Electronic Waste Management Awareness toward Sustainability among the Penang Community in Malaysia

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ABSTRACT

In this study, we explore the factors influencing e-waste management awareness within the Penang community in Malaysia, with a particular focus on sustainability. The study is set in the context of an urban region facing increasing environmental challenges from electronic waste. By examining six independent variables, awareness, knowledge, attitude, government influence, moral obligation, and subjective norms, we aim to capture the complex dynamics shaping community attitudes towards sustainable e-waste management. Quantitative data were collected through a survey of 384 respondents. The collected data analyzed using descriptive analysis and multiple regression analysis by using Statistical Package for Social Science (SPSS) software. Our findings indicate that while attitude, government influence, moral obligation, and subjective norms significantly contribute to higher awareness levels. However, awareness and knowledge did not significantly predict sustainability-driven e-waste management practices. The study suggest a more intricate interplay between behavior, policy, and environmental consciousness, necessitating tailored strategies for promoting habitual recycling. We conclude by discussing the practical implications for policymakers, environmental advocates, and community leaders in enhancing e-waste recycling initiatives and supporting sustainable development.

Keywords: Awareness, Knowledge, Attitude, Government Influence, Moral Obligation, Subjective Norms

INTRODUCTION

With recent technological advancements, electrical and electronic equipment has seen significant growth (Shad et al., 2020). However, these advancements have also contributed to major environmental issues, such as the increase in waste generation and challenges with its disposal. The overuse of electronic devices has led to various adverse effects, including high energy consumption, global warming, the accumulation of e-waste, and environmental pollution (Ghulam & Abushammala, 2023). According to Isernia et al. (2019), highlight that e-waste has rapidly emerged as one of the fastest-growing waste streams worldwide, exhibiting an annual growth rate ranging from 3% to 5%. Data from the United Nations University's Global E-waste Monitor 2020 highlights this alarming trend, reporting that a staggering 53.6 million metric tons (Mt) of e-waste were produced in 2019 (Abd-Mutalib et al., 2021; Knudsen et al., 2021). Notably, about half of this volume—24.9 Mt—originated from Asia (Adrian et al., n.d.). The study also suggests that without significant intervention, global e-waste generation could reach 74.7 million Mt by 2030 and 120 Mt by 2050. Unfortunately, only 20% of the e-waste produced is meaningfully recycled (Llerena-Riascos et al., 2021).

In Malaysia, e-waste poses significant challenges. The country generated 364 kilotons of e-waste in 2020, amounting to approximately 11.1 kg per capita (Razali et al., 2021). The situation is even more severe in developing nations, as developed countries often export their e-waste to these regions (Ilankoon et al., 2018). For instance, in 2019, Al Jazeera reported that developed countries such as the Australia, United Kingdom, Canada, and the United States sent nearly 3,000 metric tons of non-recyclable plastic waste to Malaysia. This waste often includes a mix of household refuse and e-waste, such as cables from the UK, CDs from Bangladesh, and electronic scraps from Canada, the US, Japan, Saudi Arabia, and China (Abalansa et al.,

2021). Informal recycling hubs have emerged as a result of the demand for extracting valuable metals from e-waste. However, this has led to serious consequences, including increased airborne lead levels due to improper recycling practices (Elytus, 2019). In Malaysia, illegal e-waste processing plants lacking proper filtration systems and licenses have been identified as major contributors to air pollution and public health risks (Singh, 2024). These examples highlight the urgent need for better regulations and sustainable recycling practices.

E-waste generation in Malaysia continues to grow, with the global generation of end-of-life electrical and electronic equipment expected to reach 24.5 million units by 2025. Mismanaging e-waste can lead to significant environmental degradation, exploitative labor practices, and public health concerns (Camoens, 2024). Manual sorting, disassembly, and open burning methods, commonly used to separate metals from non-metals, exacerbate these problems. Therefore, comprehensive studies on this issue are essential to guide policymakers, stakeholders, and the general public toward effective solutions before irreversible damage occurs. This study aims to explore the Penang community's awareness of sustainable e-waste management. By understanding their knowledge and practices, the findings could provide valuable insights for future research and public initiatives. Raising awareness and fostering knowledge in this area is a key step toward driving positive change and reducing the harmful effects of electronic waste on the environment and society.

