Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 203 - 223
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118416

SUSTAINABLE WASTE MANAGEMENT BEHAVIOR IN MALAYSIAN HIGHER EDUCATION INSTITUTIONS: INTEGRATING TPB AND VBN PERSPECTIVES FOR SOCIAL DEVELOPMENT

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Article history
Received date : 17-5-2026
Revised date : 18-5-2026
Accepted date : 15-6-2026
Published date : 1-7-2026

To cite this document:
Amran, A., Ab. Aziz, N., Mohd Shafie, S. N., A. Malek @ Abdul Malek, S., Abdul Rahman, R., & Mohamed, Z. (2026). Sustainable waste management behavior in Malaysian higher education institutions: Integrating TPB and VBN perspectives for social development. *Journal of Islamic, Social, Economics and Development (JISED),* 11 (84), 203 - 223

Abstract: *This study examines sustainable waste management behavior within Malaysian higher education institutions by integrating the Theory of Planned Behavior (TPB) and Value-Belief-Norm (VBN) theory. Using a quantitative approach, data from 378 respondents were analyzed through Partial Least Squares Structural Equation Modeling (PLS-SEM). The findings indicate that subjective norms and perceived behavioral control significantly influence sustainable waste practices, while financial incentives exhibit selective moderating effects. Beyond behavioral prediction, the study contributes to the discourse on social and institutional development by emphasizing the role of collective responsibility, environmental ethics, and value-driven engagement among university communities. The findings offer practical implications for policy makers and educational administrators in designing sustainability programs that strengthen social awareness, governance mechanisms, and long-term environmental accountability in higher education settings.*

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Keywords: *Campus Waste Management, Sustainability, TPB, VBN Theory, Financial Incentives, Student Behavior*

Introduction

The increasing global concern over environmental degradation, resource depletion, and waste generation has highlighted the urgent need for sustainable solutions. In Malaysia, where rapid urbanization and economic growth have led to significant waste management challenges, integrating into waste management practices offers a promising pathway toward sustainability. According to the SDG Framewrorks (United Nations, 2015), the SDG related to waste management are SDG 11 (*Sustainable Cities and Communities*), SDG 12 (*Responsible Consumption and Production*) and SDG 13 (*Climate Action*). A key aspect of sustainability for educational institutions is waste management.(Pulmo, 2023). In relation to this, universities are a good example of institution where every day a great amount of people go to work or to study. Thus, university campuses generate significant amounts of solid waste daily from academic, residential, and food-related activities. The huge amount of waste produced, and consequently the great difficulty involved in eliminating it, is still a problem in the developed societies. (Gallardo et al., 2016). Waste management in a university setting is crucial for maintaining cleanliness, promoting sustainability, and adhering to environmental regulations. Gallardo et al., (2016) stated that one of these necessities is the correct management of the waste that is daily produced by these communities.

Higher education institutions (HEIs) are increasingly recognized as important agents of sustainable development due to their role in shaping environmental awareness, ethical responsibility, and pro-environmental behavior among future generations (Mies & Gold, 2021). University campuses generate substantial volumes of solid waste through academic, residential, and food-service activities, making waste management an increasingly important institutional sustainability concern (Gallardo et al., 2016). In Malaysia, despite the implementation of recycling initiatives and sustainability campaigns, participation in waste segregation and recycling practices among university communities remains inconsistent (Baba-Nalikant et al., 2023). This situation reflects a behavioral gap between environmental awareness and actual sustainable practices. Previous studies have primarily examined isolated behavioral predictors such as environmental attitude, recycling intention, or institutional support (Lee & Ahmad, 2021; Phang & Ilham, 2023). However, limited studies have integrated both rational decision-making perspectives and moral-normative dimensions in explaining sustainable waste management behavior within Malaysian HEIs. Therefore, this study integrates the Theory of Planned Behavior (TPB) and Value-Belief-Norm (VBN) theory to provide a more comprehensive explanation of sustainable waste management behavior for social development in higher education institutions.

Literature Review

Waste Management in Malaysia

Countries experience economic growth as they become increasingly urbanized. This urbanization correlates with a rise in the consumption of goods and services, which in turn elevates living standards and disposable incomes, ultimately resulting in increased waste production (Farrelly et al., 2016). Waste management (WM) presents a local challenge that carries global implications. As the global population continues to grow, so does the volume of waste generate (Maalouf & Agamuthu, 2023). On broader sense, waste management systems

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seek to improve sustainability and lessen their negative effects on the environment. Urbanization, population expansion, and changes in lifestyle are the main causes of the rise in solid waste (International Trade Administration, 2024). This proven by The Department of Statistics Malaysia (DOSM) reports that organic materials, particularly food waste, constitute a substantial share, estimated at 40%-50%, highlighting the country's considerable food waste issue.

Worsening the scenario, waste production rises as a result of increased consumption of goods and services brought on by urbanization and economic expansion (Farrelly et al., 2016). Given that garbage generation is made worse by the world's expanding population, waste management is a local issue with global ramifications (Maalouf & Agamuthu, 2023). According to the European Waste Framework Directive, waste avoidance, reuse, recycling, and recovery are given precedence over disposal in the Waste Management Hierarchy. Related to this, Malaysia has a serious problem with food waste, as organic materials, especially food waste, make up 40% to 50% of all waste. Everyday in Malaysia, it produces more than 39,000 tons of municipal solid waste, or 1.17 kg per person, of which over 30% is food waste. 8.3 million metric tons of food, or around 260 kg per person, are wasted annually by Malaysians.

Related to this, economic growth has raised trash generation worldwide, creating problems for public health, land use, climate change, and environmental quality (Cerqua et al., 2024). Recycling rates are greater in nations like Taiwan (60%) Korea (49%), and Singapore (59%), than in the US (30.67%) and Malaysia (31%). 95% of the collected waste in Malaysia is disposed of in landfills, demonstrating the country's heavy reliance on them (Agamuthu & Fauziah, 2011). Although there has been a gradual improvement in the recycling rate in Malaysia, it still falls short compared to developed nations, with a reported rate of about 31% in 2020, which is below the government's target of 40% by 2025 (Department of Statistics in Malaysia, 2020). This deficiency is caused in part by poor recycling infrastructure and little public participation.

