Volume 5, Issue 2 (2024)
e-ISSN: 2716-666X

The Asian Journal of Professional and Business Studies

Please cite this article as:
Goh Deng Zia, & Suriani Sukri. (2024). Fostering Sustainability: Enhancing Electronic Waste Management Awareness in Penang. The Asian Journal of Professional & Business Studies, 5(2), 140–157. https://doi.org/10.61688/ajpbs.v5i2.350

FOSTERING SUSTAINABILITY: ENHANCING ELECTRONIC WASTE MANAGEMENT AWARENESS IN PENANG

Goh Deng Zia*[1], Suriani Sukri[2]

[1,2]Faculty of Business and Communication, Universiti Malaysia Perlis

Corresponding author: gohdengzia0925@gmail.com
Received 2 November 2024, Accepted 20 December 2024, Available online 30 December 2024

ABSTRACT

The growing problem of electronic waste (e-waste) is a well-known global issue. This study aims to identify the factors that influence awareness of e-waste management among the Penang community in Malaysia, specifically focusing on sustainability. The primary objective is to investigate the Penang community's understanding and attitudes towards e-waste management for a sustainable future. Six independent variables were examined: awareness, knowledge, attitude, government influence, moral obligation, and subjective norm. A survey questionnaire was distributed to 384 respondents in Penang. The findings revealed that attitude, government influence, moral obligation, and subjective norms significantly predict the Penang community's e-waste management awareness towards sustainability. Surprisingly, awareness and knowledge, as components of the Theory of Planned Behavior (TPB), did not significantly impact sustainability-focused e-waste management awareness. In conclusion, e-waste recycling initiatives should prioritize enhancing knowledge and creating specific cues to encourage habitual recycling behavior. This study also highlights practical and social implications for improving e-waste recycling policies.

Keywords: Electronic Waste, Awareness, Knowledge, Attitude, Government Influence

1.0 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); 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.

Problem Statement

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.

2.0 LITERATURE REVIEW

2.1 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).

2.2 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.

Moreover, 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. For instance, Albuquerque et al. (2020) note that Brazil's inadequate e-waste management is partly due to limited budgets and insufficient environmental education programs. However, the level of awareness and education regarding e-waste can vary based on a country's specific circumstances. According to Fatin et al. (2021), many individuals struggle to translate their awareness into action, maintaining unsatisfactory attitudes toward environmental issues.

2.3 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, a subset of 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).

Research has shown a clear relationship between knowledge and e-waste management awareness in promoting sustainability within the Penang community. Therefore, it is essential to incorporate environmental education from an early age to enhance knowledge and awareness, which in turn will foster the behaviors needed for sustainable e-waste management practices. Past studies have consistently demonstrated that knowledge is a key factor in promoting sustainable e-waste management in the Penang community (Sulaiman & Chan, 2019).

2.4 Attitudes

Attitude can be defined as a positive or negative mental state of preparedness, shaped by experience, that influences a person's reactions to people, objects, and situations. The three primary components of attitude are affect, behavior, and cognition (Liu et al., 2018). 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 (behavioral) (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.

For instance, in Ghana, waste management challenges are exacerbated by the public's negative attitude toward environmental protection. Academic institutions, due to the rise of information and communication technology, have become significant users of electronic equipment, with students being a major source of e-waste. Given the rapid pace of technological advancement, students' attitudes toward e-waste generation, collection, and segregation are critical for shaping future behavior. These attitudes, particularly their emotional components, are influenced by peer groups, parents, instructors, and leaders.

Research has 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 (Sulaiman & Chan, 2019).

2.5 Government Influence

Government is defined 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 (Liu et al., 2023).

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., 2021).

In the context of electronic waste (e-waste) recycling, 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 (Ramzan et al., 2019). 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).

2.6 Moral Obligation

Perceived moral obligation refers to individuals' understanding of their moral duty to behave ethically when confronted with ethical dilemmas (Rezaei & Ho, 2021). This concept encapsulates an individual's intrinsic motivation to engage in specific behaviors aligned with their personal sense of duty or ethical responsibilities. According to their own personal norms. 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.

2.7 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). It takes into account a person's perception of his or her ability to compete. 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).