Statement of Problem

The increasing prevalence of computers, monitors, and televisions has been accompanied by a general lack of awareness regarding the potential negative consequences of electronic devices. These devices often have shorter lifespans and are produced using methods that reduce their durability. The focus on product lifespan and quality plays an essential role in exacerbating the e-waste problem. A shift in public awareness is needed, emphasizing the importance of extending the life of electronic products. Computers and cell phones, for instance, often have a lifespan of fewer than two years, contributing to rapid increase of e-waste (Prabhu & Majhi, 2023). Addressing this issue is crucial to mitigating the adverse effects of e-waste on public health and the environment. A significant barrier to proper e-waste recycling is the lack of knowledge regarding hazardous e-waste and proper disposal methods. According to Azlan et al. (2021), inadequate knowledge of proper disposal methods is a key factor contributing to low awareness regarding e-waste management. In Malaysia, household recycling rates remain low, and most citizens are not familiar with the 3R practices of reducing, reusing, and recycling (Yuan et al., 2019; Zamani, 2016). Only 5% of household e-waste in Malaysia is recycled and collected by Material Recovery Facilities (Yuan et al., 2019). Moreover, people often store unusable electronics at home for extended periods due to uncertainty about how to dispose of them properly.

A further challenge is the illegal export of e-waste to Malaysia. Many local businesses send e-waste to unlicensed facilities to avoid the high costs and time involved in legal disposal methods. This leads to improper waste management and environmental harm. Social pressures may also influence Malaysian communities to accept certain waste management practices, even if they have unfavorable attitudes toward these changes. Malaysia is facing a severe issue with both legal and illegal imports of electronic waste. In 2024, the Kedah Department of Environment (DOE) suspended a factory in Sungai Petani for illegally processing 350 metric tons of imported e-waste. The raid uncovered various environmental violations, further highlighting the need for stricter enforcement of e-waste regulations. Establishing proper facilities for legal e-waste disposal requires significant investment and adherence to strict procedures, but some local businesses prioritize cost-saving measures over environmental protection. The lack of technological infrastructure, collaboration among stakeholders, and public awareness are key obstacles to effective e-waste management. This research aims to analyze the factors that influence electronic waste management awareness in Penang, Malaysia, and provide actionable insights to improve sustainability in e-waste practices.

LITERATURE REVIEW

Sustainability

Sustainability means the ability to maintain or preserve something over an extended period (Srivastava & Pathak, 2020). The importance of adopting sustainable waste management systems within communities is underscored by the need to promote environmental, economic, and social sustainability in urban areas. In

modern times, sustainability is a significant focus, particularly in legislative frameworks, business models, and planning initiatives, such as the European Union's Lisbon Treaty of 2007 (Ali & Shirazi, 2022). In essence, sustainability is about taking responsibility and caring for our planet to ensure a better future. By implementing sustainable practices, organizations can diminish environmental impact, foster positive relationships with stakeholders, and contribute to a more promising future for all. Sustainable e-waste management refers to minimizing the negative social and environmental impacts of electronic waste while ensuring efficient resource use and promoting long-term sustainability. This involves recycling, proper disposal, and reuse of electronic devices to mitigate the hazards they pose to the human health and environment. The primary goal of sustainable e-waste management is to reduce the production of electronic waste, recover valuable materials from outdated devices through recycling, and ensure the safe handling and disposal of hazardous substances. This may involve implementing extended producer responsibility (EPR) programs, initiatives that make manufacturers responsible for their goods' complete life cycle.

Additionally, it fosters a circular economy that emphasizes resource efficiency while raising public awareness about responsible e-waste management. By adopting sustainable e-waste practices, we can reduce environmental harm, minimize health risks, preserve valuable resources, and support a more stable and sustainable global economy. Achieving sustainable e-waste management also requires reducing the amount of e-waste generated by communities. By limiting the use of electronic devices or ensuring proper disposal, we can minimize e-waste production. This, in turn, helps conserve natural resources and energy, which are essential for manufacturing electronic products (Naik & Satya Eswari, 2022).

Awareness

Awareness refers to a concern for and informed interest in a particular situation or development. In the context of electronic waste (e-waste), awareness signifies understanding the growing volume of e-waste and its effects on both the environment and human health (Fatin et al., 2021). Awareness of the e-waste recycling process is critical for mitigating the environmental consequences of e-waste emissions. As awareness increases, people's knowledge of effective electronic waste management improves, enabling them to contribute to a healthier environment (Syahrul et al., 2022). The Malaysian Department of Environment (2018) has a website aimed at raising e-waste awareness. It gives information on the concept of e-waste, its estimation, and how Malaysian households can properly dispose of it. When people are aware of the social and environmental impacts of e-waste, they can help reduce pollution and health risks. Focusing on the product's end-of-life cycle—through recycling, reuse, reconstruction, and proper disposal—improves the overall quality of life. E-waste contributes to visual pollution, affecting mental and physical health by degrading social well-being, economic health, and aesthetic quality. This happens when disorganized dumping of materials such as electrical components (e.g., cables, wires) occurs, affecting how people perceive the environment (Syahrul et al., 2022).