Waste Management Hierarchy Model

The waste management hierarchy model is a framework used to guide waste management practices by prioritizing actions that reduce the environmental impact of waste. It is typically represented as a pyramid with five key levels, ranked from most to least preferred. Prevention the most effective strategy, which focuses on avoiding the generation of waste in the first place. Next is Minimization (or Reduction) reducing the amount and toxicity of waste produced. The 3rd one is Reuse extending the life of products and materials by using them again without significant processing. Followed by Recycling and Recovery, in which processing waste materials to create new products or recovering energy from waste; and the last one is Disposal. This is the least preferred option, involving landfilling or incineration without energy recovery. The waste hierarchy, as defined by the European Waste Framework Directive, is the sequence in which waste management activities should be prioritized. The model encourages minimizing waste production and maximizing resource efficiency before resorting to disposalThe Waste Hierarchy Index (WHI) was proposed by Pires and Martinho (2019) as a measurable indicator of waste hierarchy implementation. In order to pinpoint areas that require improvement, the WHI assesses waste management practices such recycling, incineration, and reuse. Prevention, reuse, recycling, and recovery are given precedence over disposal in the Waste Management Hierarchy, which rates waste management choices according to their effects on the environment (US EPA, 2024). In spite of ongoing efforts to enhance recycling initiatives, the combination

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of insufficient public engagement and inadequate recycling infrastructure results in a low recycling rate.

Public universities in Malaysia are microcosms of urban activity, generating diverse waste streams that mirror national challenges. Previous research Agamuthu and Fauziah, (2011) and DOSM, (2020) confirms increasing waste volume despite policies promoting waste reduction and recycling. Addition to this, perceived behavioral control has an impact on sustainable e-waste management (Ofori & Opoku Mensah, 2022). To add, the benefits including lower resource consumption, reduction of waste, and improvement in the sustainability of production have been practiced on Industry 4.0 revolution (Nascimento et al., 2019). This study is aligned with the Waste Hierarchy model, which concerns with waste management actions according to their environmental impact starting from waste prevention at the top, down to disposal as the least preferred option. This hierarchy supports many sustainability frameworks, including the national waste policies. By focusing on student behavior in campus environments, the study aims to encourage changes toward prevention, reuse, and recycling, rather than waste disposal. The integration of TPB and VBN theories helps to explain motivational and normative factors that influence such proactive waste practices. This behavioral perspective provisions the upper layers of the waste hierarchy, particularly in fostering long term sustainable habits among university students in higher education settings.

Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (TPB), developed by Icek Ajzen, explains that human behavior is primarily determined by behavioral intention, which is influenced by attitude, subjective norms, and perceived behavioral control (Ajzen, 1991). TPB has been extensively applied in environmental and sustainability research because many pro-environmental actions, including recycling and waste separation, involve planned and intentional behavior (Zhang et al., 2015). Within university settings, TPB is particularly relevant because students' waste management practices are often shaped by peer influence, institutional norms, and perceived convenience of recycling facilities (Phang & Ilham, 2023). Previous studies found that students with stronger environmental attitudes and greater perceived behavioral control are more likely to engage in sustainable waste management behavior (Rauf et al., 2021; Lee & Ahmad, 2021). Therefore, TPB provides a strong social-cognitive framework for understanding sustainable waste practices within campus communities.

TPB has been used widely to study waste habits. The theory desrcibe that a person's action is determined by their intention, or preparation, to perform that behavior. Three things determine intention: (1) attitude, which is a person's opinion about whether or not to involve in a behavior; (2) subjective norm, which is a person's opinion about social pressure to involve in or desist from engaging in a behavior; and (3) perceived behavioral control, which is a person's opinion about their capacity performs a specific behavior (Zhang et al., 2015). To describe this, Rahman and Saad (2021), in their study of Malaysian SMEs using a TPB framework, recognized perceived behavioral control and attitude as significant predictors of environmental adoption, aligning with our own finding that PBC significantly influences campus waste management behavior. Additionally, the TPB is desrcibe as the major explanatory framework for consumers' disposal behaviors (Raab, 2024), frequently guides research that uses quantitative surveys for data collection and structural equation modeling for data analysis (Venturi et al., 2025).

While the constructs of the Theory of Planned Behavior (TPB) and Value Belief Norm (VBN) theory have been widely validated, their relative influence often varies across cultural and

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contextual settings. For instance, subjective norms tend to play a stronger role in collectivist societies, such as Malaysia and other Asian contexts, where social expectations and peer influence shape pro-environmental actions more prominently than individual attitudes (Yuriev et al., 2020). Conversely, in Western contexts, where individualism is emphasized, personal norms and attitudes often emerge as stronger predictors of sustainable behavior (Klockner, 2013). This cultural divergence may explain why in the present study, personal norms and belief constructs showed weaker influence compared to subjective norms and perceived behavioral control. Such findings reinforce the importance of contextualizing behavioral models like TPB and VBN, suggesting that cultural orientation whether collectivist or individualist can shape the predictive strength of different variables in sustainability research.

Although TPB variables are widely recognized as significant predictors of environmental behavior, prior findings remain inconsistent across institutional and cultural contexts. In collectivist societies such as Malaysia, subjective norms often emerge as stronger predictors because social expectations and peer influence play an important role in shaping individual behavior (Yuriev et al., 2020). Conversely, in more individualistic contexts, attitudes and personal beliefs tend to exert stronger influence on environmental actions (Klöckner, 2013). Furthermore, several studies suggest that positive environmental attitudes alone may not necessarily translate into actual waste management practices when institutional support and enabling conditions remain inadequate (Wan et al., 2014). These inconsistencies indicate that sustainable waste behavior cannot be fully explained through rational and social-cognitive dimensions alone, thereby justifying the integration of TPB with moral-normative perspectives such as the VBN theory

Value-Belief-Norm (VBN) Theory

The Value-Belief-Norm (VBN) theory, introduced by Paul C. Stern, explains pro-environmental behavior through a chain of personal values, ecological beliefs, and moral norms that ultimately influence environmentally responsible actions (Stern et al., 1999; Stern, 2000). Unlike TPB, which emphasizes rational evaluation and perceived behavioral control, VBN focuses on moral obligation and environmental responsibility as key drivers of sustainable behavior. Individuals with strong biospheric values and ecological worldviews are more likely to develop personal norms that encourage environmentally responsible actions such as recycling and waste reduction (Al Mamun et al., 2022). Within university settings, VBN is important because sustainable waste behavior is not solely influenced by rational decision-making, but also by ethical awareness, environmental concern, and collective responsibility toward sustainability goals (Lau et al., 2019). Therefore, integrating TPB and VBN enables a more comprehensive understanding of both the social-cognitive and moral-normative dimensions underlying sustainable waste management behavior.

