

Empowering The Pulau Tuba Community Through Sustainable Practices Of The Putra Tuba Compost
(Memperkasakan Komuniti Pulau Tuba Melalui Amalan Lestari Putra Tuba Kompos)

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ABSTRACT

Drastic climate change has led to significant restructuring of the food chain, causing profound implications for the social and ecological systems of communities. Adaptive environmental education must therefore evolve in parallel with global transformations. However, the pedagogy surrounding environmental issues has not evolved effectively to meet these challenges. In response, students from Kolej Tan Sri Aishah Ghani (KTAG), Universiti Putra Malaysia (UPM) have implemented a social innovation approach through the introduction of compost fertilizer innovation, guided by human values methodology based on the Theory of Planned Behavior (TPB). This framework aims to cultivate awareness and behavioral change among participants to achieve the program objectives effectively. Through a combination of hands-on learning, direct engagement and the application of modern technology, students adopted proactive measures to assist the community of Pulau Tuba, Langkawi in managing livestock waste more sustainably. The main objective of the Putra Tuba Compost Project is to establish a systematic livestock waste management process through composting, resulting in the production of eco-friendly organic fertilizer. The project was carried out in collaboration with the Langkawi Development Authority (LADA) and the Village and Community Committee of Pulau Tuba. The production process employs Effective Microorganisms (EM) technology, which accelerates the composting process and enhances the nutrient quality of the compost produced. As a result, the project successfully reduced odor pollution and livestock waste problems while fostering positive behavioral changes among local residents in waste management practices. Furthermore, the project introduced the community to the potential of compost fertilizer as an economic resource through the commercial sale of organic compost. The initiative also had a positive impact on the tourism sector, as cleaner and greener surroundings helped enhance the image of Pulau Tuba as an attractive ecotourism destination. The project effectiveness can be observed through the direct implementation of composting technology by participants, measurable outcomes such as recorded compost sales and significant reduction of livestock waste and the overall improvement in community awareness and environmental responsibility. In conclusion, the Putra Tuba Compost Project successfully demonstrates an inclusive learning model that integrates human values and technological advancement, enabling individuals to adapt to modernization while fostering environmental sustainability and community empowerment.

Keywords: Compost, Community, Empowerment, Effective Microorganisms, Organic, Fertilizer

ABSTRAK

Perubahan iklim yang drastik telah menyebabkan penstrukturan semula rantai makanan yang ketara, memberikan implikasi mendalam terhadap sistem sosial dan ekologi sesebuah komuniti. Oleh itu, pendidikan alam sekitar yang adaptif perlu berevolusi seiring dengan transformasi global. Walau bagaimanapun, pedagogi mengenai isu-isu alam sekitar tidak berkembang dengan berkesan untuk menghadapi cabaran ini. Bagi menangani isu ini, pelajar-pelajar dari Kolej Tan Sri Aishah Ghani (KTAG), Universiti Putra Malaysia (UPM) telah melaksanakan pendekatan inovasi sosial melalui pengenalan inovasi baja kompos. Projek ini berpandukan metodologi nilai kemanusiaan berdasarkan Teori Tingkah Laku Terancang (TPB). Kerangka kerja ini bertujuan untuk memupuk kesedaran dan perubahan tingkah laku dalam kalangan peserta bagi mencapai objektif program dengan berkesan. Melalui gabungan pembelajaran secara praktikal, penglibatan langsung, dan aplikasi teknologi moden, para pelajar mengambil langkah proaktif untuk membantu komuniti Pulau Tuba, Langkawi dalam menguruskan sisa ternakan