E-waste originates from a variety of sources, such as households, institutions, and industries, all of which contribute to environmental damage. An essential factor in the rising volume of e-waste is the short lifespan of modern electronic products, which encourages frequent replacements. For example, the rapid pace of phone upgrades has led to more obsolete devices being discarded (Ramzan et al., 2019). E-waste often contains valuable but also hazardous materials. Toxic substances such as arsenic, lead, cadmium, and mercury are commonly found in e-waste and can lead to serious health problems, including cardiovascular and lung diseases (Almulhim, 2022). Exposure to these harmful substances may also cause neurological and respiratory issues. Due to health risks, e-waste accumulation is a challenge due to limited storage space and inadequate disposal methods. Consumer awareness is critical to establishing a sustainable e-waste management system (Islam et al., 2020). Schwartz outlines three components of awareness: behavior, practice and knowledge. These are essential in developing a long-term, economically and environmentally sustainable e-waste management system (Mahat et al., 2019). Moreover, education policies play an essential role in e-waste management.

Knowledge

Knowledge refers to the facts, theories, skills, and information gained through experience and education

(Hamzah et al., 2020). People who are more knowledgeable about recycling are more likely to participate in recycling activities. Knowledge-based and learning systems face significant challenges in all aspects of knowledge management due to the complexity of knowledge representation. Knowledge is a critical factor in ensuring the success of sustainable electronic waste management practices. If citizens are not educated about environmental knowledge, they are less likely to make the effort to properly dispose of their electronic devices (Ng, 2020). Environmental knowledge refers to the ability to understand and recognize the interrelationships within environmental systems and assess their health (Sumargo, 2018). Environmental education is seen as a continuous and lifelong process that is an integral part of a citizen's holistic education. It aims to build knowledge, attitudes, skills, and habits that contribute to sustainability. For the Malaysian community, especially in Penang, understanding environmental knowledge is crucial due to the significant consequences of improper disposal of electronic devices. Although there is no universal definition of environmental knowledge, scholars have identified key principles such as ecological understanding, cognitive ability to analyze environmental issues, and behavioral patterns aimed at reducing an individual's environmental impact (Liobikien & Pokus, 2019). The environmental knowledge acquired by the Penang community influences their actions regarding e-waste disposal, leading to an informed understanding of the environmental and public health impacts of electronic waste. A higher level of awareness about environmental problems may encourage the public to engage in recycling practices for e-waste (Awasthi & Li, 2018).

Attitudes

Liu et al. (2018) study examined the components of attitude, affect, behavior, and cognition. Affect is influenced by peer groups, instructors, parents, and leaders. Cognition refers to beliefs, opinions, and perceptions, with beliefs being the most crucial component, reflecting favorable or unfavorable views about an object or person. Behavior refers to a person's intention to act in a certain way toward someone or something. Thus, attitude encompasses how individuals feel (affective), what they believe (cognitive), and how they behave (Aboelmaged, 2021). Attitude shapes how individuals respond to the objects and events they encounter and plays a vital role in decision-making, particularly in environmental protection. It is a key factor in influencing people's decisions to avoid polluting the environment (Iyer, 2018). Environmental attitudes are closely tied to an individual's self-concept and their perception of their role within the natural environment. Sulaiman and Chan (2019) shown a clear relationship between attitude and e-waste management awareness in promoting sustainability among Malaysian communities. Data collected from respondents, primarily students, revealed that most had sufficient knowledge about e-waste management due to routine exposure to environmental activities. This demonstrates that a shift in attitude leads to a shift in behavior, marking a critical turning point in addressing the e-waste problem.

