e-ISSN: 2550-1569

Available online at
https://myjms.mohe.gov.my/index.php/IJSMS

International Journal of Service Management and Sustainability
10(2) 2025, 186 – 204.

International Journal of Service Management and Sustainability (IJSMSust)

Factors Influencing Malaysians' Intention to Participate in E-Waste Recycling

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ARTICLE INFO

Article history:
Received 03 February 2025
Revised 22 August 2025
Accepted 27 August 2025
Online first
Published 30 September 2025

Keywords:
Mobile e-waste
TPB
PLS-SEM
Recycling
Behaviour intention

DOI: 10.24191/ijsms.v10i2.24234

Citation in APA:
Ahmad, I. A. Z., Elgharbawy, A. A. M., Azam, M. S., Ahmad, A. N., Abd Aziz, A. F., Samsudin, N., Wan Sulaiman, W. S. H. & Nordin, N. F. H. (2025). Factors influencing Malaysians' intention to participate in e-waste recycling. *International Journal of Service Management and Sustainability, 10*(2), 186 – 204.

ABSTRACT

The rapid increase in mobile e-waste generation in Malaysia is seen to present significant environmental and health challenges. The factors influencing Malaysians' intentions to engage in mobile e-waste recycling are explored through the lens of the Theory of Planned Behaviour (TPB). The impact of attitudes, subjective norms, perceived behavioural control, environmental concern, perceived convenience, social media use, and knowledge about e-waste recycling on recycling intentions is examined. Data were collected from a survey of 552 Malaysian mobile e-waste users and analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM). The results indicate that attitudes, subjective norms, perceived behavioural control, and environmental concern have a significant impact on e-waste recycling intentions. Perceived convenience, knowledge, and social media about e-waste recycling use do not significantly affect recycling intentions. The study extends the TPB model by integrating additional factors and offers empirical evidence on their influence on e-waste recycling behaviour. Policymakers and organisations can use these findings to design targeted interventions that encourage responsible e-waste disposal practices. Future research should examine how demographic factors moderate these effects and explore the role of other psychological constructs in shaping recycling behaviour.

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1.0 INTRODUCTION

In today's world, technology is deeply embedded in people's lives. Electronic devices have become a necessary part of our daily routines, whether in the kitchen or the bedroom, from smartphone alarms that wake us up to gadgets that surround us as we fall asleep. They play a significant role in enhancing living standards globally and are used extensively in various aspects of life (Khuzaimah et al., 2020). While electronic devices offer undeniable benefits, they also pose substantial challenges. The growing demand for electronic and electrical equipment, short product life cycles, and limited repair options primarily drive the increasing volume of e-waste when these devices become obsolete (Forti et al., 2020). E-waste encompasses a broad range of electrical and electronic equipment (EEE), along with its components, that have been discarded as waste with no intention of reuse (Shad et al., 2020).

According to the Global E-waste Monitor 2020, global electronic waste has increased by 21% since 2014, reaching 53.6 million metric tonnes in 2019. However, only 17.4% of this waste was formally collected and recycled. This surge in electronic consumption increases e-waste generation, which presents significant challenges related to its proper disposal and recycling (Bag et al., 2022). Previous studies have well-documented the impact of such improper disposal practices by highlighting severe environmental consequences such as soil and water pollution, and the release of toxic substances into the air (Jaibee et al., 2014). Improper disposal of e-waste also leads to the loss of valuable resources, as electronic devices contain precious metals and rare earth elements that can be recovered and reused (Changwichan et al., 2018). This loss of valuable resources contributes to a waste of economic potential and strains the country's financial resources (Ankit et al., 2021).

Malaysia faces similar challenges with the rapid increase in e-waste generation. The Department of Environment of Malaysia (DOE) projects that Malaysia will generate 24.5 million units of e-waste by 2025. To manage this growing concern, the DOE Malaysia regulates e-waste under the Environmental Quality (Scheduled Wastes) Regulations 2005 and the Environmental Quality Act 1974. The DOE classifies e-waste as Scheduled Wastes under Code SW110. In Malaysia, e-waste is divided into two types based on its source of industrial e-waste, generated from industrial sectors, and household e-waste, which comes from everyday consumer electronics. Under these legislations, only e-waste generated from industrial sources is regulated, while e-waste from households is not subject to enforcement. This regulatory gap often leads to improper or unsafe disposal of household e-waste, which frequently ends up in landfills or unregulated disposal sites, posing potential health and environmental risks to humans, animals, and natural habitats (DOE, 2024).

The legislative framework for household e-waste in Malaysia is still developing, yet this sector significantly contributes to the country's e-waste generation. According to the DOE statistics, 2,459 tonnes of household e-waste were collected in 2021, with televisions, laptops, and mobile phones being the top three items (DOE, 2024). To develop effective policies and legislation for the household e-waste sector, it is crucial to understand the stakeholders involved. One of the most important stakeholders is the consumer, whom the DOE refers to as the ‘generator’ of e-waste. The household e-waste management system requires consumers to dispose of their e-waste through formal collection channels, such as authorised collectors, collection centres, or by returning the e-waste to retailers. Consumers are also encouraged to extend the lifespan of their electronic devices and to repair them whenever possible before disposing of them. However, since there is no enforcement in this sector, the success of this e-waste management process depends largely on consumers' awareness and intention to follow these practices.