dengan lebih lestari. Objektif utama Projek Kompos Putra Tuba adalah untuk mewujudkan proses pengurusan sisa ternakan yang sistematik melalui kompos, yang menghasilkan pengeluaran baja organik mesra alam. Projek ini dilaksanakan dengan kerjasama Lembaga Pembangunan Langkawi (LADA) dan Jawatankuasa Kampung dan Komuniti Pulau Tuba. Proses pengeluaran menggunakan teknologi Mikroorganisma Berkesan (EM), yang mempercepatkan proses pengkomposan dan meningkatkan kualiti nutrien baja kompos yang dihasilkan. Hasilnya, projek ini berjaya mengurangkan pencemaran bau dan masalah sisa ternakan, di samping memupuk perubahan tingkah laku positif dalam kalangan penduduk tempatan dalam amalan pengurusan sisa. Selain itu, projek ini memperkenalkan komuniti kepada potensi baja kompos sebagai sumber ekonomi melalui penjualan baja kompos organik secara komersial. Inisiatif ini juga memberi impak positif kepada sektor pelancongan, kerana persekitaran yang lebih bersih dan hijau membantu meningkatkan imej Pulau Tuba sebagai destinasi ekopelancongan yang menarik. Keberkesanan projek dapat dilihat melalui pelaksanaan langsung teknologi kompos oleh peserta, hasil yang boleh diukur seperti rekod jualan kompos dan pengurangan ketara sisa ternakan, serta peningkatan keseluruhan dalam kesedaran komuniti dan tanggungjawab alam sekitar. Kesimpulannya, Projek Kompos Putra Tuba berjaya mendemonstrasikan model pembelajaran inklusif yang mengintegrasikan nilai kemanusiaan dan kemajuan teknologi, membolehkan individu menyesuaikan diri dengan pemodenan sambil memupuk kelestarian alam sekitar dan pemerdayaan komuniti.

Kata Kunci: Kompos, Komuniti, Pemerdayaan, Mikroorganisma Berkesan, Baja Organik

INTRODUCTION

Climate change has emerged as one of the most pressing global issues of the 21st century, affecting ecosystems, agricultural systems and human livelihoods across the globe. The continuous rise in global temperature, changes in precipitation patterns and extreme weather events have not only disrupted natural ecosystems but also altered the food chain and community structures that depend on them. Consequently, the environmental, economic and social resilience of communities especially those in rural and island settings has been significantly challenged. In Malaysia, the impact of climate change is increasingly evident in rural island communities such as Pulau Tuba, Langkawi, where traditional livelihoods depend heavily on agriculture, livestock and tourism. Improper livestock waste management has been identified as one of the main environmental concerns on the island, leading to severe odor pollution, contamination of waterways and a decline in the overall quality of the living environment. These issues are exacerbated by the lack of structured waste management systems and limited awareness among local communities regarding sustainable environmental practices. Addressing such challenges requires not only technological solutions but also

educational transformation where environmental education becomes adaptive, participatory and rooted in real life community contexts.

Universities play a pivotal role in this transformation by engaging students and academic resources in community based learning that fosters both knowledge and behavioral change. This aligns with the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action). In this context, students from Kolej Tan Sri Aishah Ghani (KTAG), Universiti Putra Malaysia (UPM) initiated the Putra Tuba Compost Project as a community based environmental innovation program. The project adopts the social innovation framework guided by human values methodology and the Theory of Planned Behavior (TPB), emphasizing the psychological and behavioral dimensions of sustainable action. By combining scientific knowledge with local wisdom, the program aims to instill awareness, responsibility, and environmental stewardship among the residents of Pulau Tuba.

The Putra Tuba Compost Project introduces an innovative approach to livestock waste management through the production of organic compost using

Effective Microorganisms (EM) technology. EM technology utilizes beneficial microorganisms to accelerate the decomposition of organic matter, resulting in nutrient rich compost that can be used as an organic fertilizer. This approach not only mitigates waste related pollution but also creates an economic opportunity for the local community by transforming waste into a value-added product. Furthermore, the project exemplifies the principles of experiential and inclusive learning, where students directly engage with the community through hands-on implementation, capacity building workshops and behavioral intervention programs.

This participatory model bridges the gap between academia and society, allowing for mutual learning and the co-creation of sustainable solutions tailored to local needs. Therefore, this study aims to document and analyze the implementation, effectiveness and impact of the Putra Tuba Compost Project in fostering environmental awareness, behavioral change and community empowerment. Specifically, this paper will focus on examining the pedagogical and behavioral frameworks employed in the project, Describe the technological process of compost production using EM, evaluate the environmental and socio economic outcomes and discuss the project's implications for sustainable community-based education and policy development. By integrating human values, behavioral science and environmental technology, this project demonstrates how higher education institutions can serve as catalysts for local sustainability transitions. It also highlights the potential of youth driven social innovation in addressing real world environmental challenges through inclusive and transformative education.