Government Influence

Liu et al. (2023) study defined government as a political system that controls an organized community, typically comprising three branches: legislative, executive, and judiciary. Government policy means the statement of the government's political programs, objectives, and intentions regarding specific causes. The importance of government policy cannot be overstated, as it exists to ensure that citizens abide by the law. Policies provide a rationale for why certain actions should be taken and guide the direction of those actions. Public issues can emerge in numerous ways, each requiring a unique policy response. Governments establish various policies that serve as guidelines for businesses. These policies can influence fiscal matters such as trade, taxation, regulations, subsidies, interest rates, and licensing. Businesses must remain flexible and adaptive to changing policies and regulations. Government policies function at various levels, from national to local, including state and municipal governments, each with its own set of rules. Additionally, international treaties can influence how businesses conduct their operations, highlighting the vital role government policies play in maintaining the smooth functioning of society (Yong et al., 2019). Ramzan et al.(2019) carried out a study on e-waste recycling the Chinese government, data indicates that 16% of respondents report low awareness and ineffective government policies, while 13% cite a weak formal collection system and ineffective policies. These factors discourage citizens from following proper e-waste disposal procedures. In response, the Chinese government has implemented various initiatives to promote formal recycling, such as the "old for new" event to reduce informal recycling centers. Additionally, a special fund was established, and subsidies were provided to encourage formal recyclers to adopt sustainable e-waste management practices.

Research has demonstrated a clear relationship between government policy and awareness of e-waste management in promoting sustainability. While laws have been enacted to restrict the import of electronic waste and curb informal recycling activities, these measures alone have not been sufficient, as consumer participation in formal recycling remains low (Iyer, 2018).

Moral Obligation

Rezaei and Ho (2021) study refers perceived moral obligation as individuals' understanding of their moral duty to behave ethically when confronted with ethical dilemmas. This concept encapsulates an individual's intrinsic motivation to engage in specific behaviors aligned with their personal sense of duty or ethical responsibilities. Moral considerations play a crucial role in motivating individuals to take action when their own interest's conflict with those of others. When one's self-interest conflicts with the interests of others, an individual's moral concerns play a significant part in motivating them (Kumar, 2019). E-waste management promote the proper disposal, recycling, and reuse of electronic devices, reducing the negative environmental impacts associated with e-waste. Individuals who value environmental responsibility may feel a moral obligation to engage in sustainable e-waste management to minimize harm to the environment and preserve natural resources.

Subjective Norm

Subjective norm refers to a person's adoption of a specific conduct under societal pressure. Social pressure refers to the influence exerted on individuals by their interpersonal networks and immediate surrounding communities, which is shaped by a mix of injunctive and descriptive norms. These standards are based on the impression of what is considered acceptable or undesirable conduct within a certain social context. (Singh et al., 2018). The subjective norm is an additional significant criterion within the Theory of Planned Behaviour (TPB). The concept of external and internal influences proposed by Fishbein and Ajzen in 1975. External influences refer to other people or organizations, while internal influences refer to a person's relationships. In addition, perceived behavioral control, often referred to simply as behavioral control, relates to an individual's perception of how easy or difficult it is to carry out a certain action (Ajzen,1991). Subjective norms reflect the perceived expectations of important individuals or groups regarding e-waste management practices. Promoting sustainable e-waste management within Malaysian communities can shape positive subjective norms and encourage responsible behaviors (Kumar, 2019).

RESEARCH METHODOLOGY

The study used a quantitative research method with a questionnaire as the instrument. The total population of the Penang community is 1,740,405 people. This study referred to the Krejcie & Morgan,1970, table to choose the minimum number of sample of 384 respondents. Data was collected through questionnaires to answer the research questions and analyzed using descriptive statistics and multiple regression analysis.

Findings

The results in Table 1 shows the background of respondents living in Penang. The proportion of male and female respondents were almost equal, with 187 males (48.7%) and 197 females (51.3%). Whereas, Table 2 shows age, the largest group of respondents were between 21 and 30 years old, representing 63% of the sampled respondents. This was followed by those aged 31 to 40 (10.4%), 41 to 50 (11.7%), 51 to 60 (6.8%), and 61 and above (8.1%). The race of respondents in Table 3 shows that the majority were Chinese, with a total of 280 (72.9%), followed by 73 (19%) Malay, and 31 (8.1%) for Indians. The duration of stay in Penang State by respondents revealed that those who have stayed 0 – 5 years are 174 constituting 45.3% of the sampled population. This is followed by those who have stayed for 6 – 10 years, totalling 57 (14.8%). Furthermore, those who have stayed for 11 – 15 years are 47, accounting for 12.2% of the sampled population (See Table 4).

