

MINISTRY OF EDUCATION, INNOVATION AND TALENT DEVELOPMENT SARAWAK

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AND TALENT DEVELOPMENT SARAWAK



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 4th Floor, LCDA Tower, Lot 2879, The Isthmus, Off Jalan Bako,
 93050 Kuching, Sarawak.
 T : 082-356 834 . F : 082-356 934
 E : meitd@sarawak.gov.my . W : meitd.sarawak.gov.my

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**Yang Berhormat Dato Sri
Roland Sagah Wee Inn**

*Minister for Education, Innovation and
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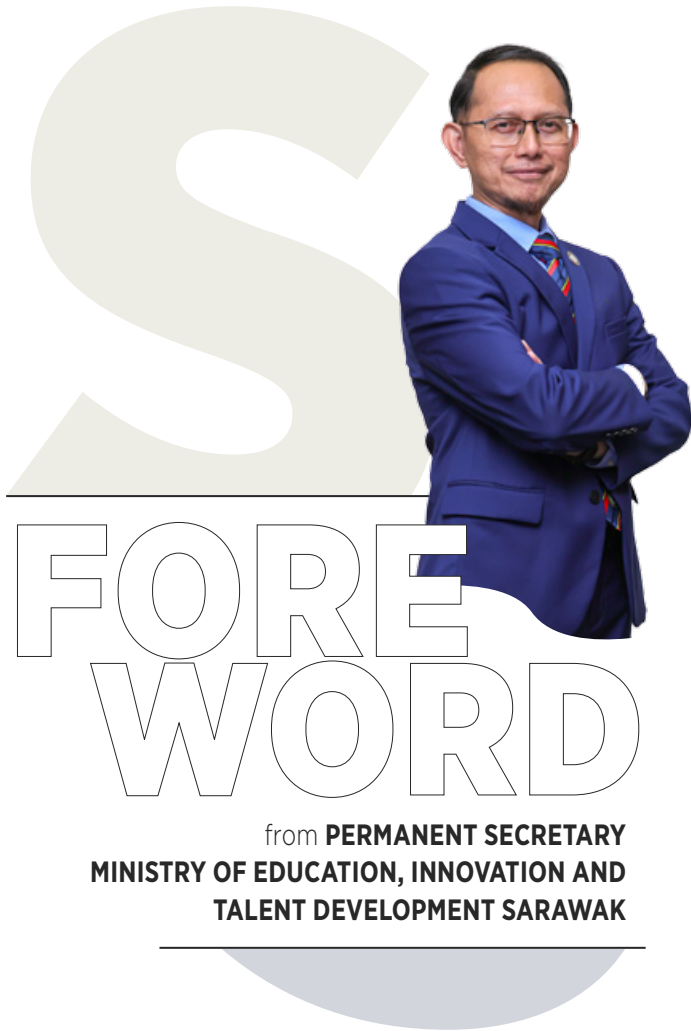
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Sarawak is taking bold steps toward a sustainable future by aligning its development projects with the UN Sustainable Development Goals (SDGs) and Environmental, Social, and Governance (ESG) principles. Through initiatives such as eco-friendly practices in the Sago and Nipah industries led by CRAUN Research Sdn. Bhd. and the Sarawak Sago and Nipah Development Board, along with traditional resource extraction methods supported by the Sarawak Biodiversity Centre, the State is committed to supporting local economies, preserving cultural heritage, and protecting natural resources. This approach seeks to harmonize economic growth with environmental stewardship while adhering to ESG principles.

Innovative systems are being implemented to enhance efficiency in education and technology, incorporating ESG-focused solutions like Sarawak Skills' digital attendance management system and CENTEXS's workforce training programs. Meanwhile, Sarawak Research and Development Council (SRDC) supports these efforts with sustainable carbon capture technologies, and Curtin University promotes business practices centered on ESG principles. Together, these initiatives drive industry innovation and prepare individuals to responsibly meet modern demands, balancing economic growth with social responsibility and strong governance.

Financially, green financing initiatives, supported by Swinburne University, enable SMEs to adopt sustainable practices, promote ESG-compliant investments, and allow Sarawak to progress toward its net-zero emissions targets. This ESG-driven framework enhances accountability and positions Sarawak as a leader in responsible economic development.

Projects in food innovation, such as those featured by the University of Technology Sarawak (UTS) focusing on indigenous products like Dabai and Halo Nypa Salt Tropical Fruit Sparkling Water, emphasize local resources, ESG-compliant production, and cultural identity preservation. Renewable energy projects, such as the solar energy initiative in Kampung Lumut Baru by i-CATS University College, empower communities, enhancing resilience, energy independence, and ESG compliance. These initiatives showcase Sarawak's approach to sustainable development, merging economic goals with environmental and social responsibility.

In conclusion, Sarawak's commitment to sustainable development is underscored by a comprehensive approach that integrates cultural preservation, environmental responsibility, and ESG-driven economic progress. From eco-friendly practices in vital industries to ESG-focused technological advancements and green financing, these efforts illustrate the State's dedication to a thoughtful, resilient future aligned with the UN Sustainable Development Goals and ESG principles.

On behalf of the Ministry, I extend my appreciation to each editorial member from Curtin University, Swinburne University of Technology Sarawak Campus, University of Technology Sarawak, CRAUN Research Sdn. Bhd., Sarawak Biodiversity Centre (SBC), Sarawak Research and Development Council (SRDC), Sarawak Skills, Centre for Technology Excellence Sarawak (CENTEXS), (UTS), and i-CATS University College for their invaluable contributions, diligence, and commitment to the publication of this second issue of Synthesis Sarawak.

Tuan Haji Adana bin Haji Jed
Permanent Secretary
Ministry of Education, Innovation and Talent Development Sarawak



CULTIVATING RESILIENCE: SAGO AND NIPAH INDUSTRIES, THE EMERGING DRIVING FORCES TOWARD A SUSTAINABLE FUTURE

Sal Hazreen Bugam*, Roland Yong Chiew Ming, Shamsul Arsad,
Nurul Nafila Ahmad and Noramina Hampden

CRAUN Research Sdn Bhd, Lot 3147, Block 14, Jalan Sultan Tengah, 93050 Kuching, Sarawak

Environmental, Social, and Governance (ESG) considerations have become increasingly essential in shaping the future of industries worldwide. In Sarawak, the Sago (*Metroxylon sagu*) and Nipah (*Nypa fruticans*) industries offer a unique opportunity to explore sustainable practices that benefit the environment and local communities. These industries, deeply rooted in tradition, have the potential to play a crucial role in advancing Sarawak's economic development, social livelihood, and environmental preservation.

INLAND NIPAH: BREAKING NEW GROUND

The Nipah palm is a critical component of the mangrove ecosystem, thriving in coastal wetlands across Southeast Asia. According to the Department of Agriculture Sarawak, 2014, Nipah palms covered approximately 111,351 hectares, primarily in the Kuching, Sarikei, and Mukah divisions. These palms have been a valuable resource for local communities for generations, providing sap that can be processed into sugar and a significant income source for smallholder farmers. However, cultivating Nipah palms in their natural mangrove habitat presents challenges. Limited access due to poor infrastructure and transportation complicates sap harvesting and processing. Furthermore, the threat of wild animal attacks and harsh working conditions in these remote areas further hinders large-scale commercial production.

Recognising the need to overcome these challenges, CRAUN Research Sdn. Bhd., co-funded by the Sarawak Research Development Council (SRDC) established a trial plot in 2019 at *Kampung Tambak*, Pusa, to study Nipah palm cultivation on inland

soil. Results indicated that with proper agronomic practices, the inland palms grow well and fruit within 2.5 years, comparable to the natural stand. This implies that the inland conditions are ideal for Nipah palm cultivation.

Furthermore, the yield productivity indicated that these inland Nipah can produce notable amounts of sap. This has profound economic potential, especially for producing products derived from the sap, such as *gula apong*, vinegar, and syrup. This inland cultivation of Nipah provides a ray of hope to attract more community participation in sap harvesting activities, thereby ensuring a consistent supply to meet its ever-increasing market demand.



Figure 1: Natural Nipah palms grow in dense stands, which can make navigation through mangrove areas difficult and further complicate access.



Figure 2: In-land Nipah cultivation adopting systematic planting distance with a density of 300 palms/ha in Kampung Tambak, Pusa.

SAGO RICE: A TRADITION TRANSFORMED

On the opposite end of the spectrum, the growing demand for rice has put intense pressure on the national food system. The escalating demand, exacerbated by stagnated local production, has resulted in Malaysia's heavy reliance on rice imports. Nevertheless, the recent conflict in Ukraine has brought to light the vulnerability of depending on external sources for essential staples and exposed the fragility of the global food supply chain, which depends on only a mere handful of key crops. In the wake of this sobering realisation, food security experts worldwide are now advocating for diversifying food sources, bringing underutilised carbohydrate crops like Sago into the spotlight.

Sago is a starch-producing plant with an average starch yield of 100 to 150kg per palm. The starch derived from the pith of the Sago trunk had been a staple food for the indigenous people of Sarawak. However, this dietary preference has shifted with the introduction of rice. Recently, CRAUN has embarked on an innovative project to explore Sago as an alternative to grain rice. One promising innovation is the creation of a Sago-based rice analogue that emulates the taste and texture of grain rice to cater to the dietary preferences of local consumers. However, since Sago lacks protein content, fortification is necessary to enhance its nutritional value. This thoughtfully developed product offers an alternative to grain rice and aligns with global efforts to diversify food sources, reducing dependence on a narrow range of staple crops.



Figure 3: Sago-based rice analogue formulated to emulate the taste and texture of the typical grain rice.

FUTURE PROOFING SARAWAK'S FOOD SYSTEM

In a world where just six crops, namely rice, wheat, maize, potato, soybeans, and sugarcane, account for more than 75% of the global plant-derived energy intake, diversifying food sources is crucial¹. Diversification has become essential to mitigate the risk arising from geopolitical instability and the risk of total crop failure stemming from adverse weather conditions due to climate change. Thus, growing robust plants capable of withstanding the climatic challenges is vital.

Sago palm stands out for its remarkable resilience, thriving even in the face of local weather adversities like flood and drought. Similarly, the Nipah palm showcases its adaptability, flourishing in the challenging environments of mangrove swamps and coastal wetlands. Sago and Nipah's resilience set them apart from other conventional staple crops, which typically falter in unpredictable weather. This makes them invaluable sources to future-proof Sarawak's food systems, guaranteeing food security for generations.

BEYOND FOOD: SAGO AND NIPAH - THE ECO-DEFENDER

Beyond safeguarding the food system, Sago and Nipah palms also stand as guardians of the environment. Sago plays a significant role in carbon sequestration, capable of absorbing up to 240 tons of CO₂ per hectare annually². In addition, as a perennial crop, Sago does not require replanting, thereby minimising the need for environmentally destructive land preparation practices.

Nipah palms, on the other hand, play a crucial role in the coastal ecosystem. They provide nursery grounds for marine species, stabilise shorelines, and prevent erosion. Nipah palms also act as a natural fortress to protect from tidal surges. These benefits highlight the importance of Sago and Nipah palms in preserving the ecosystems and combating climate change while supporting global decarbonisation efforts.

WASTE NOT, WANT NOT: TRANSFORMING SAGO WASTE INTO ENERGY INNOVATION

In addition to their ecological benefits, the Sago industry, in particular, has made commendable strides in sustainable practices. A prime example is the Sago Waste Treatment Pilot Plant located in Mukah. This facility has become an exemplary model for treating Sago processing wastes such as the Sago mill effluent (SME). The waste treatment process yields clean treated effluent and produces valuable biogas as its byproduct.

This biogas is recovered and cycled back to the plant, where it is used as fuel for burners and as a clean energy source to generate electricity to power the plant. Sago

hampas (fibrous waste) can also be dried with the hot air produced by these burners and subsequently used as animal feed. In addition, the raw biogas can be further upgraded to make it suitable for household cooking or heating purposes.

With the support of the *Projek Rakyat* initiative, a transformative gas distribution network is being constructed to supply this upgraded biogas as cooking gas to nearby households in *Kampung Teh* and *Kampung Tabo*, Mukah. This project, spearheaded by CRAUN, is actively underway and nearing completion. The circular system showcased by this pilot plant mitigates environmental concerns and breathes new life into the community, delivering renewable energy that warms both homes and hearts.



Figure 4: Internal gas pipeline installed at residents' houses in Kampung Teh and Kampung Tabo, Mukah.

GOOD GOVERNANCE: THE MISSING PIECE?

Sago and Nipah industries have long existed in Sarawak and are vital to the local economy and culture. According to the Department of Statistics Malaysia (DOSM), in 2023, Sarawak exported 35,000 metric tons of Sago starch, with a market value of RM113 million. In contrast, Nipah remains largely dominated at cottage-level operations. Despite their longstanding presence, these industries have been slow to reach their full potential.

Undoubtedly, upscale production for Sago starch has unlocked economic opportunities and supported job creation for the local communities. However, without a governing body to steer the industry, Sago log prices have remained frustratingly stagnant, even as starch prices soar. This disparity has left small-scale farmers struggling to reap the benefits of the industry's growth. Moreover, the Sago industry has also been tainted by the environmental issues related to its milling activities. While innovative solutions like the Sago Waste Treatment Plant have shown promise, the widespread receptiveness and adoption of this technology may require authoritative intervention.

To address these longstanding challenges, the Sago and Nipah Development Board (SNDB) was established in 2022 as a regulatory body to oversee and govern the

industry. The inception of SNDB is anticipated to be a game-changer in resolving the generations-old issues plaguing these industries. The SNDB plays a pivotal role in rooting ESG principles into the landscape of the Sago and Nipah industries, embodying the essence of good governance and sustainability. By addressing the core challenges stakeholders face, the SNDB is expected to create a fair, inclusive, and sustainable ecosystem. With its commitment to equitable pricing, technological advancement, productivity enhancement, and environmental stewardship, the SNDB is set to unlock the true potential of these crops and elevate these industries to unprecedented heights.

