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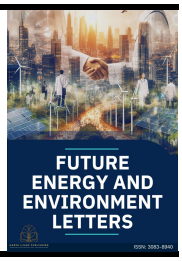

Exploring The E–Waste Recycling Intention among Students in Higher Education Institutions in Malaysia

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ABSTRACT

Electronic waste (e-waste) has become a rapidly growing environmental concern in Malaysia as increasing dependence on digital devices leads to high disposal rates and improper handling of discarded electronics. Despite various national initiatives to improve recycling systems, many higher education students still lack consistent recycling practices, reflecting gaps in awareness, accessibility, and behavioural motivation. Therefore, this research examines how the theory of planned behaviour (TPB) drives students' intention to recycle e-waste in Malaysian higher education institutions. Using a survey questionnaire of 384 higher education students, this research finds that TPB, specifically attitude, subjective norms and perceived behavioural control significantly drive students' intention to recycle e-waste. The results indicate that perceived behavioural control was the most influential driver, followed by subjective norms and attitude. It also highlights that students are more likely to engage in e-waste recycling when they feel confident and perceive support from their social circles. Increasing environmental awareness and integrating sustainability initiatives into campus activities are among the measures that can increase e-waste recycling among higher education students.

1. Introduction

The rapid advancement of technology and the increasing reliance on electronic devices have contributed to a significant rise in global electronic waste (e-waste), which has become one of the fastest-growing waste streams worldwide [1]. According to the *Global E-waste Monitor 2024*, the world generated a record 62 million tonnes of e-waste in 2022, and this figure is expected to rise to 82 million tonnes by 2030. Despite an increase in volume, the global documented formal collection and recycling rate of e-waste remains critically low at 22.3%, often leading to severe environmental pollution and health hazards due to toxic substances like lead and mercury.

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In the context of Malaysia, the scenario reflects the global crisis. As a developing nation with high digital adoption, Malaysia faces significant challenges, with increasing volumes of discarded electrical and electronic equipment resulting from shorter product lifecycles and high consumption rates. Despite the presence of formal recycling channels and registered e-waste collection centres, public participation in proper disposal remains low, leading to storage of unused devices at home and reliance on informal recycling practices that pose environmental and health risks [2].

Higher Education Institutions are critical stakeholders in this ecosystem. Students in higher education institutions are among the highest user groups of electronic devices such as mobile phones, laptops, and tablets. Research indicates that university students frequently upgrade their devices—such as smartphones, laptops, and tablets—leading to a high turnover rate of electronics [3]. Hence, their behaviour plays a crucial role in shaping future sustainability practices, yet studies indicate a gap between environmental awareness and actual recycling participation among youth [4,5]. Understanding the behavioural factors influencing their recycling intentions is therefore essential for strengthening Malaysia's e-waste management efforts.

The gap between awareness and action suggests that psychological and behavioural factors play a crucial role in determining recycling activities. Drawing on the Theory of Planned Behaviour (TPB), behavioural intention is shaped by three determinants: attitude, subjective norms, and perceived behavioural control [6]. Attitude reflects an individual's positive or negative evaluation of recycling, subjective norms refer to perceived social pressure from important others, and perceived behavioural control relates to one's confidence and ability to perform recycling. Prior studies highlight that these factors play significant roles in predicting recycling behaviour, particularly perceived behavioural control, which is influenced by knowledge, accessibility, and convenience of recycling facilities [7]. However, limited empirical evidence exists regarding how these determinants influence e-waste recycling intentions among Malaysian higher education students.

Therefore, this study aims to bridge this gap by examining the influence of attitude, subjective norms, and perceived behavioural control on students' intentions to recycle e-waste in Malaysian higher education institutions. Understanding these behavioural predictors may support the development of more effective recycling initiatives and enhance sustainability practices within academic environments. To achieve such an aim, this study addresses the following research question:

"What are the key determinants influencing the e-waste recycling intention among students in Higher Education Institutions (HEIs) in Malaysia?"

1.1 Attitude towards Malaysian Higher Education Students' Intentions to Recycle E-waste

Attitude refers to an individual's favourable or unfavourable evaluation of performing a behaviour. Within the Theory of Planned Behavior (TPB), attitudes are formed through beliefs about the expected outcomes of the behaviour and the value placed on these outcomes [8]. Fishbein and Ajzen, [9] explain that attitudes consist of affective (emotional) and cognitive (belief-based) components that influence how a person evaluates a behaviour. In the context of environmental studies, a positive attitude is consistently cited as a primary driver of pro-environmental intentions.