Furthermore, moral norms have also been shown to play a important role in recycling and waste behaviors, encompassing the core components of the Theory of Planned Behavior (Botetzagias, Dima, & Malesios, 2015). Al Mamun et al. (2022) operationalized the full VBN factor and found that social and personal norms play a central role in solid waste management intentions among Malaysian adults, providing a solid fundamental for testing VBN mechanisms in the study. Adding nuance to VBN's applicability across cultural lines, Lau et al. (2019) demonstrate that social norms augment the explanatory power of the model in diverse Malaysian subgroups, suggesting that the study should measure both personal and social norms in the study. Besides, Anuar and Hashim (2022) demonstrated that social norms and institutional support significantly influence university students' engagement in sustainable behaviors, reinforcing the findings that

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subjective norms and perceived control are critical in shaping campus waste management. Drawing on Canlas et al. (2022), the foundational VBN sequence of values, beliefs, norms behaviors offer a comprehensive lens to evaluate waste management intention frameworks. In addition, Samsudin et al. (2021) show this chain holds at the household level in Malaysia, reinforcing the relevance of value-driven belief and norm activation in explaining separation practices.

Financial Incentives in Sustainability

While financial rewards are known to influence behavior, their impact on intrinsic motivation is debated. Some researchers argue that incentives may undermine pro-social behavior (Shaw & Maynard, 2008), while others claim they enhance participation in low-commitment environmental tasks (Thøgersen & Yang, 2022). As noted by Barbier (2011), exploring and implementing diverse innovative financing mechanisms ranging from international payments for ecosystem services to taxes on financial and currency transactions, as well as international financing facilities could help mitigate the funding challenges faced in this endeavor.

For Malaysia to achieve sustainable waste management, public involvement is essential. Waste can be decreased, resource use can be enhanced, and healthier living conditions can be promoted through effective public participation. Malaysia's recycling rate was just 9.7% in 2010 and 33.17% in 2022, falling short of the 40% objective for 2025 despite efforts to raise recycling rates. Public involvement is still a major obstacle. It is understandable that, recycling rates are greatly increased by financial incentives like prizes and subsidies. For instance, economic incentives work well in the US, whereas green awards boost recycling intentions in China (Thogersen & Yang, 2022). Economic incentives, however, can lessen perceived autonomy in the United States but not in China, and environmental arguments are more persuasive than prizes in Germany.

According to recent research, financial incentives are crucial for promoting recycling practices (Thøgersen & Yang, 2022). Simplifying waste management procedures is another important function of technology, such as waste-to-energy systems and the Internet of Things (Cheng et al., 2022). Potential crowding-out of intrinsic drive can be avoided with a combination of green incentives and appeals. In some situations, though, the increase in recycling rates is accomplished without spending more money on waste collection or environmental projects. In 2024, Cerqua et al. More recent research supports the need of employing financial incentives to promote recycling behaviors, as demonstrated by a number of recent studies (Thogersen & Yang, 2022).

In order to characterize the motivating scenarios, interactions may also occur in which extrinsic elements, such as incentives, impact intrinsic, individual motivations (Shaw & Maynard, 2008). More recent study supports the need of employing financial incentives to promote recycling behaviors (Thogersen & Yang, 2022). Waste management has been made easier by technology in a number of sectors, including waste-to-energy and the Internet of Things (IoT), which are methods of reducing the amount of waste that ends up in landfills (Cheng and others, 2022). Additionally, there might be interactions in which extrinsic factors, like as rewards, have an impact on intrinsic, internal motives (Shaw & Maynard, 2008). More recent study supports the need of employing financial incentives to promote recycling behaviors (Thogersen & Yang, 2022). Therefore, it is crucial needs to explore more on the incentivizing and the adoption of circular economy concepts in the area of waste management.

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To describe the incentivizing scenario, here may also be interactions wherein inherent, personal motives are influenced by extrinsic factors like rewards (Shaw & Maynard, 2008). Official statistics from the Ministry of Urban Wellbeing, Housing and Local Government, along with the National Solid Waste Management Department, indicate that the recycling rate among Malaysians was notably low at 9.7% in 2010. To stimulates these, numerous recent studies that show the significance of using financial incentives to encourage recycling behaviors is supported by more recent research (Thogersen & Yang, 2022). Thus, waste management finance issues may be resolved with the use of creative financing methods including taxes on financial activities and international payments for ecosystem services (Barbier, 2011).

Conceptual Farmwork & Hypothesis

Therefore, this study is underpinned by two well-established behavioral theories: the Theory of Planned Behavior (TPB) (Ajzen, 1991) and the Value-Belief-Norm (VBN) Theory (Stern, 2000), both of which provide a robust lens for understanding pro-environmental behaviors such as waste management practices.

