 Februari 2026**.....
Tarikh
Date



RINGKASAN LAPORAN AKHIR GERAN PENYELIDIKAN OSAKA GAS

*END OF OSAKA GAS
GRANT REPORT SUMMARY*

A. Tajuk Projek <i>Project Title</i>	:	From sago pith waste to bioplastics: Study on mechanical and thermophysical properties
Ketua Penyelidik <i>Project Leader</i>	:	Dr Mahshuri Yusof
Fakulti/Institut <i>Faculty/Institute</i>	:	Faculty of Engineering, University Malaysia Sarawak, 94300 Kota Samarahan, Sarawak
Ahli Kumpulan Penyelidik <i>Research Team Members</i>	:	Dr Marini binti Sawawi AP Dr Nicholas Kuan Hoo Tien Dr Nur Tahirah Binti Razali Dr Noor Hisyam Bin Noor Mohamed Dr Ervina Binti Junaidi
B. Tarikh Geran Diluluskan <i>Grant Approval Date</i>	:	5 November 2025
Tempoh Projek <i>Project Duration</i>	:	1 January 2025 – 31 December 2025
Peruntukan Yg. Diluluskan <i>Budget Approved</i>	:	RM10 000
Perbelanjaan Terkini <i>Expenditure To-Date</i>	:	Total expenditure: RM8,578.6 RM5,796.00 (statement from UHSB) RM2,578.60 (I have not yet received the payment claim for the conference fee for attending and presenting at the 1st Global Conference on Industrial, Materials, and Manufacturing (GCIMM 2025), held on 20–22 October 2025 in Bandar Seri Begawan, Brunei Darussalam)
C. Pencapaian Keseluruhan <i>Overall Achievement</i> Huraikan pencapaian berbanding objektif, hipotesis serta permasalahan asal yang diselidiki.. <i>Describe the achievements in relation to the original objectives, hypothesis and research problems.</i> Three main objectives of this study: 1) To investigate the tensile properties and biodegradability of the plastics made from		

various concentrations of sago starch waste starch which are 5 g, 10 g, 15 g, 20 g, and 25 g.

- 2) To measure water absorption of the bioplastics made from sago starch
- 3) To measure the degree of crystallinity, heat capacity and thermal behaviour (degradation) of bioplastics made from sago starch

Up to December 2025, we are able to obtain all objectives successfully. However for objective 3 we cannot run the TGA test due to the apparatus is still “under maintenance”. Then, we replace the TGA test to heat conductivity test.

Objective 1: To investigate the tensile properties and biodegradability of the plastics made from various concentrations of sago starch waste starch which are 5 g, 10 g, 15 g, 20 g, and 25 g.

Finding 1: Adding sago starch might increase the tensile strength of the bioplastics

Table 1 shows that sample with 5 g of starch content recorded lower tensile strength than S1 sample which without any starch content. There is a rapidly increase in tensile strength when the sago starch content increases from 15 g to 20 g. The tensile strength recorded for 15 g sample and 20 g sample were 5.68 MPa and 11.18 MPa respectively. The sample with highest starch concentration (S6, 25 g starch) had the highest tensile strength (12.54 MPa) while the S2 sample (5 g starch) recorded the lowest tensile strength (3.07 MPa). The reduction of tensile strength of S1 (3.28 MPa) and S2 (3.07 MPa) probably due to the presence of bubbles on the surface of bioplastics film during fabrication process. Consequently, it causes poor interfacial adhesion between starch and glycerol which leads to deterioration in tensile strength of the sago starch bioplastics.

The present findings match those observed in earlier studies which stated that increase of starch content lead to the increase of tensile strength of bioplastics. Research from Hanif et al. (2019) obtained similar outcome by using cassava starch and glycerol as plasticizer. A possible explanation for this might be due to formation of stronger hydrogen bonding by the interaction of starch-starch molecules. From the perspective of crystallinity, starch is partially crystalline. Hence, when the concentration of starch increases, the crystallinity increases. Higher crystallinity tends to achieve higher tensile properties. Besides, high concentrations of glycerol will result in the decrease of tensile strength as it will reduce the interaction of intermolecular bonding between the starch molecules. This explains that the S1 and S2 has lower tensile strength than other sample which have higher starch content.

However, when comparing our result to other older studies, it must be pointed out the contrary of their findings. Another past research conducted by Sapei et al. (2015) stated that the tensile strength of starch-based bioplastics is inversely related to the concentration of starch. This result was explained by the fact that starch has inferior mechanical properties and branched structure. Therefore, with the inclusion of starch, it exhibits lower tensile strength. Judawisastra et al., 2017 supported the explanation by stated that starch has hydrophilic nature. This characteristic will influence the tensile properties of bioplastics. The possible interference of different fabrication process, thickness of bioplastics film and testing speed used cannot be ruled out.

Table 1: Tensile strength of sago starch bioplastics with different sago starch content

Samples	Starch Content (g)	Tensile Strength (MPa)				
		1	2	3	Average	Std Dev
S1	0	3.91	3.25	2.69	3.28	0.61
S2	5	3.25	3.59	2.38	3.07	0.62
S3	10	2.41	4.68	4.65	3.92	1.30
S4	15	6.58	5.25	5.21	5.68	0.78
S5	20	11.1	12.42	1.03	11.18	6.23
S6	25	8.61	15.91	13.11	12.54	3.68

Finding 2: Adding sago starch might increase the elasticity of the bioplastics

Table 2 shows the results of average tensile modulus for sago starch bioplastics with various starch contents of 0 g, 5 g, 10 g, 15 g, 20 g and 25 g. As the starch content increases, the average tensile modulus of bioplastics demonstrates an increasing performance trend. This strongly indicates that the starch content in bioplastics is directly proportional to the average tensile modulus of sago starch bioplastics. Based on Table 2, it shows that the S1 sample which is the bioplastics with 0 g starch content has the lowest value of average tensile modulus that reaches as low as 6.3 MPa. The average tensile modulus of S6 sample with 25 g starch reaches 1080.4 MPa, which is the highest average tensile modulus obtained in this study.

