Journal of Nusantara Studies 2025, Vol 10(1) 353-372
Universiti Sultan Zainal Abidin
ISSN 0127-9386 (Online)
http://dx.doi.org/10.24200/jonus.vol10iss1pp353-372

ASSESSING THE RELATIONSHIP OF KNOWLEDGE AND ATITUDES ON E-WASTE RECYCLING PRACTICES AMONG STUDENTS OF HIGHER LEARNING INSTITUTIONS

*Nur Shuhada Yaacob, Nik Amalena Najebah Nik Azman, Sharina Mohd Salleh & Bakhtiar Alrazi

Uniten Business School, Universiti Tenaga Nasional,
26700 Muadzam Shah, Pahang, Malaysia.
*Corresponding Author: Shuhada@uniten.edu.my

Received: 30.09.2024 Accepted: 17.01.2025

ABSTRACT

Background and Purpose: In Malaysia, there is a significant lack of awareness and understanding about recycling electronic waste (e-waste) among the general population, including students. The absence of consciousness regarding the appropriate handling of e-waste contributes to its inappropriate disposal, resulting in the deposition of numerous electronic gadgets in landfills. This study aims to evaluate the knowledge, attitudes, and practices on e-waste recycling among students in higher institutions in Muadzam Shah, Pahang, Malaysia.

Methodology: A cross-sectional survey was conducted via an online questionnaire, and data were analysed using SPSS version 29. The study involved 213 higher education students from Muadzam Shah, Pahang, Malaysia with the sample size validated by G*Power analysis. The questionnaire, based on the Knowledge, Attitude, Practice Variables, was measured using a 5-point Likert scale.

Findings: Descriptive statistics reveal that students exhibit high levels of knowledge, attitude and practice towards e-waste recycling with the mean value more than 3.5. Correlation analysis shows a significant positive relationship between knowledge and practice and between attitude and practice. Regression analysis confirms that attitude significantly predicts recycling practices, while knowledge does not. These findings highlight the importance of fostering positive attitudes towards e-waste within educational programmes and activities that seek to improve recycling endeavours among students.

Contributions: The necessity for conscientious e-waste management strategies is crucial to alleviate inadequate disposal methods that are detrimental to the environmental and health consequences. By delving into this issue, this study aims to contribute valuable insights to inform policies and strategies that enhance e-waste recycling efforts among higher learning institution students.

Keywords: Attitudes, e-waste, higher institution, knowledge, practices, KAP theory, sustainability.

Cite as: Yaacob, N. S., Nik Azman, N. A. N., Mohd Salleh, S., & Alrazi, B. (2025). Assessing the relationship of knowledge and attitudes on e-waste recycling practices among students of higher learning institutions. *Journal of Nusantara Studies, 10*(1), 353-372. http://dx.doi.org/10.24200/jonus.vol10iss1pp353-372

1.0 INTRODUCTION

Electronic waste, commonly referred to as e-waste, presents a pressing environmental concern in today's digital era. The exponential growth of electronic devices has led to an alarming increase in e-waste generation. According to Kemp (2022), 4.95 billion internet and 5.31 billion mobile phone users were recorded, which accounted for around 57% of our global population. Furthermore, the rise in consumer electronics demand, particularly in the field of internet technology, spurred by the lockdowns, work-from-home arrangements and the transition to online learning during the COVID-19 pandemic, has exacerbated the generation of electronic waste. This has become a cause for concern on a global scale (Vishwakarma et al., 2022).

Global e-waste production has surged, increasing by 44.4 million metric tons from 2010 to 2019, totaling 53.6 million metric tons. Projections indicate a further 30% rise to 74.7 million metric tons by 2030. Suprisingly, only 17.4% is officially collected and recycled (Forti et al., 2020). Malaysia's e-waste generation has also grown significantly, with an anticipated increase to 24.504 million units by 2025, driven by rapid technological advancements (Department of Environment, 2020). As a result, responsible e-waste management practices have become imperative for mitigating the adverse environmental and health effects associated with improper disposal (Ghulam & Abushammala, 2023). The United Nations and its member states have addressed this problem through the Sustainable Development Goals (SDGs), introduced in 2015 as part of the 2030 Agenda for Sustainable Development. These SDGs encompass 17 objectives, some of which focus on waste management, including SDG 12 (Responsible Consumption and Production). For instance, SDG 12 aims to achieve environmentally sound

waste management, waste reduction, recycling, and reuse by 2030, as outlined in Targets 12.4 and 12.5 (Forti et al., 2020).

Several studies indicate that e-waste recycling intentions among higher learning institution students are generally moderate to low, hindered by limited environmental awareness, varying attitudes and insufficient recycling infrastructure (Mohamad Zuhdi et al., 2023). Supporting this, Shaharudin et al. (2020) found similar patterns among youth in Putrajaya, who demonstrate moderate awareness but lack a strong commitment to sustainable e-waste disposal. Findings from Chibunna et al. (2012) further confirm that e-waste management efforts are still in their early stages, with students and employees showing low awareness and inadequate disposal practices. These studies suggest that, while higher learning institution students may possess some awareness, they often lack the knowledge, motivation, and resources necessary for consistent e-waste recycling behaviors. This gap highlights a critical need for higher learning institutions to implement targeted e-waste education, improve recycling facilities, and develop student-centered engagement initiatives to enhance sustainable e-waste management.