1.1 Problem Statement

The rapid increase in smartphone adoption in Malaysia, growing from a mere 14% in 2010 to 94.8% by 2021, has significantly contributed to a surge in mobile e-waste generation (Bag et al., 2022; MCMC, 2021). Government agencies such as the Department of Environment (DOE) and the Malaysian Communications and Multimedia Commission (MCMC) have initiated policies and campaigns to address

this growing concern. For instance, although there is no enforcement on individual consumers, the DOE encourages Malaysians to dispose of their household e-waste at registered collection centres or recovery facilities licensed by the DOE. The MCMC launched the "KITAR: Peranti Lama, Nafas Baharu" campaign in 2015 to promote the environmentally responsible disposal and recycling of end-of-life mobile devices (Agamuthu & Barasarathi, 2021). In 2022, this initiative was rebranded as "KITAR" to align with ITU's Resolution 79 on e-waste management and to complement the DOE's efforts in household e-waste management in Malaysia (Agamuthu & Barasarathi, 2021; Jaibee et al., 2014). Despite such initiatives, managing this e-waste presents significant challenges due to the short lifespan of smartphones, which is caused by factors like physical damage and rapid technological advancements. These factors make devices obsolete quickly, leading to frequent replacements (Bag et al., 2022). The situation is further exacerbated by inadequate management practices and inadequate recycling infrastructure (Bag et al., 2022; Jain et al., 2023). Consequently, a formidable challenge arises in managing the aftermath of their usage, particularly in relation to the proper disposal and recycling of electronic devices, often laden with hazardous materials such as lead, cadmium, and mercury, which are detrimental to both human health and the environment (Jaibee et al., 2014; Razali et al., 2019), not to mention the waste of precious metals that are available in the e-waste.

In Malaysia, e-waste management is still in its early stages, particularly regarding recycling systems. The primary issue pertaining to e-waste within the country is the suboptimal disposition of Malaysians towards e-waste recycling (Mahat et al., 2019). Since many Malaysian consumers are both end-users of mobile technology and the generators of this e-waste, a comprehensive understanding of consumer behaviours and perceptions, particularly concerning e-waste recycling, is essential for targeted research and interventions (Bag et al., 2022). Such understanding will enable the government or organisations to develop effective strategies to mitigate the adverse effects of e-waste and promote sustainable practices in Malaysia. Therefore, this paper aims to focus on the intricacies of consumer behaviour, specifically investigating the factors that influence Malaysian's intentions to engage in mobile e-waste recycling (Bag et al., 2022). While previous studies have examined e-waste in Malaysia, this research offers two unique contributions. First, it presents a comprehensive model testing seven distinct factors simultaneously, providing a holistic view of the drivers of mobile e-waste recycling intentions. Second, using recent data, it captures current consumer perspectives in a rapidly evolving digital landscape.

1.2 Theoretical Framework

The Theory of Planned Behaviour (TPB) stands as one of the most widely applied theories to understand and predict human behaviour. This theory is widely utilised to predict individual behaviour and decision-making processes in various contexts such as business, environmental science, management, psychology, hospitality, and many more (Bosnjak et al., 2020; Mendelson et al., 2023; Zhang et al., 2023). The main principle of the theory is that a person's behavioural intention is influenced by their attitude towards the behaviour, subjective norms, and perceived behavioural control (Ajzen, 2019). Attitudes towards behaviour are shaped from behavioural beliefs, which are perceptions about the outcomes of a behaviour and the experiences associated with it. When someone believes that the behaviour will lead to positive outcomes, they are likely to have a positive attitude towards the behaviour and vice versa. Meanwhile, subjective norms are derived from normative beliefs, which reflect the expectations of significant others such as family, friends, or society. These norms indicate the level of social pressure a person feels to engage in or avoid a behaviour. Perceived behavioural control is based on control belief, which involves factors that can either facilitate or hinder the execution of the behaviour. These beliefs shape a person's perceived behavioural control and reflect their self-efficacy and confidence about their ability to perform the behaviour.

The Theory of Planned Behaviour (TPB) is a flexible framework that allows for the inclusion of other constructs or variables beyond its basic components (Ajzen, 2019; Tonglet et al., 2004). Researchers often expand the model to capture a more understanding of factors influencing behaviour. In the context of e-waste disposal and recycling, many studies have applied the extended version of TPB by adding variables

such as habit, awareness, and perceived convenience to better explain the influences on individuals' recycling behaviours (Coşkun & Özbük, 2020; Tonglet et al., 2004; Vijayan et al., 2023). Some researchers combine the TPB model with other frameworks, such as the Norm-Activation Model (NAM) and Value-Belief-Norm, to understand people's behavioural intention regarding e-waste recycling (Michael et al., 2024).

This research utilises the Theory of Planned Behaviour (TPB) as its framework. Additionally, it incorporates extra constructs to provide a more comprehensive understanding of the factors influencing Malaysian consumers' intentions and participation in recycling initiatives. Figure 1 illustrates the research framework of this study, followed by the hypotheses and their details.