With inclusion of sago starch, the optimal starch content for the bioplastics to achieve the optimal tensile modulus is 25 g, which was the same as the optimum condition for tensile strength. The higher the starch content, the stiffer the bioplastics. Furthermore, there was a huge difference between the tensile modulus obtained by S4 sample and S5 sample. With a 5 g starch differences, S5 sample with 20 g of starch content yielded 0.7156 GPa which is 74.92% more than S4 sample.

The result is consistent with the research by Hanif et al. (2019), who worked with cassava starch and glycerol to fabricate bioplastics. They have shown that the increase of starch content will significantly improve the elasticity of bioplastics. However, if the glycerol concentration is higher than starch, will result in lower tensile strength but more elastic bioplastics. In addition, similar pattern of result was obtained in the study by Santana et al. (2017). Starch was extracted from jackfruit seed and glycerol was used as plasticizer as well. Santana et al. (2017) explained that the filler impact of starch causes the elasticity to increase. In this case, starch was found to act as filler and starch granules act as reinforcement. Moreover, the higher elastic modulus could be attributes to the formation of stronger bonding due to interaction between starch-starch molecules. During the formation, macromolecules was found to improve the stiffness of the bioplastics.

As both starch and glycerol are hydrophilic in nature, free hydrogen in the structure is easily penetrated with water vapour to form hydrogen bonding. This may affect the mechanical properties as the water molecules is present in the film fabricated. Besides, starch is water soluble, and presence of water will significantly reduce the mechanical properties. Remarkably, our findings have proved that dispersion of starch in bioplastics is well homogenous, and no agglomeration observed.

Another factor that might cause the rise in tensile modulus of sago starch bioplastics is the amylose content of sago pith waste. According to Lourdin et al. (1999), mechanical properties of bioplastics is affected by the amylose content of the starch itself contains. The bioplastics tends to have better mechanical properties compared to the bioplastics fabricate by lower amylose content. The amylose content of sago starch was found 21.7% – 27%. (Santoso, 2018) The only disadvantage is that the materials will become fragile. Hence, we speculate that the increase of starch concentrations in the sago starch bioplastics increase the amylose content, but the fragile effect brought by amylose was weakened by the addition of glycerol, and thus improve the elasticity of the sago starch bioplastics. Further study should be warranted to examine the effect of amylose concentrations of the starch to the mechanical properties of the bioplastics.

Table 2: Elasticity of sago starch bioplastics with different sago starch content

Samples	Starch Content (g)	Young's Modulus (MPa)				
		1	2	3	Average	Std Dev
S1	0	4.2	9.7	5.1	6.3	3.0
S2	5	19.9	40.1	44.6	34.9	13.2
S3	10	34.4	77.5	77.1	63	24.8
S4	15	196	149.7	193	179.6	25.9
S5	20	722.3	757.9	666.7	715.6	46.0
S6	25	921	1189.4	1130.8	1080.4	141.1

Finding 3: Adding sago starch might decrease the elongation at break of of the bioplastics

Table 3 shows the elongation properties of sago starch bioplastics with different starch contents which are 0 g, 5 g, 10 g, 15 g, 20 g and 25 g. The elongation properties of sago starch bioplastics shows decreasing trend. It indicates that the elongation properties of bioplastics are inversely proportional to the mass of starch. S1 sample with 0 g of starch has the highest elongation value which yield at 54.788 mm, while the S6 sample with 25 g of starch had the lowest elongation value which is 1.207 mm. The decrement is about 97.8%.

The elongation value of the S3 sample is 32.283 mm which is the third highest among the six samples. When the starch content increases to 15 g, the elongation value of S4 sample falls to 21.912 mm which is about 32.13% decrement. Higher elongation values indicates that the sample has higher ductility and can withstand greater load without breaking.

In this study, as the concentration of starch increases gradually, the effect of glycerol in bioplastics decreases progressively even though the concentration of glycerol kept constant throughout the whole process. From here, the increase in starch concentration and decrease in glycerol concentrations induces the downregulation of elongation properties.

This result ties well with prior investigation by Hanif et al. (2019) who used cassava starch and glycerol as plasticizer. The rationale of the trend could be attributed to the interaction between starch molecules which embellished the flexibility of the bioplastics by diminishing the rigidity and increase the chain mobility. This explanation was supported by Sugiharto et al. (2021) who agreed that glycerol enhance elasticity to the bioplastics by impairing the interaction between the intermolecular force of the polymer chains.

Table 3: Elongation at break of sago starch bioplastics with different sago starch content

Samples	Starch Content (g)	Elongation at Break (mm)				
		1	2	3	Average	Std Dev
S1	0	63.56	47.93	52.88	54.79	7.99
S2	5	44.61	36.52	26.97	36.04	8.83
S3	10	21.15	37.87	37.82	32.28	9.64
S4	15	23.14	26.04	16.56	21.91	4.86
S5	20	3.02	2.19	2.10	2.44	0.51
S6	25	0.97	1.41	1.24	1.21	0.23

Finding 4: Increasing of sago starch content in bioplastics caused the water absorption in sago starch bioplastics capacity to decrease.

Water absorption capacity is the ability of a material or substance to take in and retain water. It is a measure of how much water a material can absorb relative to its own mass or volume. The average weight gain is based on the average of three specimens for each sample with various starch content.

The water absorption capacity is obtained by measuring the weight of 10 mm × 30 mm specimens by calculating the weight before and after immersion in distilled water at normal room temperature for 24 hours with time intervals of 4 hours. The water uptake of specimens with different starch content (0 g, 5 g, 10 g, 15 g, 20 g and 25 g) were compared to study on the water absorption capacity. The results of water absorption capacity are shown in Table 4.

