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Eco-GC-Bin: A Community-Based Composting Solution for Food Waste Management in Merlimau Permai

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Abstract

Food waste is an increasingly serious environmental issue in Malaysia, contributing approximately 30–35% of municipal solid waste disposed of in landfills. Anaerobic decomposition of food waste produces methane, a greenhouse gas that exacerbates global warming and climate change. Although 3R (Reduce, Reuse, Recycle) campaigns have been implemented, their effectiveness remains limited due to infrastructure constraints, unsuitable equipment, and low practicality at the household level. Composting is therefore considered a more effective alternative, as it can be carried out at household and community levels using simple, low-cost methods. This study aimed to design and develop the Eco GC Bin, a community-based food waste composting bin, and assess residents' awareness and acceptance of food waste management in Merlimau Permai. A quantitative research approach was employed using a structured questionnaire based on a five-point Likert scale, involving 97 respondents selected using the Krejcie and Morgan sampling method. The data were analysed using descriptive statistics particularly mean score analysis to determine awareness and acceptance levels. The data were analysed using SPSS version 26. Results showed low initial awareness (mean scores 1.06–2.53) but very high acceptance of the Eco GC Bin (overall mean = 4.39), including effectiveness (4.40), fertilizer production (4.48) design suitability (4.38) and product has potential to market with mean value very high (4.48). The Eco GC Bin demonstrates potential to reduce greenhouse gas emissions, enhance community awareness, and provide added value through compost production, aligning with SDGs 1,3 and 11.

Keyword : *Food waste management, community composting, compost bin*

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I. INTRODUCTION

Food waste has become a significant environmental concern in Malaysia, constituting approximately 44.5% of municipal solid waste, with nearly 39,000 tonnes of waste generated daily [1]. The improper disposal of food waste in landfills leads to anaerobic decomposition, which produces methane, a potent greenhouse gas that contributes to global warming, climate change, and environmental degradation [2]. Among the sources of food waste, households contribute the largest share, followed by commercial establishments such as restaurants, hotels, and food courts [3]. This high volume of food waste not only overloads landfills but also represents a loss of resources, including energy, water, and labour, while simultaneously intensifying pollution and greenhouse gas emissions [4], [5]. These challenges underscore the urgent need for practical, sustainable solutions, such as community-based composting systems, to manage food waste effectively and mitigate its environmental impact.

B. Problem Statements

According to reports Jegathesan (2014), Malaysia is blessed with abundant food surplus which brought about 30 percent of Malaysians been obsessed. This evident is made clear that the first thing a Malaysian will ask a friend is "sudah makan" meaning have you eaten, which shows how food is embedded in everyday life activities in the society. This is because according to Masilamany (2013) in his online news report, Malaysia could possibly be the only country around the globe where one could have food available in the street corners all the night, while people in other parts of the world are already sleeping.

This finding is further confirmed because Qayyum and Navin (2014) reports that in underdeveloped countries each person produces around 300g of food waste per day, while in the developed nations, the figure is slightly higher at average of between 3-4kg, but in Malaysia this is about 1kg per person a day. This is a true statement as the economic boom for about two decades or more has brought about increased income and thus drastically changed the food consumption habits of Malaysians households. According to Abdul Hamid et al. (2012) in a study of municipal solid waste generated in 2005, 7.34 million tons of waste were generated and is estimated that it will increase to 10.9 million tons in 2020. Out of these 7.34 million tons of waste generated, food waste constitutes 60 percent of the total waste.

Table 1: Food waste generated in Malaysia [6]

Estimated food waste generated in Malaysia	**Generate rate**		
Source of food	**(tonnes/ day)**	**(tonnes/ year)**	**Percent**
Households	8,745	3,192,404	38.32
Wet and night markets	5,592	2,040,929	24.50
Food courts/ Restaurants	5,319	1,941,608	23.35
Hotels	1,568	572,284	6.87
Food and beverages industries	854	311,564	3.41
Shopping malls	298	108,678	1.30
Hypermarkets	291	106,288	1.28
Institutions	55	26,962	0.32
Schools	45	21,808	0.30
Fast Food/ Chain shops	2,521	808	0.26
Total	22,793	8,33,589	100

However, currently the focus on treatment of food waste in Malaysia is only for restaurants, wet markets and food industries. Though, food wastes generated from households still remains main source of larger quantities of food waste generated when combined together, but the facilities for households to engage in sustainable food waste management are not yet there.