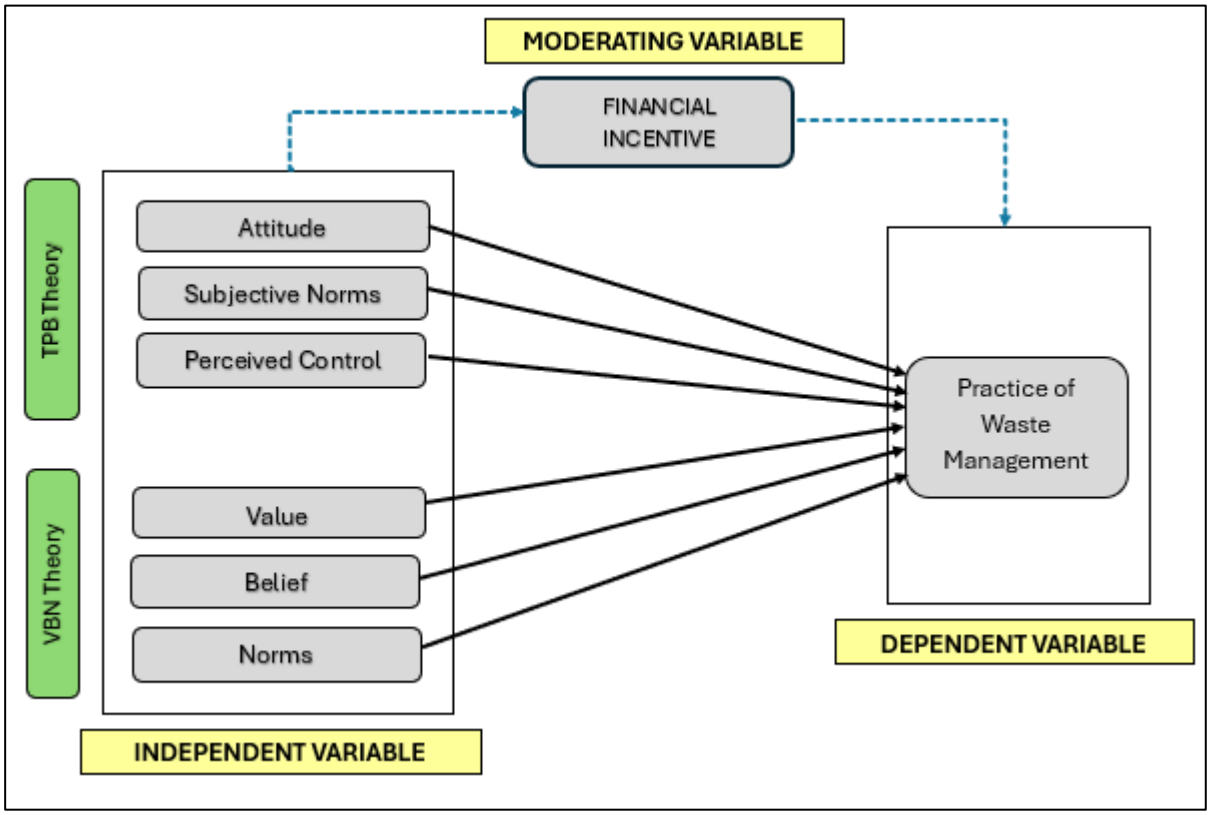

Figure 1: Conceptual framework integrating TPB, VBN, and financial incentive toward sustainable waste management practices

As illustrated in Figure 1, the TPB constructs Attitude, Subjective Norms, and Perceived Behavioral Control and the VBN constructs Value, Belief, and Personal Norms are treated as independent variables. These variables are hypothesized to influence the dependent variable, which is the practice of waste management among university students.

In addition, financial incentive is introduced as a moderating variable that potentially affects the strength and direction of the relationship between the independent variables and the dependent variable. This conceptualization is grounded in previous findings suggesting that

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economic motivators may amplify or weaken behavioral outcomes depending on individual and contextual factors (Tang et al., 2021; Wang et al., 2016). . As shown in the conceptual framework (Figure 1), the relationships among these constructs are hypothesized to explain variance in waste management practices, forming the basis for the following testable hypotheses:

Hypotheses Based on TPB Constructs

H1: Attitude has a significant positive effect on the practice of waste management.
H2: Subjective norms have a significant positive effect on the practice of waste management.
H3: Perceived behavioral control has a significant effect influence on the practice of waste management.

Hypotheses Based on VBN Constructs

H4: Value has a significant positive effect on the practice of waste management.
H5: Belief has a significant positive effect on the practice of waste management.
H6: Personal norms have a significant positive effect on the practice of waste management.

Hypotheses on the Moderating Effect of Financial Incentives

H7: Financial incentives have a significant positive effect on the practice of waste management.
H8: Financial incentives moderate the relationship between attitude and the practice of waste management.
H9: Financial incentives moderate the relationship between subjective norms and the practice of waste management.
H10: Financial incentives moderate the relationship between perceived behavioral control and the practice of waste management.
H11: Financial incentives moderate the relationship between value and the practice of waste management.
H12: Financial incentives moderate the relationship between belief and the practice of waste management.
H13: Financial incentives moderate the relationship between personal norms and the practice of waste management.

Methodology

This study adopted a quantitative research design, as all latent constructs were measured using numerically coded survey instruments adapted from prior validated scales (Hair et al., 2021). The research aimed to examine behavioral determinants of campus waste management practices using established theories thus necessitating structured data for hypothesis testing and model evaluation.

The unit of analysis for this study consisted of undergraduate students from Universiti Teknologi MARA (UiTM) Kelantan Branch, Malaysia. University students were selected because higher education institutions function as important environments for cultivating sustainability awareness and environmentally responsible behavior among future generations (Mies & Gold, 2021). Convenience sampling was employed due to its practicality and effectiveness in accessing the targeted respondents within the university setting, which is consistent with prior behavioral and sustainability studies (Podsakoff et al., 2003; Saunders et al., 2019). Respondents were approached through online questionnaire distribution using Google Forms with the assistance of university lecturers. The inclusion criteria required

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respondents to be active students currently enrolled at the university and aged 18 years and above. A total of 400 questionnaires were distributed, and 378 usable responses were successfully collected, representing a response rate of 94.5%.

A rigorous data cleaning procedure is adopted to exclude incomplete and invalid responses. The final data for this study are 378 valid response. This sample size meets the minimum requirements for Partial Least Squares Structural Equation Modeling (PLS-SEM), which was used for analysis due to its suitability for theory-driven, exploratory models with latent variables (Hair et al., 2021; Ramayah et al., 2018). The data were analyzed using SmartPLS version 4.1.1.2.

Data analysis and findings

Respondent profile

Table 1 provides the demographic profile of the 378 respondents. The respondents were students and workers in a university in Malaysia. The sample consisted of 105 (27.8%) male and 273 (72.2%) female respondents. The age of the respondents' ranged between 18 to 30 years old. A majority of the respondents (61.9%) were between 20 to 24 years old, followed by 36.8% in the "Below 20 years old" category, 0.8% aged between 25 to 29 years, and 0.5% aged 30 years and above. The ethinicity and nationality of the respondents are Malays and Malaysian respectively. In the field of study, majority of the respondents are from the Diploma (52.6%), followed by Bachelor's Degree (46.8%) and the rest are from Master's Degree (0.3%) and PhD (0.3%). Regarding the respondents' faculty, the largest group came from the Administrative Science & Policy Studies faculty (50%), followed by Computer & Mathematical Sciences (30.2%), and Business & Management (18.8%). A small number of respondents came from faculties such as Accountancy, Art & Design, and Information Management. When considering residency status, a significant portion of the respondents lived on-campus (42.9%), while 39.2% rented accommodations off-campus, and 18% commuted from home. In terms of monthly allowance, the largest group (47.9%) had an allowance of less than RM300, followed by RM301 to RM500 (33.1%). A smaller proportion of respondents had RM501 to RM800 (14.3%) or more than RM800 (4.8%) as their monthly allowance. Lastly, regarding active participation in campus sustainability activities or recycling programs, 38.9% of respondents reported actively participating, while the remaining 61.1% were not involved.