Based on obtained result, increasing of sago starch content in bioplastics caused the water absorption capacity to decrease. S1 sample without any sago starch recorded the highest water uptake (6.51 g after 24 hours immersion) among all the samples. Meanwhile, S6 sample with 25 g of sago starch obtained lowest water uptake (2.21 g after 24 hours immersion). S1 sample with 0 g of starch content has the highest water uptake due to the presence of hydroxyl groups in glycerol molecules. The hydrophilic nature of glycerol causing the S1 sample can absorb more water than other samples. S1 sample does not contain starch, hence, hydrogen bond is weaker which ease the water absorption.

After 16 hours immersion, the increment of water uptake starts to increase gradually. Table 4 also shows the maximum water uptake of sago starch bioplastics with different starch content. The higher the starch content in bioplastics, the lower the water absorption. This indicates that the increase in starch content strengthen the hydrogen bond of starch-based bioplastics, causing the water uptake decrease with the increase of starch content.

Similar result was reported by Fauziah et al. (2020). Sago starch also employed in their research to study the mechanical properties of starch-based bioplastics. From the result they observed, the water uptake of their sago starch bioplastics is inversely proportional to the starch content in the bioplastics. They explained that the hydrophilic nature of starch and glycerol caused the water uptake to increase. Thus, they concluded that the amount of glycerol and starch can significantly clout the water absorption of bioplastics.

Furthermore, several previous studies also claimed that increase in starch content in bioplastics will cause the water absorption to decrease. (Tarique et al.,2021; Sahari et al.,2012) Tarique et al. (2021) fabricate the bioplastics film by using arrowroot starch and glycerol as plasticizer, while Sahari et al. (2012) utilises the sugar palm starch and glycerol as well. Both researchers attain the identical outcome that the higher the starch and glycerol content, the lower the water absorption. This phenomenon is explained that the hydrogen bonding in starch molecules is combined with

hydroxyl groups in glycerol molecules, forming stronger bonding and preventing the water molecules to penetrate in.

Table 4: Water absorption capacity of sago starch bioplastics with different sago starch content

Samples	Starch content (g)	Original weight (g), wo	Average Weight gain (g)					
			4 hours	8 hours	12 hours	16 hours	20 hours	24 hours
S1	0	0.24	3.97	4.57	5.96	6.34	6.49	6.51
S2	5	0.21	3.12	3.71	4.23	4.52	4.58	4.60
S3	10	0.22	2.89	3.4	4.05	4.31	4.42	4.46
S4	15	0.23	2.83	2.92	3.02	3.22	3.24	3.24
S5	20	0.22	1.98	2.27	2.48	2.5	2.54	2.57
S6	25	0.21	1.76	2.09	2.19	2.21	2.21	2.21

Finding 5: Increasing of sago pith content in sago starch bioplastics will enhance the degree of crystallinity.

The % crystallinity of bioplastics with SPW as filler was found to be greater than neat sago starch bioplastics. Adding 5g increased the % crystallinity to 35.8 for. At 10 g filler loading increased the % crystallinity to 43.6. Adding 25 g SPW enhanced the % crystallinity to 51.31.

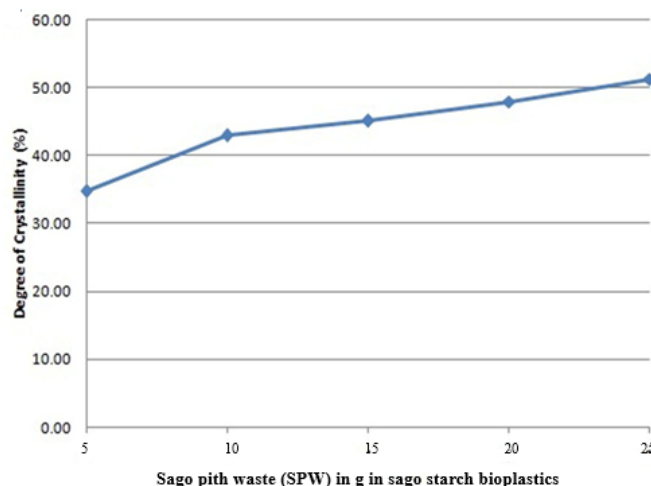


Figure 3: Degree of crystallinity of various SPW content in sago starch bioplastics

Finding 6: Increasing sago starch contentt in sago starch based bioplastics will reduce the specific heat capacity (Cp).

As the sago starch content increases in glycerol-based bioplastics, the specific heat capacity (Cp) of the composite generally decreases. This is because starch has a lower heat capacity compared to glycerol and water, so higher starch fractions reduce the overall Cp of the blend. However, as the sago pith waste (SPW) content increase in the bioplastics the Cp will decreases because SPW becomes more thermally responsive (

Finding 7: The effective thermal conductivity of all the sago starch bioplastics increases with

the increment of weight of sago pith waste

It can be clearly seen from the table that the thermal conductivity of all the sago starch bioplastics increases with the increment of weight of SPW. Initially, thermal conductivity of the sample without SPW added is 8.895 W/mK. Upon introducing SPW of 5 g, the thermal conductivity decreased to 8.056 W/mK. and eventually increase until the 25 g SPW. The thermal conductivity increased higher at 10 g of SPW and it is observed to slow down from 10g to 20g. A great improvement can be observed for 25 g of SPW weight at 11.552 W/mK which is 1.3 times better than the neat sago starch bioplastic.