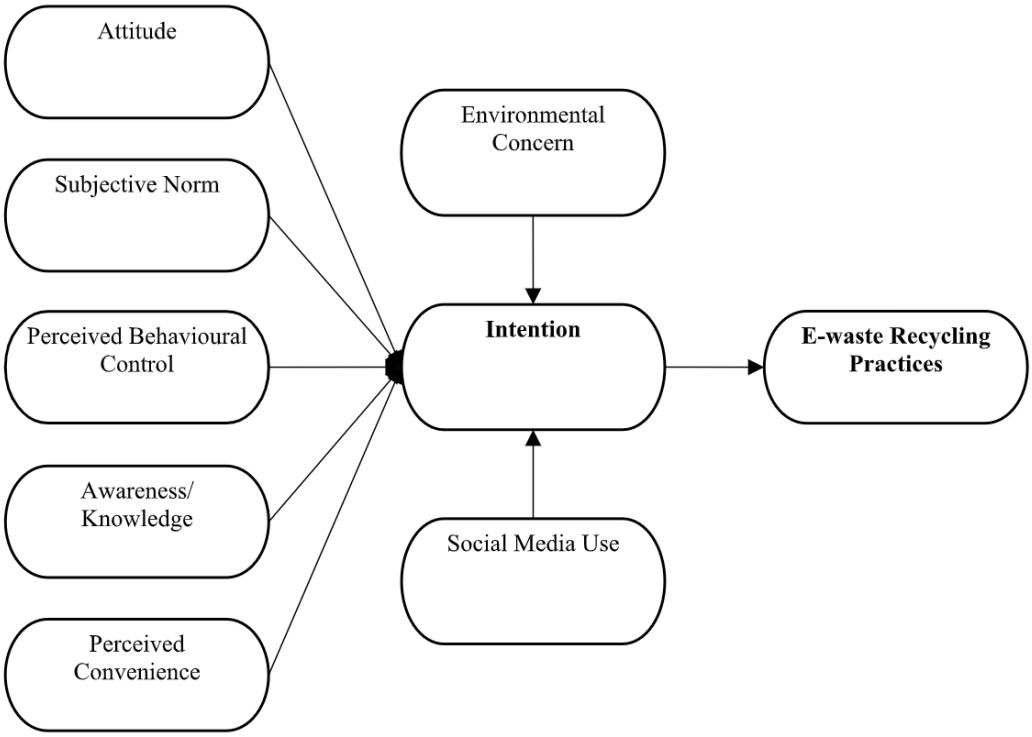

Fig 1. Structural Model of the Study Showing the Relationships Between Factors, Intention, and Recycling Practices

Attitude refers to the degree to which a person evaluates recycling behaviours positively or negatively. Attitudes are recognised as significant predictors of intentions to engage in e-waste recycling behaviour (Chang et al., 2023; Najmi et al., 2022; Thukral et al., 2023; Van der Werf et al., 2019). Studies of the general public and households in Malaysia have demonstrated that positive attitudes are significantly related to the intention to engage in e-waste recycling (Afroz et al., 2020; Nadarajan et al., 2023; Sujata et al., 2019). These findings support the hypothesis of this study that a positive attitude towards mobile e-waste recycling is likely to result in a stronger intention to recycle (Sabbir et al., 2023). Therefore, below is the first hypothesis:

H1. Attitude towards mobile e-waste recycling has a significant positive relationship with the intention to perform mobile e-waste recycling in Malaysia.

Studies indicate that subjective norms significantly influence consumers' intentions towards e-waste recycling (Kumar, 2019; Nadarajan et al., 2023; Sabbir et al., 2023). Nadarajan et al. (2023) found that subjective norms impact e-waste recycling intentions among the Malaysian public, indicating that people

are more likely to recycle when they are pressured by their surroundings and important people in their lives. Therefore, if an individual's social circle supports and encourages e-waste recycling, this will increase their intention to recycle. Conversely, if the social circle views recycling negatively or does not support it, the individual's intention to recycle may decrease. Therefore, the second hypothesis proposed is:

H2. Subjective norms have a significant positive relationship with the intention to perform mobile e-waste recycling in Malaysia.

Perceived behaviour control (PBC) covers perceptions of how easy or difficult it is to perform the behaviour, considering factors such as the accessibility of recycling facilities and the availability of necessary resources. For instance, when individuals view the recycling process as manageable and within their capabilities, their intention to engage in recycling increases. PBC has a positive effect on e-waste recycling intentions and behaviours, reflecting an individual's confidence in their ability to perform the behaviour. However, this relationship is not always straightforward. Some studies report that the link between PBC and recycling intentions is weak or context dependent. This is often because PBC's influence is moderated by external factors such as the perceived cost of recycling or the actual availability of government-supported infrastructure (Ofori & Mensah, 2022; Sari et al., 2021). For example, Sari et al. (2021) found that perceived behavioural control did not have a significant direct effect on consumer intentions. Instead, it has a significant indirect effect through government drivers, which mediated the relationship between PBC and consumer intention. Despite this, PBC is a crucial element within the TPB model for understanding and promoting e-waste recycling behaviour. Hence, this study proposes the following hypothesis:

H3. Perceived behavioural control over mobile e-waste recycling has a significant positive relationship with the intention to perform mobile e-waste recycling in Malaysia.

Previous studies indicate that environmental concern has a direct influence on recycling intention (Chang et al., 2023; Nadarajan et al., 2023). Individuals who are concerned about environmental preservation are more likely to engage in behaviours that support environmental sustainability, such as recycling. This is likely because they recognise the harmful consequences of improper e-waste disposal, making them more responsible and mindful of environmental sustainability (Ofori & Mensah, 2022; Sabbir et al., 2023). Consequently, higher levels of environmental concern typically lead to a stronger intention to recycle e-waste, driven by a commitment to reducing environmental harm and promoting sustainability (Nadarajan et al., 2023). Hence, this study hypothesises that:

H4. Environmental concern has a significant positive relationship with the intention to perform mobile e-waste recycling in Malaysia

Perceived convenience is a key factor influencing e-waste recycling intentions and behaviour. Research indicates that consumers are more likely to engage in e-waste recycling when recycling options are convenient and accessible (Nadarajan et al., 2023; Thukral et al., 2023). Factors such as facility accessibility (ease of access and short distance within the community), infrastructure development, and effective e-waste recycling systems and services enhance the consumers' perceived convenience of e-waste recycling (Afroz et al., 2020; Nadarajan et al., 2023; Sari et al., 2021; Thukral et al., 2023; Wang et al., 2018). Therefore, studies showed that the easier and more convenient the recycling process is perceived to be, the stronger the intention to engage in recycling behaviours. Therefore, this study hypothesises that:

H5. Perceived convenience of mobile e-waste recycling has a significant positive relationship with the intention to perform mobile e-waste recycling in Malaysia.