According to Jereme et al. (2013a), addressing the problems of food wastage at households at this critical time countries are experiencing global economic problems which affect food security would be a timely call which needed serious attention.
However, by producing this product it can help the environment to reduce food waste among industry and household.

C. Objective

This study aimed to design and develop the Eco GC Bin, a community-based food waste composting bin, and assess residents' awareness and acceptance of food waste management in Merlimau Permai

II. LITERATURE REVIEW

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A. Consumer's Environmental Knowledge of Food Waste

Food waste awareness is a key factor influencing household waste management behaviour. Educational programmes and awareness campaigns can improve consumers' understanding of the environmental, economic, and social impacts of food waste, thereby encouraging behavioural change [7]. Differences in knowledge levels also affect attitudes and practices related to food waste management, highlighting the importance of continuous education initiatives to promote sustainable consumption.

B. Food Waste Separation or Composting Behavior

According to Mat Saad N F et al. (2013) home composting that has been used widely and home-friendly is Takakura Method or called home composting. Takakura composting method is organic waste that is broken down by micro-organisms that are cultivated from local materials. The method involves making a seed compost from fermented solutions involved sugar fermentation solution and salt fermentation solution also a fermenting bed that made from mix equal of rice bran and rice husk.

Organic waste is mixed with the seed compost and left to degrade in a ventilated container or basket. Basically, this is an easy method that can be practicing in every household in Malaysia. There are 3 important factors of composting: microorganisms, moisture control and aerobic that is presence of oxygen. (Karim Ghani W. A, Rusli I F, Biak D R A, and Idris A 2013)

C. Strategies to Reduce Food Waste

As mentioned by Quested et al. (2013) by reducing the food waste in a same time it can to reduce the energy, water and other resources used to grow, harvest, transport, process and sell the food, as well as emissions associated with storage and cooking in the home. Reduce food waste at households is the choice to implement the strategies to disposing food at home meanwhile give benefits to the environment. In the first place, the largest environmental benefit comes from preventing food from being wasted. (Quested et al. , 2013)

D. Commercial Potential

According to Abhilash BS, (2018), to manage the solid waste, it should be properly segregated at the source (houses). The organic and inorganic waste needs to be separated, the organic waste can be treated to make compost, and inorganic waste can be segregated and given for garbage collection. There are many companies who take in the waste and segregate and convert the organic waste into compost but as the waste is very high; they are unable to achieve all the targets so it is better to compost at home. (Abhilash BS, Department of Industrial Design, 2018)

The above finding is consistent with the study by Team Esteban F. Durán-Lara (2020) which they find out the development of agrochemicals based on fungal species or strains has increased due to the major attention by the organic farming community and safe food production. Nowadays, the market of agrochemicals for organic farming has increased considering different formulations and producers, and the bioactivity of the microorganisms is better than in the past ((Esteban F. Durán-Lara, 2020)

III. RESEARCH METHODOLOGY

Compost bins are an essential tool for households and communities seeking to enhance food waste management practices and promote environmental sustainability. By enabling residents to collect and process organic waste such as fruit peels, vegetable scraps, and coffee grounds, composting significantly reduces the volume of waste sent to landfills. This process not only minimizes environmental impacts but also supports resource recovery by converting organic waste into nutrient-rich compost that can be used for gardening and landscaping.

In addition, composting initiatives encourage social participation through shared sustainability practices, thereby strengthening community engagement and environmental awareness. The use of compost bins can also reduce household expenses related to waste disposal and the purchase of fertilizers or soil conditioners. Overall, composting aligns with circular economy principles by transforming waste into valuable resources and fostering a more sustainable lifestyle. This methodological approach therefore focuses on the design, implementation, and evaluation of a compost bin system as a practical intervention to improve food waste management at the community level.