Table 1: Thermal conductivity of neat sago starch bioplastics and with SPW filler

Sample	Thermal conductivity (W/mK)					
	Neat sago bioplastics	5with SPW filler (g)				
		5	10	15	20	25
1	9.398	7.936	9.653	10.222	10.364	11.671
2	9.057	8.222	9.713	9.994	10.331	11.471
3	8.231	8.342	9.925	9.979	10.258	11.515
Average	8.895	8.167	9.764	10.065	10.318	11.552
Std Dev	0.6	0.209	0.143	0.136	0.054	0.105
Enhancement (%)	-	-9.43	9.77	13.15	16	29.87

References

- Judawisastra, H., Sitohang, R. D. R., & Marta, L. (2017, July). Water absorption and its effect on the tensile properties of tapioca starch/polyvinyl alcohol bioplastics. In IOP conference series: materials science and engineering (Vol. 223, No. 1, p. 012066). IOP Publishing.
- Fauziah, A. R., Lanuru, M., Syahrul, M., Werorilangi, S., & Demmallino, E. B. (2020). Utilization of Solid Waste from Sago Flour Industry (Sago Pith Waste) as Biodegradable Plastic. *Advances in Environmental Biology*, 14(1), 42-48.
- Santana, R. F., Bonomo, R. C. F., Gandolfi, O. R. R., Rodrigues, L. B., Santos, L. S., dos Santos Pires, A. C., ... & Veloso, C. M. (2018). Characterization of starch-based bioplastics from jackfruit seed plasticized with glycerol. *Journal of food science and technology*, 55, 278-286
- Sapei, L., Padmawijaya, K. S., Sijayanti, O., & Wardhana, P. J. (2017, July). Study of the influence of ZnO addition on the properties of chitosan-banana starch bioplastics. In IOP Conference Series: Materials Science and Engineering (Vol. 223, No. 1, p. 012044). IOP Publishing.
- Sugiharto, A., Syarifa, A., Handayani, N., & Mahendra, R. (2021). Effect of Chitosan, Clay, and CMC on Physicochemical Properties of Bioplastic from Banana Corm with Glycerol. *Jurnal Bahan Alam Terbarukan*, 10(1), 31-35.
- Santoso, B. (2018). Recovery of starch from sago pith waste and waste water treatment. *Sago Palm: Multiple Contributions to Food Security and Sustainable Livelihoods*, 261-269.

D. Pencapaian Utama

Key Findings

3 main findings related to mechanical properties, water absorption and thermophysical properties:

- 1) Adding sago starch may increase the tensile strength and elasticity of the bioplastics, but not the elongation at break.
- 2) Increasing of sago starch content in bioplastics caused the water absorption in sago starch bioplastics capacity to decrease
- 3) Increasing sago starch content in sago starch-based bioplastics will reduce the specific heat capacity (Cp) but enhance the degree of crystallinity.

E, Hasil Penyelidikan

Deliverables

Sila tandakan item yang berkaitan pada senarai berikut:

Please tick the relevant items below:

	Item	Bilangan/Number
	Kertas teknikal/bersiri dalaman <i>Internal technical/serial papers</i>	
	Tesis/disertasi pelajar sarjana <i>Student's Masters thesis/dissertation</i>	
	Tesis pelajar PhD <i>Student's PhD thesis</i>	
	Kertas persidangan tempatan <i>Local conference papers</i>	
√	Kertas persidangan antarabangsa <i>International conference papers</i>	2
	Makalah dalam jurnal tempatan <i>Local journal papers</i>	
	Makalah dalam jurnal antarabangsa <i>International journal papers</i>	
	Monograf atau buku <i>Book/monograph</i>	

Lain-lain/others (sila nyatakan/*please specify*)

Sila senaraikan maklumat (pengarang, tahun, tajuk, jurnal/penerbit, jilid, halaman) bagi penerbitan/tesis yang dihasilkan (jika ada).

Please specify the publications (authors, year, title, journal/publisher, volume, page nos.) (if any)

2 manuscripts were submitted to *ASEAN Journal on Science and Technology for Development* (AJSTD) and the status is under review.

- Properties of Biodegradable Plastics from Tapioca Skin Waste Starch
- Mechanical Properties of Bioplastics from Sago Pith Waste

F. Pengecaman Output
Output Identification

Sila tandakan penerangan yang berkaitan pada senarai berikut:

Please tick the relevant description as given below:

☐	Suatu sumbangan besar kepada bidang ilmu yang berkaitan <i>A major contribution to knowledge (new knowledge) in the respective discipline</i>
☒	Suatu sumbangan kecil tetapi bermakna kepada bidang ilmu yang berkaitan <i>A minor but important contribution to knowledge in the respective discipline</i>
☐	Suatu sumbangan besar kepada teknologi/ciptaan/algoritma dalam bidang yang berkaitan <i>A major contribution to technology/invention/algorithm or a tangible product</i>
☐	Suatu sumbangan kecil tetapi bermakna kepada teknologi/ciptaan/algoritma berkaitan <i>A minor but important contribution to relevant technology/invention/algorithm</i>
☐	Terdapat potensi yang baik untuk kajian lanjutan ke arah pemasaran <i>There is a good potential for further R & D and commercialization</i>
☐	Suatu sumbangan besar kepada kerangka polisi pengurusan/garis panduan <i>A major contribution to management policy framework/guidelines (in relevant areas)</i>
☐	Suatu sumbangan kecil tetapi bermakna kepada kerangka polisi pengurusan/garis panduan <i>A minor contribution to management policy framework/guidelines (in relevant areas)</i>
☐	Sesuai untuk dijadikan bahan pengajaran/case study atau bahan latihan <i>The finding is suitable for use as a complementary teaching/training material (a case study)</i>
☐	Suatu output yang baik dan berpotensi untuk memenangi hadiah penyelidikan <i>A quality output that has a potential for winning a research award</i>
☐	Suatu bahan yang baik/sesuai untuk hebahan atau pameran <i>A good/suitable material for showcasing/publicizing/exhibition</i>

Lain-lain/Others (Sila nyatakan/Please specify)

G. Sinopsis Hasil Penyelidikan bagi Tujuan Promosi

Synopsis for Promotional Purposes

(Beri huraian ringkas yang tidak melebihi 400 perkataan dan dalam bahasa yang mudah, bagi maksud hebahan hasil penyelidikan ini melalui media massa dan 'Unimas Research Update')
(Please provide a synopsis not exceeding 400 words, in a not-too-technical language, for the purpose of promoting this research findings through the mass media and Unimas Research Update).