Therefore, this study focuses on higher learning institution students in Muadzam Shah, Pahang, Malaysia, with the overarching goal of examining the e-waste recycling practices within this specific demographic. Higher learning institutions are assumed to be hubs of knowledge dissemination, but it remains unclear whether the knowledge of e-waste recycling among higher learning institution students translates into actual recycling behavior (Chen & Wang, 2020). By delving into this issue, this study aims to contribute valuable insights that can inform policies and strategies aimed at enhancing e-waste recycling efforts among higher learning institution students. Objectives of the study are:

i. To measure the level of knowledge and attitude on e-waste recycling practices among students of higher learning institution
ii. To investigate the relationship between knowledge on e-waste recycling practices among students of higher learning institution
iii. To investigate the relationship between attitude on e-waste recycling practices among students of higher learning institution

2.0 LITERATURE REVIEW

2.1 E-Waste Practice in Malaysia

Electronic waste, or "e-waste," is the term used frequently to refer to electronic items that are reaching or have reached the end of their useful lives (Needhidasan et al., 2014). E-waste is defined as a broad range of electronic gadgets abandoned by their owners, ranging from huge household appliances like refrigerators, air conditioners, mobile phones, personal stereos, and consumer electronics to PCs (Puckett et al., 2002). E-waste production is expected to increase due to economic expansion and widespread access to technology, as the increase in Gross Domestic Product (GDP) encourages consumers to buy more electronics, which in turn increases the amount of e-waste generated (Jain et al., 2023). Along with the swift shift in global information and technological advancements, the use of electronic gadgets is increasing globally (Rautela et al., 2021). As a result, there was an alarming crisis on a global scale as the volume of e-waste produced rose dramatically over the year.

Currently, Malaysia does not have specific regulations regarding e-waste (Nurul Hidayana et al., 2023). However, in 2010, the Department of Environment (DOE) issued a revised version of its "Guidelines for the Classification of Used Electrical and Electronic Equipment in Malaysia" to assist all parties involved in e-waste management in identifying and classifying used electrical and electronic equipment and components in accordance with the regulatory codes (Department of Environment, 2020). Unfortunately, there is an absence of a formal framework for disposing of and dismantling e-waste, which leads to an increase in community health problems (Shad et al., 2020). Consequently, Yong et al. (2019) proposed that the DOE and the National Solid Waste Management Department (JPSPN) collaborate formally to create mandatory e-waste collection by local and state authorities and to send the sorted e-waste fractions to DOE-licensed recovery facilities.

E-waste is not prohibited from being exported or imported. Nevertheless, it must be approved by the Director General before shipment (Ismail & Hanafiah, 2019). A number of manufacturers and organisations have taken the initiative to organise multiple programmes to reduce the amount of e-waste and to increase community awareness of the issue. Moreover, Malaysia has developed incentive programmes to ensure the correct e-waste management (Nurul Hidayana et al., 2023). Malaysia is now making improvements in the management of e-waste through legislative initiatives, government programmes, and cooperative efforts. Any policy initiatives must be local and tailored to the nation's unique socio-cultural, economic, political, and environmental concerns in order to promote more sustainable and responsible e-waste management in Malaysia (Andeobe et al., 2021).

2.2 E-Waste and Higher Learning Institutions

E-waste has emerged as the fastest-growing waste stream globally, presenting significant environmental and health challenges. In Malaysia, projections suggest that by 2025, the volume of e-waste will reach approximately 24.5 million units, (Dusim, 2024). Higher learning institutions (HEIs) also contribute to the accelerating accumulation of e-waste, driven by the increased use of mobile phones, laptops, and other Information and Communication Technology (ICT) equipment. This growing quantity of e-waste highlights an urgent need to improve e-waste handling and disposal methods, particularly within the context of higher learning institutions (Hashim et al., 2024).

Studies indicate a broad spectrum of awareness levels and attitudes toward e-waste management among students in Malaysian higher learning institutions. Eidham et al. (2022) explored students' e-waste awareness in the one of the higher learning institution in the central region of Malaysia using the Knowledge, Attitude, and Practice (KAP) model, finding that students generally demonstrated a low understanding of e-waste management. Similarly, Mohamad et al. (2021) investigated e-waste awareness among Malaysian youth and found that although more than half of the respondents recognized the environmental and health hazards posed by e-waste, they often preferred to keep their broken or outdated electronic devices at home rather than dispose of them properly.

Azlan et al. (2021) studied the e-waste management knowledge, attitudes, and practices among business students at a public higher learning institution in the southern region of Malaysia. Findings indicated a moderate level of understanding and engagement with e-waste management practices, highlighting the need for enhanced educational initiatives to foster more proactive waste handling behaviors.

In the eastern region, Jobit et al. (2024) examined the relationships between Environmental Concern (EC), Perceived Behavioral Control (PBC), and Attitude (ATT) with the intention to participate in e-waste recycling (ERI) among higher learning institution students. Their findings show the importance of attitudes, perceived control, and environmental concern in shaping students' intentions to engage in e-waste recycling practices.

Finally, Mohamad Zuhdi et al. (2023) assessed the factors contributing to e-waste recycling intentions among higher learning institutions students, with attitudes identified as the most significant influence on students' willingness to engage in recycling activities. This suggests that while there is some awareness of e-waste issues, proactive steps toward recycling remain limited, emphasizing the need for targeted educational and behavioral interventions.