The latest definition of social media refers to any online resource designed to facilitate engagement between individuals (Aichner et al., 2021). Social media covers a variety of platforms, each with distinct functions and applications. Consequently, the purposes and perceived value of social media can vary widely among different platforms and users, such as for socialising, building relationships, business, and brand awareness (Aichner et al., 2021). Similarly, social media can be used to influence recycling behaviour by

raising awareness about e-waste recycling practices. Studies of e-waste recycling intention in Malaysia found that social media usage significantly and positively influences consumers' intentions to recycle (Nadarajan et al., 2023; Sujata et al., 2019). This suggests that social media platforms can effectively raise awareness about e-waste recycling and facilitate the dissemination of information regarding recycling processes, benefits, and available facilities. Therefore, the hypothesis is:

H6. Social media use related to environmental issues has a significant positive relationship with the intention to perform mobile e-waste recycling in Malaysia.

Knowledge plays a critical role in enhancing e-waste recycling rates. Several studies emphasised that a high level of consumer awareness about e-waste and recycling programmes is important to increase their e-waste disposal rates (Borthakur & Govind, 2019; Thukral et al., 2023; Vijayan et al., 2023). For instance, Wang et al. (2018) demonstrated that understanding how and where to recycle e-waste boosts participation in recycling efforts. Thus, it is crucial for consumers to be well-informed about recycling methods, the types of products to recycle, and other related details to enhance recycling rates. Studies also indicate that a lack of knowledge about e-waste recycling poses a significant barrier to the effectiveness of e-waste management. Many consumers are unaware of the proper channels for e-waste disposal, which can lead to e-waste being stored at home or disposed of through informal means, potentially causing environmental damage and health risks (Kumar, 2019; Nanath & Kumar, 2021). Therefore, increased knowledge about e-waste and its recycling processes is expected to positively influence individuals' intentions to engage in recycling. As awareness about the benefits and procedures of e-waste recycling grows, individuals are likely to be more motivated to participate in recycling efforts. Hence, the hypothesis of this study is as below:

H7: Knowledge about mobile e-waste recycling has a significant positive relationship with the intention to perform mobile e-waste recycling in Malaysia.

2.0 METHODOLOGY

2.1 Sample and Data Collection

This study employed quota convenience sampling as the primary data collection method. Structured surveys were administered to urban and rural e-mobile users in Malaysia, with respondents recruited through both online and offline channels. The survey successfully achieved a sample size of 552 within a limited timeframe. It was deemed sufficient for further analysis based on prior studies, which recommend minimum sample sizes of 200 (Kline, 2016) and 400 (Hair et al., 2017) for Structural Equation Modelling (SEM) analyses. The quota sampling distribution of 71% urban and 29% rural respondents is justified, as it aligns closely with the demographic distribution of the Malaysian population of 75.1% urban and 24.9% rural (Department of Statistics Malaysia, 2024). All respondents were informed of the study's purpose and assured of anonymity and confidentiality.

2.2 Measures

The items for the structured survey questionnaire were adapted from previous studies of TPB and other studies on extended constructs. Respondents were asked to provide demographic information and respond to the following constructs: 1) Behaviour (four items) (Darby & Obara, 2005; Nguyen et al., 2018), 2) Intention (four items) (Rakhmawati et al., 2023), 3) Attitude (five items) (Rakhmawati et al., 2023), 4) Subjective Norm (five items) (Nguyen et al., 2018; Wan et al., 2017), 5) Perceived Behavioural Control (four items) (Rakhmawati et al., 2023), 6) Knowledge (four items) (Fan et al., 2019), 7) Environmental Concerns (four items) (Tarrant & Cordell, 1997), 8) Social Media Usage (three items) (Sujata et al., 2019), 9) Perceived Convenience (four items) (Kochan et al., 2016; Wan et al., 2012). Each item was measured using a five-point Likert scale, ranging from 1 as Strongly Disagree to 5 as Strongly Agree.

2.3 Data Analysis

Partial Least Squares Structural Equation Modelling (PLS-SEM) was employed in this study using SMARTPLS software to evaluate both the measurement and structural models. Following the two-step approach outlined by Henseler et al. (2009), the measurement model was assessed, followed by the analysis of the structural model for hypothesis testing. The measurement model was assessed through Confirmatory Factor Analysis (CFA), which involved examining internal consistency reliability, convergent validity, and discriminant validity. The Standardised Root Mean Square Residual (SRMR) index was used to assess model fit, with a value below 0.08 considered acceptable (Henseler et al., 2009). Subsequently, the structural model was analysed by reviewing the standard path coefficients. Statistical significance was assessed using a one-tailed test with a p-value threshold of less than 0.05.