Lastly, respondents who have lived in Penang for more than 15 years are 106, representing 27.6% of the sampled population. In terms of district, among the 384 respondents, 145 (37.8%) lived in Penang Island,

which includes Georgetown and Bayan Lepas. The remaining 239 respondents (62.3%) resided in Penang Mainland, which comprises Butterworth, Kepala Batas, Bukit Mertajam, and Nibong Tebal (See Table 5). Majority of the respondents have higher level of educational background which include; Diploma, Bachelor's degree, Master's as well as PhD's, these respondents were 222 and constituted 57.8% of the respondents (See Table 6). Majority of the respondents are also employed. Those employed were 206 and they constitute 53.6% of the sampled population, followed by 117 (30.5%) students, and 61 (15.9%) unemployed (See Table 7).

Table 1: Gender

Gender	**Frequency (n)**	**Percentage (%)**
Male	187	48.7
Female	197	51.3
Total	**384**	**100**

Source: Survey Data (2024)

Table 2: Age

Age	**Frequency (n)**	**Percentage (%)**
21 - 30	242	63.0
31 - 40	40	10.4
41 - 50	45	11.7
51 - 60	26	6.8
61 and above	31	8.1
Total	**384**	**100**

Source: Survey Data (2024)

Table 3: Race

Race	**Frequency (n)**	**Percentage (%)**
Chinese	280	72.9
Malay	73	19.0
India	31	8.1
Total	**384**	**100**

Source: Survey Data (2024)

Table 4: Percentage of how many years have you been staying in Penang State?

Year	**Frequency (n)**	**Percentage (%)**
0 - 5 years	174	45.3
6 - 10 years	57	14.8
11 - 15 years	47	12.2

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> 15 years	106	27.6
Total	**384**	**100**

Source: Survey Data (2024)

Table 5: District

District	**Frequency (n)**	**Percentage (%)**
North Seberang Perai (Butterworth, Kepala Batas)	72	18.8
Central Seberang Perai (Bukit Mertajam)	89	23.2
South Seberang Perai (Nibong Tebal)	78	20.3
Northeast Penang Island (Georgetown)	74	19.3
Southwest Penang Island (Bayan Lepas)	71	18.5
Total	**384**	**100**

Source: Survey Data (2024)

Table 6: Education background

Education	**Frequency (n)**	**Percentage (%)**
Primary Education (Standard 1 to 6)	37	9.6
Secondary Education (SPM)	72	18.8
Post-Secondary Education (STPM/Matriculation)	53	13.8
Higher Education (Diploma/Bahelor's Degree/ master's degree/PhD)	222	57.8
Total	**384**	**100**

Source: Survey Data (2024)

Table 7: Occupation

Occupation	**Frequency (n)**	**Percentage (%)**
Student	117	30.5
Employed	206	53.6
Unemployed	61	15.9
Total	**384**	**100**

Source: Survey Data (2024)

Table 8: Descriptive Analysis

Variables	**Number of Respondents (N)**	**Mean**	**Std. Deviation**
Awareness	384	3.79	1.06
Knowledge	384	3.65	1.02

Attitude	384	3.88	1.05
Government Influence	384	3.55	1.08
Moral Obligation	384	3.83	1.12
Subjective Norm	384	3.43	1.14
Sustainability	384	3.58	1.12

Source: Survey Data (2024)

Table 8 presented the results, indicating that the mean score for the dependent variable, sustainability, was recorded at 3.58. The mean scores for the independent variables were as follows: awareness had a mean of 3.79, knowledge recorded a mean score of 3.65, government influence had a mean score of 3.55, and moral obligation registered a mean score of 3.83. Overall, the mean scores for all variables were relatively moderate and categorized as high (agree). Among these, attitude exhibited the highest mean score at 3.88, while subjective norm had the lowest mean score at 3.43. The respondents indicated that the independent variables — awareness, knowledge, attitude, government influence, moral obligation, and subjective norm, significantly influenced the dependent variable, sustainability. For the standard deviation, awareness was recorded at 1.06, while attitude was recorded at 1.05. The standard deviations for moral obligation and sustainability were both recorded at 1.12. Government influence had a standard deviation of 1.08. Additionally, the standard deviation for knowledge was the lowest at 1.02, whereas subjective norm exhibited the highest standard deviation at 1.14. Consequently, these results indicated that the respondents' scores were not closely clustered around the mean.