Thus, these previous studies collectively highlight that, while awareness of e-waste hazards is gradually increasing among higher learning institutions students in Malaysia, practical actions toward responsible e-waste management remain limited.

2.3 Knowledge Attitude Practice (KAP) Theory

The KAP Theory is a frequently employed framework in the social sciences, education, and public health (Luo et al., 2022). It is employed to evaluate and comprehend how people's practices are influenced by their knowledge, attitudes, and behaviours, notably in environmental issues (Tukiman et al., 2021). According to Green and Kreuter (1991), KAP theory is rooted in the idea that knowledge is a precursor to attitude formation and that attitudes, in turn, shape individual behaviours.

According to Qiquan (2021), the three components of KAP work together as one seamless system. He further explained by describing each component in depth:

1. The foundational information and abilities necessary for human survival which is knowledge.
2. Affective attitudes and values, which comprise both techniques, refer to the fundamental ways of learning and ways of life.
3. Procedures and techniques showing affective attitudes and values pertaining to one interest, which is the integration of personal value and social value.

Consequently, people gain knowledge about a topic of interest, which influences their attitudes and views about it in the future. Eventually, these attitudes influence their actions and behaviours.

2.3.1 Knowledge and Practice

According to Vijayan et al. (2023), there is a positive correlation between heightened levels of knowledge of the environmental consequences of e-waste and an individual's propensity to engage in e-waste recycling activities. The study also found that awareness of e-waste recycling laws and policies will favourably affect recycling practices, particularly in areas with stringent laws. Additionally, educational initiatives and awareness campaigns are successful in raising awareness of e-waste recycling and boosting knowledge levels (Eidham et al., 2022).

A study by Azlan et al. (2021) indicates that while respondents demonstrate a high level of knowledge regarding e-waste, their actual e-waste management practices remain relatively

low. This finding is consistent with earlier research by Mahat et al. (2019), which reported a similarly high level of e-waste knowledge among Malaysians.

In accordance with the findings of Wang et al. (2016), there has been a positive correlation between higher levels of income and education and increased participation in e-waste recycling. This relationship may be attributed to increased knowledge and improved accessibility to recycling facilities. Thus, the following hypothesis is developed:

H1: There is a positive relationship between knowledge on e-waste recycling practices among students of higher learning institution.

2.3.2 Attitude and Practice

Previous research discovered favourable opinions regarding recycling e-waste, which led to an increase in recycling activities (Nguyen et al., 2018). According to a study by Tanskanen (2013), certain nations have implemented incentive programmes wherein individuals are given awards for surrendering their unneeded electronic devices. This initiative has resulted in a notable rise in the rates of e-waste recycling. Kumar (2019) found that individuals are more inclined to engage in e-waste recycling when they regard it as a behaviour that is socially accepted and responsible. In addition, the implementation of convenient and user-friendly e-waste recycling alternatives, such as home pickup services, has been found to have a substantial impact on enhancing recycling rates (Wang et al., 2019).

Past research by Tengku Hamzah et al. (2020) supports the KAP Theory in the context of e-waste recycling. Their study found that individuals who possessed higher knowledge levels about e-waste hazards and recycling options are more likely to have positive attitudes towards recycling electronic devices. Furthermore, these individuals are more inclined to engage in actual recycling practices. This study highlights the significance of knowledge as a catalyst for changing attitudes and ultimately driving responsible e-waste recycling behaviours in contemporary society.

Azlan et al. (2021) found that business students hold a moderate attitude toward e-waste management, which contrasts with earlier findings by Kalana (2010) suggesting that Malaysians generally exhibit poor attitudes toward e-waste management. Furthermore, research by Mohamad Zuhdi et al. (2023) highlights that attitudes play a significant positive role in shaping intentions to engage in e-waste recycling. Thus, the following hypothesis is developed:

H2: There is a positive relationship between attitude on e-waste recycling practices among students of higher learning institutions.

From the hypotheses discussion above, the summary of the research framework is presented as per Figure 1 below:

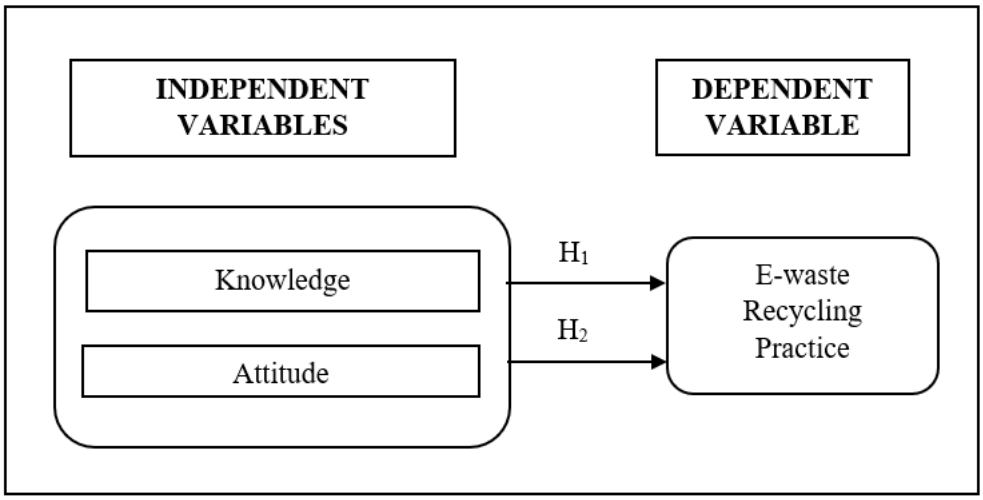

Figure 1: Research framework

3.0 METHODOLOGY

A cross-sectional survey was employed via an online survey, and SPSS version 29 was used to analyze the data. The data collected were purely quantitative, coming from students in higher learning institutions. The online survey was conducted with close monitoring during the E-Waste Awareness Day, ensuring that students answered the questionnaire in a focused environment. This approach helps to reduce bias by encouraging thoughtful responses and increasing the reliability of the data collected. The questions and instruments were adopted from the extant research on the KAP Theory by Tukiman et al. (2021). The questionnaire comprises four sections: Section 1 is designed to assess the respondents' prior knowledge of e-waste. Section 2 encompasses two attributes of the KAP model, which serve as independent variables in this study. Section 3 contains questions related to the dependent variable, and finally, Section 4 gathers demographic information about the respondents.

The variables were measured using a 5-point Likert scale. For the knowledge section, the scale ranges from 1 (Not familiar at all) to 5 (Extremely familiar), aiming to gauge the respondents' familiarity with e-waste. In the attitude section, a 5-point scale assesses agreement or disagreement with statements, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). As

for the dependent variable, the scales employed are: 1 (Never), 2 (Sometimes), 3 (Occasionally), 4 (Always), and 5 (Very Frequently). These scales serve to identify the e-waste recycling practices among the respondents.

The population of this study comprises students enrolled in higher education institutions in Muadzam Shah, Pahang, Malaysia, including both public and private entities. As of July 2023, there was a total student population of 2,992 across these three institutions. For this study, feedback was collected from a sample of 213 respondents. Muadzam Shah was selected for this study due to its logistical advantages, allowing the authors to effectively monitor and administer the data collection process. Focusing on this smaller area, which hosts several higher learning institutions facilitates a more manageable and concentrated study. Conducting research in Muadzam Shah enables efficient data collection, particularly beneficial for the research team, as proximity to these institutions streamlines access to participants. This localized focus not only enhances the feasibility of the study but also ensures high-quality data collection within the available resources. By concentrating on Muadzam Shah, the research can yield meaningful insights that are contextually relevant and practically applicable to the educational landscape. To determine the adequacy of this sample size in representing the entire population, a Statistical Power Analysis using G*Power was conducted. As recommended by Memon et al. (2020), recent developments in research suggest that sample size should be determined through power analysis. G*Power is a widely recognized tool in the behavioral sciences for calculating the required sample size (Faul et al., 2007). Utilizing an effect size of 0.15 and a predictor count of 2, as depicted in Figure 2 below, the calculated minimum sample size is 68. Therefore, the decision to use 213 respondents for this study is considered sufficient to obtain results that accurately reflect the population, in accordance with G*Power's recommendations.

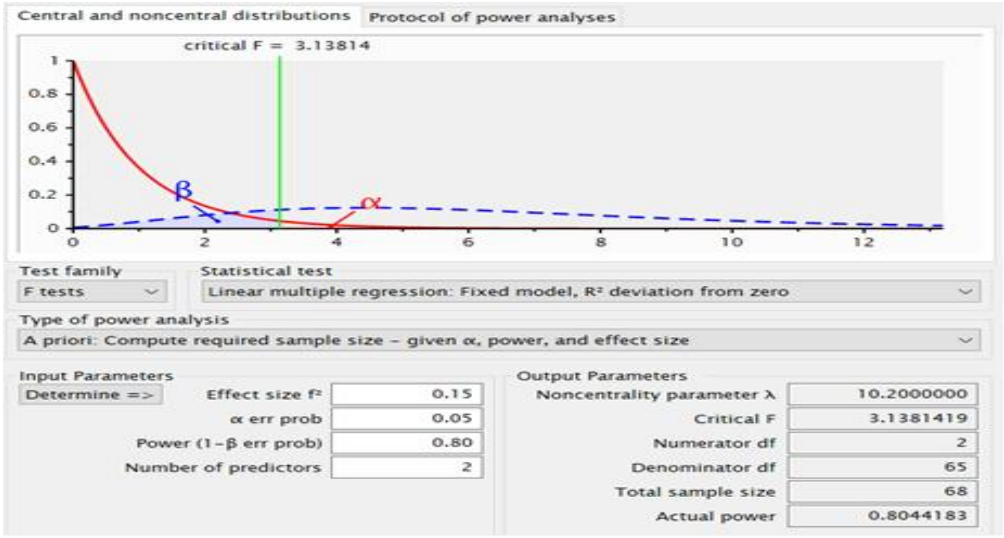

Figure 2: G*Power analysis

Table 1 below shows the summary of the respondents' demographic. The survey encompassed a total of 213 respondents. Among these respondents, 82 are male, constituting approximately 38% of the sample. Meanwhile, 131 respondents are female, making up 62% of the sample. Regarding the age distribution, respondents under 20 comprise 30 individuals, accounting for approximately 14% of the sample. The majority of respondents, 183 individuals (86%), fall into the 20-30 year age range. The ethnic composition of the survey respondents showcases a diverse representation. Malay/Bumiputra respondents constitute the majority, with 184 individuals, representing a significant 86% of the sample. Indian ethnicity is the second most prevalent, with 24 respondents, comprising 11% of the sample. Additionally, a small percentage of respondents are identified as Chinese (1%) and Others (1%). This diverse ethnic representation reflects the multicultural nature of the study's population. In terms of the education level of the respondents, the majority (126 respondents) are currently pursuing Bachelor's Degrees, representing 59.2% of the sample. Additionally, 84 respondents (39.4%) are working towards a Diploma, while a smaller percentage are pursuing Certificate and Master's Degrees as their current educational status, comprising 0.5% and 0.9% of the respondents, respectively.