For e-waste recycling in Malaysia, recent empirical studies support this relationship. For instance, Afroz *et al.,* [10] found that attitude significantly influences the intention of Malaysian households to dispose of mobile phones properly, suggesting that when individuals perceive recycling as a beneficial and responsible act, their intention to participate increases. Similarly, a study conducted among students at a Malaysian public university by Mahat *et al*., [4] revealed a significant positive correlation between environmental attitude and recycling practices. Their findings indicate that students

generally possess a high level of environmental concern, which translates into a stronger intention to recycle when they are aware of the detrimental effects of improper e-waste disposal. Hence, the following hypothesis is proposed.

H1: *Attitude towards recycling has a positive influence on students' e-waste recycling intention.*

1.2 Subjective Norms towards Malaysian Higher Education Students' Intentions to Recycle E-waste

Subjective norms refer to the perceived social pressure to perform or not perform a behaviour. According to Ajzen, [8] subjective norms arise from normative beliefs about what important referent groups such as family, friends, and peers expect an individual to do. Fishbein and Ajzen, [9] further explain that these norms depend on one's motivation to comply with these expectations. Research shows that social influence plays a crucial role in recycling behaviour, particularly when environmental actions are encouraged by one's immediate social environment. Park and Smith, [11] distinguish between injunctive norms (what others think one should do) and descriptive norms (what others are actually doing), both of which influence behavioural intention. Rivis and Sheeran, [12] found that descriptive norms can sometimes have a stronger effect on intentions compared to injunctive norms. In Malaysia, Afroz *et al.*, [2] found that social networks have a significant impact on waste management behaviour, reinforcing the importance of subjective norms in recycling practices. Hence, the following hypothesis is proposed.

H2: *Subjective norms have a positive influence on students' e-waste recycling intention.*

1.3 Perceived Behaviour Control towards Malaysian Higher Education Students' Intentions to Recycle E-waste

Perceived behavioural control refers to an individual's perceived ability, resources, and opportunities to perform a behaviour. Ajzen [8] explains that perceived behavioural control represents the perceived ease or difficulty of performing a specific behaviour and is influenced by internal abilities and external constraints. Bandura's concept of self-efficacy complements this by explaining that individuals are more likely to carry out a behaviour if they believe they can successfully perform it [13]. Studies on recycling behaviour indicate that access to recycling facilities, convenience, and knowledge significantly enhance perceived control, which in turn increases intention to recycle e-waste. Previous research by Wang *et al*. and Kumar showed that clear procedures and available collection points strengthen individuals' perceived ability to carry out e-waste recycling [6,7]. Armitage and Conner, [14] further suggest that perceived behavioural control not only predicts intention but also directly predicts actual behaviour. Tucker and Speirs, [15] highlight that logistical barriers, such as limited facilities or unclear disposal processes, can reduce perceived control and discourage recycling. This is further supported by Baba-Nalikant and Satar, [3], who identified that the lack of proper collection channels at public universities serves as a major psychological barrier, lowering the perceived control and, consequently, the intention to recycle. Hence, the following hypothesis is proposed.

H3: *Perceived behavioral control has a positive influence on students' e-waste recycling intention.*

Based on the existing studies, the conceptual framework proposes the relationship between attitude, subjective norms, perceived behavioural control, and Malaysian higher education students' intentions to recycle e-waste as demonstrated in Figure 1.