3.0 METHODOLOGY

3.1 Conceptual Framework

The study's conceptual framework is illustrated in Figure 1. The framework highlighted the six factors which are awareness, knowledge, attitude, government influence, moral obligation, and subjective norms, as extensions of the Theory of Planned Behavior (TPB) in the context of sustainability e-waste management. These factors are expected to play a crucial role in reducing e-waste.

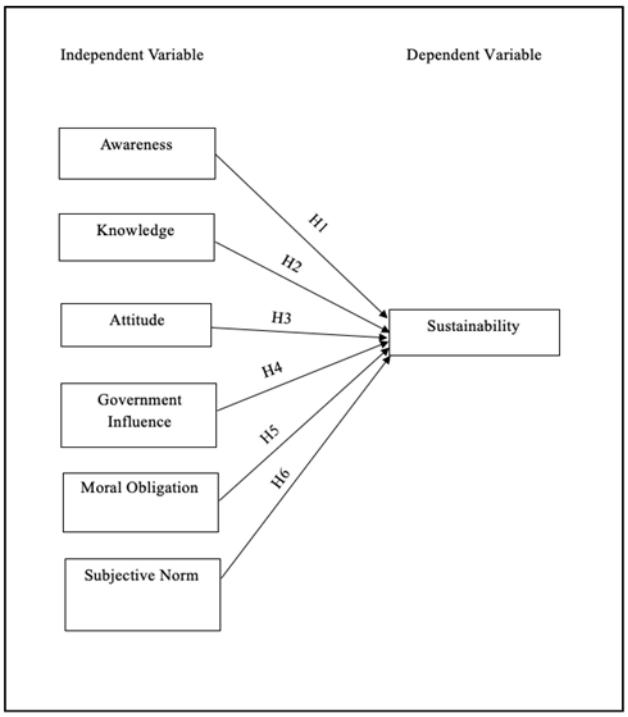

Figure 1. Conceptual Framework

3.2 Research Design

The study used a quantitative research method with a questionnaire as the instrument. Quantitative data was collected using survey forms with questions related to the study (Bhandari, 2023). The questionnaire included questions linked to independent variables (awareness, knowledge, attitudes, government influence, moral obligation, subjective norm) and dependent variables (sustainability) and the study framework, were established. Data was collected through questionnaires to answer the research questions and analyzed using statistical analysis with the SPSS tool.

3.3 Population and sample

The total population of the Penang community is 1,740,405 people from Penang Island and Penang Mainland, which is more than 1 million people. Figure 2 shows Penang Island and mainland location. The number of Penang communities in these five districts is separated into five specific areas: Southwest Penang, Northeast Penang, Central Seberang Perai, North Seberang Perai, and South Seberang Perai (See Table 1). Therefore, this study referred to the Krejcie & Morgan,1970, table to choose the minimum number of 384 respondents.

In this study, the targeted population was the Penang community, aged 21 to 60 and above, as this age group had the purchasing power for electronic products. In contrast, individuals under 20 were excluded due to their lower purchasing capacity, as they were not legally adults and had not yet formally entered the workforce.

Table 1 Number of peoples by districts in Penang Island and Mainland, Malaysia.

District	Population	Sample
Southwest Penang	237,738	52
Northeast Penang	184,007	41
Central Seberang Perai	422,990	93
North Seberang Perai	339,095	75
South Seberang Perai	556,575	123
Total	1,740,405	384

Source: Population Penang Malaysia, 2024

Figure 2 Map of Penang, Malaysia.
Source: Memoriesandsuch, 2024

3.4 Study Instrument

A questionnaire was used as the instrument of data collection. The questionnaire contained three sections: A, B, and C. In section A, the demographic details include name, gender, age, race, how many years have you been staying in Penang State, district, education background, occupation, have you ever heard about what is electronic waste will be required. In sections B and C, the details for awareness, knowledge, attitude, government influence, moral obligation, subjective norms, and sustainability will be asked for filling. All the questions were compulsory for the respondents to answer. The study targeted individuals who worked, studied, or lived in Penang State, as the research aimed to assess electronic waste management awareness towards sustainability among the Penang community. The measurement scale of the items for each variable uses the Likert scale, which includes 1 to 5 with the sequence of “strongly disagree” to “strongly agree”. Responses to the constructs were measured using a five-point Likert-type scale, where 1 represents "Strongly Disagree," 2 indicates "Disagree," 3 is "Neutral," 4 signifies "Agree," and 5 stands for "Strongly Agree" (Tanujaya et al., 2023).