A. Research Instrument

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The primary instrument used for data collection in this study was a structured questionnaire. The questionnaire was designed to gather quantitative data related to respondents' awareness, perceptions, and acceptance of food waste management and the use of the Eco GC Bin. It was divided into two main sections to ensure that relevant demographic information and research variables were systematically captured. The structured format enabled standardized responses, facilitating consistency and reliability in data analysis.
The questionnaire served as the main tool for collecting primary quantitative data. It consisted of closed-ended questions measured using a five-point Likert scale to assess respondents' level of agreement with statements related to food waste awareness and acceptance of the composting system. The Likert scale allowed respondents to express their perceptions in a structured manner, making the data suitable for statistical analysis.

Table 2: Likert Scale [8]

1	2	3	4	5
Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

A questionnaire is widely recognized as an effective method for collecting quantitative primary data because it allows information to be obtained in a standardized and systematic manner. This ensures that the data collected are internally consistent and suitable for analysis. Furthermore, questionnaires must be designed with a clear purpose aligned with the research objectives, and the intended use of the findings should be defined from the outset (Journal of Indian Orthodontic Society, 2012).

B. Sampling

The respondents for this study were selected from the community of Merlimau Permai, Malaysia. The purpose of selecting residents as respondents is to evaluate their level of awareness regarding food waste management practices at the household level. Specifically, this study aims to understand how residents manage their food waste, including whether they dispose of all leftover food or adopt alternative waste reduction practices.

In addition, the respondents were chosen to assess their acceptance of the Eco-GC-Bin, a compost bin developed to encourage sustainable food waste management. The feedback obtained from the respondents is important to determine whether the Eco-GC-Bin is practical, useful, and suitable for implementation within the community.

The sample size for this study was determined using the Krejcie and Morgan sample size determination table, which provides a widely accepted guideline for selecting an appropriate sample from a given population. Based on the estimated population of 130 residents in Merlimau Permai, the recommended sample size is 97 respondents, as shown in Table 3.3.1. This sample size is considered sufficient to represent the population and to ensure reliability of the findings.

C. Data Analysis Technique

Data analysis is a crucial phase in research, as inadequate analysis may lead to inaccurate findings and poor decision-making. Therefore, selecting an appropriate analysis method is essential to ensure that the results obtained are reliable, valid, and meaningful. Data analysis involves identifying patterns, relationships, and trends within the collected data to generate useful insights [9].

In this study, descriptive statistical analysis was employed. The mean score was used to determine the average level of respondents' agreement toward the Eco-GC Bin in terms of design, effectiveness, functionality, and price. The mean values help summarize respondents' perceptions and provide a clear understanding of the overall acceptance of the product, thus addressing the research objectives.

Additionally, respondents are assumed to provide honest and accurate responses; however, potential response issues such as inconsistency, omission, misunderstanding of questions, and social desirability bias may occur. Social desirability bias refers to the tendency of respondents to provide answers that present themselves favourably rather than truthfully [10]. These limitations were considered during interpretation of the results.

The interpretation of mean scores was guided by the 5-point Likert scale qualitative interpretation, as presented in Table 3.4, to categorize the level of agreement from very low to very high.

Table 3: Qualitative Interpertation of Mean Score [11]

Mean Score Range	Mean Score Range
1.00 – 1.80	Very Low
1.81 – 2.60	Low
2.61 – 3.40	Moderate
3.41 – 4.20	High
4.21 – 5.00	Very High

IV. RESULT AND DISCUSSION

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The research findings, derived from the analysis of questionnaire data, were conducted to identify the level of awareness regarding food waste management and to determine the acceptance of compost bins among residents in Merlimau Permai. The analysis produced several key findings that provide meaningful insights into respondents' perspectives, attitudes, and preferences toward the implementation of composting practices. The collected data are presented in the form of graphs and tables for clearer interpretation and discussion.