Table 1: Respondents' demographic summary

Gender			Age			Ethnicity			Education Status		
Male	82	38%	< 20	30	14%	Malay /Bumiputra	184	86%	Certificate	1	0.5%
Female	131	62%	20-30	183	86%	Indian	24	11%	Diploma	84	39.4%
						Chinese	2	1%	Bachelor's Degree	126	59.2%
						Others	3	1%	Master's Degree	2	0.9%
	213	100%		213	100%		213	100%		213	100%

4.0 ANALYSIS AND DISCUSSION

The first objective of this study is to measure the level of knowledge, attitude, and practice of e-waste among students in higher institutions in Muadzam Shah, Pahang, Malaysia. The study analysed the descriptive statistics of the sample, as presented in Table 2 below. The mean value of knowledge, attitude and practice are 3.8766 (77.532%), 4.1103 (82.206%) and 3.5886 (71.772%), respectively. It can be concluded that their level of knowledge, attitude and practice about and towards e-waste is high and above moderate score. This is consistent with Tukiman et al. (2021).

In this study, a statistical method of Skewness and Kurtosis were applied to assess the normality of distribution of the data. From the Table 2, the skewness values are within the range of -2 to +2 and the kurtosis values are within -7 to +7. According to Hair et al. (2010) and Byrne (2010), values that fall within the range of -2 to +2 for the skewness, and -7 to +7 for the kurtosis are considered normally distributed.

Table 2: Descriptive statistics and normality test

Variable	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Deviation Statistic	Skewness	Kurtosis
Knowledge	1.29	5.00	3.8766	.79920	-0.630	0.328
Attitude	2.00	5.00	4.1103	.55079	-0.304	0.622
Practice	1.00	5.00	3.5886	.98634	-0.101	-0.874

Secondly, in order to assess the internal consistency and stability of the research instruments, a reliability test was conducted. Table 3 is referred to the Cronbach's Alpha coefficient for the

Knowledge variable, which is computed to be 0.914. This high coefficient signifies a robust level of internal consistency, indicating that the items reliably measure the same underlying construct. Similarly, the Attitude variable displays strong internal consistency, with a Cronbach's Alpha coefficient of 0.907. This result affirms that the items assessing attitudes towards the research topic are internally reliable, bolstering the validity of the measurements. The Practice variable exhibits excellent internal consistency, yielding a Cronbach's Alpha coefficient 0.935. This notably high coefficient indicates that the items consistently and effectively measure the same construct.

It is worth noting that all items surpass the predetermined threshold set at greater than 0.7, as recommended by Hair et al. (2010). In summary, these reliability test results provide strong evidence that the instruments employed to assess Knowledge, Attitude, and Practice in this study are dependable and produce consistent measurements. This enhances the confidence in the accuracy of the data and the validity of the research findings.

Table 3: Reliability test

Variable	Cronbach's Alpha	N of items
Knowledge	0.914	7
Attitude	0.907	8
Practice	0.935	8

In light of the normal distribution of the data, Pearson's correlation coefficient was employed to analyze the relationships between the variables. The results are as presented in Table 4 below. The correlation coefficient between Knowledge and Practice is calculated as 0.325**, indicating a positive correlation. This correlation is highly statistically significant ($p<0.001$). The findings suggest that individuals with a more extensive understanding of e-waste tend to exhibit more favorable recycling practices in their daily lives.

The correlation coefficient between Attitude and Practice is 0.500**, revealing a strong, positive correlation. This correlation is highly statistically significant ($p<0.001$). These results imply that individuals with more positive attitudes toward e-waste are more likely to engage in corresponding positive practices in the management and recycling of e-waste in their lives. Furthermore, the correlation analysis confirmed the absence of multicollinearity issues among the tested variables, as none of the correlation coefficients exceeds 0.9. This indicates that the variables examined in this study are not highly correlated. Consequently, no variables were excluded from the analysis, as the highest correlation value observed is between Attitude and

Practice at 0.500. Moreover, all variables exhibited statistically significant positive correlations at the 0.01 significance level.

Table 4: Correlation analysis

		Knowledge	Attitude	Practice
Knowledge	Correlation	1	.473**	.325**
	Sig.		<.001	<.001
Attitude	Correlation		1	.500**
	Sig.			<.001
Practice	Correlation			1
	Sig.			

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

In an extension of the correlation analysis, a regression analysis was conducted to test Hypotheses 1 and 2, examining the relationships between the predictor variables (Knowledge and Attitude) and the dependent variable (Practice). The assessment of multicollinearity through tolerance values and Variance Inflation Factor (VIF) indicated that multicollinearity was not a concern, meeting the assumption criteria with tolerance values greater than 0.1 and VIF values less than 10 (O'Brien, 2007). As indicated in Table 5, Knowledge and Attitude jointly account for 25.3% of the variance in Practice. Additionally, the results highlighted that the model was well-specified, as evidenced by an F value of 36.863, significant at $p < 0.001$.