ESG EXCELLENCE: A PATHWAY TO SUSTAINABILITY AND PROSPERITY

Viewed through the lens of ESG, the future of the Sago and Nipah industries gleam with promise. As the world grapples with the daunting challenges of climate change and food security, the abundance of Sago and Nipah offers a lifeline to Sarawak's resilient future. By adhering to the principles of ESG, these crops can be developed into industries that not only have the potential to thrive but also to safeguard the environment and elevate the quality of life for future generations. This blueprint for the Sago and Nipah industries is a testament to how traditional practices can be innovatively adapted and embedded into the ESG framework, charting a pathway towards Sarawak's sustainable and prosperous future.



Figure 5: Systematic Sago farming for sustainable Sago production and combating climate change through carbon sequestration.

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THE STORY OF SEKIU: GOLDEN, PURE AND NATURAL

by Sarawak Biodiversity Centre (SBC)

Sekiu is a precious oil derived from the seed kernel of the *Madhuca motleyana* tree, a species native to Malaysia, Indonesia, and Thailand. In Sarawak, Kampung Jemoreng in the Matu District of Mukah is one of the best locations to find Sekiu trees.

The village is accessible by a three-hour drive from Mukah town, and the Melanau community here continues to uphold a time-honoured tradition passed down from their ancestors, extracting Sekiu oil using traditional technology and sustainable methods.

This oil is an essential part of their culinary heritage, often blended with sago pearls and salt or added to porridge and salted fish, offering a unique, rich flavour characterised by a strong, bitter almond scent and a rich golden colour.

SEKIU OIL EXTRACTION - A TRADITION ROOTED IN CONSERVATION

The Sekiu tree bears fruit once every four to five years, usually from January to March. The seeds that drop into the rivers are collected from the water surface using rattan baskets. This ensures that the trees are not disturbed and minimises environmental impact. Because this species flourishes along riverbanks, it plays a vital role in sustaining the complex network of plants and animals in the riverine ecosystem. The sustainable harvesting of the seeds from the river and conservation of the tree have far-reaching impacts on ensuring river health, water quality, and the fish populations that depend on them.

The traditional process of making Sekiu oil involves drying the seeds under the sun for three days. The villagers ensure that the seeds are thoroughly dried by shaking them to hear if the kernels have separated from the shells, a clever method rooted in traditional knowledge. The dried seeds are then pounded and sifted to extract the kernels, which are further ground into a fine powder before being cooked using the traditional 'Pais' method.

The extraction process uses specialised tools called "Kepisen" and "Ales," where the cooked kernel powder is filtered through a clean cloth and pressed to release

the oil. Three kilograms of cooked powder can yield about one litre of Sekiu oil. Even with traditional technology, the oil extraction process proves to be efficient, where the remaining powder from the first pressing, known as 'Umas,' is re-pressed to extract more oil, which is milder in taste and favoured by consumers.

A HEALTHY AND VERSATILE OIL

Beyond its rich flavour, Sekiu oil is a healthy addition to the diet, containing 60% oleic acid, a monounsaturated omega-9 fatty acid known for its heart-protective properties. This makes Sekiu oil comparable to olive oil, which is known for its high oleic acid content. Studies have shown that oleic acid can reduce cholesterol levels and inflammation and support cardiovascular health.

The Sekiu oil's versatility extends beyond cooking. It has long been used in soap and candle making, dating to when the gutta-percha or latex from Sekiu trees was highly prized and widely traded. This multi-purpose oil demonstrates the enduring value of Sarawak's natural resources.

A HOLISTIC APPROACH TO ECONOMIC GROWTH, SOCIAL INCLUSIVITY AND ENVIRONMENTAL SUSTAINABILITY

With funding from the United Nations Development Programme (UNDP) Malaysia, the Sarawak Biodiversity Centre (SBC) partners with the Ministry of International Trade and Industry, Industrial Terminal and Entrepreneur Development (MINTRED), and the Sarawak Digital Economy Corporation (SDEC) on the Sekiu Oil Project to create a model of sustainable development.

By preserving traditional knowledge and empowering the Kampung Jemoreng community through virtual learning and capacity-building programmes, this initiative fosters resilience against socio-economic challenges, including those brought about by the COVID-19 pandemic.

The project's integration of digital platforms and e-commerce modernises the traditional Sekiu oil industry and opens new markets for community-based businesses while maintaining cultural and environmental integrity.

The enthusiastic participation of 45 homes in Kampung Jemoreng, alongside the presence of approximately 3,000 Sekiu trees, is poised to uplift the community, strengthen the local economy, and promote Sarawak's unique products in broader markets, all while ensuring that development is sustainable and inclusive.

In May 2023, the Sarawak Biodiversity Centre (SBC) signed its third Benefit Sharing Agreement (BSA) with the Melanau communities of Kampung Jemoreng Hulu,

Kampung Jemoreng Hilir in Matu, and Kampung Penibong on Pulau Bruit in Daro, involving the Sekiu oil. This agreement is the third of its kind in Sarawak and across Malaysia.

The BSA represents a threefold benefit to the participating communities - it acknowledges and respects their rights to biological resources and associated Traditional Knowledge; ensures fair and equitable sharing of monetary and non-monetary benefits derived from these resources; and underscores the importance of biodiversity conservation.

Yang Berhormat Datuk Roland Sagah Wee Inn, Minister for Education, Innovation, and Talent Development, witnessed the significant BSA signing.

The project is designed to deliver more than immediate economic benefits. It aligns with Environmental, Social, and Governance (ESG) principles, as well as Sarawak's Post COVID 19 Development Strategy 2030 (PCDS 2030) supporting long-term environmental stewardship, enhancing the sustainable livelihoods of local communities, and encouraging responsible trade practices.

Interesting Fact: The *Madhuca motleyana* is named after an engineer and naturalist, James Motley, who lived and worked in Borneo in the 1850s.



Figure 1: Sekiu Oil - golden, pure and natural.



Figure 2: Womenfolks collect Sekiu seeds that float along the Batang Jemoreng.

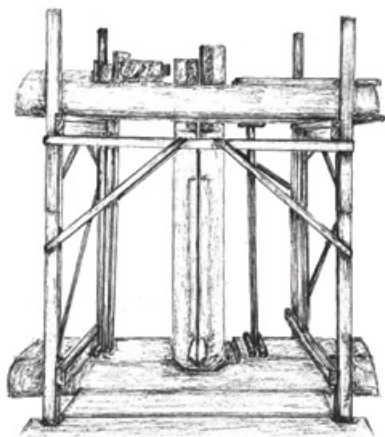


Figure 3: A sketch of the "Ales", a traditional contraption used to press and filter Sekiu oil.

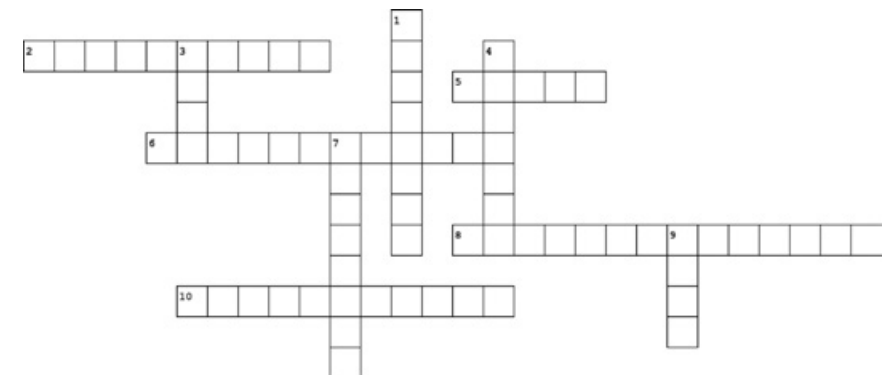


Figure 4: Nur Fitri binti Mohd Johan Anjie and Kulai bin Basmi of Kampung Jemoreng, Matu, Mukah with Sekiu seeds and the oil, respectively.



Figure 5: Exchange of the Benefit Sharing Agreement (BSA) on Sekiu Oil with Melanau communities of Kampung Jemoreng Hulu, Kampung Jemoreng Hilir in Matu, and Kampung Penibong on Pulau Bruit in Daro. The event held on 27th May 2023 in conjunction with SBC's Biodiversity Day was witnessed by Yang Berhormat Datuk Roland Sagah Wee Inn, Minister for Education, Innovation, and Talent Development.

SEKIU WORD WIZARD



Across

- 4. Preserving resources for future generations
- 6. A village, three-hour drive from Mukah
- 8. Online buying and selling transactions
- 9. A traditional contraption to press and filter Sekiu oil
- 11. Natural latex from tropical trees
- 12. A district in Mukah

Down

- 1. Natural surroundings described in one word
- 2. A village on Pulau Bruit, Daro
- 3. The species name of the Sekiu tree
- 5. Indigenous community found largely in Mukah, Sarawak
- 7. The Genus to which the Sekiu tree belongs
- 10. A bitter almond-scented and rich golden oil

Please refer to Page 70 for answers.



CAPTURING CO₂ USING LIMESTONE AND STORING IT IN BRICK WITH INDUSTRIAL WASTE

Slyvester Chai Yew Wang and Ir Dr Ngu Lock Hei
Sarawak Research and Development Council (SRDC)

ESG THROUGH SUSTAINABLE MANUFACTURING

One of the main agendas in achieving sustainability in manufacturing is reducing the emission of carbon dioxide (CO₂). CO₂ emissions mainly come from burning fossil fuels for power generation, transportation, and manufacturing. The cement industry in Sarawak contributes approximately 24 % of its Gross Domestic Product (GDP) (DayakDaily, 2024; Lee and Voon, 2022) and is a crucial component of the construction and mining sectors. However, the cement industry emits tremendous CO₂ and solid waste (i.e., cement kiln dust). Based on the International Energy Agency (IEA), cement industries worldwide contributed 15.26 % of the global CO₂ emissions, the main contributors to global warming (IEA, 2023, 2024). On the other hand, the global cement kiln dust (CKD) production rate is approximately 820 MT.yr⁻¹, making it one of the highest produced solid wastes in the world (Chai et al., 2024).

Embedding ESG principles in manufacturing helps abate climate change, reduce greenhouse gas emissions, address resource depletion and improve health and safety. These are also tied to Sustainable Development Goal (SDG) goals, including SDG 9: Industry, Innovation, and Infrastructure, SDG 11: Sustainable Cities and Communities, SDG 12: Responsible Consumption and Production, and SDG 13: Climate Action.



Reducing the excessive CO₂ emission from cement industries in Sarawak is crucial as CO₂ is the main Greenhouse Gas (GHG) that leads to global warming and climate change. Strategies toward zero or net carbon emissions allow Sarawak to contribute towards global climate action to achieve a greener future. Promoting the responsible

use of waste materials by integrating them into new products reduces the need for raw materials and minimizes waste.

Industrial processes produce various wastes that can harm the environment and human health. The beneficial utilization of industrial solid wastes promotes sustainable industry processes and reduces the need and cost for landfilling or storage. Storing industrial waste in building materials fixed them in solid form, limiting leaching to the environment. This prevents the leaching of harmful substances into the environment that eventually enter water resources and soil, creating a safer environment. New product development using industrial wastes as a green material offers a sustainable alternative to conventional materials. This can help propel Sarawak towards being a more sustainable and greener state.

CAPTURING CO₂

There are various technologies for capturing CO₂, such as chemical absorption, carbon mineralization, adsorption and membrane separation. However, each has its limitations, such as being economically unsustainable due to their high operational cost and lack of an effective CO₂ utilization pathway to generate revenue (Kanjilal et al., 2020). In an effort to overcome these, research on employing solid waste to capture and store CO₂ via carbon mineralization as a binder substitution for cement or lime in building materials is an attractive effort to boost utilization (Chai et al., 2024).

In Swinburne University of Technology Sarawak Campus (SUTS), we have utilized a process called accelerated weathering of limestone (AWL) to capture CO₂. The captured CO₂ is utilized to make bricks with industrial waste and sand to produce sustainable building materials. The process is illustrated in *Figure 1*.

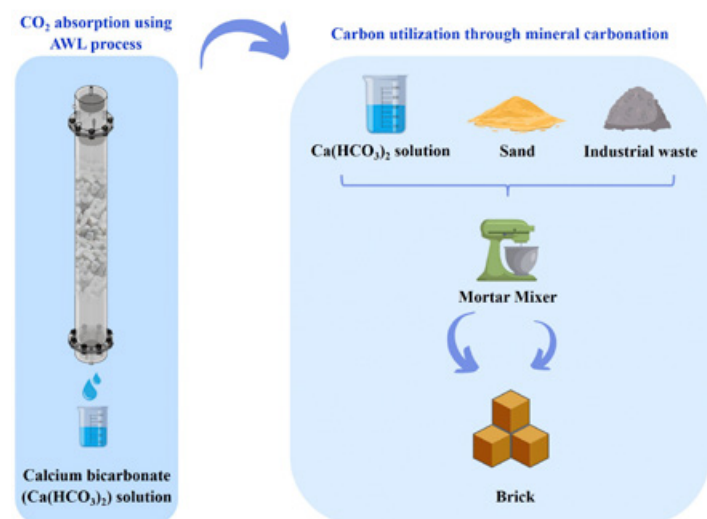


Figure 1: Capturing CO₂ through accelerated weathering of limestone (AWL) process and using them to make brick with industrial waste.

CAPTURING CO₂ USING LIMESTONE

At Swinburne, we have built and tested a CO₂-capturing process using limestone (*Figure 2*). CO₂ is initially dissolved in water to produce carbonic acid (H₂CO₃), which reacts with the limestone (CaCO₃) to produce calcium bicarbonate (Ca(HCO₃)₂). This process converts CO₂ in the gas state to liquid.