Table I: Demographic characteristics of respondents

Characteristics	Items	Frequency	%
Gender	Male	273	72.2 %
	Female	105	27.8 %
Age	20 - 24 years old	234	61.9 %
	25 – 29 years old	3	0.8 %
	30 years and above	2	0.5 %
	Below 20 years old	139	36.8 %
Academic Level	Bachelor's Degree	177	46.8 %
	Diploma	199	52.6 %
	Master's Degree	1	0.3 %
	PhD	1	0.3 %
Faculty	Accountancy	2	0.5%
	Administrative Science & policy Studies	189	50 %
	Art & Design	1	0.3 %

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	Business & Management	71	18.8 %
	Computer & Mathematical Sciences	114	30.2 %
	Information Management	1	0.3 %
Residency Status	Commutes from home	68	18 %
	Off-campus (rented accommodation)	148	39.2 %
	On-campus resident1	162	42.9 %
Monthly Allowance	Less than RM300	181	47.9 %
	More than RM800	18	4.8 %
	RM301 to RM500	125	33.1 %
	RM501 to RM800	54	14.3 %
Active Participate	No	231	61.1 %
	Yes	147	38.9 %

Assessment of the measurement model

The data from the questionnaire was analyzed using Smart PLS, a two-step approach which involves evaluating both the measurement and structural models. The measurement model examines the relationship between items and constructs, while the structural model explores the relationship between exogenous and endogenous constructs in the research model. Figure 2 shows the measurement model, which must meet the criteria for internal consistency reliability, convergent validity and discriminant validity. Internal consistency reliability is to ensure the consistency of results across items, while convergent validity is tested to ensure that multiple items measuring the same concept agree with each other.

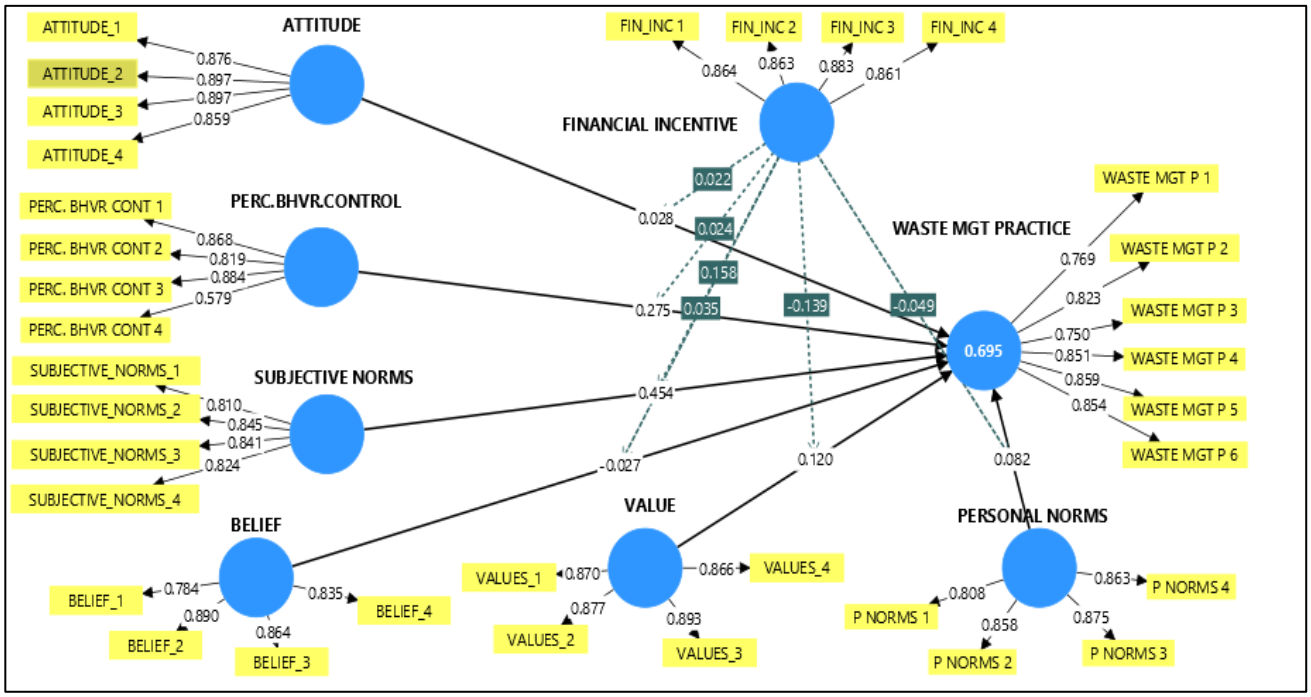

Figure 2: Measurement Model

To assess the internal consistency reliability and convergent validity of the measurement model, the loadings, composite reliability (CR), and average variance explained (AVE) were evaluated. Hair et al. (2017) recommend that the loading, AVE, and CR values should be at least 0.6, 0.5, and 0.7, respectively, to establish convergent validity. Table 2 demonstrates that the reliability

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and convergent validity of the construct was satisfactory as the loading, AVE, and CR values exceeded the recommended values. The loading varied from 0.579 to 0.897, AVE ranged from 0.635 to 0.779, and CR ranged from 0.836 to 0.909, indicating that convergent validity was achieved.