The second objective of this study aimed to investigate the relationships between (i) Knowledge about e-waste and the Practice of e-waste recycling and (ii) Attitude towards e-waste and the Practice of e-waste recycling among higher institution students. Hypothesis 1 (H1) posited that Knowledge about e-waste may have a significant relationship with the Practice of recycling e-waste. However, as shown in Table 5, the results reveal a standard coefficient and t-value of Knowledge at 0.114 and 1.692, respectively. With a p-value of 0.092, it can be concluded that there is no statistically significant relationship between Knowledge and the Practice of e-waste recycling among students in Muadzam Shah, Pahang, Malaysia. Consequently, Hypothesis 1 is not supported.

In contrast, when considering the Attitude variable, a significant and positive relationship with the Practice of e-waste recycling among students in Muadzam Shah, Pahang, Malaysia was observed at a 99% confidence level, with a p-value of <0.001. The standard coefficient value for Attitude is 0.446, and the t-value of the coefficient is 6.618. These results

provide substantial evidence to support Hypothesis 2 (H2) of this study, indicating a significant relationship between Attitude and the Practice of e-waste recycling.

Table 5: Regression analysis

Dependent variable			Practice		
R square			26.0%		
Adjusted R square			25.3%		
F			36.863		
Sig.			<0.001		
Model	Standardized coefficient	t	Sig	Tolerance	VIF
(Constant)		-0.531	0.596		
Knowledge	0.114	1.692	0.092	0.777	1.288
Attitude	0.446	6.618**	<0.001	0.777	1.288

5.0 CONCLUSION AND RECOMMENDATIONS

In summary, this study suggests that, among higher learning institution students in Muadzam Shah, Pahang, Malaysia, attitude plays a more significant role in influencing the practice of e-waste recycling. While knowledge about e-waste does not have a significant impact on recycling behavior, a positive attitude towards e-waste is associated with a greater likelihood of engaging in e-waste recycling practices. This is in line with the study by Muhamad Zuhdi et al. (2023) that found attitudes had a significant positive influence towards e-waste recycling intention among higher learning institution students in the northern region. Aboelmaged (2021), in a study, found that young consumers' attitudes toward e-waste were demonstrated to be strong predictors of young adults' e-waste recycling intention. This prior study suggested that e-waste recycling programmes should first target attitudes and create specific cues that trigger habits.

This finding also aligns with previous studies that emphasised the significant impact of attitudes on shaping the intention to engage in environmentally friendly actions. Gkargkavouzi et al. (2019) affirmed that positive attitudes towards pro-environmental behaviors favourably affect individuals' intentions to adopt such behaviors in environmental contexts. Similarly, it was determined that consumers' attitudes have a positive impact on their intention to purchase environmentally friendly products, as indicated in studies by Kautish and Sharma (2019), Tang et al. (2014), and Woo and Kim (2019).

This can express that students with a strong positive attitude toward environmental protection, including e-waste recycling, are more likely to participate in recycling programmes. Therefore, this shows that attitude is a crucial predictor of recycling behavior in this context. These findings also emphasise the importance of fostering a positive attitude about e-waste in educational programmes and initiatives promoting sustainable recycling practices among students. The research also concentrates on e-waste recycling, which directly aligns with Sustainable Development Goal (SDG) 12, emphasising the need for responsible and sustainable consumption and production patterns. It highlights the importance of promoting recycling practices among higher learning institution students, specifically in the context of electronic waste. Encouraging responsible consumption and the proper disposal of electronic devices can contribute to reducing waste and conserving resources.

The onus of educating the students about e-waste and its appropriate management lies within governmental bodies, Non-Governmental Organizations (NGOs), and other accountable entities. As students gain a better understanding of the e-waste management, they are likely to develop a positive attitude towards e-waste, resulting in an increased adoption of responsible e-waste management practices in their daily lives.

The findings of this research study can contribute both theoretically and practically to the field of the study, which can contribute to the advancement of theoretical frameworks in the field of environmental psychology and behavior change. It provides empirical evidence that attitude plays a more significant role than knowledge in influencing e-waste recycling practices among students. The practical implications of the findings are significant, especially for higher learning institutions. It suggests that educational programmes should not only focus on imparting knowledge about e-waste but also emphasise the importance of cultivating a positive attitude toward recycling. Higher learning institutions can develop targeted campaigns and curricula that promote pro-environmental attitudes. Meanwhile, government agencies like Department of Environment (DOE), Ministry of Environment and Water (KASA), Solid Waste Management and Public Cleansing Corporation (SWCorp Malaysia) and Non-Governmental Organizations (NGOs) responsible for e-waste management can use these findings to inform their policies and initiatives. They can allocate resources to awareness campaigns that aim to change public attitudes towards e-waste, which could, in turn, lead to increased participation in e-waste recycling programmes.

This study has several limitations that affect its generalisability. Firstly, the study population consisted of students from higher learning institutions in Muadzam Shah, Pahang limiting the diversity of responses, as other higher learning institutions were not included.

Consequently, the findings may not be fully representative of all higher learning institution students in Malaysia. Secondly, the sample primarily comprised undergraduate students, suggesting that further cross-sectional studies with a balanced composition of undergraduate and postgraduate students across multiple institutions must capture broader trends on this issue.