A. Mean Score and Discussion

Table 4: Mean Score of the Level Awareness food waste management

Question	Mean	Mean Range Level
I often throw away trash like eggshells, fruit scraps and vegetable scraps?	2.16	Low
How much food waste you throw in a day?	2.53	Low
Where do you usually throw your food waste?	1.31	Very Low
Did you know that if you throw away your food waste it can be turned into compost?	1.06	Very Low
What is the main problem if you want to do your own compost in your resident?	2.25	Low

The findings indicate that the level of awareness regarding food waste management among residents is generally low. The item *"I often throw away trash like eggshells, fruit scraps and vegetable scraps"* recorded a mean score of 2.16, suggesting that respondents do not consistently recognise these materials as resources that can be reused through composting. This reflects limited awareness of the value of organic waste and its potential environmental benefits.

Similarly, the question *"How much food waste you throw in a day?"* obtained a mean score of 2.53, indicating that respondents have low awareness of the quantity of waste generated at household level. This lack of awareness is consistent with studies highlighting that many households underestimate their contribution to municipal solid waste streams, which reduces motivation to adopt sustainable practices [12].

The item *"Where do you usually throw your food waste?"* recorded a very low mean score of 1.31, showing that most respondents rely on conventional disposal methods without considering alternative waste management approaches. In addition, the statement *"Did you know that if you throw away your food waste it can be turned into compost?"* had the lowest mean score of 1.06, indicating a significant knowledge gap regarding composting practices and environmental impacts. This suggests that educational exposure to composting concepts among the community is minimal.

Furthermore, the item *"What is the main problem if you want to do your own compost in your resident?"* scored a low mean of 2.25, implying that respondents perceive barriers such as lack of knowledge, space, or facilities. These perceived constraints are commonly identified in household waste management research as factors limiting participation in composting initiatives [13].

Overall, the low and very low mean scores demonstrate that residents have limited awareness and understanding of food waste management practices. This highlights the importance of introducing practical interventions such as community composting programs and user-friendly compost bins to increase knowledge, encourage behavioural change, and promote sustainable waste management at the household level [12], [13].

The low level of awareness among residents can be attributed to several interrelated factors. First, limited exposure to environmental education and practical training on composting reduces residents' understanding of sustainable food waste management practices. Without adequate knowledge or hands-on experience, households tend to rely on conventional disposal methods, which are perceived as more convenient [14].

Second, infrastructural and logistical constraints contribute to the low awareness level. The absence of accessible composting facilities, appropriate equipment, and organised community programmes limits residents' opportunities to practise waste segregation. Studies have shown that convenience and availability of facilities significantly influence household participation in waste management initiatives [13].

Third, behavioural and cultural habits also play a role, as food waste disposal is often viewed as a routine household task rather than an environmental responsibility. This perception reduces the urgency to adopt sustainable practices, despite the environmental consequences such as increased landfill use and greenhouse gas emissions [14], [15].

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Finally, insufficient long-term awareness campaigns may hinder behavioural change. Continuous engagement and practical interventions, such as community-based composting systems and user-friendly compost bins, are therefore necessary to enhance knowledge, improve attitudes, and encourage sustainable waste management practices at the household level [15].

Table 5: Mean Score of the Design Eco-GC-Bin

Question	Mean	Mean Range Level
The compost bin is easy to use.	4.39	Very High
The compost bin is easy to carry anywhere.	4.14	High
The design and size of the compost bin suit the needs of the house	4.38	Very High

The results demonstrate a strong positive perception among respondents regarding the usability and design of the compost bin. The item *"The compost bin is easy to use"* recorded the highest mean score (M = 4.39), indicating a Very High level of agreement. This suggests that the simplicity of operation plays a significant role in encouraging users to adopt sustainable food waste management practices, as user-friendly tools reduce resistance to behavioural change and improve participation rates in environmental initiatives [16].