3.5 Variables and Items

Table 2 shows variables and items of this study

Variables	Variables Measured	Adapted Items	Sources of Data	No. of Items
IV	Awareness	1. I am aware that e-waste is harmful to animals. 2. I am aware of harmful effect of e-waste to our health. 3. I am aware of harmful effect of e-waste to environment. 4. I am aware of law and policies that are enhanced by the government about e-waste. 5. I am aware of the process of recycling e-waste properly.	(Almulhim, 2022) (Awasthi & Li, 2018) (Kumar, 2019)	5
IV	Knowledge	1. I know that electronic waste may pollute the environment. 2. I know the negative effect of selling used electronic products to informal recyclers (waste collectors). 3. I know what types of electronic waste can be recycled. 4. I understand the 3R for e-waste management. (3R-Recycle, Reuse, Reduce) 5. I learned the knowledge about e-waste management.	(Jahan & Mim, 2023) (Mohammed, 2022) (Zhao, et al., 2023)	5
IV	Attitude	1. Recycling electronic waste makes me feel very satisfied. 2. Recycling electronic waste contributes to society. 3. Recycling electronic waste is everyone's responsibility. 4. I will share my awareness of e-waste management with everyone. 5. Proper e-waste management would contribute to a healthy and safe environment.	(Kumar, 2019) (Wang et al., 2018) (Zhao et al., 2023)	5
IV	Government Influence	1. I understand the relevant laws and regulations for the recovery of electronic waste. 2. I understand exactly what I have to do to obey the law and recycle electronic waste.	(Andeobu et al., 2021)	5

		3. Local authorities provide recycling bins for residents to recycle electronic waste. 4. There is a need for the government to strengthen laws pertaining to electronic waste management. 5.The government should establish educational platforms to promote understanding and proficiency in electronic waste management.	(Anwar, 2020) (Awasthi & Li, 2018) (Zhao, et al., 2023)	
IV	Moral Obligation	1. I have to take responsibility for recycling electronic waste. 2. It would be unethical of me not to recycle waste. 3. I never dispose of electronic waste by throw into rivers or sea. 4. I never dispose electronic waste as any way I want to. 5. I would feel guilty if I did not perform recycling.	(Aboelmaged, 2021) (Kumar, 2019)	5
IV	Subjective Norm	1. Many people want me to separate e-waste and general waste while recycle the waste. 2. My friends always teach me knowledge about e-waste management. 3. My family expect me to safely dispose the old electronic equipment. 4. I heard from various sources that it's important to recycle e-waste with licensed recyclers. 5. The media influence me to recycle e-waste.	(Laeequddin et al., 2022) (Wang et al., 2018)	5
DV	Sustainability	1. I always recycle electronic equipment that already broke. 2. I will continuously be enhancing my knowledge in managing electronic waste responsibly. 3. I will separate electronic waste out of the other general waste when throw. 4. I will try to repair the broken electronic equipment rather than just buying a new one. 5. I will pay for licensed recycler to dispose my electronic waste.	(Jahan & Mim, 2023) (Lau et al., 2021)	5

4.0 FINDINGS AND DISCUSSION

4.1 Demographic characteristics of Respondents

Table 3 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, regarding 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 showed that the majority of them 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. 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. While the respondents' educational background, as noted by Al-Khateeb et al. (2017), plays a crucial role, as individuals with higher education are generally more likely to respond positively to external stimuli. 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. 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. The level of awareness of electronic waste (e-waste) in the study area shows that a larger proportion of the population (299) are aware of electronic waste issues and they constitute 77.9%. Only about 85 respondents claim not to be aware of electronic waste issues and the constitute 22.1% of the sampled population.

Table 3 Gender

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

Source: Survey Data (2024)

Table 4 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 5 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 6 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
> 15 years	106	27.6
Total	**384**	**100**

Source: Survey Data (2024)

Table 7 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 8 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 9 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 10 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)

The results from the questionnaire will be presented separately in the subsequent sub-section. Every variable was assessed using a 5-point scale. Table 4 outlines the various mean levels, derived from the average or total scores for each variable.