METHODOLOGY

Research Design

This study employed a community based participatory action research (CBPAR) design that integrates both qualitative and quantitative approaches. The design was chosen to allow researchers and participants to collaboratively identify problems, implement solutions and evaluate the outcomes in a real community setting. The focus of the study was to explore the implementation and impact of the Putra Tuba Compost Project as a social innovation model that promotes behavioral change and sustainable waste management practices among the residents of Pulau Tuba, Langkawi.

The research process was divided into three main phases:

- i. Pre-implementation (Preparation and Awareness Phase) - identification of community needs, stakeholder consultation and baseline data collection.
- ii. Implementation (Action and Engagement Phase) - hands-on composting workshops, technology demonstration and community participation.
- iii. Post-implementation (Evaluation and Reflection Phase) - data collection, analysis of outcomes and assessment of behavioral and environmental impacts.

Study Location

The project was conducted at Pulau Tuba, Langkawi, Kedah, Malaysia, an island located off the southwestern coast of Langkawi. The island's economy is primarily driven by small scale agriculture, livestock farming and tourism. Pulau Tuba was selected as the project site due to its ongoing environmental challenges related to unmanaged livestock waste, limited awareness of sustainable waste practices and strong local interest in community based environmental initiatives.

Participants and Stakeholders

A total of 60 community participants were involved in the project, comprising livestock farmers, local youth and residents from several villages on Pulau Tuba. Participants were selected through collaboration with the Village Community Management Council (JPKK) and the Langkawi Development Authority (LADA).

In addition, 35 students from Kolej Tan Sri Aishah Ghani (KTAG), Universiti Putra Malaysia (UPM) served as facilitators and project implementers under the supervision of lecturers and university advisors. The involvement of LADA officials and local leaders ensured that the project activities were aligned with community development goals and local environmental regulations.

Theoretical Framework

The project was guided by the Theory of Planned Behavior (TPB) (Ajzen, 1991) and the Human Values Approach. TPB was used to understand and influence the behavioral intentions of participants toward sustainable waste management. The intervention was structured around three core components of TPB:

- i. Attitude: strengthening positive perceptions

- toward composting as a beneficial activity.
- ii. Subjective Norms: encouraging social support and community cooperation.
- iii. Perceived Behavioral Control: improving participants' confidence in managing livestock waste through practical training.

The Human-Values Approach complemented TPB by embedding ethical and moral dimensions such as care for nature, responsibility and respect into the educational and behavioral processes of the project.

Implementation Procedures

The implementation of the Putra Tuba Compost Project was carried out over a three years period (Project High Impact), involving the following key activities:

- i. Community Engagement and Awareness Campaigns
 - Conducted introductory sessions and briefings with residents and local authorities to introduce the project objectives.
 - Distributed educational leaflets and organized discussions about the environmental effects of improper livestock waste management.
- ii. Composting Workshops and Hands-On Training
 - Conducted practical workshops on the production of organic compost using Effective Microorganisms (EM) technology.
 - Participants were guided through each step, including collection of livestock waste, mixing with organic materials, inoculation with EM solution and compost curing.
 - Demonstrations were held in designated community composting sites established in collaboration with LADA.
- iii. Monitoring and Support
 - Weekly visits were conducted by UPM students and facilitators to monitor compost temperature, moisture levels and microbial activity.
 - Feedback sessions were held to identify challenges and adjust methods accordingly.
- iv. Evaluation and Feedback
 - At the end of the project, a final workshop was organized to share results, reflect

on lessons learned and discuss the continuation of composting practices within the community.

Data Collection Methods

Multiple data collection techniques were employed to obtain a comprehensive understanding of the project's impact:

- i. Questionnaire Survey: Distributed before and after the intervention to measure changes in knowledge, attitude and behavioral intention related to composting and environmental management.
- ii. Interviews: Semi structured interviews with selected participants, local leaders and LADA representatives to explore their perspectives on the project relevance and outcomes.
- iii. Observation: Field observations were conducted during composting activities to record participants engagement, cooperation and practical performance.
- iv. Document and Record Analysis: Review of compost production data, including the amount of waste processed, quantity of compost produced and recorded sales of compost fertilizer.
- v. In addition, basic water quality parameters, including Biological Oxygen Demand (BOD), were measured at selected drainage channels to assess changes in organic pollution levels before and after the intervention.