3.0 RESULTS

3.1 Demographic Profile

The demographic of respondents is presented in Table 1. The majority of respondents fall within the younger age brackets, particularly between 20-29 years. Females constituted a larger proportion of respondents compared to males. Education levels among respondents were notably high, with over three-quarters having attained a first degree or equivalent qualification, indicating a well-educated sample in this study. In terms of income, a considerable portion of respondents fell within the lower to middle-income brackets, with a significant percentage reporting income below RM3,000. Additionally, the survey captured a diverse range of occupations, with a substantial proportion being students or employed individuals. This reflects varied socioeconomic backgrounds and lifestyles among respondents. Family size varied widely, with single individuals and small to medium-sized families comprising the majority of respondents. Finally, the location distribution of respondents (71.5% urban and 28.5% rural) reflects the latest population census by DOSM.

Table 1. Demographic statistics of respondents

Demographics		Frequency	Percent (%)
1.	**Age**		
	Below 20 years	26	5.0
	20-29 years	232	44.4
	30-39 years	129	24.7
	40-49 years	84	16.1
	50 years and above	51	9.8
	Below 20 years	26	5.0
2.	**Gender**		
	Male	148	28.4
	Female	369	70.7
	Prefer not to say	5	1.0
3.	**Education**		
	Non-formal education	2	.4
	Primary school	1	.2
	Secondary	30	5.7
	Diploma	90	17.2
	First degree/equivalent	269	51.5
	Postgraduate	129	24.7
	Other	1	.2
4.	**Income**		
	Below RM1,000	102	19.5
	RM1,000 to RM2,999	91	17.4
	RM3,000 to RM4,999	77	14.8

Demographics		Frequency	Percent (%)
	RM5,000 to RM7,999	90	17.2
	RM8,000 to RM10,999	76	14.6
	RM11,000 to RM14,999	39	7.5
	RM15,000 to RM19,999	23	4.4
	RM20,000 and above	18	3.4
5.	**Occupation**		
	Student	192	36.8
	Employed (Government/Private)	240	46.0
	Retired	7	1.3
	Unemployed	20	3.8
	Housewife	22	4.2
	Volunteer	3	.6
	Self-employed	31	5.9
	Other	7	1.3
6.	**Family size**		
	Single	183	35.1
	Couple without children	37	7.1
	Small family (family with 1 or 2 children)	103	19.7
	Medium family (3 or 4 children)	115	22.0
	Large family (5 or more children)	84	16.1
7.	**Location**		
	Urban	373	71.5
	Rural	149	28.5

3.2 Measurement Model Assessment

The Confirmatory Factor Analysis (CFA) results showed an SRMR of 0.098, which is slightly above the 0.08 threshold but still indicates an acceptable fit (Henseler et al., 2015). In PLS-SEM, such deviation is not critical, as the focus lies on explained variance and predictive power rather than global fit indices (Hair et al., 2022). The details of the measurement model assessment are presented in Table 2. Internal consistency and reliability of the constructs were assessed using Cronbach's alpha scores and composite reliability (CR). According to Hair et al. (2017), Cronbach's alpha scores greater than 0.7 indicate strong internal consistency, while a composite reliability (CR) of 0.7 or higher signifies good construct reliability. The findings reveal high levels of internal consistency and construct reliability across all measured variables. Cronbach's alpha coefficients range from 0.780 to 0.950, exceeding the generally accepted threshold of 0.7 (Hair et al., 2017; Kline, 2016), thus confirming robust reliability. Furthermore, the composite reliability values, ranging from 0.743 to 0.949, further confirm the consistency of the measured constructs. Next is convergent validity (CV). CV is established when AVE values exceed 0.5 and are less than the CR (Fornell & Larcker, 1981). In this study, the average variance extracted (AVE) values for all constructs, ranging from 0.477 to 0.810, exceed the recommended threshold of 0.5 (Hair et al., 2017), indicating satisfactory convergent validity. Discriminant validity was assessed by the Heterotrait–Monotrait ratio of correlations (HTMT), with values remaining below 0.85 (Henseler et al., 2015). Table 3 shows that all values in the HTMT matrix were indeed below this threshold, thereby establishing the discriminant validity of all constructs.

3.3 Structural Model Assessment

The structural model outlines the hypothesised pathways between constructs within the research framework. It was constructed and assessed using a bias-corrected bootstrapping technique with 5,000 replications to determine the significance of the path coefficients. The results of the analysis are presented in Table 4.

Table 2. The measurement model assessment

Variables	Items	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Attitude (At)	5	0.950	0.949	0.789
Subjective Norms (SN)	5	0.856	0.854	0.543
Perceived Behavioural Control (PBC)	4	0.813	0.816	0.531
Environmental Concern (EC)	4	0.780	0.768	0.477
Knowledge (Knw)	4	0.924	0.923	0.751
Perceived convenience (PC)	4	0.845	0.743	0.490
Social Media Use (SMU)	3	0.927	0.927	0.810
Intention (In)	4	0.934	0.934	0.781
Recycling Practices	4	0.798	0.805	0.590

Table 3. HTMT values

	A	EC	I	K	PBC	PC	RP	SMU	SN
Attitude									
Environmental Concern	0.120								
Intention	0.476	0.379							
Knowledge	0.075	0.682	0.420						
PBC	0.305	0.552	0.558	0.693					
Perceived convenience	0.060	0.086	0.120	0.149	0.200				
Recycling Practices	0.134	0.603	0.579	0.692	0.613	0.154			
Social Media Use	0.046	0.739	0.244	0.555	0.467	0.039	0.493		
Subjective Norms	0.433	0.560	0.638	0.577	0.702	0.068	0.561	0.405	

*A: Attitude, EC: Environmental concern, I: Intention, K: Knowledge, PBC: Perceived behaviour control, PC: Perceived convenience, RP: Recycling practices, SMU: Social media use, SN: Subjective norms