Table 11 Classification of Mean Level

Mean level	Indication
High	3.34 to 5.00
Medium	1.67 to 3.33
Low	1.00 to 1.66

Table 12 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

5.0 CONCLUSION

In summary, this study which was conducted among the Penang community has highlights 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.

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 recycling electronic waste, and so on., are all serious challenges currently faced by the authorities. rite here.

6.0 ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to Universiti Malaysia Perlis for providing the resources and support necessary to complete this study. We would also like to thank all participants who contributed their time and insights to this research. Special appreciation is extended to colleagues and peers who offered valuable feedback during the development of this manuscript.

REFERENCES

Abalansa, S., El Mahrad, B., Icely, J., & Newton, A. (2021). Electronic waste, an environmental problem exported to developing countries: The good, the bad and the ugly. *Sustainability (Switzerland), 13*(9).

Abd-Mutalib, H., Muhammad Jamil, C. Z., Mohamed, R., Shafai, N. A., & Nor-Ahmad, S. N. H. J. N. (2021). Firm and Board Characteristics, and E-Waste Disclosure: A Study in the Era of Digitalisation. *Sustainability, 13*(18), 10417.

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

Adrian, S., Drisse, M. B., Cheng, Y., Devia, L., Deubzer, O., Goldizen, F., Gorman, J., Herat, S., Honda, S., Iattoni, G., Jingwei, W., Jinhui, L., Khetriwal, D. S., Linnell, J., Magalini, F., Nnororm, I. C., Onianwa, P., Ott, D., Ramola, A., … Zeng, X. (n.d.). *Quantities, flows, and the circular economy potential The Global E-waste Monitor 2020.*

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211. https://doi.org/https://doi.org/10.1016/0749-5978(91)90020-T

Albuquerque, C. A., Henrique, C., Mello, C., Henrique, J., Gomes, F., Santos, V., Santos, & Zara, J. (2020). E-waste in the world today: An overview of problems and a proposal for improvement in Brazil. *Environmental Quality Management, 29*. https://doi.org/10.1002/tqem.21682

Ali, S., & Shirazi, F. (2022). A Transformer-Based Machine Learning Approach for Sustainable E-Waste Management: A Comparative Policy Analysis between the Swiss and Canadian Systems. *Sustainability, 14*(20). https://doi.org/10.3390/su142013220

Al-Khateeb AJ, Al-Sari MI, Al-Khatib IA & Anayah F. (2017). Factors affecting the sustainability of solid waste management system—the case of Palestine. *Environmental monitoring and assessment, 182*(2):1-12.

Almulhim, A. I. (2022). Household's awareness and participation in sustainable electronic waste management practices in Saudi Arabia. *Ain Shams Engineering Journal, 13*(4), 101729.

Andeobu, L., Wibowo, S., & Grandhi, S. (2021). A Systematic Review of E-Waste Generation and Environmental Management of Asia Pacific Countries. *International Journal of Environmental Research and Public Health, 18*, 9051.

Anwar, Z. (2020). *Development of Policy and Regulations for Hazardous Waste Management in Malaysia. 5*(2).

Awasthi, A., & Li, J. (2018). Assessing resident awareness on e-waste management in Bangalore, India: a preliminary case study. *Environmental Science and Pollution Research, 25*.

Azlan, R., Abd Razak, S., & Indiran, L. (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*. https://doi.org/10.6007/IJARBSS/v11-i8/10609

Bevans, R. (2023, June 22). *Multiple Linear Regression | A Quick and Simple Guide*. Scribbr. https://www.scribbr.com/statistics/multiple-linear-regression/

Bhandari, P. (2023, June 21). *Population vs. sample: Definitions, Differences & Examples.* Scribbr. https://www.scribbr.com/methodology/population-vs-sample/

Camoens, A. (2024, August 13). Police crackdown on illegal e-waste factories in 4 states, 55 held [WATCH].