Data Analysis

Quantitative data from the questionnaires were analyzed using descriptive statistics (mean, percentage, frequency) to identify changes in participants' knowledge and attitudes before and after the program. Qualitative data from interviews and observations were analyzed thematically to capture emerging patterns and insights regarding community engagement, behavioral change and project sustainability.

Ethical Considerations

The study adhered to the ethical standards of Universiti Putra Malaysia and received ethical approval from the Ethic Committee for Research Involving Human Subjects (JKEUPM), Universiti Putra Malaysia. All participants were informed about the objectives and procedures of the study, and informed consent was

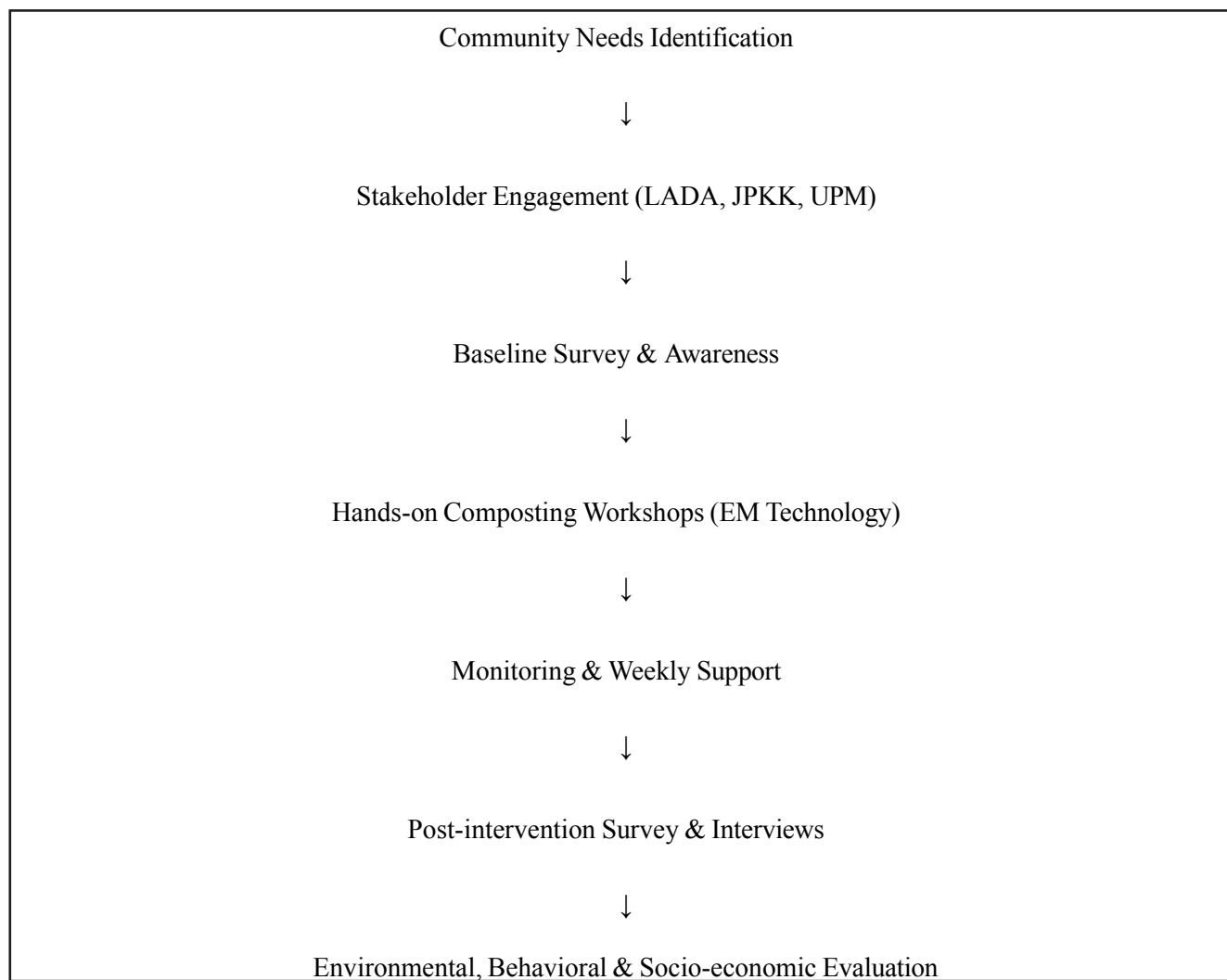


FIGURE 1. Methodological Flow of the Putra Tuba Compost Project

obtained prior to participation. Participation was voluntary, and confidentiality of personal information was strictly maintained throughout the research process.

RESULTS & DISCUSSION

Overview of Project Outcomes

The Putra Tuba Compost Project achieved substantial outcomes in terms of environmental improvement, behavioral transformation and community empowerment. The integration of the Effective Microorganisms (EM) technology into livestock waste management practices successfully reduced environmental pollution while introducing a new form of green entrepreneurship to the local community.

A total of 2.8 tonnes of livestock waste

were collected and processed during the six month implementation period. The process yielded approximately 1.6 tonnes of organic compost, which was distributed for local agricultural use and partially sold within the community. The recorded sale value of compost fertilizer was RM1,280.00 with proceeds reinvested into sustaining the composting site and purchasing additional EM solutions.

Environmental Impact

Reduction of Waste and Odor Pollution

Observation and field monitoring showed a 65% reduction in uncollected livestock waste around residential and farming areas by the end of the program. Residents also reported noticeable improvement in air

quality, particularly the reduction of unpleasant odors previously caused by open livestock waste dumping.

In line with these observations, water quality testing (conducted on three nearby drainage channels) indicated a decrease in Biological Oxygen Demand (BOD) levels from 12.4 mg/L to 6.2 mg/L, suggesting reduced organic contamination. These findings indicate that the composting system effectively minimized waste runoff and improved local sanitation.