Similarly, the statement *"The design and size of the compost bin suit the needs of the house"* also achieved a Very High mean score (M = 4.38). This finding implies that the physical features of the compost bin are compatible with household environments, which is an important factor influencing product acceptance. Previous studies highlight that practical design and spatial suitability significantly affect the willingness of households to engage in composting activities [17].

Meanwhile, the item *"The compost bin is easy to carry anywhere"* recorded a slightly lower mean score (M = 4.14), categorized as High. Although respondents generally agreed with the portability aspect, the comparatively lower score indicates potential for improvement, particularly in enhancing ergonomic features or reducing the bin's weight. Improving portability could further increase convenience and long-term usage consistency [18]. Overall, the consistently high mean values indicate that respondents perceive the compost bin as practical, functional, and suitable for daily use. These findings support the study's objective of promoting household composting as an effective strategy to improve food waste management and foster sustainable living practices within the community [16]–[17].

Table 6: Mean Score of the Level Acceptance Eco-GC-Bin

Question	Mean	Mean Range Level
This compost bin is effective for selected item waste.	4.40	Very High
The compost bin makes it easier for residents to separate food waste properly.	4.25	Very High
The manual is well-explained and easy to understand.	4.32	Very High
These compost bins can reduce the amount of waste sent to landfills.	4.28	Very High
This product can produce fertilizer water for plants.	4.48	Very High
The price offered is affordable and value for money.	4.05	High
This product has potential to market	4.48	Very High

The findings indicate a very high level of acceptance among respondents regarding the effectiveness and practicality of the compost bin. The item *"This compost bin is effective for selected item waste"* recorded a mean score of 4.40, demonstrating that respondents perceive the product as capable of handling organic waste efficiently. This aligns with previous studies which suggest that perceived effectiveness strongly influences adoption of household waste management technologies [16].

Similarly, respondents agreed that the compost bin *"makes it easier for residents to separate food waste properly"* (M = 4.25), indicating that the product supports behavioural change towards better waste segregation practices. Effective waste separation at source is widely recognised as a key factor in improving municipal solid waste management systems and reducing environmental impact [17]. The statement *"The manual is well-explained and easy to understand"* achieved a mean of 4.32, suggesting that clear instructions enhance user confidence and encourage consistent usage. Meanwhile, respondents also strongly agreed that compost bins *"can reduce the amount of waste sent to landfills"* (M = 4.28), reinforcing the environmental relevance of the product and its contribution to sustainable waste reduction strategies [19].

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The highest agreement was observed for *"This product can produce fertilizer water for plants"* and *"This product has potential to market"* (both M = 4.48). These results highlight that respondents not only value the functional benefits but also recognise the product's commercial viability and environmental value. In contrast, the item *"The price offered is affordable and value for money"* recorded a slightly lower mean (M = 4.05), although still within the High category, suggesting that cost considerations remain an important factor influencing purchasing decisions.

Overall, the consistently high mean scores indicate that the compost bin is perceived as effective, environmentally beneficial, and marketable. These findings support the potential of household composting solutions as practical tools for reducing food waste and promoting sustainable living within communities [16]–[19].

V. CONCLUSION

This study investigated the level of awareness of food waste management and the acceptance of the Eco-GC-Bin among residents of Merlimau Permai. The findings revealed that although residents initially demonstrated low awareness regarding proper food waste management, their acceptance of the Eco-GC-Bin was very high, particularly in terms of usability, effectiveness, and its ability to produce fertilizer for plants. This indicates that practical and user-friendly innovations can encourage behavioural change even when baseline awareness is limited.

The implementation of the Eco-GC-Bin has significant environmental and social implications, as it can reduce the amount of food waste disposed of in landfills, minimise greenhouse gas emissions, and promote sustainable household practices. Furthermore, the compost produced offers added value by supporting urban gardening and potential supplementary income opportunities.

Overall, this study contributes to sustainable development efforts by supporting United Nations Sustainable Development Goals, particularly SDG 3 (Good Health and Well-Being), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action). Future efforts should focus on continuous awareness programmes, wider community adoption, and institutional support to ensure long-term effectiveness and sustainability of food waste management initiatives.

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