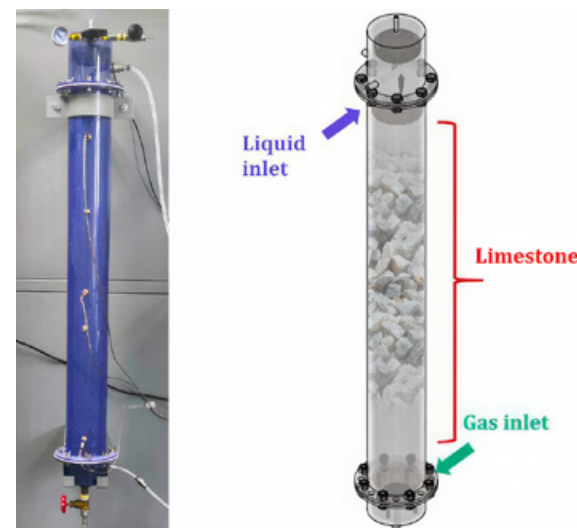


Figure 2: CO₂ Absorption Column with Limestone Packing.

Limestone has various key advantages over the conventional amine-based absorption process used in industries. Unlike amine-based absorbents that are prone to degradation, limestone is chemically and thermally stable (Karunadasa et al., 2019; Nygård et al., 2022), enabling it to resist harsh industrial conditions. Most importantly, AWL is considerably cheaper, with an approximate CO₂ capture cost of \$ 3 – 4.tco₂⁻¹ (Rau et al., 2007) compared to the \$ 20.66 – 25.48.tco₂⁻¹ CO₂ capture cost of a conventional amine-based system (Ye et al., 2019). The low CO₂ capture cost of the AWL process is attributed to its low material cost (i.e., CaCO₃ and water), and it also does not require much post-CO₂ capture processes (i.e., regeneration, CO₂ separation, and storage) to handle its captured CO₂.

In this research, we use potable water instead of the conventional seawater used in other AWL facilities. The utilization of seawater is not favorable for CO₂ capture due to its naturally high bicarbonate content, which would limit the CO₂ intake by the AWL system. Seawater dependency also restricts the AWL process's applicability to coastal areas. The replacement of seawater with potable water, which has an approximately 75.75 % lower

bicarbonate concentration than seawater, allows the AWL process to enhance its CO₂ capture efficiency, capacity, and absorption rate. Aside from improving the overall performance of the AWL process, the switch to potable water as its main water source allows for a decentralized process, making it suitable for application to cement plants around Sarawak.

Apart from that, the AWL process also exhibits excellent CO₂ capture efficiency (up to 97 %) and capacity (0.91 – 1 mol CO₂.mol absorber⁻¹), which is comparable to that of amine-based systems (CO₂ capture efficiency 80 – 100 %; CO₂ capture capacity: 0.35 – 1 mol CO₂.mol absorber⁻¹) (Chai et al., 2022). In addition, the AWL process is able to produce a Ca(HCO₃)₂ solution with a high bicarbonate content (measured by alkalinity) of 3.63 mM, which is suitable for carbon mineralization.

STORING CAPTURED CARBON IN BRICK WITH INDUSTRIAL WASTE

The captured CO₂ in the form of calcium bicarbonate (Ca(HCO₃)₂) solution is conventionally discharged into the ocean to combat ocean acidification (Kirchner et al., 2020). However, it was reported that up to 50% of the captured CO₂ would re-enter the atmosphere within a year. At Swinburne, we developed an alternative storage solution for the captured carbon by utilizing the bicarbonate solution to produce value-added products. Our research employs solid waste to store CO₂ via carbon mineralization. Suitable industrial solid waste includes CKD from the cement industry, steel slag and metal processing slag, which contain high amounts of metal oxides, especially calcium oxide (CaO). The CaO reacts with Ca (HCO₃)₂ to form CaCO₃, which acts as a binder for the sand aggregates to produce bricks, as illustrated in *Figure 3*. In this process, the captured carbon in the liquid state is permanently stored as a solid

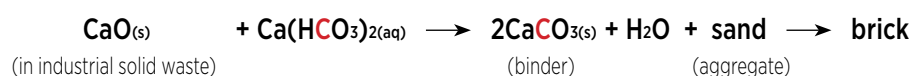


Figure 3: Brick produced from industrial solid waste, calcium bicarbonate and sand.

This approach not only boosts the utilization of industrial solid wastes but also allows low-cost building material production. This is because the price associated with using industrial solid wastes is often negligible compared to the high cost of cement (\$ 88 – 104.t⁻¹) and lime (\$ 120.80 – 160.t⁻¹) (Chai et al., 2024). From the experimental findings, the optimal mix ratio of CKD:sand:Ca(HCO₃)₂ was able to achieve a maximum compressive strength of 2.09 MPa, which is higher than the compressive strength of 1.70 MPa set by the ASTM C141 standard for hydrated hydraulic lime for structural purpose while meeting the standard workability range of 105 – 155 % set by the ASTM C270 standard for mortar.

Our future research direction focuses on exploring the testing and integration of this system in an actual industry emission to evaluate its operational performance with different CO₂ concentrations. Actual industry emissions contain various other gaseous pollutants such as sulfur oxides (SO_x), nitrogen oxides (NO_x), carbon monoxide (CO), particulates and other acidic gases. Understanding their impact on the process and reaction mechanism can help optimize the process.

CONCLUSION

In conclusion, ESG principles can aid the Sarawak industry in achieving green and sustainable manufacturing. Sarawak has invested in various research and ongoing efforts toward a low-carbon economy, as demonstrated in this project, to develop a sustainable solution for CO₂ capture coupled with innovative storage and waste utilization pathways. The proposed solutions are technically feasible, economically viable, and environmentally beneficial, offering a sustainable pathway for the cement industry in Sarawak and beyond. Integrating the AWL process and metal carbonation process addresses CO₂ emissions and industrial solid waste management, contributing to developing cost-effective and environmentally friendly building materials.

ACKNOWLEDGMENT

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USING IOT TO MANAGE STUDENT ATTENDANCE

by Sarawak Skills

With the importance of sustainability in all aspects of our lives and the need to embrace the Environmental, Social, and Governance Global Framework, the students of Sarawak Skills Kuching have embarked on the project "Using IoT to Manage Student Attendance".

The advancement of digital technology today has resulted in a tremendous change in how society interacts, works, and learns. Physical presence in education and industry is a critical factor affecting quality and productivity. However, traditional attendance processes are often time-consuming and prone to human negligence. Looking at the need to modernise this attendance system, this project introduces the latest technological innovation in the form of a digital attendance system based on the face recognition concept. This initiative not only answers the need for more efficient processes but also leverages the power of the latest technology, such as CCTV cameras, webcams, and the NVIDIA Jetson Orin Nano.

This project's development using 'proof of concept' embraced facial recognition technology and integrated it with an advanced algorithm developed using TensorFlow and OpenCV (Computer Vision) in Python. The uniqueness of this system lies in its ability to automatically identify and record the presence of individuals accurately and efficiently, reducing room for human error and improving data integrity. The system is designed to be easily adapted to various uses in educational environments and industry, where presence and surveillance are important.

In achieving the objectives of this project, several in-depth studies were carried out to understand the problems inherent in conventional attendance systems and explore the potential of the latest technological solutions. This study involves the needs of educational institutions, evaluating existing technology, and testing with prototypes to ensure the reliability and functionality of the recognition system. Through this approach, the target is not only to produce innovative products but also to make a real contribution to society by improving student attendance management through facial recognition technology at the educational institution level.

In developing this project, several problems were identified:

1. Conservative attendance systems using signature methods can be a hassle for many users.
2. The traditional unsystematic attendance system must undergo various assessment and calculation processes that cause negligence.
3. The traditional attendance system requires students to line up and wait to sign the attendance form, so doing so wastes time.

Based on the above, the following solutions were proposed:

1. Apply the concept of a real-time facial recognition presence system to accommodate many users.
2. Ensure the facial recognition attendance system functions systematically, automatically, and accurately with system monitoring through the website.
3. Ensure the facial recognition attendance system saves students time by preventing them from having to wait and line up.

There are five (5) phases in this project's development: the data collection phase, the data encoding phase, the data coding phase, the face verification phase, and the attendance record phase. The data collection phase consists of the main display for collecting data sets such as student information and student photos. The student's first and last names need to be filled in, as in the example shown in *Figure 1*. This number works as a unique code to make it easier to search with a unique code only. Here we have two ways to find quick information: by using the first name part or a unique code.

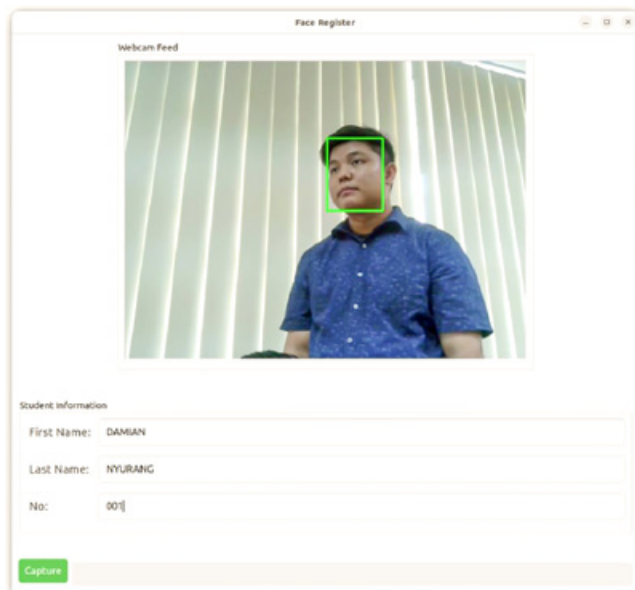


Figure 1: Main dashboard for data collection.

After completing the student data set collection, this data set is saved to the DatasetFace file, as shown in *Figure 2*. The total number of photos collected is 20 photos for each student. One of the reasons for taking 20 photos is to ensure that the system can recognise the student's face accurately and quickly. This image data collection is the first stage.

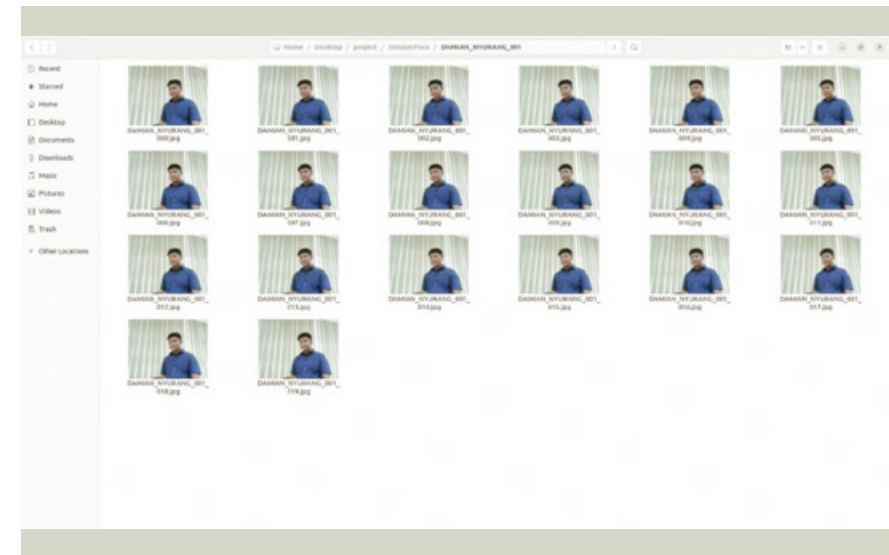


Figure 2: Results of student data collection.

The next process is the encoding phase, followed by coding. The coding results are from the input of the DatasetFace file, which uses the Python library, which is face_recognition. This coding process is divided into two, namely pictures and student information. Generating this will produce the output file face_encodings.pickle.py. This coding is done after completing the data collection of the student set, and it is considered the second stage of the process.

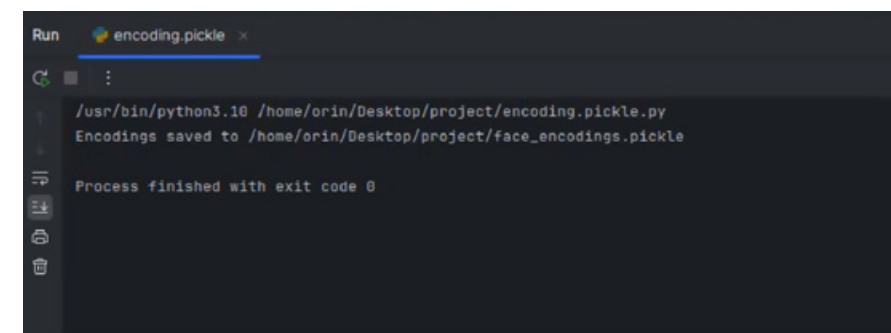


Figure 3: Encoding results.

Next is the face verification process. In this phase, the system compares the data set model, we have two ways to find quick information: by using the first name embedded into the system, face_encoding and knn_model, with the original data set file. This comparison is made to ensure that the system can recognise the student's face and the student's name.

```

face.verify >
:
/home/orin/.local/lib/python3.10/site-packages/mumpy/core/getlimits.py:518: UserWarning: The value of the smallest subnormal
setattr(self, word, getattr(machar, word).flat[0])
/home/orin/.local/lib/python3.10/site-packages/mumpy/core/getlimits.py:89: UserWarning: The value of the smallest subnormal
return self._float_to_str(self.smallest_subnormal)
Selected image for verification: /home/orin/Desktop/project/DatasetFace/DAMIAN_NYURANG_001/DAMIAN_NYURANG_001_004.jpg
Verification result: ['DAMIAN_NYURANG_001']

Process finished with exit code 0

```

Figure 4: Face Verification Process.

The final process is the face identification process. This is the process of recognising student's faces and recording student attendance. The results can be seen in *Figure 5*. In images, the system can recognise faces accurately and correctly. At the same time, the system can also give the correct label, such as the name that was registered from the beginning during the collection of the data set and the registration of student information (full name and unique code). This attendance file uses CSV format, which is Excel format. The system records the student's name, date, and time. This is the result involving two students who were used as tests.

Name	Date	Time
LIO_KLIEMADA ANAK INTAL_001	2024-07-17	15:01:29
DAMIAN_NYURANG_001	2024-07-17	15:01:30

Figure 5: Attendance Result.

PROTOTYPE: USING IOT TO MANAGE STUDENTS' ATTENDANCE

This project is an important step forward for users to manage the efficiency of attendance records well - to monitor real-time data on attendance recording. This project will also be useful for the education sector by making it easier for users to identify and produce accurate attendance records.