Cucos, L. (2022). *How to calculate Cronbach's Alpha in SPSS?* https://uedufy.com/how-to-calculate-cronbachs-alpha-in-spss/

Department of environment, 2018. Malaysia E-Waste Management in Malaysia. *Journal of Cleaner Production, 280*(12), 124-146.

Elytus. (2019). E-*Waste & its negative effects on the environment.* Elytus.

Fatin, N., Tukiman, I., Aslinda, N., Seman, A., & Mustaffa, S. A. (2021). A Study of E-Waste Disposal Management Awareness among Local Community based on KAP Model. *Research in Management of Business and Technology, 2*(2), 881–892.

Fishbein, M., & Ajzen, I. (1975). Belief, attitude, intention and behaviour: An introduction to theory and research (Vol. 27).

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), 1837.

Hamzah, A., Mohd Yahya, A., & Aziz, S. (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. https://doi.org/10.47836/pjssh.28.4.13

Ilankoon, I. M. S. K., Ghorbani, Y., Chong, M. N., Herath, G., Moyo, T., & Petersen, J. (2018). E-waste in the international context – A review of trade flows, regulations, hazards, waste management strategies and technologies for value recovery. *Waste Management, 82*, 258-275.

Isernia, R., Passaro, R., Quinto, I., & Thomas, A. (2019). The reverse supply chain of the e-waste management processes in a circular economy framework: Evidence from Italy. *Sustainability (Switzerland), 11*(8). https://doi.org/10.3390/su11082430

Islam, A., Ahmed, M., Awual, M., Rahman, M. A., Sultana, M., Abd Aziz, A., Monir, M., Teo, S. H., & Hasan, M. (2020). Advances in sustainable approaches to recover metals from e-waste-A review. *Journal of Cleaner Production, 244*, 118815. https://doi.org/10.1016/j.jclepro.2019.118815

Iyer, L. (2018). Knowledge, attitude and behaviour (KAB) of student community towards electronic waste a case study. *Indian Journal of Science and Technology, 11*, 1-9. https://doi.org/10.17485/ijst/2018/v11i10/109038

Jahan, D., & Mim, A. (2023). Evaluating the level of knowledge and awareness regarding e-waste among university students in Bangladesh. *International Journal of Economics, Commerce and Management United Kingdom, 11*.

Knudsen, E., Lien, L., Timmermans, B., Belik, I., & Pandey, S. (2021). Stability in turbulent times? The effect of digitalization on the sustainability of competitive advantage. *Journal of Business Research, 128*, 360-369.

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*, 378-389.

Laeequddin, M., Kareem Abdul, W., Sahay, V., & Tiwari, A. K. (2022). Factors That Influence the Safe Disposal Behavior of E-Waste by Electronics Consumers. *Sustainability, 14*(9), 4981.

Lau, Y.-Y., Kawasaki, T., Guan, J., & Not, C. (2021). An investigation into the attitude and behaviours of ferry passenger towards general waste management. *Ocean & Coastal Management, 213*, 105879.

Liobikienė, G., & Poškus, M. S. (2019). The Importance of Environmental Knowledge for Private and Public Sphere Pro-Environmental Behavior: Modifying the Value-Belief-Norm Theory. *Sustainability, 11*(12). https://doi.org/10.3390/su11123324

Liu, K., Tan, Q., Yu, J., & Wang, M. (2023). A global perspective on e-waste recycling. *Circular Economy, 2*(1), 100028.

Liu, Y., Hong, Z., Zhu, J., Yan, J., Qi, J., & Liu, P. (2018). Promoting green residential buildings: Residents' environmental attitude, subjective knowledge, and social trust matter. *Energy Policy, 112*, 152-161. https://doi.org/10.1016/j.enpol.2017.10.020

Llerena-Riascos, C., Jaén, S., Montoya-Torres, J. R., & Villegas, J. G. (2021). An Optimization-Based System Dynamics Simulation for Sustainable Policy Design in WEEE Management Systems. *Sustainability, 13*(20), 11377.