To enhance the study's comprehensiveness, future research could conduct a longitudinal study to track the changes in e-waste recycling behavior and attitudes among higher learning institutions around Pahang students over time. This can help determine if knowledge and attitudes evolve as students' progress through their academic careers and if educational interventions have a lasting impact. It also suggests complementing the quantitative findings with qualitative research methods such as interviews or focus groups among the higher learning institutions' students around Pahang. Qualitative data can provide a deeper understanding of the reasons behind students' knowledge and attitudes related to e-waste recycling practices, shedding light on the nuances of their decision-making processes. Comparing e-waste recycling knowledge and attitudes among higher learning institution students from different regions or countries can help identify cultural or contextual factors influencing recycling practices and attitudes, leading to more targeted interventions. Finally, yet importantly, develop and validate measurement tools or scales tailored to assessing e-waste recycling knowledge, attitudes and practices among students of higher learning institutions. This can enhance the precision and reliability of data collection in future studies.

ACKNOWLEDGEMENTS

This work was supported by the Ministry of Higher Education, Malaysia, through the Fundamental Research Grant Scheme (FRGS), under the project code of FRGS/1/2022/2201/UNITEN/03/5.

REFERENCES

Aboelmaged, M. (2021). E-waste recycling behaviour: An integration of recycling habits into the theory of planned behaviour. *Journal of Cleaner Production, 278*(1), 124182.

Azlan, R. M. D., Razak, S. S. A., & Indiran, L. A. (2021). Knowledge, attitude and practices on e-waste management among business students in a public university. *International Journal of Academic Research in Business and Social Sciences, 11*(8), 1472–1478.

Byrne, B. M. (2010). *Structural equation modeling with AMOS: Basic concepts, applications and programming* (2nd eds.). Routledge Taylor & Francis Group.

Chen, L., & Wang, S. (2020). Knowledge and practices of e-waste recycling among college students. *Journal of Environmental Education*, *41*(3), 87-98.

Chibunna, J. B., Siwar, C., Begum, R. A., & Mohamed, A. F. (2012). The challenges of e-waste management among institutions: A case study of UKM. *Procedia-Social and Behavioral Sciences, 59*(1), 644-649.

Department of Environment. (2020). E-waste Management in Malaysia. *E-Waste.* https://ewaste.doe.gov.my/index.php/what-is-e-waste/

Dusim, H. H. (2024, February 9). Balancing Malaysia's digital growth and e-waste management. *Bernama.* https://www.bernama.com/en/thoughts/news.php?id=2332110#:~:text=The%20E%2DWaste%20Challenge,to%2082%20Petronas%20Twin%20Towers

Eidham, M. N. S., Aswad, A. M. A., & Adilla, A. R. F. (2022). The study of e-waste management awareness among students of UiTM Seremban 3. *Borneo AKademika, 6*(1), 67–75.

Faul, F., Erdfelder, E., & Lang, A. G. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(1), 175–191.

Forti, V., Baldé, C. P., Kuehr, R., & Bel, G. (2020). *The global e-waste monitor 2020: Quantities, flows, and the circular economy potential*. United Nations Institute for Training and Research.

Gkargkavouzi, A., Halkos, G., & Matsiori, S. (2019). Environmental behavior in a private-sphere context: Integrating theories of planned behavior and value belief norm, self-identity and habit. *Resources, Conservation and Recycling, 148*(1), 145-156.

Green, L. W., & Kreuter, M. W. (1991). Health promotion planning: An educational and environmental approach. *Deepblue.* http://deepblue.lib.umich.edu/bitstream/2027.42/30012/1/0000380.pdf

Ghulam, S. T., & Abushammala, H. (2023). Challenges and opportunities in the management of electronic waste and its impact on human health and environment. *Sustainability, 15*(3), 1-22.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis: A global perspective.* Pearson Education International.

Hashim, R., Salleh, N. A., Ibrahim. J. A., Mohd Zahari, F., & Cooper, S. (2024). E-waste management practices through the eyes of responsible departments at Malaysian public

universities. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *52*(1), 309–319.

Ismail, H., & Hanafiah, M. M. (2019). Discovering opportunities to meet the challenges of an effective waste electrical and electronic equipment recycling system in Malaysia. *Journal of Cleaner Production*, *238*(1), 117927.

Jain, M., Kumar, D. S., Chaudhary, J., Kumar, S., Sharma, S., & Verma, A. S. (2023). Review on E-waste management and its impact on the environment and society. *Waste Management Bulletin, 1*(3), 34–44.

Jobit, E. J., & Fawehinmi, O. (2024). Investigating the predictors of intention to participate in e-waste recycling among university students: A case of Universiti Malaysia Terengganu. *Universiti Malaysia Terengganu Journal of Undergraduate Research, 6*(2), 12–28.

Kalana, J. A. (2010). Electrical and electronic waste management practice by households in Shah Alam, Selangor, Malaysia. *International Journal of Environmental Sciences, 1*(2), 132-144.

Kautish, P., & Sharma, R. (2019). Value orientation, green attitude and green behavioral intentions: An empirical investigation among young consumers. *Young Consumers, 20*(4), 338-358.

Kemp, S., (2022). Digital 2022: Global overview report. *Data Reporter*. https://datareportal.com/reports/digital-2022-global-overview-report

Kumar, A. (2019). Exploring young adults' e-waste recycling behaviour using an extended theory of planned behaviour model: A cross-cultural study. *Resources, Conservation and Recycling, 141*(1), 378–389.