Going paperless, this project embraces the Environmental, Social, and Governance (ESG) Global Framework, especially in reducing deforestation, pollution and waste.



Figure 6



SUSTAINABILITY AND ENVIRONMENTAL, SOCIAL AND GOVERNANCE (ESG) IMPLEMENTATION IN CENTRE FOR TECHNOLOGY EXCELLENCE SARAWAK (CENTEXS)

Dr. Nadianatra binti Musa

Chief Academic Officer, Industry and Environmental, Social and Governance (IESG) Academy, CENTEXS

As envisioned by YAB Premier, CENTEXS is continuously providing industry-based competency certification training programmes where skilled workforce and talent development are essential for driving economic growth in line with United Nations (UN) Sustainable Development Goals (SDG), Post Covid-19 Development Strategy (PCDS2030) and Sarawak Digital Economy Blueprint 2030 (SDE2030). CENTEXS IESG Academy offers fifty-five (55) industry-based competency certification programmes for various industry sectors including Oil & Gas, Electrical, Plantation, Agriculture, Aquaculture, Geomatics, Land & Survey, Construction, Hospitality & Tourism, Wellness, Heritage Fashion Technology and Gastronomy. Apart from its training programmes, CENTEXS has also developed its Technology Testbeds and technology applications related to ESG and sustainability.

In alignment with Sustainable Development Goal (SDG4) Quality Education, CENTEXS incorporates sustainability and ESG elements into IESG Academy training programmes.

- CENTEXS offers a **Certificate in ESG for Enterprise** which is designed to build knowledge of trainees on sustainability challenges for reaching net-zero



Figure 1



Figure 2

goals and meeting the Sustainable Development Goals (SDGs). The desirable outcome of the training is to enable trainees to become the change and courage catalysts within the organisations they are employed as their ESG behaviours will contribute to improvements in productivity, efficiency, service levels and add value to their organization. The program covers topics such as sustainability, green financing and reporting standards, carbon neutrality, Greenhouse Gas (GHD) Accounting and Reporting, ESG as risks or opportunities and developing ESG as an organisation strategy.

- CENTEXS has a partnership with Professor Datuk Dr Jimmy Choo, OBE, the World-Famous Shoe Designer and Dodi London on the **Certificate in Shoemaking Artisanry**. Apart from shoe-making skills, this course has integrated sustainability and a holistic approach that combines personal well-being, spiritual fulfillment, and environmental responsibility. Artisans should embrace traditional craftsmanship while prioritising self-care and a balanced work-life environment, enhancing both their creativity and well-being. Spiritual sustainability fosters a deep connection to the craft, aligning personal values with economic stability and success. In addition, focusing on slow fashion, an approach to fashion that emphasises quality over quantity, encourages mindful



Figure 3



Figure 4

consumption, and promotes sustainable practices. Slow fashion advocates for buying fewer, higher-quality items that are ethically produced and meant to last. This comprehensive approach supports a sustainable fashion ecosystem, merging artisanal quality with environmental and social responsibility.

Through industry partnership, CENTEXS provides a testbed platform by incorporating proven technology, conducting a real working environment, undergoing commercialisation, and conducting Research and Development to accelerate workforce and industry transformation. CENTEXS testbeds related to ESG and Sustainability are presented as follows:

- In 2021, CENTEXS in collaboration with industry partners and KNX Association has incorporated energy efficiency elements within Smart Building and



Figure 5

Electrical Lab. The building promotes energy efficiency by installing KNX system and equipped with smart control, smart monitoring, smart control, smart automation, smart natural light, smart dimming light, motion light sensor, smart temperature control and smart aerated water tap to ensure minimal usage of lighting, cost saving benefit, optimum efficiency and minimise water towards Environmental Sustainability. With Smart Building facilities, CENTEXS has introduced a **Certificate in Basic Smart Building Automation (KNX)** and a **Certificate in Advanced Smart Building Automation (KNX)**.

- Furthermore, in 2024, Cascading Energy Test Bed is a joint strategic collaboration between Sarawak Energy Berhad (SEB) and CENTEXS. In realising this strategic partnership, SEB provides technical expertise, advisory roles and concept design in the area of Electric, Hydro, and Renewable Energy, while CENTEXS provides support in the latest technologies and educational facilities. Cascading Energy Test Bed is recognised to be environment friendly as the dam required is a smaller area and does not cause the displacement of people in the nearby area. CENTEXS has integrated cascade hydro-power and sustainability modules into electrical academy training programmes such as **Wireman** and **Chargeman**. The demands of Sarawak's burgeoning hydro industry which is indigenous to the state as a form of green power, require skilled chargemen and wiremen for its construction, operation, and maintenance. Chargemen and Wiremen can

be upskilled into non-qualified engineers and technicians specialising in hydro turbine operations, ensuring they play integral roles in sustaining this vital energy sector.

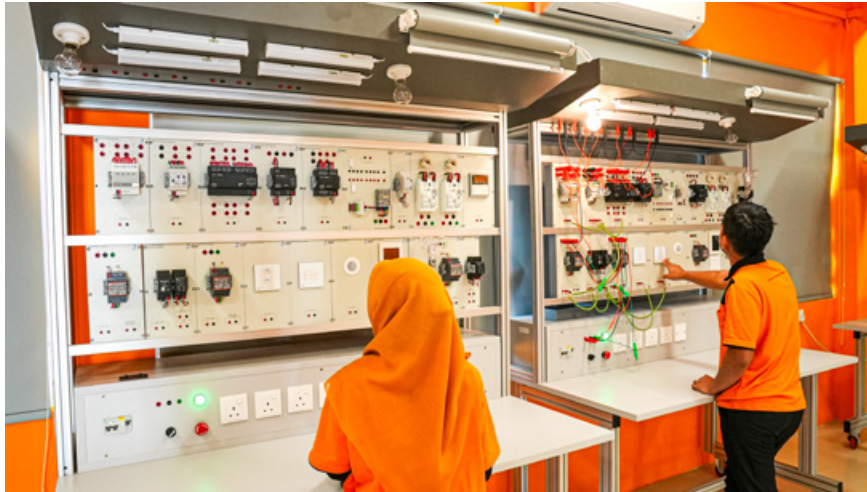


Figure 6



Figure 7

In addition to that, the Sustainability and ESG Roadshow has been rolled out across CENTEXS Campuses in Sarawak to enhance awareness and understanding of sustainability and ESG issues among all CENTEXS trainees and cultivate the 17 Sustainable Development Goals by the United Nations. In conclusion, CENTEXS remains committed to supporting sustainability efforts in alignment with the UN SDGs, PCDS2030, and SDE2030.

ESG AS SUSTAINABLE BUSINESS CATALYST FOR SARAWAK

Leong Kong Yong, High Park Ng, Bryan Paul
Curtin University Malaysia

INTRODUCTION

Environmental, Social, and Governance (ESG) criteria have become essential for driving sustainable practices in the modern business landscape. ESG principles are increasingly integrated into corporate strategies to meet stakeholder expectations. These principles help businesses minimise the negative impact on the environment and society while positioning them as leaders in ethical governance.

Globally, ESG has been implemented in many industries, such as oil and gas, energy, transportation, manufacturing, tourism, and construction, which evidenced the widespread adoption of ESG among large corporations. A survey conducted by Deloitte in 2022 found that 81% of global companies published ESG reports [1]. In Malaysia, approximately 94% of the top 50 listed companies in Malaysia implemented ESG strategies and 68% with carbon emissions reduction management according to PwC's research in 2021 [2]. KPMG's Survey of Sustainability Reporting 2022 found that 97% of Malaysia's Top 100 companies include sustainability data in their annual reports, as shown in Fig 1 [3]. These surveys show that many companies embed the ESG principles into their business.

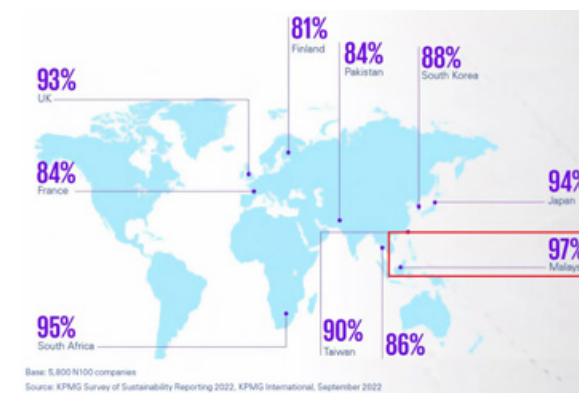


Figure 1: Top 10 countries, territories and jurisdictions by percentage of N100 companies that include sustainability information in annual financial reports 2022.

(source: KPMG Survey of Sustainability Reporting, 2022)

UNDERSTANDING THE ESG IN BUSINESS

ESG in business refers to the operational performances in Environmental, Social, and Governance, where these three pillars represent the key areas in which businesses can make positive impacts.

Environmental: Efforts to improve environmental performances, such as reducing carbon emissions, energy management, waste management, water quality, and resource efficiency. In addition, companies are encouraged to focus on renewable energy, sustainable sourcing, and emissions reduction.

Social: This pillar focuses on the company's responsibilities to people and society, including company cybersecurity, customer privacy, customer welfare, employee benefits, occupational safety and health, corporate social responsibility (CSR), community engagement, and human rights. In general, companies should work to ensure fair treatment of employees, support local communities, and promote diversity and inclusion.

Governance: Involves the company's competitive behaviour, the management of the companies, the structures and processes for decision-making, accountability, and financial transparency. Good governance practices include ethical business conduct, strong risk management, and transparent reporting.

ESG ADOPTION IN SARAWAK

Sarawak has seen an increasing number of companies incorporating ESG principles into their operations, including in the palm oil, timber, oil and gas, energy, and transportation industries. Businesses are investing in environmental initiatives to reduce their ecological impact, such as adopting sustainable land-use practices, promoting reforestation, and investing in renewable energy.

The Sarawak government has published the Post-COVID-19 Development Strategy 2030 (PCDS 2030) to support environmental sustainability, balancing economic growth with conservation to ensure long-term ecosystem health. Initiatives like the Sarawak Corridor of Renewable Energy (SCORE) aim to attract investment in renewable energy and green industries, creating a sustainable economic future for Sarawak.

In addition, Sarawak is the first in Malaysia to pass a bill on carbon emissions, the LAWS OF SARAWAK, Environment (Reduction of Greenhouse Gases Emission) Ordinance, 2023 [4]. This initiative aims to achieve net-zero carbon emissions by 2050.

ADVANTAGES OF EMBEDDING ESG IN BUSINESS

1. Attracting and Retaining Investors

Investors are increasingly considering sustainable investment, focusing on the companies that align with their values and provide long-term returns. Companies that incorporate ESG principles would gain investors' attention, as they are better equipped to handle their businesses dealing with climate change risks and social challenges. In the stock exchange market, investment funds prioritising ESG criteria attract significant capital, such as socially responsible investment (SRI) funds and green bonds. Those companies that demonstrate good ESG performances can access a broader pool of investors and thus enhance their capital flows.

2. Improving Operational Efficiency and Cost Savings

Integrating environmental, social and corporate governance into the enterprise can significantly improve the efficiency of operational processes and operating costs. The companies' sustainability will be increased by optimising the resources used and reducing waste. A sustainable supply chain is essential. For example, good energy management will result in significant savings in utility costs, and good waste management will reduce waste disposal costs. In addition, a sustainable supply chain is essential, as a sustainable business requires an uninterrupted supply. Companies that prioritise ethical sourcing and responsible supplier relationships can mitigate risks and ensure the continuity of their operations.

3. Enhancing Corporate Reputation and Branding

Beyond Corporate Social Responsibility (CSR), ESG practices can significantly enhance a company's image, reputation and branding by showing its strong commitment to sustainability and ethical governance. This attracts eco-conscious consumers and investors, builds trust, and helps the business stand out in a competitive market. For example, companies that actively reduce their carbon footprint and promote sustainable products often receive favourable attention from environmentally conscious consumers. As a result, it leads to stronger brand loyalty, better customer retention, and a positive reputation that drives long-term success.

4. Driving Innovation and Competitive Advantage

ESG initiatives encourage companies to innovate and develop sustainable solutions, which can lead to identifying new market opportunities and creating sustainable products and services. Besides, investors and consumers will prefer businesses with sustainable innovation because of their competitive advantage. With the growing demand for sustainable solutions, businesses that lead in sustainability innovation, sustainable products and services will drive long-term growth and gain more market share.

5. Mitigating Risks and Ensuring Resilience

Risk is the element that most businesses and investors are concerned about, and it is closely linked with return and profits. Companies that address relevant risks are better prepared for challenges, which can lead to reduced liabilities and ensure long-term stability. For instance, companies that assess climate risks and implement adaptation strategies can protect their assets and operations from climate-related impacts. Besides, those prioritising social responsibility and stakeholder engagement can build stronger relationships and reduce the risk of social conflicts.

6. Fostering Employee Engagement and Talent Attraction

Companies with ESG principles will significantly increase employee engagement and attract top talents to work with them. Besides good pay, young generations nowadays are increasingly looking to work for companies that align with their values. Moreover, employee benefits and a good working environment are also considered. Businesses prioritising diversity, inclusion and well-being shape employees to be more productive, innovative and committed to their companies. Meanwhile, recruiting and retaining talents will enhance their human capital and thus drive sustainable business success.

MEASURING ESG METRICS AND REPORTING ESG PERFORMANCE

Reporting ESG performances are essential for transparency and accountability. Measurement of the ESG metrics can be different across industries due to the complexity of sustainability factors. Several sustainability reporting frameworks can be referred to, such as the Global Reporting Initiative (GRI), Task Force on Climate-related Financial Disclosure (TCFD), Sustainability Accounting Standards Board (SASB), and BURSA Sustainability Reporting Guide. Companies could have several types of sustainability



Figure 2: Advantages of Embedding ESG in Business.

reports. Sustainability reporting frameworks can be used for different purposes. For instance, investors are more interested in the TCFD framework because of its financial disclosure; Malaysia PLCs should comply with the BURSA Sustainability Report Guide. Businesses can increase their credibility by publishing sustainability reports or ESG reports, building that specialising trust and benefiting their stakeholders.