The analysis of the structural model reveals varied relationships between the factors influencing e-waste recycling intentions. Results indicate a strong and significant positive relationship between attitude towards e-waste recycling and intention to recycle ($T = 6.947$, $p = 0.000$), suggesting a higher level of favourable attitude is associated with a stronger intention to engage in e-waste recycling practices. Similarly, a significant positive relationship is found between subjective norms and intention to participate in mobile e-waste recycling initiatives among Malaysian users ($T = 5.857$, $p = 0.000$). This finding implies that subjective norms, such as perceived social pressure or influence, play a significant role in shaping individuals' intentions regarding e-waste recycling, indicating the importance of social factors in driving behavioural intentions related to e-waste management. Perceived behavioural control (PBC) reveals a moderate and significant positive relationship with intention ($T = 2.861$, $p = 0.004$), highlighting that greater perceived control enhances individuals' e-waste recycling intentions. Environmental concern also shows a moderate and significant positive relationship with e-waste recycling intention ($T = 2.217$, $p = 0.027$), suggesting that higher levels of environmental concern lead to stronger intentions to participate in e-waste recycling. In contrast, knowledge about e-waste recycling shows a weak and non-significant relationship with recycling intention ($T = 1.397$, $p = 0.162$), depicting that the level of knowledge does not significantly influence individuals' intentions to engage in e-waste recycling. Perceived convenience shows a weak and marginally significant relationship with recycling intention ($T = 1.842$, $p = 0.066$). While there is a tendency for perceived convenience to influence intention, the relationship is not statistically robust. Social media use indicates a weak and non-significant relationship with intention to recycle e-waste ($T = 0.649$, $p = 0.516$), suggesting that social media usage does not significantly influence individuals' intentions to engage in e-waste recycling practices. Finally, a strong and significant positive relationship is observed between intention to recycle e-waste and actual recycling practices ($T = 14.810$, $p = 0.000$), highlighting that higher recycling intentions are associated with an increased likelihood of participating in recycling activities.

Table 4. Structural model assessment

	Sample Mean (M)	Standard Deviation (STDEV)	T-Statistics	P-Values
Attitude --> Intention	0.274	0.039	6.947	0.000***
Environmental Concern --> Intention	0.119	0.052	2.217	0.027**
Intention --> Recycling Practices	0.519	0.035	14.810	0.000***
Knowledge --> Intention	0.071	0.052	1.397	0.162
PBC --> Intention	0.144	0.051	2.861	0.004***
Perceived convenience --> Intention	-0.073	0.037	1.842	0.066
Social Media Use --> Intention	-0.033	0.051	0.649	0.516
Subjective Norms --> Intention	0.301	0.051	5.857	0.000***

***p < 0.01; **p < 0.05

3.4 Model Fit Analysis

The structural model of the study is illustrated in Figure 2, which shows the outer loadings, path coefficients, and R-square values. The model fit statistics, as presented in Table 5, indicate a moderate to strong fit for the structural equation model. The R-squared value for intention is 0.440, suggesting that 44 per cent of the variance in intention to participate in mobile e-waste recycling initiatives is explained by the model. For recycling practices, the R-squared value is 0.268, indicating that 26.8 per cent of the variance in actual recycling behaviours is accounted for by the model. Additionally, the Standardised Root Mean Square Residual (SRMR) for the model is 0.098, which falls within an acceptable range, indicating a good fit between the observed and predicted covariance matrices. Overall, these fit statistics suggest that the model adequately represents the relationships between the variables, providing valuable insights into the factors influencing intentions and behaviours related to mobile e-waste recycling.

Table 5. Model fit statistics

Dependent Variables	R Square	SRMR
Intention	0.440	0.098
Recycling Practices	0.268	

4.0 DISCUSSION

The results demonstrate that attitudes have a significant and positive influence on Malaysians' intentions to participate in mobile e-waste recycling (H1). This result is consistent with previous studies that identified attitude as a critical factor influencing mobile e-waste recycling behaviour (Afroz et al., 2020; Chang et al., 2023; Najmi et al., 2022; Sabbir et al., 2023; Sujata et al., 2019). One possible explanation for this result is the high level of education among the respondents, with over three-quarters possessing at least a first degree or its equivalent. This is consistent with Sujata et al. (2019), which suggests that individuals with higher educational attainment are more likely to have favourable attitudes towards recycling. Such individuals are generally better informed about the importance of recycling and its positive outcomes of environmental protection, resource conservation, and potential economic advantages. Understanding the general public's attitudes towards e-waste recycling enables policymakers to identify prevailing biases and misconceptions. Such insights facilitate the development of targeted information campaigns that address these specific concerns. For instance, if research indicates that a community perceives e-waste recycling as inconvenient, policy interventions can be designed to enhance accessibility by increasing the number of recycling points and streamlining the recycling procedures (Afroz et al., 2020). In this study, the intervention should focus on improving the attitude of Malaysians towards e-waste recycling.