Bioplastics has become an attractive area for scientists and researchers due to their outstanding performance in terms of biodegradability. As synthetic plastics cannot decompose which poses a threat to the environment. The implementation of bioplastics can help to reduce the plastics pollution and waste reduction. However, poor mechanical properties of bioplastics, such as highly sensitive to water and lower tensile strength, had limit the use of bioplastics. In this research, starch-based bioplastics was fabricated with sago starch as raw materials and glycerol as plasticizer. There are five proposed combinations of

SPW bioplastics with starch contents of 0 g, 5 g, 10 g, 15 g, 20 g and 25 g respectively. The result shows that the tensile strength of bioplastics made from sago starch increased by 2.8 times when 5 g of sago starch was added, compared to the sample without sago starch. The most substantial enhancement was observed in the elasticity of the bioplastics. Incorporating 5 g of sago starch resulted in a remarkable increase, reaching up to 170-fold compared to the sample without sago starch. Despite the improvements in mechanical properties, the elongation at break significantly decreased—from 54.8 mm to 1.24 mm—upon the addition of 5 g of sago starch. The inclusion of sago starch resulted in reduced water absorption. Following 24 hours of immersion, the bioplastic with 5 g of sago starch demonstrated lower water absorption (2.21 g) compared to the starch-free bioplastic (6.51 g). In summary, the incorporation of 5 g of sago starch into the glycerol-plasticized bioplastic matrix significantly enhances the material's mechanical resilience, most notably its tensile strength and elasticity. As one of the major producers of sago, Sarawak should capitalise on this advantage by venturing into bioplastic production to enhance the state's economic revenue. The potential of sago-starch-based bioplastics must be explored in greater depth to ensure that this natural resource is fully and optimally utilized.

Catatan Penting/Important Notes

Penyelidik diminta mengemukakan kepada Pusat Penyelidikan:

- Borang ini dalam kedua-dua bentuk bercetak dan elektronik
- Researchers are required to submit to the Research Centre:*
- *This form in both hard- and soft-copies*



Dr. Maheshuri Yusof
 Senior Lecturer
 Faculty of Engineering
 Universiti Malaysia Sarawak

20 Feb 2026

.....
Tandatangan (Penyelidik Utama)
 Signature (Principal Researcher)

.....
Tarikh
 Date



RINGKASAN LAPORAN AKHIR
GERAN PENYELIDIKAN OSAKA GAS
END OF OSAKA GAS
GRANT REPORT SUMMARY

A. Tajuk Projek <i>Project Title</i>	: Assessing the Tribological Characteristics of Used Motor Oil from Local Automotive Workshops
Ketua Penyelidik <i>Project Leader</i>	: Ts. Dr Aidil Azli bin Alias
Fakulti/Institut <i>Faculty/Institute</i>	: FACULTY OF ENGINEERING
Ahli Kumpulan Penyelidik <i>Research Team Members</i>	: 1. Assoc. Prof. Ir. Dr Mohd Danial Ibrahim 2. Dr Mohamad Iskandar Jobli 3. Dr Lee Chiew Tin
B. Tarikh Geran Diluluskan <i>Grant Approval Date</i>	: 7 October 2024
Tempoh Projek <i>Project Duration</i>	: 1 year
Peruntukan Yg. Diluluskan <i>Budget Approved</i>	: RM 10,000.00
Perbelanjaan Terkini <i>Expenditure To-Date</i>	: RM6830.45
C. Pencapaian Keseluruhan <i>Overall Achievement</i> Huraikan pencapaian berbanding objektif, hipotesis serta permasalahan asal yang diselidiki.. <i>Describe the achievements in relation to the original objectives, hypothesis and research problems.</i>	
☐ Tribometer Development: Successfully designed and developed two modular, low-cost tribometers using open-source tools (Arduino-based) to conduct rotating and reciprocating friction tests.	
☐ Validation: The custom-built systems were validated against theoretical values, achieving a measurement error of $\leq 5.74\%$, confirming their reliability for assessing used motor oil.	
☐ Current Status: While the hardware development phase is 100% complete, the final objective, assessing the tribological characteristics of used motor oil is currently in the data	

analysis by the current final year student.

- ☐ The project has met its primary objective of developing a functional testing platform and is on track to complete comparative analysis between used and new motor oil. However, the publication for the findings will be delayed.

D. Pencapaian Utama

Key Findings

Functional pin on disk and modular tribometers were developed using Arduino controlled module and successfully tested. The integration with PLX-DAQ allows for real-time monitoring of frictional test results.

The variation of test sampling of used oil was collected and tested for viscosity, density and dispersancy. These results are still in analyzing process.

E, Hasil Penyelidikan

Deliverables

Sila tandakan item yang berkaitan pada senarai berikut:

Please tick the relevant items below:

	Item	Bilangan/Number
☐	Kertas teknikal/bersiri dalaman <i>Internal technical/serial papers</i>	
☐	Tesis/disertasi pelajar sarjana <i>Student's Masters thesis/dissertation</i>	
☐	Tesis pelajar PhD <i>Student's PhD thesis</i>	
☐	Kertas persidangan tempatan <i>Local conference papers</i>	
☐	Kertas persidangan antarabangsa <i>International conference papers</i>	
☐	Makalah dalam jurnal tempatan <i>Local journal papers</i>	
☐	Makalah dalam jurnal antarabangsa <i>International journal papers</i>	
☐	Monograf atau buku <i>Book/monograph</i>	

Lain-lain/others (sila nyatakan/please specify)

- ☐ **Student Dissertations (Tesis/disertasi):** Two undergraduate theses were completed in 2025 focusing on the design and development of the low-cost and modular tribometers (Erna Mizanie binti Berhim and Elhan Najmuddin bin Johan).

☐ **Planned Publication:** Once the current final year student (Sherilyn Chloe Anak David) completed her work, the outcomes will be submitted for publication.

The final data analysis is continuing through the student's project to ensure high-quality data for future publication.

Sila senaraikan maklumat (pengarang, tahun, tajuk, jurnal/penerbit, jilid, halaman) bagi penerbitan/tesis yang dihasilkan (jika ada).