CHALLENGES & OPPORTUNITIES

Although the Sarawak government is increasingly promoting businesses' adoption of sustainability and ESG, many challenges remain to be overcome, such as the lack of awareness and understanding of ESG among some businesses and the lack of experts in the sustainability industry. Therefore, more education and training are needed to help Sarawak companies effectively incorporate ESG into their business operations. In addition, there are challenges regarding the authority to enforce ESG standards and monitor compliance.

Despite these challenges, Sarawak's abundant natural resources offer opportunities for sustainable growth as follows:

Sustainable Economic Growth: Embedding ESG principles in business presents significant opportunities for sustainable economic growth in Sarawak. More Sarawak companies investing in green economy, such as renewable energy, sustainable resources, sustainable transportation, eco-tourism, sustainable agriculture, etc., would significantly impact Sarawak's economic growth, thus achieving the objectives of PCDS 2030.

Global Market Access: Companies with ESG practices are better positioned to access global markets, including attracting investment and reducing carbon tax. According to the World Bank, 36 countries have implemented carbon tax systems, and 32 have established emissions trading systems (ETS) as of June 2022. Investors and consumers in countries with carbon taxes, such as Europe and Canada, will be interested in sustainable products and services with low carbon footprints as they also look to reduce costs.

Carbon Credit Investment: Investing in Exchange-Traded Funds (ETFs) focused on carbon credits provides exposure to the carbon market and diversifies risk across various credit-generating projects. Engaging with carbon trading platforms specialising in carbon credits allows direct participation in market dynamics and price fluctuations.

Grants Opportunities: An MOU was signed between InvestSarawak, UNGCMYB, and Alliance Bank in November 2023 to extend RM1 billion in green financing to Sarawak SMEs that adopt sustainable practices [5]. Deputy Premier Datuk Amar Awang Tengah Ali Hasan stated the funds aim to enhance sustainable trade readiness and ESG compliance.

In addition, the Malaysia Investment Development Authority introduced the Domestic Investment Accelerator Fund (DIAF) in March 2024 to support Malaysian-owned Small and Medium Enterprises (SMEs) and Mid-Tier Companies (MTCs) in the manufacturing and selected services sectors (such as Hotel & Tourism, Private Healthcare, Oil & Gas, Logistics, etc.) for the transition into ESG practices [6].

CURTIN MALAYSIA'S EFFORTS IN PROMOTING SUSTAINABILITY AND ESG

Curtin Malaysia responds positively to sustainability and ESG initiatives, including energy management on campus, employee benefits, students' welfare, and establishing good relationships with its stakeholders. Curtin Malaysia's efforts in promoting sustainability and ESG are reflected in its active participation in sustainability-related events across the ASEAN region and the organisation of accreditation workshops and events (Fig 3. to Fig 5.). In addition, Curtin Malaysia also established the Curtin ESG Club (CESG) in 2023, a student-run academic club aimed at promoting sustainable practices among students, faculty, staff, and the wider community. In conjunction with the establishment of the CESG, Kafé Kenyalang was declared Curtin Malaysia's ESG Hub due to its popularity with students, staff and visitors; its suitability for meetings and events; and the operator's demonstrated support of ESG principles through sustainability practices in its daily operations (Fig 6.). As a leading organisation representing the educational sector, Curtin Malaysia has shaped its curriculums to align with sustainable development goals (SDGs). To strengthen its commitment to promoting sustainability and ESG initiatives, Curtin Malaysia has signed an MoU with ESG Malaysia in 2023 (Fig 7.); the MoU focuses on sharing knowledge and expertise in ESG practices, joint research, capacity building, promoting sustainable development and driving positive changes in society. Through these efforts, Curtin Malaysia has demonstrated excellent performance in driving sustainability and ESG in Sarawak and the ASEAN region.

CONCLUSION

ESG is emerging as a powerful catalyst for sustainable business. With its rich green resources and the growing number of companies adopting ESG principles, Sarawak highlights the potential for sustainable development. The Sarawak government has demonstrated great ambition in pursuing continuous economic growth and a green, sustainable future. By integrating ESG into their strategies, businesses in Sarawak can drive positive environmental and social impact while ensuring long-term economic success. As more companies embed ESG in their businesses, the vision of a sustainable and prosperous future for Sarawak becomes increasingly attainable.



Figure 3: Curtin Malaysia organised an ESG workshop for organisations interested in ESG accreditation in Oct 2022.

Figure 4: Curtin Malaysia hosted a Sustainability Event for students and the public in collaboration with the professional body in Sep 2023.



Figure 5: Curtin Malaysia delegate Dr. Leong Kong Yong (1st left) participated in the World ESG Summit in 2023.

Figure 6: ESG Club and ESG Hub were established at Curtin Malaysia to foster sustainable practices in May 2023.



Figure 7: MOU Signing Ceremony between Curtin Malaysia & ESG Malaysia on 15th May 2023.

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INTEGRATE ESG INTO GREEN FINANCE FOR SUSTAINABILITY DEVELOPMENT

Yii Kwang Jing¹, Maggie Tang May Jean¹, and Leong Choi Meng¹

¹School of Business, Swinburne University of Technology Sarawak Campus

GREEN FINANCE

Green finance provides an alternative financing route for individuals, corporations, and governments to support green or low-carbon activities. It offers benefits like environmental preservation, promoting sustainable trade and investment, providing low-risk financing, and developing green investment instruments (Ozili, 2022). Green finance aims for financial returns and a sustainable future by directing capital into environmentally beneficial projects. It prioritizes sectors such as renewable energy, energy efficiency, clean technology, sustainable agriculture, waste management, and climate resilience. By encouraging investment in these areas, green finance helps mitigate climate change, reduce greenhouse gas emissions, and protect ecosystems.

Since the introduction of the Sustainable Responsible Investment (SRI) Framework by the Securities Commission Malaysia (SC) in 2014, there has been a rising demand for sustainable financial products. Green Sukuk, bonds, social bonds, and sustainability bonds have become more popular, allowing investors to back projects that deliver positive environmental and social outcomes. This development aligns with Malaysia's ambition to establish itself as a center for sustainable finance. Bank Negara Malaysia (BNM) facilitates the shift to a low-carbon economy by fostering a supportive environment for green financing and investment, ensuring the necessary frameworks and support systems are established.

ENVIRONMENTAL, SOCIAL, AND GOVERNANCE (ESG) AND GREEN FINANCE

The global community, along with civil society and private sector efforts, has progressively adopted the sustainability movement. The 1972 United Nations Conference on the

Human Environment resulted in the establishment of the United Nations Environmental Programme (UNEP), which began incorporating environmental, social, and governance (ESG) factors into financial performance evaluations. In 1988, UNEP and the World Meteorological Organization (WMO) created the Intergovernmental Panel on Climate Change (IPCC) to offer scientific perspectives on climate change. The subsequent year saw the formation of the Coalition for Environmentally Responsible Economies (CERES), which set the stage for UNEP's Global Reporting Initiative (GRI), boosting global emphasis on environmental transparency for large corporations (Berrou, Dessertine, & Migliorelli, 2019).

ESG AND GREEN FINANCE IN SARAWAK

In Sarawak, the integration of ESG initiatives and green finance plays a crucial role in promoting sustainable development, particularly among small and medium enterprises (SMEs). A notable collaboration in 2023 between Alliance Bank Malaysia Berhad, InvestSarawak Sdn Bhd, and the UN Global Compact Network Malaysia & Brunei (UNGCMYB) led to the launch of the "Climate Inclusive Financing & Development Programme". This initiative includes a RM1 billion green financing fund aimed at helping Sarawakian SMEs develop ESG roadmaps and strengthen business resilience. It also introduced the Promoting Green Resilient & Sustainable SMEs (PRO-GRESS) tool, designed to assist SMEs in assessing their climate action maturity and gaining access to preferential financing rates. Further support comes from capacity-building workshops and roadshows.

The Sarawak government encourages entrepreneurs to leverage green financing for sustainable business practices. The Ministry of International Trade, Industry, and Investment (MITI) provides financial aid through programs such as the Sarawak Micro Credit Scheme (SKMS) and the Small and Medium Industry Loan Scheme (SPIKS), along with grants supporting entrepreneurship and technology adoption. These efforts are part of a broader strategy to integrate ESG considerations into green finance, including green infrastructure, urban planning, and technological innovation.

GREEN INFRASTRUCTURE AND URBAN PLANNING

With urbanization challenges, green infrastructure has emerged as a transformative solution that tackles issues such as pollution and climate change. Rapid urbanization brings significant environmental and social challenges, including poor air and water quality, waste-disposal problem, and extreme weather events. By reintroducing the environmental lifecycle into urban settings, green infrastructure improves environmental

quality, fosters sustainability and promotes community well-being. Since awareness of climate risk grows, the urgency for investment in green infrastructure becomes increasingly clear and imperative.

Recognizing the importance of environmental sustainability, Sarawak is committed to transforming into a sustainable green city. Striving to become Southeast Asia's green energy powerhouse, Sarawak is shifting from traditional energy models to renewable energy and positioning itself as a leader in the new economy. To achieve its sustainability goals, Sarawak is developing low-carbon society blueprints focused on reducing carbon footprints, promoting renewable energy, and fostering sustainable transportation.

One significant initiative is the Kuching Smart City Master Plan which emphasizes low-carbon mobility and smart infrastructure. Similar initiatives are planned for cities across the state. These efforts aim to create livable, healthy, and vibrant urban environments. A range of green infrastructure including green space development and energy-efficient buildings are needed to achieve these goals. The growing adoption of the Green Building Index highlight Sarawak's dedication to sustainable urban development.

Additionally, Sarawak is advancing plans to produce new energy materials and develop infrastructure, such as the Energy Hub in Samalaju and Kiduring and the Trans Borneo Pipeline. In 2023, the state attracted RM 21.4 billion in investments, significantly boosting manufacturing and renewable energy sectors. With ongoing digital infrastructure projects expected to drive 8% annual GDP growth, Sarawak aims to reduce greenhouse gas emissions by 45% by 2030 through technology advancements.

In recent years, financing options for sustainable urban infrastructure have expanded significantly. Financiers are increasingly allocating capital to green infrastructure projects that offer financial returns alongside social and environmental value. In Malaysia, much infrastructure investment is carried out through public funding and Public-Private Partnerships (PPPs). However, public funding alone is insufficient to meet the growing demand for green infrastructure. To bridge this gap, it is essential to mobilize private capital through new channels. Green debt instruments, such as green bonds and green loans, have emerged as valuable tools for private investors that directing funds towards climate and environmental projects.

A proactive approach to public policy engagement is crucial for creating a supportive environment for green infrastructure development. Supporting research on ESG issues and climate risks allows stakeholders to better understand the impacts of their investments. Sector initiatives aimed at developing resources to assess risks and integrate ESG considerations into business models are essential steps forward. In response to global challenges like climate change and social inequality, the infrastructure and construction industry is embracing innovative ESG practices. These initiatives enhance sustainability and contribute to long-term profitability and resilience, ensuring that green infrastructure remains at the forefront of sustainable progress.

SUSTAINABLE PRACTICES AND TECHNOLOGY INNOVATION

Sarawak's commitment to achieving net-zero emissions underscores its dedication to a sustainable future. The state aims to transform its economy by embedding environmental sustainability into its recovery plans, thereby fostering investment opportunities and growth in the green sector. MITI, in collaboration with InvestSarawak, leads the RM1 billion green financing initiative for SMEs, promoting the adoption of ESG principles across business models. These initiatives align with Sarawak's Post-Covid Development Strategy (PCDS) 2030, which outlines a vision for a dynamic, resilient, and sustainable region. The strategy focuses on innovation, inclusivity, and environmental stewardship, emphasizing digitalization, innovation, and entrepreneurship to build a sustainable future. A key component of this vision is the establishment of a Centre of Excellence for Clean Energy, which will serve as a hub for innovation, research, and development in green technology. This center will bring together experts to advance technologies utilizing renewable resources, with a focus on hydrogen, hydroelectric power, solar energy, biomass, and other clean energy sources.

The Sarawak Hydrogen Roadmap, supported by green financing initiatives, underscores the region's commitment to advancing hydrogen energy. A significant research grant from South Korea's Ministry of Economy and Finance will fund pioneering studies in hydrogen production and utilization, furthering innovative energy solutions and sustainable development in Sarawak. As the region moves forward, integrating ESG principles into the hydrogen sector and beyond is crucial. This includes environmental considerations like reducing carbon emissions and optimizing resource use, social aspects such as promoting diversity, and governance measures to ensure transparency and accountability.

Sarawak's green economy initiative aligns with practices in leading developed nations, including the G7 countries, including Canada, France, Germany, Italy, Japan, United Kingdom, and United State. Yang, Du, Razzaq, and Shang (2022) highlight that green financing, particularly through green bonds, clean energy investments, and overall green economy development, has contributed to sustainable practices in these nations, reflecting ESG principles. By incorporating ESG principles into its economic and industrial policies, Sarawak demonstrates a strong commitment to sustainable development and responsible governance. This alignment with global sustainability trends positions Sarawak as a key investment hub for foreign investors, reinforcing its dedication to ESG compliance.

FRAMEWORK RECOMMENDATIONS AND CONCLUSION

The proposed ESG and Green Finance Framework for Sarawak (see Figure 1) is designed to integrate environmental, social, and governance (ESG) components. Environmental (E) initiatives focus on promoting a low-carbon, resilient economy by expanding green

finance and sustainable practices. Key strategies include increasing access to eco-friendly financing options, such as Green Sukuk and sustainability bonds, which direct capital into vital sectors like renewable energy, energy efficiency, clean technology, sustainable agriculture, waste management, and climate resilience. The establishment of a Clean Energy Research Center is crucial for advancing innovation in renewable technologies, including hydrogen, solar, and biomass. Additionally, the framework emphasizes setting specific emission reduction targets, aligning with Sarawak's commitment to achieving net-zero emissions by 2030. The use of digital tools will be crucial for monitoring and enhancing green technologies, supporting the development of energy-efficient buildings and green infrastructure.