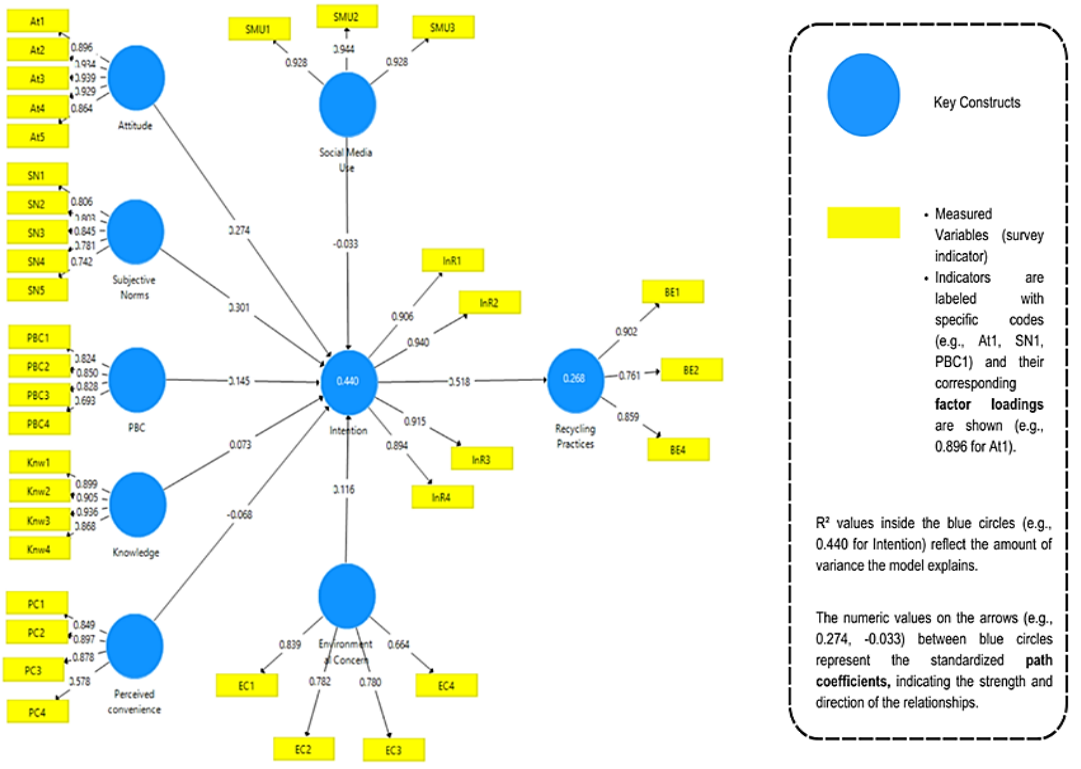

Fig 2. Path coefficient of the structural model assessment

The results of the study indicate that subjective norms significantly affect Malaysian individuals' intentions to engage in mobile e-waste recycling. This outcome is aligned with previous research showing that subjective norms play a significant role in shaping individuals' intentions regarding e-waste recycling (Kumar, 2019; Mohamad & Chin, 2020; Nadarajan et al., 2023; Ramzan et al., 2021; Sari et al., 2021; Sujata et al., 2019; Thukral et al., 2023; Wang et al., 2018). This finding underscores the importance of social factors in driving behavioural intentions related to e-waste management. Subjective norms significantly influence individuals' recycling behaviours by shaping perceptions of what is socially acceptable and responsible. Policymakers, authorities, and stakeholders, including mobile companies, can strategically leverage social influence to promote e-waste recycling programmes and foster social norm activities (Chang et al., 2023; Chathuri et al., 2024; Sabbir et al., 2023). Disseminating information about e-waste recycling through community campaigns and endorsements from influential figures can enhance communal understanding of the importance and benefits of responsible e-waste disposal (Chathuri et al., 2024). Such efforts can shape social norms by establishing recycling as an expected and accepted behaviour within the community.

As with other studies on recycling electronic waste that have shown the importance of perceived behaviour control (PBC) (Kumar, 2019; Nadarajan et al., 2023; Najmi et al., 2022; Sabbir et al., 2023), the results showed that PBC has a significant effect on recycling intention. However, the impact of PBC can vary based on how it is defined and measured. For example, a study in Malaysia examining e-waste recycling using collection boxes found that when perceived behavioural control (PBC) was defined as the perceived cost of using the recycling infrastructure, it did not have a significant impact on people's intentions to recycle. However, when perceived behavioural control (PBC) is measured based on the convenience of the recycling infrastructure, studies have found a significant positive relationship with the intention to recycle e-waste (Afroz et al., 2020). By highlighting the specific aspects of PBC, the study can uncover more detailed relationships between PBC and people's intentions to engage in e-waste recycling.

The study shows that environmental concern significantly impacts people's intention to recycle e-waste. This finding aligns with results from previous studies (Chang et al., 2023; Nadarajan et al., 2023), which similarly demonstrate that heightened environmental concern drives more proactive recycling behaviours. To understand the relationship between environmental concerns and the intention to recycle e-waste, researchers often employed variables from the TPB framework. Studies indicate that environmental concerns can affect recycling intentions both directly and indirectly through TPB variables (Chang et al., 2023; Sari et al., 2021; Wang et al., 2018). For example, Chang et al. (2023) demonstrate that environmental concern indirectly influences recycling intentions by shaping attitudes and subjective norms. Individuals with higher levels of environmental concern tend to develop more positive attitudes towards recycling and view it as socially acceptable due to supportive norms, which subsequently increases their intention to engage in e-waste recycling behaviours. Understanding this relationship can help governments or organisations design effective public awareness campaigns aimed at increasing environmental awareness, promoting environmental benefits and values of environmental protection, and emphasising social responsibility (Nadarajan et al., 2023).