Please specify the publications (authors, year, title, journal/publisher, volume, page nos.) (if any)

Nil

F. Pengecaman Output *Output Identification*

Sila tandakan penerangan yang berkaitan pada senarai berikut:

Please tick the relevant description as given below:

	Suatu sumbangan besar kepada bidang ilmu yang berkaitan <i>A major contribution to knowledge (new knowledge) in the respective discipline</i>
/	Suatu sumbangan kecil tetapi bermakna kepada bidang ilmu yang berkaitan <i>A minor but important contribution to knowledge in the respective discipline</i>
	Suatu sumbangan besar kepada teknologi/ciptaan/algoritma dalam bidang yang berkaitan <i>A major contribution to technology/invention/algorithm or a tangible product</i>
	Suatu sumbangan kecil tetapi bermakna kepada teknologi/ciptaan/algoritma berkaitan <i>A minor but important contribution to relevant technology/invention/algorithm</i>
	Terdapat potensi yang baik untuk kajian lanjutan ke arah pemasaran <i>There is a good potential for further R & D and commercialization</i>
	Suatu sumbangan besar kepada kerangka polisi pengurusan/garis panduan <i>A major contribution to management policy framework/guidelines (in relevant areas)</i>
	Suatu sumbangan kecil tetapi bermakna kepada kerangka polisi pengurusan/garis panduan <i>A minor contribution to management policy framework/guidelines (in relevant areas)</i>
/	Sesuai untuk dijadikan bahan pengajaran/case study atau bahan latihan <i>The finding is suitable for use as a complementary teaching/training material (a case study)</i>
	Suatu output yang baik dan berpotensi untuk memenangi hadiah penyelidikan <i>A quality output that has a potential for winning a research award</i>
	Suatu bahan yang baik/sesuai untuk hebahan atau pameran <i>A good/suitable material for showcasing/publicizing/exhibition</i>

Lain-lain/*Others* (Sila nyatakan/*Please specify*)

Nil

G. Sinopsis Hasil Penyelidikan bagi Tujuan Promosi

Synopsis for Promotional Purposes

(Beri huraian ringkas yang tidak melebihi 400 perkataan dan dalam bahasa yang mudah, bagi maksud hebahan hasil penyelidikan ini melalui media massa dan 'Unimas Research Update')

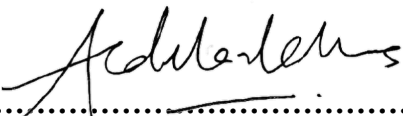
(Please provide a synopsis not exceeding 400 words, in a not-too-technical language, for the purpose of promoting this research findings through the mass media and Unimas Research Update).

This research addresses environmental challenges by evaluating the potential for reconditioning used motor oil from local workshops in Kota Samarahan. To facilitate this, we successfully developed a low-cost, Arduino-controlled modular tribometer that provides a sustainable and affordable alternative to expensive commercial testing equipment. These devices are now being utilized to analyze the friction and wear characteristics of reconditioned oil, aiming to provide a cost-effective lubrication alternative for mechanical systems.

Catatan Penting/Important Notes

Penyelidik diminta mengemukakan kepada Pusat Penyelidikan:

- Borang ini dalam kedua-dua bentuk bercetak dan elektronik
- Researchers are required to submit to the Research Centre:*
- *This form in both hard- and soft-copies*



.....
Tandatangan (Penyelidik Utama)
Signature (Principal Researcher)

12 Mei 2026

.....
Tarikh
Date



Faculty of Engineering

DEVELOPMENT OF LOW-COST TRIBOMETER USING OPEN-SOURCE TOOLS

Erna Mizanie binti Berhim

Bachelor of Engineering Mechanical

Engineering with Honors

2025

DEVELOPMENT OF LOW-COST TRIBOMETER USING OPEN-SOURCE TOOLS

ERNA MIZANIE BINTI BERHIM

A dissertation submitted in partial fulfilment
of the requirement for the degree of
Bachelor of Engineering
Mechanical Engineering with Honors

Faculty of Engineering
Universiti Malaysia Sarawak

2025

ABSTRACT

This study presents the development of a low-cost, open source tribometer designed to measure the coefficient of friction (COF) between mild steel and aluminium surfaces. The objectives were to (1) provide an affordable alternative to commercial tribometers, (2) design a portable device suitable for educational settings, and (3) validate its accuracy through experimental testing. The device employs a pin-on-disk configuration with Arduino-based control, a NEMA 23 stepper motor, and a 1 kg load cell. It achieved an average measurement error of $\leq 5.74\%$ compared to the theoretical COF value of 0.47. Results demonstrated stable friction readings across varying loads (2.94–5.89 N), while material costs were reduced by 95% (RM410) compared to commercial systems. The tribometer's open-source design and integration with real-time PLX-DAQ data logging make it highly accessible for engineering education. Noted limitations include sensitivity to vibration and the absence of environmental control. Potential applications include materials science laboratories and student research projects. Future improvements could focus on modular enhancements and environmental monitoring. Overall, this work contributes a functional and affordable solution for tribological testing in educational and resource-limited contexts.



Faculty of Engineering

DEVELOPMENT OF MODULAR TRIBOMETER FOR MULTIPURPOSE TRIBOLOGICAL TESTING

Elhan Najmuddin Bin Johan

Bachelor of Mechanical

Engineering with Honors

2025

DEVELOPMENT OF MODULAR TRIBOMETER FOR
MULTIPURPOSE TRIBOLOGICAL TESTING

**Development Of Modular Tribometer For Multipurpose
Tribological Testing**

ELHAN NAJMUDDIN BIN JOHAN

A dissertation submitted in partial fulfilment
of the requirement for the degree of
Bachelor of Mechanical Engineering with Honours

Faculty of Engineering
Universiti Malaysia Sarawak

2025

ABSTRACT

Tribology study plays a critical role in understanding friction and wear behaviour in mechanical systems. Traditional tribometers often lack flexibility prompting the need for more adaptable solutions. This study aimed to develop a modular tribometer capable of performing both rotating and reciprocating friction tests under dry sliding conditions. The primary objective was to evaluate the coefficient of friction (CoF) between a steel pin and an aluminium plate, using a custom-built system integrated with an Arduino Uno, HX711 amplifier, and a 3 Kg load cell for data acquisition. Experiments were conducted under a fixed normal load of 3 N, with data collected via PLX-DAQ for real-time monitoring. The CoF was calculated for each motion type, yielding results between 0.20 to 0.74 for rotating motion and 0.38 to 0.55 for reciprocating motion. Observations revealed dynamic frictional behaviour influenced by motion type, surface interaction, and mechanical stability. While the system produced useful data, certain limitations such as environmental variability and minor alignment issues introduced inconsistencies. Overall, the modular tribometer successfully demonstrated its potential for low-cost, repeatable, and flexible tribological testing, providing a foundation for future studies involving variable loads, enhanced stability, and broader applications in material evaluation.