Social (S) components focus on enhancing social equity and public engagement in sustainable development. A key element is capacity building and education, achieved

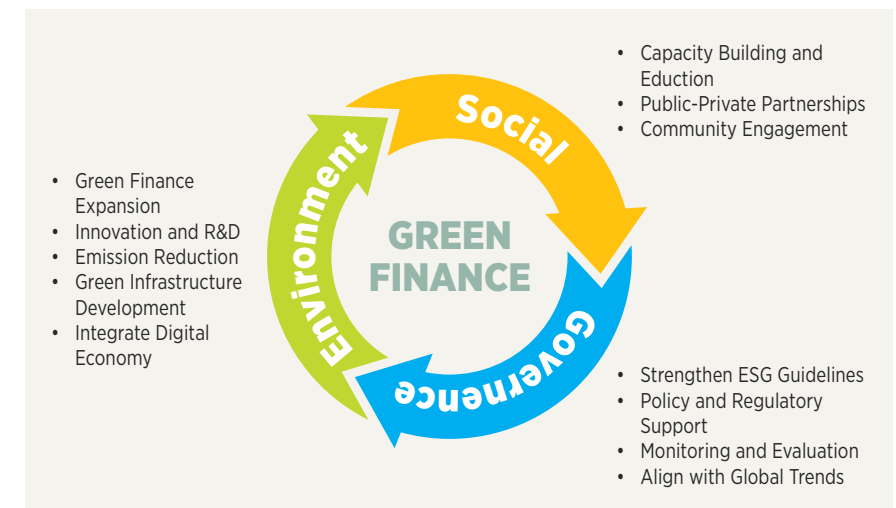


Figure 1: ESG and Green Finance Framework.

through workshops, seminars, and training programs that increase awareness and understanding of ESG practices and green finance among public and private sectors. Public-Private Partnerships are encouraged to foster collaborative efforts between government, industry, and civil society, thereby scaling sustainability initiatives through cooperative action. The framework also emphasizes community engagement, ensuring that the benefits of sustainable development are equitably distributed, thus fostering community resilience and social inclusion.

Governance (G) strategies are vital for ensuring transparency, accountability, and compliance in ESG practices. The framework advocates for the development and enforcement of clear ESG guidelines and reporting mechanisms, including regular assessments to ensure adherence to established norms. Strengthening policies and

regulations is crucial, particularly to facilitate green finance and the transition to a low-carbon economy. By aligning Sarawak's ESG framework with global standards and trends, the region can enhance international cooperation and maintain relevance on the global stage. Robust monitoring and evaluation systems will be established to assess the effectiveness of ESG initiatives, using performance data to refine and improve strategies continually.

In a nutshell, this comprehensive framework integrates environmental, social, and governance aspects to guide Sarawak's transition toward a sustainable future. It prioritizes green finance, promotes social equity, and ensures responsible governance, positioning Sarawak as a model for sustainable development and economic growth in the region.

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FOOD INNOVATIONS: DABAI, THE INDIGENOUS DELIGHT OF SARAWAK

Ts. Farah Syahirah Abdul Shukri

Lecturer Food Technology Programme, University of Technology Sarawak (UTS)

In Sarawak's lush, tropical forests, a small yet intriguing fruit quietly marks the region's rich tapestry of flavours. Known locally as "Dabai" (*Canarium odontophyllum* Miq.), this indigenous fruit has long been cherished by the people of Sarawak, Malaysia, but remains a hidden gem to many outside its native land. Let's delve into the fascinating world of Dabai and uncover the reasons behind its growing reputation for new food development.



Figure 1: Dabai fruit.

A TASTE OF TRADITION

Dabai is not just any fruit—it's a hidden treasure with deep roots in the traditions of Sarawak. Known for its distinctive, dark purple skin and rich, creamy flesh, Dabai is often likened to a cross between an olive and a date, both in appearance and taste. Its flavour is

a complex blend of sweetness and savoury notes, often described as nutty with hints of butter.

Traditionally, Dabai is enjoyed in a simple yet flavorful way: it is soaked in hot water until the flesh softens and then seasoned with salt, sugar, or soy sauce. This preparation method brings out the fruit's unique characteristics, making it a beloved side dish or snack, particularly during festive seasons and family gatherings.

CULTIVATION AND HARVEST

Dabai trees thrive in the humid, tropical climate of Borneo, especially in Sibuan, Song and Kapit regions, and their cultivation is a testament to the region's rich biodiversity. These trees can grow up to 20 meters high and produce fruit that clusters in small, grape-like bunches. The fruit's seasonality is closely tied to the rainy season, which ensures optimal growth and ripening.

Harvesting Dabai is a meticulous process. Local farmers climb the tall trees or use long poles to gently collect the ripe fruit, ensuring they don't damage the delicate skin. The collected Dabai is then sorted and prepared for consumption or sale. This hands-on approach reflects the close connection between the people of Sarawak and their natural environment.



Figure 2: Dabai tree. Adapted from (Lim, 2012).

NUTRITIONAL POWERHOUSE

Beyond its delightful taste, Dabai packs a nutritional punch. This fruit contributes to a balanced diet and overall well-being and is rich in essential fatty acids, vitamins, and antioxidants. Its high oil content makes it a great source of healthy fats, which are important for heart health and maintaining healthy skin. Additionally, Dabai contains vitamins like A and E, which are crucial for maintaining good vision and immune function.

CREATIVITY AND INNOVATIONS

While Dabai is traditionally enjoyed straightforwardly, its unique flavour profile offers exciting new food product development possibilities. Food technologists and scientists are beginning to experiment with Dabai in food products, such as table spread, instant noodles, vegan mayonnaise, and even margarine. At the University of Technology Sarawak, the Food Technology programme has successfully innovated various interesting Dabai-based products that caught the attention of the locals and won several exhibitions internationally.



Figure 3: *DabKer* – Dabai Kernel Spread has won a Gold Award in Defence, Security & Sustainability (DSS 2022), two Silver Awards in Malaysia Technology Expo (MTE 2022) and PECIPTA 2022.



Figure 4: *Instant Dabaimee* – Instant Dabai noodles that participated in the Malaysia Institute of Food Technologists (MIFT) 13th National Food Science and Technology Competition.



Figure 5: *Dabayo!* – Vegan Dabai Mayonnaise has won the Silver Medal in the 34th International Invention, Innovation & Technology Exhibition (ITEX 2023).

Dabai's versatility allows it to be paired with a wide range of ingredients, showcasing its adaptability and enhancing the flavour of sweet and savoury creations.

CULTURAL SIGNIFICANCE

Dabai is more than just a fruit; it symbolises Sarawak's rich cultural heritage. For the indigenous communities, Dabai represents a link to their ancestral lands and traditions. It is often featured in local festivals and ceremonies, where its presence underscores the importance of maintaining and celebrating traditional food practices.

CONSERVATION AND SUSTAINABILITY

As interest in Dabai grows beyond Sarawak, there is an increasing focus on sustainable cultivation practices to ensure that this Indigenous fruit can continue to thrive for generations. Efforts are being made to promote responsible farming techniques and to preserve the natural habitats where Dabai trees grow. This supports the fruit's continued availability and helps protect the broader ecosystem.

CONCLUSION

Dabai is a testament to Sarawak's natural bounty's incredible diversity and richness. Its unique flavour, nutritional benefits, and cultural significance make it a fruit worth celebrating. As Dabai continues to gain recognition on the global stage, it serves as a delicious reminder of the deep connections between food, tradition, and identity. For those lucky enough to encounter it, Dabai offers a taste of Sarawak's vibrant heritage and a glimpse into the timeless traditions of its people.

For more information about Dabai and its role in Sarawak's food innovations, visit [set.uts.edu.my] or contact us through [farah.syahirah@uts.edu.my].



THE GENESIS OF HALO: NYPA SALT TROPICAL FRUIT SPARKLING WATER - A JOURNEY OF SUSTAINABILITY, CULTURE, AND INNOVATION

Mohd Syafiq Abdullah

University of Technology Sarawak (UTS)

The story of Halo: Nypa Salt Tropical Fruit Sparkling Water is one of discovery and innovation, deeply rooted in sustainability and cultural reverence. This journey began with a simple vision—to create a beverage that delights the senses and promotes responsible consumption and production practices in alignment with Sustainable Development Goal (SDG) 12. Through exploring the nypa palm (*Nypa fruticans*), a symbol of resilience and versatility in Malaysia, particularly in Sarawak, Halo was born, marking a new chapter in sustainable beverage production.



Figure 1: Halo - Nypa Salt Tropical Fruit Sparkling Water.

DISCOVERING THE UNTAPPED POTENTIAL OF THE NYPA PALM

In the lush coastal landscapes of Malaysia, the nypa palm thrives, its fronds swaying gracefully in the breeze. This plant, long cherished in Malaysian culture, has provided for communities in myriad ways. Its sweet sap is transformed into traditional delicacies, and its fibrous leaves are crafted into various items, reflecting the palm's versatility. Despite its abundance, much of the nypa palm's potential remained untapped—until the inception of Halo.



Figure 2: Nypa palm (*Nypa fruticans*).

Halo's idea emerged from a desire to unlock the hidden treasures of the nypa palm. In particular, the discovery of nypa salt, a natural salt extracted from the fronds of the nypa palm, became the cornerstone of this innovative journey. Nypa salt is rich in minerals, free from harmful additives, and offers a unique depth of flavour, making it an ideal ingredient for a refreshing and sustainable beverage. This revelation set the stage for Halo: Nypa Salt Tropical Fruit Sparkling Water, a drink that embodies sustainability principles and environmental stewardship.

ALIGNING WITH SDG 12 - RESPONSIBLE CONSUMPTION AND PRODUCTION

At the heart of Halo's creation is a commitment to SDG 12, which calls for responsible consumption and production practices. Using nypa salt in Halo is a powerful example of

how underutilised resources can be transformed into valuable commodities, reducing waste and minimising environmental impact. Unlike conventional salt production methods, which often rely on practices that harm the environment, the extraction of nypa salt is inherently sustainable. It requires minimal inputs and leaves behind no harmful by-products, making it a perfect choice for a beverage that prioritises sustainability.

The resilience of the nypa palm also makes it an ideal candidate for agroforestry initiatives aimed at mitigating the effects of climate change. By promoting the cultivation of nypa palms in coastal areas, Halo contributes to preserving fragile ecosystems, enhancing biodiversity, and providing livelihood opportunities for local communities. This alignment with SDG 12 is not just about the product itself but about the broader impact of Halo on the environment and society.

CRAFTING A BEVERAGE THAT CELEBRATES MALAYSIA'S RICH CULTURAL HERITAGE

The inspiration for Halo goes beyond sustainability; it is also a celebration of Malaysia's rich cultural heritage and natural resources. The nypa palm, with its deep roots in Malaysian culture, served as the starting point for the creation of this unique beverage. The journey began with a group of passionate individuals who shared a common goal: to craft a drink that not only tastes delicious but also promotes health, wellness, and sustainability.

As the Food Technology Programme team at the University of Technology Sarawak delved deeper into the potential of the nypa palm, they were inspired by its versatility and the abundance of resources it offers. Exploring this underutilised botanical treasure led to the discovery of nypa salt, which became the key ingredient in Halo. To complement the subtle brininess of nypa salt, the team carefully selected tropical fruits like pineapple, lime, and pudina leaves, which thrive in Malaysia's fertile soils. These ingredients were chosen for their vibrant colours, flavours, and aromas, creating a harmonious blend that captures the region's essence.

THE ART OF FLAVOR: A SYMPHONY OF INGREDIENTS

Crafting Halo: Nypa Salt Tropical Fruit Sparkling Water was a meticulous process involving a deep understanding of flavour profiles and ingredient synergy. Each element in Halo is thoughtfully curated and meticulously balanced, resulting in a beverage that is not only refreshing but transcendent in its ability to delight the senses.

The journey through Halo's flavour begins with the succulent sweetness of ripe pineapple, transporting the drinker to a tropical paradise. The tangy zest of freshly squeezed lime follows, awakening the palate with its vibrant acidity. As the refreshing

aroma of pudina leaves dances on the breeze, a cool, minty freshness envelops the senses, offering a moment of pure bliss. But it is the subtle presence of nypa salt that ties everything together. With its delicate salinity and rich mineral profile, nypa salt elevates the flavours of pineapple, lime, and pudina, adding depth and complexity to the beverage.

The final touch is the effervescent carbonation, which dances across the tongue, enhancing the experience with its lively bubbles and crisp texture. Each sip of Halo is a reminder of nature's bounty and the artistry of blending ingredients in perfect harmony.



Figure 3: Ingredients of Halo.

BEYOND THE BEVERAGE: ENGAGING COMMUNITIES AND PROMOTING ENVIRONMENTAL AWARENESS

Halo: Nypa Salt Tropical Fruit Sparkling Water is more than just a beverage; it is a movement that extends its impact beyond the drink itself. Halo is committed to engaging with communities, promoting environmental awareness, supporting local farmers, and empowering sustainable practices. These efforts are integral to the brand's mission of nurturing a culture of environmental stewardship and social responsibility.

Halo is deeply committed to supporting local farmers and promoting sustainable agricultural practices. By sourcing ingredients locally whenever possible, the brand reduces carbon emissions associated with transportation and supports local economies. This commitment to local sourcing also ensures that the ingredients used in Halo are of the highest quality, reflecting the richness of Malaysia's agricultural heritage.

At its core, Halo is about nurturing a deep respect for the natural world and promoting sustainable practices in everything it does. By fostering a culture of environmental stewardship and social responsibility, Halo aims to inspire others to join in the journey towards a brighter, more sustainable future. The brand believes that environmental stewardship is everyone's responsibility, and through its actions and initiatives, Halo seeks to empower individuals and communities to make a difference.

As Halo continues to grow, it remains committed to its core values of quality, sustainability, and authenticity. The brand's journey is one of continuous exploration and innovation, always seeking new ways to harness the power of nature and create products that taste great and positively impact the world. Through its dedication to sustainability and environmental stewardship, Halo is paving the way for a brighter, more sustainable future that begins with a simple greeting and ends with a revitalising sip of Halo.