Luo, Y. F., Chen, L., Yang, S. C., & Hong, S. (2022). Knowledge, Attitude, and Practice (KAP) toward COVID-19 pandemic among the public in Taiwan: A cross-sectional study. *International Journal of Environmental Research and Public Health, 19*(5), 2784.

Memon, M., Ting, H., Hwa, C., Ramayah, T., Chuah, F., & Cham, T., (2020). Sample size for survey research: Review and recommendations. *Journal of Applied Structural Equation Modeling, 4*(2), i-xx.

Mahat, H., Hashim, M., Nayan, N., Saleh, Y., & Norkhaidi, S. B. (2019). E-waste disposal awareness among the Malaysian community. *Knowledge Management & E-Learning: An International Journal, 11*(3), 393-408.

Mohamad, M., Omar, A. J., & Mohamad, A. (2021). Awareness of e-waste among youth in Malaysia. *Proceedings of Malaysian Technical Universities Conference on Engineering and Technology, 1*(1), 431-342.

Mohamad Zuhdi, M. A., Rabun, M. N., Hamdan, H. I., & Ridzuan, M. R. (2023). No time to dispose? A study on the correlations and its contributing factors affecting university students' intention to practise e-waste. *Voice of Academia, 19*(1), 240-261.

Needhidasan, S., Samuel, M., & Chidambaram, R. (2014). Electronic waste - An emerging threat to the environment of urban India. *Journal of Environmental Health Science & Engineering, 12*(1), 1-9.

Nguyen, T. T. H., Hung, R.-J., Lee, C.-H., & Thi Thu Nguyen, H. (2018). Determinants of residents' e-waste recycling behavioral intention: A case study from Vietnam. *Sustainability, 11*(1), 1-24.

Nurul Hidayana, M. N., Nur Alia F. S., & Alia Syafiqah. K. A. (2023). To recycle or not to recycle? factors affecting Malaysian residents' intention for recycling e-waste. *Malaysian Journal of Social Sciences and Humanities, 8*(2), e002102.

O'Brien, R. M. (2007). A caution regarding rules of thumb for variance inflation factors. *Quality & Quantity: International Journal of Methodology, 41*(5), 673-690.

Puckett, J., Byster, L., & Westervelt, S. (2002). Exporting harm. The high-tech trashing of Asia. *The Basel Action Network*. http://www.ban.org/E-waste/technotrashfinalcomp.pdf.

Qiquan, Z. (2021). The KAP theory. In Z. Qiquan (Ed.), *The logic of China's new school reforms* (pp. 38–50). Brill.

Rautela, R., Arya, S., Vishwakarma, S., Lee, J., Kim, K., & Kumar, S. (2021). E-waste management and its effects on the environment and human health. *Science of the Total Environment, 773*(1), 145623.

Shad, K. M., Tan, Y. L., & Karim, M. E. (2020). Sustainable e-waste management in Malaysia: Lessons from selected countries. *IIUM Law Journal, 28*(2), 415–447.

Shaharudin, M. R., Said, R., Hotrawaisaya, C., Nik Abdul Rashid, N. R., & Azman Perwira, N. F. S. (2020). Linking determinants of the youth's intentions to dispose of portable e-waste with the proper disposal behavior in Malaysia. *The Social Science Journal, 60*(4), 680-694.

Tang, Y., Wang, X., & Lu, P. (2014). Chinese consumer attitude and purchase intent towards green products. *Asia-Pacific Journal of Business Administration, 6*(2), 84-96.

Tanskanen, P. (2013). Management and recycling of electronic waste. *Acta Materialia, 61*(3), 1001–1011.

Tengku Hamzah, T. A. A., Yahya, A. S. M., & Shafie, A. (2020). Knowledge, attitude, and practices on e-waste recycling among public in Port Dickson. *Pertanika Journal of Social Sciences and Humanities*, *28*(4), 2731-2748.

Tukiman, N. F. I., Abu Seman, N. A., & Mustaffa, S. A. (2021). A study of e-waste disposal management awareness among local community based on KAP model. *Research in Management of Technology and Business, 2*(2), 881–892.

Vijayan, R. V., Krishnan, M. M., Parayitam, S., Anantharaman Duraisami, S. P., & Saravanaselvan, N. R. (2023). Exploring e-waste recycling behaviour intention among the households: Evidence from India. *Cleaner Materials, 7*(1), 1-12.

Vishwakarma, S., Kumar, V., Arya, S., Tembhare, M., Dutta, D., & Kumar, S. (2022). E-waste in information and communication technology sector: Existing scenario, management schemes and initiatives. *Environmental Technology & Innovation, 27*(1), 1-17.

Wang, Z., Guo, D., & Wang, X. (2016). Determinants of residents' e-waste recycling behaviour intentions: Evidence from China. *Journal of Cleaner Production, 137*(1), 850–860.

Wang, B., Ren, C., Dong, X., Zhang, B., & Wang, Z. (2019). Determinants shaping willingness towards on-line recycling behaviour: An empirical study of household e-waste recycling in China. *Resources, Conservation and Recycling, 143*(1), 218–225.

Woo, E., & Kim, Y. G. (2019). Consumer attitudes and buying behavior for green food products: From the aspect of Green Perceived Value (GPV). *British Food Journal, 121*(2), 320-332.

Yong, Y. S., Lim, Y. A., & Ilankoon, I. M. S. K. (2019). An analysis of electronic waste management strategies and recycling operations in Malaysia: Challenges and future prospects. *Journal of Cleaner Production, 224*(1), 151-166.