Faculty of Engineering

**TITLE: TRIBOLOGICAL STUDY ON USED MOTOR OIL
FROM LOCAL WORKSHOP IN SARAWAK**

SHERILYN CHLOE ANAK DAVID

Bachelor of Engineering (Hons)

Mechanical Engineering

2025

ABSTRACT

This study presents a tribological investigation of used motor oil collected from local automotive workshops in Sarawak. During engine operation, motor oil undergoes degradation due to contamination, oxidation, thermal stress and mechanical loading, which can significantly affect its lubrication performance. In this research, used motor oil samples were analysed to evaluate their physical, chemical and tribological properties including viscosity, density, Total Acid Number (TAN), coefficients of friction, wear behaviour and visual oil condition. Standardised testing methods such as wear and friction tests, acidity titration and visual inspection techniques were employed to assess the extent of oil degradation and its impact on tribological performance. The relationship between oil degradation and lubrication effectiveness was examined to determine whether used motor oil retains potential for reuse or recycling. The findings of this study provide insight into the condition of used motor oil generated by local workshops and contribute to improved understanding of sustainable lubricant management and responsible used oil handling practices in Sarawak.



RINGKASAN LAPORAN AKHIR
GERAN PENYELIDIKAN OSAKA GAS
END OF OSAKA GAS
GRANT REPORT SUMMARY

A. Tajuk Projek <i>Project Title</i>	: Feasibility Study of Archimedes Wind Turbine in Sarawak Borneo
Ketua Penyelidik <i>Project Leader</i>	: Hishammudin Afifi bin Huspi
Fakulti/Institut <i>Faculty/Institute</i>	: Fakulti Kejuruteraan / Faculty of Engineering
Ahli Kumpulan Penyelidik <i>Research Team Members</i>	: Ahmad Adzlan Fadzli bin Khairi
B. Tarikh Geran Diluluskan <i>Grant Approval Date</i>	: 1 Januari 2025
Tempoh Projek <i>Project Duration</i>	: 12 Bulan
Peruntukan Yg. Diluluskan <i>Budget Approved</i>	: 10000
Perbelanjaan Terkini <i>Expenditure To-Date</i>	: 2903.70
C. Pencapaian Keseluruhan Overall Achievement Huraikan pencapaian berbanding objektif, hipotesis serta permasalahan asal yang diselidiki.. <i>Describe the achievements in relation to the original objectives, hypothesis and research problems.</i> This report details the successful execution of the research project investigating the Archimedes Wind Turbine (AWT) as a viable renewable energy solution for Sarawak. The study effectively	

bridged the gap between theoretical aerodynamic design and practical regional application, culminating in a peer-reviewed publication at EnCON 2026. The findings confirm that the AWT's helical rotor design significantly outperforms traditional horizontal (HAWT) and vertical (VAWT) designs in the low-to-moderate wind speeds characteristic of the region.

Objective

Status

Achievements

Obj 1: Evaluate deployment feasibility across Sarawak.

Achieved

Conducted site-specific wind distribution assessments for **Residential, Coastal, and Highland** areas. Identified Sarawak's 2–6 m/s wind range as ideal for AWT activation.

Obj 2: Compare energy capture efficiency.

Achieved

Produced empirical data via 3D-printed lab-scale models. Comparative testing against HAWT and VAWT (H-Rotor) confirmed the AWT's superior power output.

HYPOTHESIS VALIDATION & RESEARCH PROBLEM

Hypothesis: *The Archimedes turbine will demonstrate higher energy capture efficiency than traditional fan blades in Sarawak due to its nautilus-inspired helical rotor.*

- Validation: The hypothesis was strongly supported. Experimental results published in the EnCON 2026 proceedings showed that at 20 m/s, the AWT achieved a power output of 14.64 mW, exceeding traditional H-Rotor outputs by over an order of magnitude.
- Research Problem Resolution: The primary challenge—finding a turbine capable of generating meaningful power at Sarawak's low wind speeds (2–6 m/s)—was addressed. The AWT proved to be the most effective "localized" solution, capturing energy more efficiently than conventional designs that often struggle with the region's low-inertia wind conditions.

D. Pencapaian Utama Key Findings

The project achieved impact across three primary domains:

Technical Excellence: Demonstrated through rigorous controlled airflow testing, proving the AWT's high torque and energy capture capabilities compared to H-Rotors and HAWTs of identical diameter (150 mm).

Academic Contribution: The work was formally recognized through a paper presentation at the 16th International Engineering Conference UNIMAS 2026.

Human Capital: Successfully mentored two Final Year Project (FYP) students, contributing to the local talent pool in renewable energy engineering.

**E, Hasil Penyelidikan
Deliverables**

Sila tandakan item yang berkaitan pada senarai berikut:
Please tick the relevant items below:

	Item	Bilangan/Number
	Kertas teknikal/bersiri dalaman <i>Internal technical/serial papers</i>	
	Tesis/disertasi pelajar sarjana <i>Student's Masters thesis/dissertation</i>	
	Tesis pelajar PhD <i>Student's PhD thesis</i>	
	Kertas persidangan tempatan <i>Local conference papers</i>	
	Kertas persidangan antarabangsa <i>International conference papers</i>	1 conference proceeding
	Makalah dalam jurnal tempatan <i>Local journal papers</i>	
	Makalah dalam jurnal antarabangsa <i>International journal papers</i>	
	Monograf atau buku <i>Book/monograph</i>	

Lain-lain/others (sila nyatakan/*please specify*)

1. 2 FYP undergraduates' students.
2. Small scale wind turbine experimental setup.