Production of Quality Compost

The improvement in nutrient balance (notably the reduction in C/N ratio) indicates the compost maturity and suitability for agricultural application. Farmers who applied the compost to small scale vegetable plots reported visible improvements in soil structure and crop growth after four weeks of application.

TABLE 1. Laboratory testing on the produced compost revealed favorable nutrient composition:

Parameter	Before (Raw Waste)	After Composting
pH	6.2	7.1
Organic Carbon (%)	28.6	36.2
Nitrogen (%)	0.8	1.4
C/N Ratio	35.8	25.9

Behavioral and Educational Outcomes

Change in Knowledge and Attitude

Pre and post program surveys involving 60 participants revealed significant improvements in environmental knowledge and awareness. Before the intervention, only 35% of respondents demonstrated adequate understanding of composting benefits, this figure increased to 92% after the program.

Similarly, the percentage of participants who agreed that “livestock waste can be converted into useful products” rose from 48% to 95%, reflecting strong attitudinal change. These findings support the Theory of Planned Behavior (TPB) assumption that enhanced knowledge and social reinforcement can influence behavioral intentions toward sustainable practices.

Community Participation and Ownership

Attendance and engagement data indicated consistent participation, with 87% average attendance across all workshops and field sessions. Follow up interviews revealed that 78% of participants expressed commitment to continue composting independently, while several farmer groups expressed interest in forming a community composting cooperative to scale production and sales.

The participatory nature of the project also strengthened social cohesion. Participants highlighted improved cooperation among villagers, particularly between livestock farmers and youth volunteers, in maintaining clean surroundings and shared composting facilities.

Socio Economic Impact

Development of Local Green Economy

The sale of compost fertilizer, though modest in the pilot phase, demonstrated potential for income diversification. The estimated production cost per 10 kg bag of compost was RM3.50, while the selling price ranged between RM5.00 to RM6.00, generating a net profit margin of around 40%. Beyond direct income, the initiative created a new value chain linking waste management, organic farming and small scale sales of compost products. This aligns with SDG 8 (Decent Work and Economic Growth) by introducing sustainable livelihood opportunities within a rural context.