EMBRACING SUSTAINABILITY: HALO'S JOURNEY TOWARDS ENVIRONMENTAL RESPONSIBILITY

Halo's dedication to minimising its ecological footprint and promoting a healthier planet is evident in its production process. While acknowledging areas for improvement, Halo remains committed to continuous progress towards environmental responsibility.

Halo takes pride in its utilisation of renewable resources, particularly nypa salt sourced from the fronds of the nypa palm. By harnessing the natural abundance of nypa palms, Halo minimises its reliance on non-renewable resources and fosters a more sustainable supply chain. This approach supports the preservation of Malaysia's natural ecosystems and aligns with Halo's broader commitment to sustainability. While certain aspects of production may contribute to carbon emissions, Halo continues to explore innovative solutions to mitigate environmental impact and enhance sustainability.

One of Halo's key innovations in sustainable production is using high-efficiency muffle furnaces for calcination during salt extraction. Unlike traditional open-burning methods, these advanced furnaces are



Figure 4: High Efficiency Muffle Furnace.

designed to optimise heat transfer and combustion efficiency, resulting in significantly lower carbon emissions. By adopting this technology, Halo reduces its environmental impact while ensuring the safety and well-being of surrounding communities by minimising air pollution.

Celebrate Halo's commitment to sustainability as we explore how each bottle of Halo refreshes and contributes to a greener, healthier planet. Through its use of renewable nypa palm resources, reduction of waste through natural carbonation techniques, and promotion of eco-friendly practices, Halo leads by example in sustainable beverage production.

A WAY FORWARD

We envision Halo not just as a brand but as a movement towards a more conscious and connected way of living that celebrates diversity, promotes wellness, and preserves the natural world for future generations. By staying true to our values and listening to the needs and aspirations of our customers, we aim to be a trusted partner in their journey towards a healthier, happier, and more sustainable lifestyle.

In essence, our future is bright, and we are excited to continue innovating, inspiring, and delighting our customers with products and experiences that positively impact their lives and the world around us. Let's raise a glass to a future filled with health, happiness, and harmony. Cheers to the journey ahead.



ECO ACACIA BAMBOO SANDWICH WALL PANEL (ECO-SWAP): A REVOLUTIONARY STEP IN SUSTAINABLE CONSTRUCTION

Ts Mohamad Saiful Sulaiman

Centre of Excellence in Wood Engineered Products (CeWEP),
School of Engineering and Technology, University of Technology Sarawak

The construction industry has undergone significant transformation in recent years, owing to the urgent need to adopt more sustainable and environmentally friendly practices. At the forefront of this transformation is the development of innovative materials that meet the functional requirements of construction and align with global sustainability objectives. One-edge composite material designed for modern construction requirements.

Sandwich wall panels are advanced composite materials that have become increasingly popular in the construction industry due to their unique combination of lightweight properties, structural strength, and superior thermal insulation. These panels consist of three layers: two outer skins and a core in the middle. The skins are made from durable materials like metals, polymers, or natural fibers, which provide structural support and protection for the core. The core, typically composed of lightweight materials such as foam or low-density fiber composites, enhances the panel's stiffness and contributes to its thermal and acoustic insulation capabilities.

The design of sandwich wall panels allows them to be both strong and lightweight, making them easier to transport and install than traditional materials like concrete or solid wood. This structural efficiency can be tailored by varying the materials used for the skins and core, enabling customization for specific needs, including fire resistance, sound insulation, or enhanced thermal performance.

These panels are versatile and widely used across various residential, commercial, and industrial construction sectors. They serve multiple purposes, exterior cladding, roofing systems, partition walls, and load-bearing structures. Their excellent insulation properties make them ideal for energy-efficient buildings, and their soundproofing capabilities are valuable in noise-sensitive environments like offices and studios. Additionally, sandwich wall panels offer aesthetic flexibility, as they can be

produced in various finishes and colours, allowing architects and designers to achieve desired visual effects while maintaining technical performance.

As sustainability becomes increasingly important in construction, the industry has grown interested in eco-friendly sandwich wall panels made from renewable and recycled materials. Traditional sandwich panels, often made with synthetic cores and skins, pose environmental concerns due to their production and disposal impacts. In response, researchers and manufacturers have been developing panels using natural fibers, recycled content, and biodegradable resins, aligning with global sustainability goals and reducing the environmental footprint of construction projects.

The ECO-SWAP (Eco Acacia Bamboo Sandwich Wall Panel) is a notable example of this shift towards sustainability. This innovative product uses Acacia waste as the core material and bamboo fibers for the skins, combined with bio-epoxy resin derived from renewable sources. ECO-SWAP panels offer the same advantages as conventional sandwich panels—strength, insulation, and ease of installation—while promoting waste reduction and using renewable materials. This makes ECO-SWAP an ideal choice for green building projects and for those committed to reducing the environmental impact of construction.

In other words, sandwich wall panels' versatility, efficiency, and performance are essential in modern construction. Developing eco-friendly options like ECO-SWAP reflects the industry's commitment to sustainable innovation, paving the way for building materials that support high performance and environmental responsibility.



Figure 1: The Eco Acacia Bamboo Sandwich Wall Panel (ECO-SWAP) composite-reinforced bio-epoxy resin is biodegradable.

FIBER ECO-FRIENDLY RESOURCES: ACACIA WASTE AND BAMBOO FIBER

Acacia trees, belonging to the genus *Acacia*, are widely found in various regions worldwide, including Sarawak, Malaysia. These trees are highly valued for their rapid growth and adaptability to different soil conditions, making them an ideal source of timber and wood chips. However, the Acacia industry also generates significant waste, particularly from the bark, often discarded or used for low-value applications. ECO-SWAP redefines the value of this waste by repurposing it as the core material for sandwich wall panels.

Bamboo is renowned for its rapid growth, flexibility, and sustainability, making it an excellent choice for eco-friendly construction materials. In this context, bamboo



Figure 2: ECO-SWAP Acacia bark waste core composite.

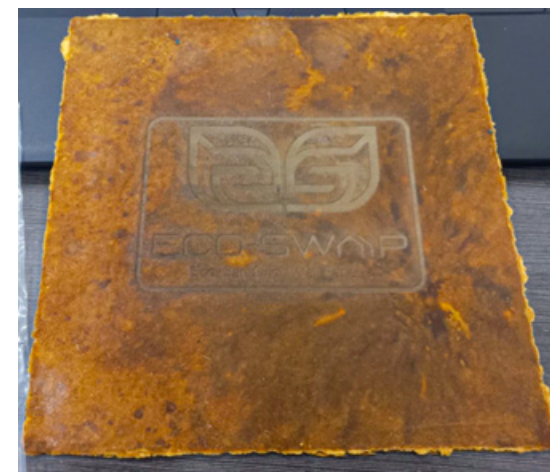


Figure 3: ECO-SWAP bamboo fiber skin composite.

fibers are processed into micro-sized particles and used to form the panel's outer layers, or "skins". This enhances the panel's structural integrity and contributes to its eco-friendly profile. Bamboo's cultural significance and economic value are particularly emphasized in Sarawak, where the government aims to cultivate 20,000 hectares of commercial bamboo by 2030.

SUSTAINABLE MANUFACTURING: TURNING WASTE INTO WALL PANELS

The production of ECO-SWAP panels involves a meticulous process that transforms Acacia waste and bamboo into high-performance composite materials. It starts with collecting and preparing Acacia waste from Sarawak, harvesting, debarking, and grinding bamboo. These raw materials are dried at 103 ± 2 °C for 24 hours to ensure quality and durability.

The dried fibers are then blended with bio-epoxy resin to enhance the eco-friendliness of the panels while binding the fibers together and adding strength. The blended material undergoes the hot press to cure the composite and achieve the desired strength. Finally, the bamboo skins and Acacia core are laminated using bio-epoxy resin, creating a lightweight, strong, and environmentally resistant sandwich panel. This product combines the benefits of Acacia and bamboo, offering a versatile and sustainable construction solution.

ECO-SWAP: ALIGNING WITH SUSTAINABLE DEVELOPMENT GOALS

ECO-SWAP is not just another building material but a product designed with sustainability. The use of Acacia waste and bamboo fibers directly aligns with the United Nations' 15th Sustainable Development Goal (SDG), which focuses on sustainable use of terrestrial ecosystems, sustainable forest management, combating desertification, halting and reversing land degradation, and halting biodiversity loss.

By repurposing waste materials and utilizing fast-growing, renewable resources like bamboo, ECO-SWAP contributes to the global push for more sustainable construction practices. Moreover, bio-epoxy resin, derived from renewable resources, reduces the reliance on petroleum-based products, further minimizing the environmental impact.

REAL-WORLD USES AND ADVANTAGES OF ECO-SWAP

ECO-SWAP panels are versatile and can be used in various construction applications. They are well-suited for interior wall panels, room partitions, and studio spaces. The

panels' lightweight nature makes them easy to handle and install, while their strength and durability ensure long-lasting performance.

One of the critical benefits of ECO-SWAP panels is their excellent thermal and acoustic insulation properties. Combining Acacia waste and bamboo fibers creates a composite material that effectively reduces heat transfer and dampens sound, making it ideal for residential and commercial buildings.

Furthermore, the environmental benefits of ECO-SWAP are manifold. By utilizing waste materials and renewable resources, the production of these panels minimizes waste and reduces the carbon footprint associated with construction. Additionally, using bio-epoxy resin ensures that the panels are free from harmful chemicals, making them safe for the environment and human health.

In addition to their functional benefits, ECO-SWAP panels offer a unique aesthetic appeal. Acacia and bamboo's natural textures and colours create a warm, organic look that can enhance the visual appeal of any interior space. This makes ECO-SWAP an attractive option for architects and designers seeking to incorporate sustainable materials without compromising style.

POTENTIAL OF ECO-SWAP

As the demand for sustainable building materials grows, ECO-SWAP is well-positioned to capture a significant market share. Its combination of sustainability, functionality, and aesthetic appeal makes it an attractive choice for various construction projects, from residential homes to commercial complexes.

ECO-SWAP is more than just a building material; it is a symbol of the future of construction. By repurposing waste materials and utilizing renewable resources, ECO-SWAP offers a sustainable solution that meets the needs of modern construction while aligning with global sustainability goals. As the construction industry evolves, products like ECO-SWAP will be critical in shaping a more sustainable, eco-friendly future.

The journey of ECO-SWAP is just beginning, and with ongoing advancements in materials science and manufacturing processes, the potential for this innovative product is limitless. Whether you are an architect, a builder, or a homeowner, ECO-SWAP offers a compelling solution that combines sustainability, functionality, and aesthetic appeal. As the world moves towards more sustainable practices, ECO-SWAP stands out as a beacon of innovation and environmental responsibility in the construction industry.



SOLAR ENERGY AS A SOURCE OF SUSTAINABLE ELECTRICITY: A SOLAR PROJECT AT KAMPUNG LUMUT BARU, SEBANGAN IN THE DISTRICT OF SEBUYAU, SARAWAK

Chin Kui Fern, Philip Nuli Anding, Florence Francis-Lothai, John Tin Yuen En,
Mohd Syukur Mahali, Asfarina Abu Bakar, Nurul Farahana Mohammad
i-CATS University College, Jalan Stampin Timur, 93350, Kuching, Sarawak

INTRODUCTION

A team from i-CATS University College (i-CATS UC) carried out a rural community project that concerned solar energy as a source of sustainable electricity at Kampung Lumut Baru, Sebangan, in the District of Sebuyau, Sarawak, from August 2023 until February 2024. The team comprised seven lecturers, five being IEEE and IEEE EDS members, and was assisted by a lab assistant and fifteen electrical engineering students. The project's stakeholders were the local community of Kampung Lumut Baru, led by Mr. Angki Anak Alfred Ban, and the project team, led by Ir. Ts. Chin Kui Fern. This project was funded by the IEEE Humanitarian Technologies Board (HTB) and Special Interest Group on Humanitarian Technology (SIGHT) grant 23-HTB-046. The 23-HTB-046 grant was RM 40,995.50 (approximately USD 9,010.00).

Figures 1 and 2 show the project site, which includes a chapel (House of Grace) and a preschool (Tadika Simfoni). The site survey highlighted the urgent need for a stable electricity supply, which is prone to disruption and essential for the chapel and preschool's activities.



Figure 1: Chapel and Preschool.

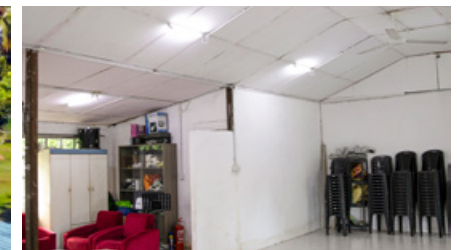


Figure 2: Inside the Chapel.

A hybrid solar energy system was proposed to address this issue. This solar energy system consists of three modes: photovoltaic (PV) mode, battery mode, and utility (generator) mode, whereby this system operates only in either one of these modes. The solar PV array must have sufficient energy gain for PV mode to operate. When PV mode is activated, the battery will be charged simultaneously. If the conditions for PV mode are not fulfilled, the system will switch to battery mode. When PV mode is unavailable, and the battery storage is insufficient, the utility mode is turned on. In this mode, the load draws power directly from the utility source (generator), and the battery would be charged concurrently. The implementation of this solar project successfully addresses the challenges the local community faces.

SOLAR ENERGY PROJECT: IN LINE WITH SDGS AND ESG PRINCIPLES

The solar energy project is a comprehensive approach to sustainable development that aligns with key Sustainable Development Goals (SDGs) and Environmental, Social, and Governance (ESG) principles, as indicated in Figures 3 and 4, respectively. As a result, it boosts innovations in technology, social resilience, and economic sustenance through clean power supply, an efficient learning system, community involvement, and enhancement of well-being to facilitate advancement while sufficing for each of those pillars.