Sila senaraikan maklumat (pengarang, tahun, tajuk, jurnal/penerbit, jilid, halaman) bagi penerbitan/tesis yang dihasilkan (jika ada).

Please specify the publications (authors, year, title, journal/publisher, volume, page nos.) (if any)

1.
FEASIBILITY AND PERFORMANCE EVALUATION OF THE ARCHIMEDES WIND TURBINE FOR LOW-WIND REGIONS: EXPERIMENTAL COMPARISON WITH VERTICAL AND HORIZONTAL AXIS WIND

Hishammudin Afifi Bin Huspi^{1*}, Ahmad Adzlan Fadzli Bin Khairi, Mohd Amirul Faiz bin Morsidi¹, Ilya Maizurah Binti Hisham¹

¹Faculty of Engineering, Universiti Malaysia Sarawak, 94300, Kota Samarahan, Sarawak, MALAYSIA

F. Pengecaman Output Output Identification

Sila tandakan penerangan yang berkaitan pada senarai berikut:

Please tick the relevant description as given below:

	Suatu sumbangan besar kepada bidang ilmu yang berkaitan <i>A major contribution to knowledge (new knowledge) in the respective discipline</i>
✓	Suatu sumbangan kecil tetapi bermakna kepada bidang ilmu yang berkaitan <i>A minor but important contribution to knowledge in the respective discipline</i>
	Suatu sumbangan besar kepada teknologi/ciptaan/algoritma dalam bidang yang berkaitan <i>A major contribution to technology/invention/algorithm or a tangible product</i>
	Suatu sumbangan kecil tetapi bermakna kepada teknologi/ciptaan/algoritma berkaitan <i>A minor but important contribution to relevant technology/invention/algorithm</i>
✓	Terdapat potensi yang baik untuk kajian lanjutan ke arah pemasaran <i>There is a good potential for further R & D and commercialization</i>
	Suatu sumbangan besar kepada kerangka polisi pengurusan/garis panduan <i>A major contribution to management policy framework/guidelines (in relevant areas)</i>
	Suatu sumbangan kecil tetapi bermakna kepada kerangka polisi pengurusan/garis panduan <i>A minor contribution to management policy framework/guidelines (in relevant areas)</i>
	Sesuai untuk dijadikan bahan pengajaran/case study atau bahan latihan <i>The finding is suitable for use as a complementary teaching/training material (a case study)</i>
	Suatu output yang baik dan berpotensi untuk memenangi hadiah penyelidikan <i>A quality output that has a potential for winning a research award</i>
	Suatu bahan yang baik/sesuai untuk hebahan atau pameran <i>A good/suitable material for showcasing/publicizing/exhibition</i>

Lain-lain/Others (Sila nyatakan/Please specify)

G. Sinopsis Hasil Penyelidikan bagi Tujuan Promosi

Synopsis for Promotional Purposes

(Beri huraian ringkas yang tidak melebihi 400 perkataan dan dalam bahasa yang mudah, bagi maksud hebahan hasil penyelidikan ini melalui media massa dan 'Unimas Research Update')

(Please provide a synopsis not exceeding 400 words, in a not-too-technical language, for the purpose of promoting this research findings through the mass media and Unimas Research Update).

Harnessing the Breeze: Revolutionizing Sarawak's Renewable Energy with the Archimedes Wind Turbine The Future of Localized Power in Borneo

In the pursuit of a greener Sarawak, traditional wind turbines often face a silent challenge: the region's unique, low-speed wind profile. This project introduces a breakthrough solution inspired by nature—the Archimedes Wind Turbine (AWT). Featuring a revolutionary helical rotor based on the mathematics of the nautilus shell, this turbine is designed to "catch" wind from any

direction, turning even the gentlest Sarawakian breeze into clean, sustainable power.

Why the Archimedes Turbine?

While conventional "fan-style" turbines require high, steady winds to be effective, our research proves that the AWT thrives in the diverse conditions of Sarawak. From the turbulent gusts of urban residential areas to the steady flows of our coastal and highland regions, the AWT offers:

Superior Efficiency: Lab tests show power outputs significantly higher than traditional horizontal and vertical designs at identical scales.

Low-Wind Optimization: Specifically engineered to operate effectively within Sarawak's typical 2–6 m/s wind speeds.

Smart Design: A 360-degree capture area that maximizes energy harvest without the need for complex tracking systems.

Proven Success & Local Impact

This isn't just a concept—it's a validated engineering milestone. Presented at the 16th International Engineering Conference (EnCON 2026), our research combines cutting-edge 3D-printing technology with rigorous site analysis across Sarawak. By involving local engineering talent and university researchers, we are building a renewable energy ecosystem that is made in Sarawak, for Sarawak.

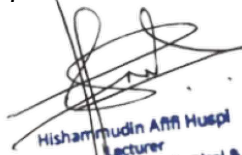
Our Vision

We are moving beyond the laboratory. By identifying the most promising sites across the state, this project paves the way for decentralized, quiet, and highly efficient wind power for homes, schools, and remote communities.

Catatan Penting/Important Notes

Penyelidik diminta mengemukakan kepada Pusat Penyelidikan:

- Borang ini dalam kedua-dua bentuk bercetak dan elektronik
- Researchers are required to submit to the Research Centre:*
- *This form in both hard- and soft-copies*



Hishammudin Amir Huspi
Lecturer

Department of Mechanical & Manufacturing Engineering
Faculty of Engineering
UNIVERSITI MALAYSIA SARAWAK

Tandatangan Penyelidik Utama)
Signature (Principal Researcher)

13/5/2026

Tarikh
Date