Table 2: The measurement model assessment

Constructs	Measurement items	Loadings	Cronbach's α	CR	AVE
Attitude	Attitude_1	0.876	0.905	0.909	0.779
	Attitude_2	0.897			
	Attitude_3	0.897			
	Attitude_4	0.859			
Perceived Behaviour Control	Perc. Bhvr Cont 1	0.868	0.8	0.836	0.635
	Perc. Bhvr Cont 2	0.819			
	Perc. Bhvr Cont 3	0.884			
	Perc. Bhvr Cont 4	0.579			
Subjective norms	Subjective_Norms_1	0.81	0.85	0.852	0.689
	Subjective_Norms_2	0.845			
	Subjective_Norms_3	0.841			
	Subjective_Norms_4	0.824			
Value	Values_1	0.87	0.899	0.9	0.768
	Values_2	0.877			
	Values_3	0.893			
	Values_4	0.866			
Belief	Belief_1	0.784	0.865	0.872	0.713
	Belief_2	0.89			
	Belief_3	0.864			
	Belief_4	0.835			
Personal norms	P Norms 1	0.808	0.873	0.873	0.725
	P Norms 2	0.858			
	P Norms 3	0.875			
	P Norms 4	0.863			
Financial Incentive	Fin_Inc 1	0.864	0.892	0.908	0.753
	Fin_Inc 2	0.863			
	Fin_Inc 3	0.883			
	Fin_Inc 4	0.861			
Waste Management Practice	Waste Mgt P 1	0.769	0.901	0.908	0.671
	Waste Mgt P 2	0.823			
	Waste Mgt P 3	0.75			
	Waste Mgt P 4	0.851			
	Waste Mgt P 5	0.859			
	Waste Mgt P 6	0.854			

Assessment of the structural model

After the measurement model had been validated, a structural model analysis was conducted to test the thirteen hypotheses. In the assessment of the structural model, the direction of the beta value, the significance level of the t-values and p-values were examined, as suggested by Hair et al. (2017). A bootstrapping procedure with a resampling of 5,000 was performed to test the direct and moderating effects. Figure 3 depicts the structural model of this study. Table 3

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provides the results of hypotheses testing. Specifically, in H1 it was hypothesized that attitude would have a positive influence on waste management practice. The results showed an insignificant relationship (β = 0.028, t = 0.692, p > 0.05). Therefore, H1 was not supported. As for H2, it was posited that belief would negatively influence waste management practice. The beta result showed a positive direction; however, the relationship was not significant (β = -0.027, t = 0.700, p > 0.05). Thus, H2 was not supported. For H3, which proposed that financial incentive would have a negative influence on waste management practice, the result showed a small and insignificant effect (β = -0.003, t = 0.941, p > 0.05). Therefore, H3 was not supported. In H4, it was predicted that financial incentive moderates the relationship between attitude and waste management practice. The results indicated a positive but insignificant relationship (β = 0.022, t = 0.768, p > 0.05). Thus, H4 was not supported. Regarding H5, which tested the moderating effect of financial incentive on belief, the results were not significant (β = 0.035, t = 0.647, p > 0.05), and H5 was not supported. For H6, the moderating effect of financial incentive on perceived behavioral control was also tested. The results showed no significant relationship (β = 0.024, t = 0.686, p > 0.05), indicating that H6 was not supported. H7 predicted that financial incentive moderates the relationship between personal norms and waste management practice. However, the results were not significant (β = -0.049, t = 0.535, p > 0.05). Therefore, H7 was not supported. On the other hand, H8 posited that financial incentive moderates the relationship between subjective norms and waste management practice. The results showed a significant and positive relationship (β = 0.158, t = 2.414, p < 0.05), indicating that H8 was supported. Similarly, H9, which proposed that financial incentive moderates the relationship between value and waste management practice, also showed a significant effect (β = -0.139, t = 2.267, p < 0.05). Therefore, H9 was supported. H10 hypothesized that perceived behavioral control would positively influence waste management practice. The results confirmed this with a significant and strong relationship (β = 0.275, t = 4.512, p < 0.001), so H10 was supported. In H11, it was predicted that personal norms would positively influence waste management practice. However, the results were not significant (β = 0.082, t = 1.100, p > 0.05). Therefore, H11 was not supported. H12 tested the effect of subjective norms on waste management practice, and the results showed a significant and strong relationship (β = 0.454, t = 6.452, p < 0.001), hence H12 was supported. Finally, H13 posited that value would positively influence waste management practice. The results were approaching significance but did not meet the conventional threshold (β = 0.120, t = 1.809, p = 0.071). Therefore, H13 was not supported, although it showed a marginal effect.

Table 3: Structural model assessment and hypothesis testing

Hypothesis		Beta	Standard deviation	T value	P values	Decision
H1	Attitude -> Waste Mgt Practice	0.028	0.071	0.397	0.692	Not Supported
H2	Subjective Norms -> Waste Mgt Practice	0.454	0.070	6.452	0.000	Supported
H3	Perc.Bhvr.Control -> Waste Mgt Practice	0.275	0.061	4.512	0.000	Supported
H4	Value -> Waste Mgt Practice	0.120	0.066	1.809	0.071	Not Supported
H5	Belief -> Waste Mgt Practice	-0.027	0.071	0.386	0.700	Not Supported

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H6	Personal Norms -> Waste Mgt Practice	0.082	0.074	1.100	0.271	Not supported
H7	Financial Incentive -> Waste Mgt Practice	-0.003	0.045	0.074	0.941	Not Supported
H8	Financial Incentive x Attitude -> Waste Mgt Practice	0.022	0.074	0.295	0.768	Not Supported
H9	Financial Incentive x Subjective Norms -> Waste Mgt Practice	0.158	0.065	2.414	0.016	Supported
H10	Financial Incentive x Perc.Bhvr.Control -> Waste Mgt Practice	0.024	0.058	0.405	0.686	Not Supported
H11	Financial Incentive x Value -> Waste Mgt Practice	0.021	0.061	2.267	0.023	Supported
H12	Financial Incentive x Belief -> Waste Mgt Practice	0.035	0.076	0.458	0.647	Not Supported
H13	Financial Incentive x Personal Norms -> Waste Mgt Practice	-0.049	0.079	0.620	0.535	Not Supported

A reasonable explanation for the insignificance of several predictors (e.g., attitude, beliefs, personal norms, and values) is the structural constraint of limited on-campus waste facilities, which dampens the translation of favorable dispositions into action. Within the TPB, perceived behavioral control (PBC) captures people's appraisal of the ease or difficulty of performing a behavior; when enabling conditions (e.g., proximity and clarity of labeled bins, stable collection schedules) are lacking, PBC and thus behavior suffers even if attitudes and norms are favorable (Ajzen, 1991). Empirical waste-management studies consistently show that facility availability, convenience, and accessibility are decisive determinants of recycling/separation behavior through PBC. Classic TPB recycling research found that situational factors such as access to facilities materially shape intentions and behavior beyond attitudes and norms (Tonglet et al., 2004). In contexts with poor or inconvenient facilities, intentions weaken, and actual behavior drops (Barr, 2003; Knussen et al., 2004). More recent evidence corroborates this mechanism across settings: higher accessibility to recycling infrastructure elevates PBC and increases participation (Zhang et al., 2016), while perceived policy/facility effectiveness strengthens the TPB pathway to recycling (Wan et al., 2014). In Malaysian university settings specifically, inconvenience and limited infrastructure have been identified as salient barriers that depress recycling among students despite generally positive attitudes (Ghani et al., 2013; Baba-Nalikant et al., 2023). Taken together, our non-significant paths likely reflect a behavior–context gap: students may endorse pro-environmental values and norms, yet without sufficient, visible, and user-friendly facilities, those cognitions do not consistently materialize into waste-sorting practice.