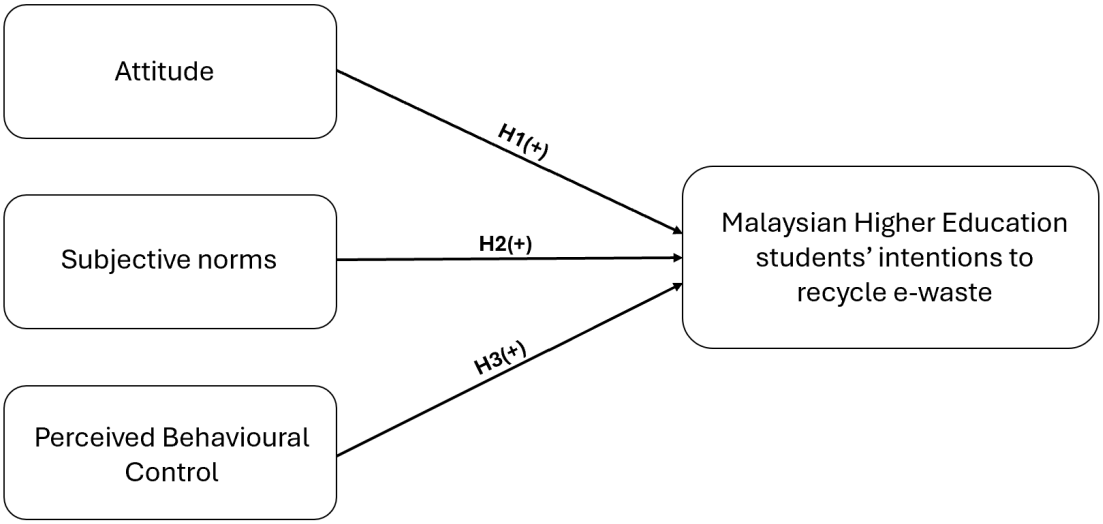

Fig. 1. Conceptual framework of the study

2. Methodology

In this study, a quantitative approach using a survey questionnaire was employed to test the conceptual framework and the developed hypotheses. The self-administered questionnaire had two sections. The first section asked about the respondents' demographic profile, while the second section contained questions about the constructs. All the measurement items of the constructs were adapted from previous literature (see Table 1). Attitude and subjective norms were measured by using seven items, whilst perceived behavioural control was measured by using eight items. All the constructs were adapted from Holland *et al*., [16] and measured on a five-point Likert-type scale between 1 (Strongly Disagree) - 5 (Strongly Agree), except that the attitude construct was measured on a five-point Likert scale ranging from Very Unpleasant to Very Pleasant. However, for the intention to recycle construct, five items were adapted from Forza, [17]. Prior to data collection, a pilot study was conducted to measure the reliability of the items.

Table 1
Instrumentation source

Variables	Number of Item	References
Attitude	7	[19]
Subjective norms	7	[19]
Perceived behaviour control	8	[19]
Intention to recycle e- Waste	5	[16]

The study was focused on students from higher education institutions in Malaysia; therefore, a simple random sampling was employed because it helps in the generalisation of the results. Hence, the questionnaires were circulated to students of public and private higher education institutions. The final sample comprised 403 valid responses as summarised in Table 2.

Table 2
Respondents' demographics (N = 403)

	Demographics	Frequency	Percent
Gender	Male	215	53.3
	Female	299	46.7
Age	20 - 24	182	45.2
	25 – 29	70	17.4
	30 - 34	58	14.4
	35 – 39	57	14.1
	Over 40	36	8.9
Higher education institution	Public university	185	45.9
	Institute of teacher education	64	15.9
	Polytechnic	63	15.6
	Community college	52	12.9
	Private higher education	39	9.7

3. Results

3.1 Reliability

Cronbach's alpha was employed to measure the internal consistency of the items. Referring to Nunnally (as cited in Forza, [17]), the threshold for alpha should be 0.7 or greater, with alpha ≥ 0.8 considered very reliable. Table 3 shows the reliability results for both the pilot and the main study, where all the values were higher than 0.8, indicating good reliability.

Table 3
Reliability results

Construct	No. of items	Cronbach's alpha (n = 30)	Cronbach's alpha (n = 403)
Attitude	7	0.84	0.81
Subjective norms	7	0.95	0.83
Perceived behavioural control	8	0.94	0.87
Intention to recycle e-waste	5	0.95	0.92

3.2 Descriptive Analyses

Table 4 presents descriptive analyses for four variables. Attitude scores had a mean of 4.19, showing that students' attitudes towards e-waste recycling were pleasant. The subjective norms mean (4.00) indicated that students perceived strong social pressure and encouragement from important people, such as family, peers, or community, to engage in e-waste recycling. The perceived behavioural control's mean was 3.88, suggesting that students perceived themselves as empowered and capable of making environmentally responsible choices. The standard deviation for all values was rather small. Values for skewness and kurtosis statistics must be within ± 1.0 to be considered normally distributed. Findings showed that skewness for attitude and perceived behavioural control constructs was normal. However, skewness for subjective norms (-1.06) and intention to recycle (-1.38) were moderately skewed. For kurtosis, all constructs were normally distributed, except the intention to recycle construct, which was moderately heavy tailed.

Table 4
Descriptive analyses for TPB constructs

	Attitude	Subjective norms	Perceived behavioural control	Intention to recycle e-waste
N	403			
Mean	4.19	4.00	3.88	4.10
Std deviation	0.59	0.71	0.76	0.82
Skewness	-0.95	-1.06	-0.78	-1.38
Kurtosis	0.14	0.98	0.75	1.6

3.3 Correlation

The correlation analysis explored the relationships between attitude, subjective norms, perceived behavioural control, and intention to recycle e-waste. Table 5 presents the correlation results of the study. Unlike the previous study, this study found that attitude ($r = 0.344$, $p < 0.001$) was positively correlated with e-waste recycling intention. Thus, H1 was accepted [18]. This finding was consistent with prior studies, that positive attitudes towards the environment and recycling shape the intention to recycle [19-21]. However, Kumar, [19] indicated that the relationship between attitude and recycling intention varies depending on 'sense of duty'.