Table 9: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.873[a]	0.761	0.758	0.55216

Predictors: (Constant), awareness, knowledge, attitude, government influence, moral obligation, and subjective norm

Dependent Variables: sustainability

Source: Survey Data (2024)

According to the summary model of the sustainability table, the value of R Square is 0.761 or 76.1%. The value of 0.761 implies that 76.1% of the variance for sustainability was the dependent variable explained by the independent variables to this research. Moreover, the modified R Square should indicate how far the model is generalising. On the other hand, the summary model of the sustainability table above has resulted that the Adjusted R Square is 0.758 or 75.8% which was a value near to the R Square. See Table 9.

Table 10: ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	366.717	6	61.119	200.469	<.001 [b]
	Residual	114.940	377	.305		
	Total	481.657	383			

Predictors: (Constant), awareness, knowledge, attitude, government influence, moral obligation, and subjective norm

Dependent Variables: sustainability

Source: Survey Data (2024)

Table 10 describes the overall variance of the model of this research. The F ratio has been adopted to measure the whole fitness of the regression model. The F-value is 200.469, while the Mean Square Regression is 61.119, divided by the Mean Square Residual, 0.305. According to the correlation of variables table, the probability indicated as 'sig' is <.001 [b], whereby the independent variables to this research were found to explain the variance of the dependent variable effectively. Therefore, the overall decline in the outcome is significant.

Table 11: Coefficient Analysis

Coefficients[a]				
Model		Beta	t	Sig.
	(Constant)		-554	.580
	Awareness	0.054	1.214	.226
	Knowledge	-0.028	-.574	.566
	Attitude	0.092	1.802	.072
	Government Influence	0.249	5.635	<.001
	Moral Obligation	0.328	6.789	<.001
	Subjective Norm	0.292	7.426	<.001

[a] Dependent Variables: sustainability

Source: Survey Data (2024)

Based on the Coefficient of sustainability Table 11, the power of attitude (β = 0.092, t = 1.802, p = 0.072), government influence (β = 0.249, t = 5.635, p = <0.001), moral obligation (β = 0.328, t = 6.789, p = <0.001), and subjective norm (β = 0.292, t = 7.426, p = <0.001) variables result in an important impact on the dependent variable was examined by the standard coefficient beta value while awareness and knowledge are not statistically significant. See Table 12.

Table 12: Summary for Hypothesis Testing Results

	Hypothesis	**Remark**
H_1	There is a relationship between awareness and the sustainability of e-waste management.	Rejected
H_2	There is a relationship between knowledge and the sustainability of e-waste management.	Rejected
H_3	There is a relationship between attitude and the sustainability of e-waste management.	Accepted
H_4	There is a relationship between government influence and the sustainability of e-waste management.	Accepted
H_5	There is a relationship between moral obligation and the sustainability of e-waste management.	Accepted
H_6	There is a relationship between subjective norm and the sustainability of e-waste management.	Accepted

CONCLUSIONS AND RECOMMENDATIONS

The study highlighted that electronic waste management awareness toward sustainability is a crucial factor in evaluating the community's awareness, knowledge, attitudes, government influence, moral obligations, and subjective norms regarding e-waste management. The results have shown that attitude, government influence, moral obligation, and subjective norms will have an impact on sustainability, while awareness and knowledge do not have a significant relationship with sustainability. Thus, it shows that attitude, government influence, moral obligation, and subjective norms have an essential impact on sustainability, and the aim of the study has been achieved.

In order to reduce the quantity of e-waste transported to landfills, promoting and encouraging e-waste recycling activities among the public is essential. Although awareness and knowledge may not directly influence sustainability, this study underscores the importance of shaping attitudes, government policies, and moral obligations to enhance awareness of e-waste management and its impact on environmental well-being. Providing the public with comprehensive information on e-waste recycling, including the benefits, proper management, segregation, and registered collection centers, is essential. Government bodies, with support from NGOs, must ensure that the public has access to accurate and sufficient information. In turn, the public should actively participate in managing e-waste by recycling responsibly.

The study concludes that improper handling of e-waste poses risks to both human health and the environment, underscoring the need for proper disposal methods, such as using designated e-waste collection centers and recycling bins, rather than storing it at home. In the future, research can be conducted on the generation and disposal management of electronic waste, and sustainability e-waste recycling and collection technologies can be developed to achieve sustainability. Regulatory enforcement, skill enhancement of the informal sector, transparent recycling systems, awareness campaigns, incentives for electronic waste recycling, and so on., are all serious challenges currently faced by the authorities.

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