Integration with Tourism

Cleaner surroundings and better waste management indirectly enhanced the island tourism appeal. Interviews with local tourism operators indicated that tourists increasingly perceived Pulau Tuba as a “Langkawi UNESCO Global Geopark” Several homestay operators expressed willingness to participate in future composting or community garden programs as part of eco-tourism packages.

Educational and Institutional Implications

The involvement of Kolej Tan Sri Aishah Ghani (KTAG) students showcased how higher education institutions can act as catalysts for social and environmental transformation. Through experiential learning, students developed practical competencies in

project management, community communication and applied sustainability.

From an institutional standpoint, the project reinforced the role of Universiti Putra Malaysia (UPM) in advancing community based environmental education under the university's broader sustainability agenda. The combination of Human Values Education and Behavioral Theory (TPB) effectively translated academic knowledge into community action, supporting the transition from awareness to real behavioral change.

Discussion

The findings confirm that the integration of behavioral theory, environmental technology and community participation can produce tangible results in waste management and environmental education. The application of EM technology not only improved waste conversion efficiency but also served as a tangible learning tool for participants, demonstrating how

science can directly solve community level problems.

Furthermore, behavioral outcomes observed in this study align with Ajzen's Theory of Planned Behavior, wherein increased environmental knowledge and supportive social norms led to stronger behavioral intentions and actions. The human values approach, meanwhile, deepened participants' moral responsibility toward nature, ensuring that environmental behavior was not merely procedural but also value driven. The socio-economic benefits, although preliminary, reveal promising potential for scaling up. With institutional support from LADA and local governance bodies, the project could evolve into a sustainable community enterprise, generating continuous income while maintaining ecological integrity.

These outcomes emphasize the effectiveness of the Putra Tuba Compost Project as a replicable model for education-based environmental innovation, bridging the gap between academia and rural community empowerment in Malaysia.



FIGURE 2. Dr. Daljit Singh leading the knowledge transfer session on composting techniques with local community members



FIGURE 3. Finished compost product derived from the waste stream of Pulau Tuba's sustainable management initiative



FIGURE 4. Engaged participants at the Compost Knowledge Transfer Session held at Dewan Keda, Pulau Tuba, Langkawi

CONCLUSION

The Putra Tuba Kompos Project has successfully demonstrated the transformative potential of community based composting as an effective strategy to address both environmental pollution and agricultural sustainability in Pulau Tuba, Langkawi. Through a collaborative approach involving Lembaga Pembangunan Langkawi (LADA), Kolej Tan Sri Aishah Ghani (KTAG), Universiti Putra Malaysia (UPM) and the local community, the project not only mitigated the problem of unmanaged livestock waste but also empowered the residents to adopt sustainable agricultural practices.

The project's outcomes indicate that the conversion of livestock manure and organic waste into high quality compost can significantly reduce odour pollution, improve soil fertility and increase crop productivity. This has provided local farmers with an affordable and environmentally friendly alternative to chemical fertilizers. Moreover, the initiative enhanced environmental awareness and practical knowledge among participants through hands-on workshops, community training sessions and collaborative research with UPM students. The involvement of international students further fostered cross cultural exchange and strengthened the project's educational and global outreach components.

From the social perspective, the project fostered a strong sense of community ownership and responsibility towards local environmental conservation. It successfully aligned with several United Nations Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger), SDG 4 (Quality Education), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action). These achievements underline the broader implications of the Putra Tuba Kompos Project

as a replicable model for sustainable rural development in other island or agricultural communities facing similar waste management challenges.

Quantitatively, the project processed 2.8 tonnes of livestock waste into 1.6 tonnes of organic compost, achieved a 65% reduction in uncollected waste, reduced BOD levels from 12.4 mg/L to 6.2 mg/L, and generated RM1,280.00 in compost sales. These outcomes demonstrate measurable environmental improvement, behavioral change, and economic potential at the community level.

In conclusion, the Putra Tuba Kompos Project exemplifies how academic community partnerships can effectively bridge the gap between research, education and environmental stewardship. The initiative has not only contributed to the ecological wellbeing of Pulau Tuba but also strengthened the university role in promoting community driven innovation and sustainable agricultural transformation. Moving forward, it is recommended that similar initiatives receive continuous institutional support and policy backing to ensure long term sustainability, scalability and integration into the local green economy framework of Langkawi.

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