As posited by H2, a significant relationship was found between subjective norms ($r = 0.429$, $p < 0.001$) and recycling intention. This showed that students were more likely to recycle e-waste when important people support or expect such action. A possible explanation is that the collectivist culture of Malaysians encourages students towards recycling intentions [22]. Subjective norms influence Malaysians' recycling intentions by reflecting social expectations from others about what is considered acceptable [20]. In contrast, Park and Ha, [23] found that the effect of subjective norms on recycling intention was indirect through attitude, personal norms, and perceived behavioural control. Moreover, La Rosa and Johnson Jorgensen's study showed that respondents' family and friends did not influence their intention to engage in sustainable behaviour [21]. Although subjective norms had an insignificant relationship with intention, the construct emerged as the most relevant determinant for disposal intentions [24,25]. This was in line with Ahmad *et al.*, [20] that subjective norms continue to be the most influential factor shaping recycling intention, especially in emerging economies like Malaysia.

Mirroring the findings of another survey conducted in Malaysia [20], perceived behavioural control ($r = 0.470$, $p < 0.001$) had the strongest positive relationship with e-waste recycling intention. Thus, H3 was accepted. While traditional TPB studies on general recycling (e.g., paper or plastic) often identify 'Attitude' as the primary predictor of intention, our findings reveal that for e-waste, PBC is the stronger determinant. This suggests a theoretical distinctiveness for 'high-effort' pro-environmental behaviors. It implies that in the context of Malaysian HEIs, students already possess the necessary pro-environmental attitude, but the translation of this attitude into intention is strictly gated by infrastructure accessibility and convenience. This result was consistent with a study of Malaysian school students that perceived behavioural control was the strongest predictor of recycling intention behaviour [24]. The result of the present study implies that students who perceived themselves as capable of recycling and believed they had access to the necessary resources were more likely to recycle e-waste [26]. It also suggests that students' beliefs regarding the ease or difficulty in recycling will determine their intention [26].

Table 5
Correlation results

		X1	X2	X3	Y
Attitude (X_1)	Pearson Correlation	1	0.365**	0.256**	0.344**
	Sig. (2-tailed)		<0.001	<0.001	<0.001
	N	403	403	403	403
Subjective Norms (X_2)	Pearson Correlation	0.365**	1	0.385**	0.429**
	Sig. (2-tailed)	<0.001		<0.001	<0.001
	N	403	403	403	403
Perceived Behaviour Control (X_3)	Pearson Correlation	0.256**	0.385**	1	0.470**
	Sig. (2-tailed)	<0.001	<0.001		<0.001
	N	403	403	403	403
Intention to Recyle E- Waste (Y)	Pearson Correlation	0.344**	0.429**	0.470**	1
	Sig. (2-tailed)	<0.001	<0.001	<0.001	
	N	403	403	403	403

** Correlation is significant at the 0.01 level (2-tailed)

4. Conclusions

To conclude, this study successfully identified the critical drivers of e-waste recycling intention among students in Malaysian higher education institutions. The findings confirm that attitude, subjective norms, and perceived behavioural control play pivotal roles in shaping students' willingness to participate in recycling programs. The results revealed that attitude had a positive but modest influence, suggesting that favourable views toward recycling alone are insufficient to strongly drive intention. Subjective norms showed a moderate relationship with intention, indicating that encouragement from peers, family, and educators meaningfully motivates students to recycle. The strongest effect came from perceived behavioural control, highlighting that students are most likely to intend to recycle when they feel confident, capable, and supported by accessible facilities and clear instructions.

Theoretically, this study contributes to the environmental behaviour literature by confirming that the standard TPB constructs are relevant in the Malaysian educational context. This study also provides a critical theoretical extension to the Theory of Planned Behavior by identifying the dominant role of Perceived Behavioural Control in the context of e-waste recycling. Practically, the results highlighted the necessity for university policymakers to reassess current strategies. Facilitating the transition from intention to action necessitates a tangible investment in user-friendly e-waste facilities and a simplified recycling process. Our findings indicate that Perceived Behavioural Control (PBC) is the strongest predictor of e-waste recycling intention, suggesting that students are already motivated to recycle but are hindered by logistical barriers. Therefore, relying solely on awareness campaigns is insufficient. University administrators should focus more on structural interventions to improve convenience, i.e., infrastructure expansion to increase the density of e-waste collection points in high-traffic areas (e.g., cafeterias, dormitories) to reduce the effort required for disposal and simplify the process of e-waste recycling.

Limitations of this study include the focus solely on student populations and self-reported intentions. Hence, there is a potential for social desirability bias. Given that e-waste recycling is viewed as a pro-social behavior, respondents may have overstated their recycling intentions to align with perceived social norms. Furthermore, the study models behavioural intention as the ultimate dependent variable, without extending to the measurement of actual recycling behaviour. According to the TPB framework, a significant intention-behavior gap often exists, particularly when PBC is the dominant predictor. Since our results indicate that structural barriers (PBC) are high, theoretical models suggest that high intention may not translate into action. Future research should therefore employ longitudinal designs to measure actual recycling behavior, specifically testing if high PBC scores successfully moderate the conversion of intention into action over time."

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