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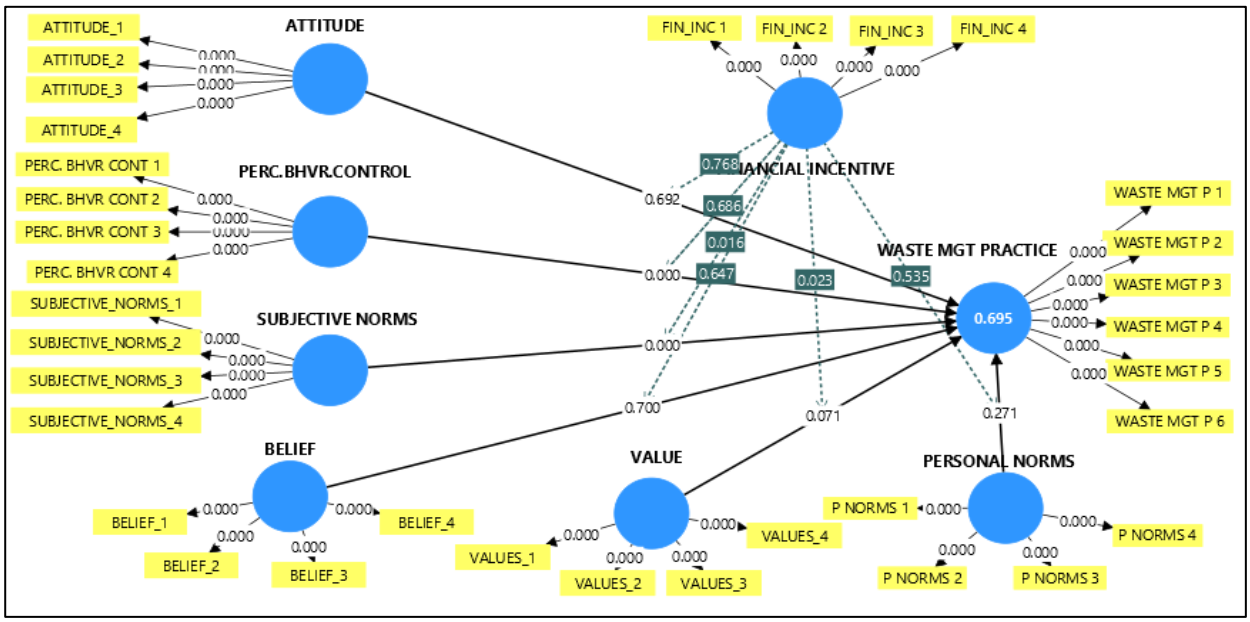

Figure 3: Path Model (measurement and structural model)

Table 4 presents the values of the coefficient of determination (R^2) and effect size (f^2) of the exogenous variables on the endogenous variable. The R^2 value represents the amount of variance in the endogenous construct explained by all the exogenous constructs in the research model. As can be seen from the table, the R^2 was 0.695, which denoted that the exogenous variables (Attitude, Percentage Behaviour Control, Subjective norms, Belief, Personal norms, Value and Financial Incentive) explained 69.5 % of the variance in the endogenous variable (waste management practices in the campus). As regards the effect size, f^2, this represents the value of R^2 that is changed when a specific construct is omitted from the model. Following Cohen (1988), the impact of the effect size was judged to be small if the value of f^2, was 0.02, medium if it was 0.15 and large if it was 0.35. The results in Table 4 indicate that the supported exogenous variables (Attitude), f^2, = 0.001, (Percentage Behaviour Control) f^2, = 0.115, (Subjective norms f^2, = 0.241), (Belief) f^2, = 0.001, (Personal norms) f^2, = 0.158, (Value) f^2, = 0.014 and (Financial Incentive) f^2, = 0.000 to 0.0037 (moderating) had a small and medium effect size on the endogenous variable.

Table 4: Result of R^2 and f^2

Construct	R^2	f^2	Decision
Waste Management Practice in Campus	0.695		
Attitude		0.001	Small
Beliefs		0.001	Small
Financial Incentive		0.000	Small
Financial_Incentive x Attitude		0.000	Small
Financial_Incentive x Beliefs		0.001	Small
Financial_Incentive x Perc.Bhvr.Control		0.001	Small
Financial_Incentive x Personal_Norms		0.002	Small
Financial_Incentive x Subjective Norms		0.037	Small
Financial_Incentive x Value		0.021	Small
Perc.Bhvr.Control		0.115	Small
Personal_Norms		0.006	Small
Subjective Norms		0.241	Medium
Value		0.014	Small

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Conclusion from Findings

The findings of this study propose a beneficial understanding into the behavioral factors influencing campus waste management practices among university students in Malaysia. Despite high internal consistency and convergent validity across all constructs, the structural model results discovered that only a few variables had significant influence. Specifically, subjective norms and perceived behavioral control emerged as strong predictors of sustainable waste practices, confirming the relevance of social and perceived capacity factors in behavioral decision-making. Financial incentives presented limited direct and moderating effects, with only two significant moderation paths between subjective norms and waste behavior, and between value and waste behavior denotes their selective impact. Other constructs such as attitude, belief, personal norms, and value exhibited limited or moderate influence. The model accounted for 69.5% of the variance in campus waste behavior, with subjective norms representing the highest effect size ($f^2 = 0.241$). These results uncovers the importance of nurturing peer influence and perceived control factor to promote sustainable behaviors within university ecosystems, while also signifying a more nuanced role for financial incentives in encouraging pro-environmental actions.