In this study, perceived convenience shows an insignificant relationship with the intention to engage in e-waste recycling. This finding may have an underlying cause, such as inadequate infrastructure or a lack of comprehensive information, which affects how effective perceived convenience is. Firstly, the absence of well-established and accessible recycling infrastructure can make it challenging for individuals to assess perceived convenience accurately. For instance, a study in China shows that in areas lacking recycling infrastructure, the concept of convenience is difficult to perceive due to the practical difficulties in accessing recycling services (Thukral et al., 2023; Kumar, 2019). Meanwhile, other research highlights that simply creating awareness about recycling infrastructure might not be enough to influence behaviour. People might be aware of the available options, but if they lack comprehensive information about the benefits of e-waste recycling, the process involved, or the potential risks of improper disposal, the perceived convenience might not translate into increased intention (Chathuri et al., 2024). Therefore, contextual factors like infrastructure accessibility, perceived benefit, and information campaign efficacy can moderate the impact of perceived convenience.

For hypothesis (H6), the study showed that social media use indicates a weak and non-significant relationship with the intention to recycle mobile e-waste. This finding contradicts the previous research, which indicated that social media usage significantly influenced the Malaysian public's intention to engage in e-waste recycling (Nadarajan et al., 2023; Sujata et al., 2019). While some studies do acknowledge the positive roles of social media in promoting e-waste recycling, others have shown that its influence on individuals' recycling intentions can be limited (Sujata et al., 2019). This limitation may stem from the fact that social media often provides only a momentary sense of satisfaction, which might not translate into sustained engagement with pro-environmental behaviour. This finding may also reflect the phenomenon of 'slacktivism,' where online engagement and awareness do not translate into committed and real-world action. The term, a combination of "slacker" and "activism," describes the disconnection between digital awareness and tangible results (Glen, 2015). More comprehensive and engaging strategies are needed to transform fleeting interest into long-term commitment and to foster a deep psychological connection to e-waste recycling. To leverage social media effectively for improving e-waste recycling, governments, organisations, and other stakeholders should focus on developing more comprehensive and engaging strategies. These could involve interactive and immersive content, community-driven initiatives, and ongoing engagement efforts that encourage long-term behavioural change.

Knowledge also does not have a significant relationship with the intention to engage in mobile e-waste recycling. One possible explanation is a lack of comprehensive knowledge and understanding of sustainable green practices. While knowledge about e-waste recycling did not have a significant direct relationship with the intention to recycle in this study, it is plausible that knowledge influences intention indirectly. This mediated pathway suggests that knowledge is not sufficient on its own because it must first be internalised into a positive attitude before it can effectively drive behavioural intention.

5.0 CONCLUSION

This study reveals that attitudes, subjective norms, and perceived behavioural control are the primary factors influencing Malaysians' intentions to recycle mobile e-waste. Environmental concern also plays a significant role, whereas perceived convenience, knowledge of e-waste recycling, and social media use show no significant impact on recycling intentions. By highlighting the surprising non-significance of these factors, this study challenges common assumptions and offers a deeper understanding of the Theory of Planned Behaviour (TPB) in the Malaysian context, thereby filling an important gap in regional literature. It also advances the application of TPB by underscoring its contextual sensitivity. In a developing nation like Malaysia, the core constructs of attitude and subjective norms remain the strongest predictors of behavioural intention.

In practice, policymakers and organisations can use these findings to design more effective recycling campaigns by focusing on the significant variables. Emphasising the social and environmental benefits of recycling can strengthen positive attitudes and norms. Providing comprehensive information on the environmental impacts of improper disposal and focusing on specific recycling methods may further enhance participation. Examining demographic differences could also enable more targeted interventions, tailoring messages to different groups to improve campaign effectiveness.

Future research should explore ways to enhance the influence of currently insignificant variables, such as convenience, knowledge, and social media use, on recycling behaviour. Additionally, further studies could investigate the interactions among these factors to gain a deeper understanding of their role in shaping recycling intentions.

6.0 LIMITATION

The study has several limitations. First, there is sample bias, as the respondents are predominantly younger and more educated, which may limit the generalisation of the findings to the broader population. However, this focus on a key demographic provides useful insights for targeting future recycling initiatives. Second, self-reporting bias may affect the accuracy of the data due to self-administered questionnaires, which might not fully reflect respondents' actual recycling behaviours and attitudes. Nevertheless, the large sample size and consistency of responses enhance the reliability of the findings. Lastly, time constraints impacted the depth of data collection and analysis, although the study still successfully identified significant trends and behaviours related to e-waste recycling.

7.0 CONTRIBUTION OF AUTHORS

Izzah Az Zahra Ahmad contributed to the writing and revision of the manuscript. Amal A. M. Elgharbawy was responsible for conceptualisation, supervision, and data curation. She formulated the central research idea, oversaw research progress and analysis, and participated in data collection. Md Siddique Azam contributed to data collection and performed the data analysis. Anis Najiha Ahmad contributed to the study’s conceptualisation and anchored the review and revisions. Anis Farihah Abd Aziz assisted in data collection. Nurhusna Samsudin and Wan Syibrah Hanisah Wan Sulaiman both contributed to the study’s conceptualisation and data collection. Noor Faizul Hadry Nordin contributed to data curation and was involved in data collection.

8.0 FUNDING

This research received the 2023 Digital Society Research Grant from the Malaysian Communications and Multimedia Commission (MCMC).

9.0 CONFLICT OF INTEREST STATEMENT

The authors agree that this research was performed in the absence of any self-benefits, commercial or financial conflicts, and declare the absence of conflicting interests with the funders.

10.0ACKNOWLEDGEMENT

The authors would like to acknowledge and thank the Malaysian Communications and Multimedia Commission, International Institute for Halal Research and Training (INHART), IIUM, Kuala Lumpur, Academy of Contemporary Islamic Studies (ACIS), Shah Alam, and Bioenvironmental Engineering Centre (BERC), IIUM, Kuala Lumpur, for their support on this research.

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