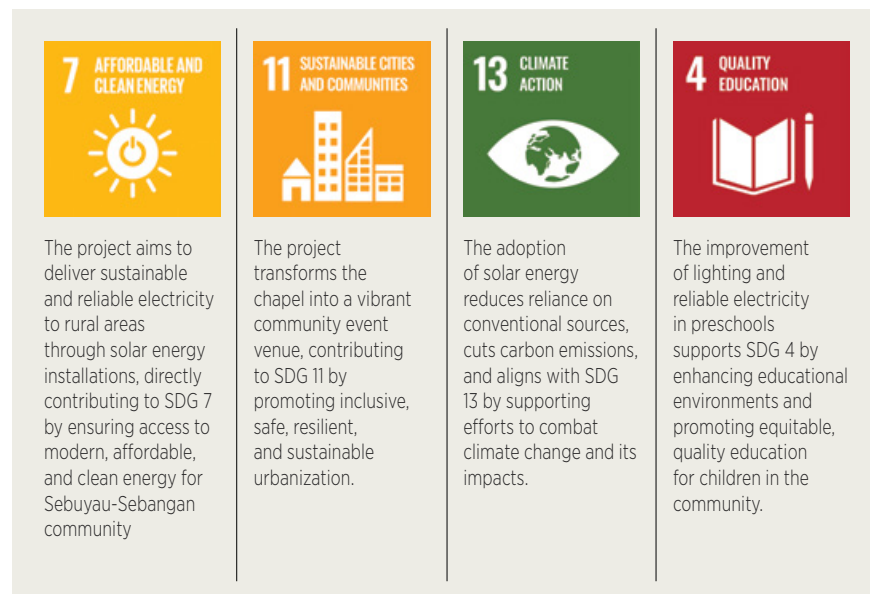


Figure 3: The project aligns with SDGs 7, 11, 13 and 4.

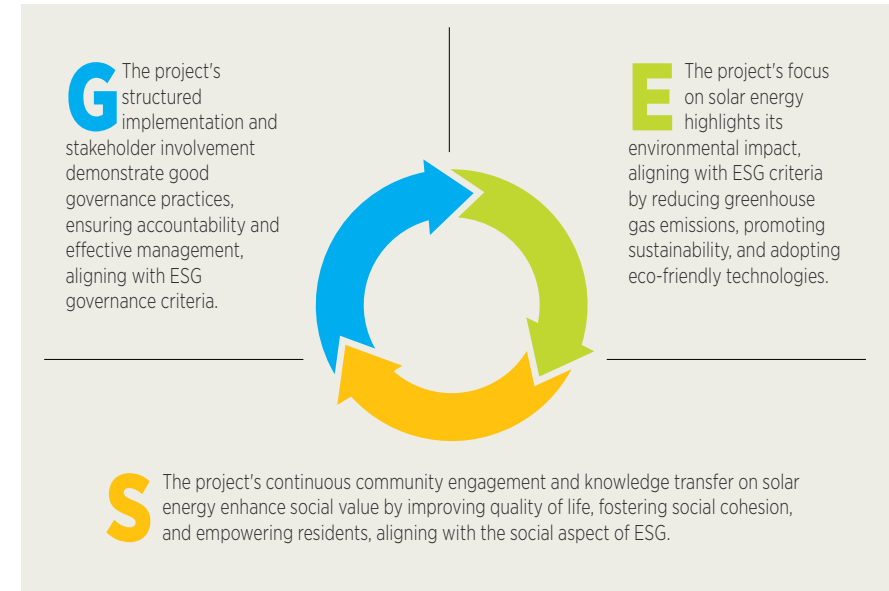


Figure 4: Environmental, Social and Governance.

PROJECT SITE: KAMPUNG LUMUT BARU, SEBANGAN

Kampung Lumut Baru is a village steeped in rich cultural heritage. Under the leadership of Chairman Angki Anak Alfred Ban of the Kampung Lumut Baru Village Development and Security Committee and with the capable support of Secretary Polly Nasib Anak Langgi, the community exemplifies unity, cooperation, and harmonious coexistence. The village comprises 109 people of various ethnicities like Iban, Chinese, Bidayuh, and Selako. There are 23 dwellings in the village, which are organised throughout. The area's main infrastructure includes a multi-purpose hall for community events, Tadika Simfoni preschool, and the House of Grace, a religious centre accommodating diverse spiritual needs in the community. Agriculture, small company owners, and government jobs are the primary drivers of the local economy. Education is a priority in Kampung Lumut Baru, with students of different educational levels.

1. In-House Training for the Team

The project started with comprehensive in-house training for the team. It involved installing solar panels, batteries, and inverters. This training provided hands-on experience to prepare everyone before transitioning to the project site. Figure 5 shows the trial installation of the solar panels, and Figure 6 shows the lecturers and students working on the training kits.



Figure 5: Trial Installation.



Figure 6: Working on Training Kits.

Apart from the in-house training and preparation of standalone solar training kits, the team also developed a training manual. The team members' dedication may be seen from the efforts of the lecturers and students who sacrificed their semester breaks to support the project. Even those on internships took half-day leave from their companies to return to campus and helped prepare the training kits for the community. The training kits and manual were designed to help the community understand and maintain the solar energy system effectively. The overwhelming support from the community inspired the team to offer 20 sets of training kits instead of the initial ten planned. The team also refined the specifications of the solar panels, inverters, and batteries while keeping costs within budget.

2. Project Implementation

(a) Solar Training for the Community

The community training aimed to equip 30 community members with the knowledge and skills to independently adopt and maintain the solar energy system. The training was on-site, with lecturers and students sharing their expertise in renewable energy. The programme started by introducing the fundamentals of solar power and the practical aspects of installing and maintaining solar panels. Participants of all ages engaged enthusiastically during the hands-on workshops. The active involvement of i-CATS UC students was a cornerstone of the initiative, which led to the development



Figure 7: Participants with their solar kits.



Figure 8: Installation of Solar Panels.

of a sense of hope and high motivation among the local youth. During the training, i-CATS UCs staff guided participants in installing and troubleshooting their training kits, as illustrated in Figure 7. Residents holding up their assembled solar panel kits proudly exemplify the programme's progress. This moment served as an epitome of the initiative: a community working together for a common goal towards a better and sustainable future.

(b) Solar Installation

The hybrid solar energy system combines utility sources with solar power to ensure that electricity is consistently available even if there is not enough sunlight for the solar panels alone. Figure 8 shows the installation of solar panels at the chapel and preschool.

The team was divided into three groups, each given a different assignment.

Group A: Chapel, Preschool & Outdoor Electrical Upgrades

i. Rewiring

Group A was assigned to address the outdated electrical wiring at the chapel and preschool and replace them with new and high-quality cables.

ii. Placing Surface Wiring into PVC Conduit

The surface wiring was enclosed in PVC conduit to enhance its safety and durability. Additionally, it protects from environmental damage while giving the system a more organised appearance.

Group B: Resource Centre Enhancements

i. Building a Battery Rack & Assembling the Battery Connection

Group B was tasked to construct a robust battery rack at the resource centre. Battery connections were assembled accordingly to ensure a stable and efficient setup.

ii. Rewiring Incoming Utility Cable

Next, the team also rewired the incoming utility cable to ensure that the power supply to the resource centre was reliable and safe. This step was essential for integrating the hybrid solar system with the existing electrical grid.

iii. Installing PVC Trunking

PVC trunking was installed throughout the resource centre to ensure the new wiring layout was organised and shielded.

iv. Installing an Earthing System

An earthing system was installed to protect the building from electrical surges and lightning strikes. This system ensures that excess electrical energy is safely grounded, thus reducing the risk of electrical hazards.

Group C: Solar PV Installation

i. Solar Rooftop Mounting

Group C was allocated the task of installing the solar panels. Rooftop mounting was done before the solar panels were attached to the roof.

ii. Installing the PV Junction Box

The PV junction box was installed to manage and consolidate the electrical connections from the solar panels. It combines the power generated by multiple panels before directing it to the appropriate storage and usage points.

iii. Installing PV Panels

After installing the rooftop mounting, the team carefully aligned the panels to maximise sunlight exposure and ensure optimal efficiency efficiently

iv. Connecting the PV Outgoing Cable

Group C was also assigned to connect the PV outgoing cables to link the solar panels to the storage batteries and the electrical system.

v. Installing Lightning Rod & Earthing

A lightning rod and earthing system were also installed to protect the installation from lightning strikes.

3. Monitoring the Project

The monitoring process is one of this project's most important elements and is divided into two main categories. The first category focuses on monitoring the overall system performance, while the second tracks electricity consumption after the solar project installation. Monitoring system performance is critical for ensuring consistent and sustainable usage in the local community. To further facilitate this, the local community was asked to regularly monitor the initiative following the earlier training. Routine site visits were also conducted to ensure that the local population properly handled and maintained the installed solar energy system. In addition, a messaging platform group was formed to address any problems the community may have regarding the system.

The monitoring procedure is the second step that concerns the power consumption level. This pertained to identifying how the energy produced by the solar panels was utilised in the community. Data was collected to analyse electricity usage trends, identify peak consumption periods, and calculate the quantity of energy to monitor the initiative following the earlier training regularly saved from the utility socket. The goal was to ensure that solar energy was used to its full capacity and determine areas for improvement. These also aided future expansion and modernisation of the system that the community required to efficiently meet their energy needs.

4. Project Application

Besides learning the essentials of solar panel installation and maintenance, the community at Kampung Lumut Baru also used their creativity to adapt the technology to their specific needs. The participants demonstrated the versatility of the solar kit by using it as a backup power supply during blackouts. In addition, installing a hybrid solar PV system at the local chapel and preschool has provided a reliable power source for these community spaces, especially in supporting their activities and events while providing stable energy for their educational purposes.

5. Project Handover

The project handover ceremony commemorated the successful completion of the project, which was held at Dewan Kampung Lumut Baru. The community leaders and stakeholders attended the ceremony, with the District Officer of Sebuyau as the guest of honour. The ceremony began following a visit to the project site by the guest of honour, community leaders, and the project team. In his speech, Mr. Angki expressed his dedication and hope that the project would positively impact the neighbourhood. Meanwhile, the District Officer of Sebuyau conveyed the government's support for the project, mentioning that promoting sustainable development in rural areas is important.



Figure 9: Group photograph to meet their energy needs efficiently handover ceremony.

A participant-sharing session titled “Training and Application of the IEEE HTB/SIGHT Solar System” was also included in the event. One of the participants, Mr. Annuar Raka, shared the knowledge he gained during the training. He emphasised the basic installation and application of the solar energy system. To recognise their contribution, participants who had completed the basic installation and maintenance training were invited to come on stage and receive their certificates. Figure 9 shows the group photograph at the handover ceremony.

A symbolic handover letter signified the project transfer from the team to the community. The letter, received by Mr. Angki representing Kampung Lumut Baru, symbolises the successful transfer of responsibility and the project's official conclusion. Even though the project has been formally handed over to the community, the team will remain in contact to assist with any problems or maintenance concerns.

CONCLUSION

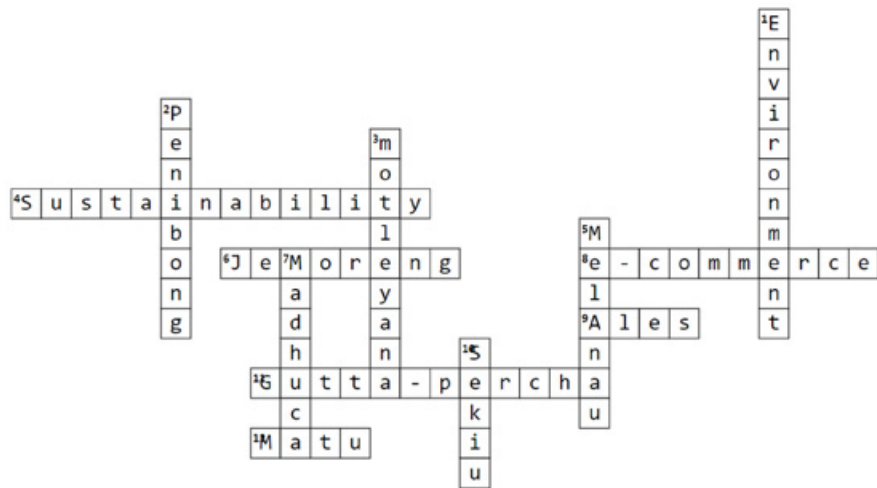
Providing sustainable energy to rural communities is not an easy task. i-CATS UC team had to overcome several challenges, such as a two-hour drive to reach the location of the remote site and the unpredictable weather that made outdoor work difficult. Budget restrictions require careful resource management and planning. Transportation problems, especially navigating rural areas, put the team's commitment to the test. However, these obstacles can be overcome with perseverance and cooperation. The team overcomes every obstacle by working together, having active communication, and having unwavering support from project advisors. The people of Kampung Lumut Baru are very helpful and cooperative. They offered help and a warm welcome, which greatly fueled the team's motivation to complete this project.

The collaboration between the community and the i-CATS UC team highlights the value of community-driven innovation. The ever-enthusiastic staff and students contribute technical expertise to this project and a deep commitment to service learning. From starting as a basic effort to provide clean and affordable energy, it has grown into a holistic learning experience that has brought the surrounding community together. The project has delivered significant benefits, including increased energy security and reduced dependence on non-renewable resources. In addition, it has fostered a spirit of empowerment and independence among the participants. The community has demonstrated its ability to adapt and grow voluntarily, overcoming technical challenges and meeting ongoing support needs with resilience and creativity.

This journey is far from over; rather, it marks the beginning of a sustainable future for the Sebuyau-Sebangan community. This project represents more than a technological upgrade; it marks an important step towards energy independence and environmental

stewardship. The collaboration between the community and the i-CATS-UC team has sown the seeds for continued growth and innovation. As communities take the reins, building on the foundations built by these projects, they are not only participants in the program, they are leaders in the movement towards a greener and more sustainable world. The impact of this project will be ripples, proving that with the right support and vision, a small community guided by a dedicated educational institution can drive big change.

ANSWERS TO SEKIU WORD WIZARD





MINISTRY OF EDUCATION, INNOVATION
AND TALENT DEVELOPMENT SARAWAK

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