Discussion

The findings of this study suggested critical insights into the behavioral and normative predictors of waste management practices among university students in Malaysia. Referring to the Theory of Planned Behavior (TPB) and the Value-Belief-Norm (VBN) theory, the study proposed to identify the psychosocial factors that influence individual participation in sustainable waste practices, particularly within a campus environment. The results partly support the integrated framework, considering several theoretical and practical implications.

Among the TPB constructs, *subjective norms* and *perceived behavioral control* (PBC) were expose to significantly forecast waste management behavior. The strong influence of subjective norms ($\beta = 0.454$, $p < 0.001$; $f^2 = 0.241$) approves the critical role of social pressure and peer expectations in driving pro-environmental behavior, consistent with past research by Chen et al. (2019) and Phang and Ilham (2023). This proposes that when students remark that their peers or significant others expect them to involve in sustainable activities, they are more likely to comply. Similarly, the significant effect of PBC ($\beta = 0.275$, $p < 0.001$; $f^2 = 0.115$) confirms that the ease or difficulty perceived by students in managing waste significantly shapes their behavioral outcomes (Ajzen, 1991). The findings support the notion that capability perception such as access to waste bins or recycling infrastructure strengthens behavioral intentions and subsequent actions (Wan et al., 2017).

On the other way round, *attitude*, *belief*, and *personal norms* despite having strong measurement validity did not represent significant results. While this finding appears to reverse the assumptions of TPB and VBN, it may reflect a behavior–attitude gap commonly found in sustainability contexts. Ajzen (2001) recognizes that favorable attitudes only may be insufficient predictors of behavior without complementary social and control factors. Correspondingly, Stern (2000) claims that personal norms are more likely to influence behavior when activated by contextual triggers such as awareness of consequences or attribution of responsibility factors which might not have been fully addressed in this study.

Furthermore, *financial incentives*, which were presented as a moderating variable, had a limited role in enhancing the TPB-VBN. The only significant moderating effects were observed between financial incentive and subjective norms ($\beta = 0.158$, $p = 0.016$) and between financial

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incentive and value (β = -0.139, p = 0.023). These results suggest that while financial rewards can strengthen normative motivation in some contexts, their influence is neither dependable nor universally effective. This aligns with the discussion in the literature regarding the efficacy of extrinsic motivators in promoting intrinsic environmental behavior (Deci et al., 1999; Thøgersen & Yang, 2022). The findings suggest that while financial incentives may encourage certain students, especially when combined with normative factors, their general effect remains uncertain.

Furthermore, the overall R^2 value of 0.695 indicates that approximately 69.5% of the variance in campus waste behavior was explained by the integrated model. This is consistent with prior studies employing TPB in environmental behavior research (Yuriev et al., 2020). However, most of the individual effect sizes (f^2) were in the small to medium range, emphasizing the complex nature of waste behavior among youth.

In sum, the findings underline the importance of educating social influence factors, improving perceived behavioral control through better infrastructure, and cautiously integrating extrinsic motivators such as incentives. The results suggest for a behavioral strategy that blends normative and control-based interventions over purely attitudinal or reward-driven approaches to foster lasting waste management practices in universities.

Implications and Recommendations

The results of this study provide important implications for organizational sustainability efforts in Malaysian universities, particularly in enhancing campus waste management practices through behavioral frameworks. The important factor of subjective norms and perceived behavioral control indicates that social and psychological enablers are critical levers for improving pro-environmental behaviors among university students.

From a theoretical perspective, the findings support the combination of the Theory of Planned Behavior (TPB) and Value-Belief-Norm (VBN) theory in modeling sustainability behavior. The evidence that subjective norms (β = 0.454, p < 0.001) and perceived behavioral control (β = 0.275, p < 0.001) are significant predictors underscores the relevance of combining social influence and perceived capability in predicting waste management practices. Moreover, the significant moderating effect of financial incentives on subjective norms and values, although limited in scope, highlights the potential of contextual stimuli to reinforce sustainable intentions.

The results highlight the centrality of subjective norms and perceived behavioral control in driving students' waste management practices, consistent with TPB predictions (Ajzen, 1991). This suggests that interventions on campus should not only foster pro-environmental attitudes but also ensure that students perceive waste practices as both feasible and socially expected. Strengthening peer influence through student clubs or ambassador programs may reinforce subjective norms, while improving the ease of waste disposal even at a basic operational level enhances perceived control.

At the same time, the insignificant effects of attitudes, personal norms, and beliefs do not imply that these constructs lack relevance. Instead, they may reflect the "behavior context gap" (Yuriev et al., 2020), whereby positive dispositions fail to materialize without supportive situational conditions. For TPB based interventions, this underlines the importance of addressing both cognitive predictors (values, attitudes, beliefs) and practical enablers (visible

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bins, routine prompts) to bridge the gap between intention and practice. By situating interventions within this combined framework, universities can strengthen the explanatory and predictive power of TPB in real-world campus contexts

In terms of practical implications, universities should focus on strengthening social norms such as developing peer-led campaigns and sustainability ambassador programs can encourage students to align their behaviors with group expectations. Integrating sustainability messages into student leadership and clubs can amplify the impact of subjective norms. Besides, to improve the waste management practice in the campus, it is recommended to improve perceived behavioral control. Campus administrators should prioritize the installation of visible, well-labeled, and accessible waste segregation facilities across academic and residential spaces. Training sessions, signage, and prompts could reinforce the sense of control among students.

Based on the findings, it is crucial for the university to reinforcing values-based education. Although values showed only marginal significance, educational programs that connect environmental behavior with personal and ethical values should be strengthened through curriculum integration and co-curricular activities. In addition to this, designing conditional incentive programs may be appropriate too. The results suggest that financial incentives alone are not strong predictors, but they can enhance behaviors when aligned with social influence and values. Reward systems tied to group participation, competitions, or redeemable eco-points may be more effective than individual cash-based rewards.

Conclusion

This study provides empirical evidence on the behavioral mechanisms shaping sustainable waste management practices in Malaysian higher education institutions through the integration of TPB and VBN frameworks. The prominence of subjective norms and perceived behavioral control highlights the importance of social influence and structural support in translating environmental awareness into action. While financial incentives demonstrate conditional effectiveness, the findings suggest that long-term sustainability is better strengthened through value-based education, peer engagement, and institutional governance strategies. From a social development perspective, the study underscores the need for universities to function not only as centers of academic excellence but also as agents of environmental stewardship and community responsibility. Future research may expand this framework across diverse educational and societal contexts to further enhance sustainable behavioral transformation at the national and regional levels.

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