Mahat, H., Hashim, M., Nayan, N., Saleh, Y., & Norkhaidi, S. B. (2019). E-waste disposal awareness among the Malaysian community. *Knowledge Management and E-Learning, 11*(3), 393–408. https://doi.org/10.34105/j.kmel.2019.11.021

Memoriesandsuch. (2024, February 6). *Travel Bucket List: Malaysia Part 32 – Penang Part 1*. Memories and Such. https://memoriesandsuch.com/2024/02/09/travel-bucket-list-malaysia-part-32-penang-part-1/

Mohammed, S. (2022). E-Waste Management in Different Countries: Strategies, Impacts, and Determinants. *Advances in Green Electronics Technologies*.

Naik, S., & Satya Eswari, J. (2022). Electrical waste management: Recent advances challenges and future outlook. *Total Environment Research Themes, 1-2.*

Ng, S. L. (2020). Knowledge-intention-behavior associations and spillovers of domestic and workplace recycling. *The Social Science Journal.* https://doi.org/10.1080/03623319.2020.1735857

NST Online. https://www.nst.com.my/news/crime courts/2024/08/1090854/police-crackdown-illegal-e-waste-factories-4-states-55-held-watch

Online, S. (2024, June 27). Kedah DOE issues suspension order against Sg Petani factory. *The Star*.

Prabhu N, S., & Majhi, R. (2023). Disposal of obsolete mobile phones: A review on replacement, disposal methods, in-use lifespan, reuse and recycling. *In Waste Management and Research,41*, 18–36.

Ramzan, S., Liu, C., Munir, H., & Xu, Y. (2019). Assessing young consumers' awareness and participation in sustainable e-waste management practices: a survey study in Northwest China. *Environ Sci Pollut Res Int, 26*(19), 20003-20013.

Razali, M. S., Hara, H., Riyadi, F. A., Akhir, F. N. M., Othman, N., & Yuzir, M. A. M. (2021). Isolation and Characterisation of Copper Leaching Microbes from Sanitary Landfill for E-waste Bioleaching. *Journal of Advanced Research in Applied Sciences and Engineering Technology, 23*(1), 56–66.

Rezaei, S., & Ho, R. (2021). E-waste-word of mouth (EW-WOM) generation: a fuzzy set qualitative comparative analysis (fs/QCA). *Online Information Review, ahead-of-print*. https://doi.org/10.1108/OIR-11-2019-0343

Senthilnathan, S. (2019). Usefulness of Correlation Analysis. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3416918

Shad, K. M., Ling, S. T. Y., & Karim, M. E. (2020). Comparative study on e-waste management and the role of the basel convention in Malaysia, Singapore, and Indonesia: a way forward. *Indonesia Law Review, 10*(1), 63–84.

Singh, M. P., Chakraborty, A., & Roy, M. (2018). Developing an extended theory of planned behavior model to explore circular economy readiness in manufacturing MSMEs, India. *Resources, Conservation and Recycling, 135*, 313-322. https://doi.org/10.1016/j.resconrec.2017.07.015

Singh, S. (2024, May 27). Take stern action on officers who turned a blind eye to illegal ewaste plant, says Negri MB. *The Star*.

Srivastav, A. L., Markandeya, Patel, N., Pandey, M., Pandey, A. K., Dubey, A. K., Kumar, A., Bhardwaj, A. K., & Chaudhary, V. K. (2023). Concepts of circular economy for sustainable management of electronic wastes: challenges and management options. *Environmental Science and Pollution Research, 30*(17), 48654-48675.

Steven Nickolas. (2021). *Correlation Coefficients: Positive, Negative, Zero.* https://www.investopedia.com/ask/answers/032515/what-does-it-mean-if-correlation-coefficient-positive-negativeor-zero.asp

Sulaiman, N., & Chan, S. W. (2019). *Factors Influencing Recycling Intention among University Students. 8*, 337-340.

Sumargo, B. (2018). Comparing Better Environmental Knowledge Based on Education and Income Using the Odds Ratio. *Procedia Computer Science, 135*, 105-112. https://doi.org/https://doi.org/10.1016/j.procs.2018.08.155

Syahrul, E., Nazree, M., Aizul, A., Farah, A. (2022). The Study of E-Waste Management Awareness Among Students of UITM Seremban 3. *UiTM Cawangan Sabah 6* (1), 67–75. https://doi.org/https://ir.uitm.edu.my/id/eprint/80378

Taber, K. (2018). The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education. *Research in Science Education, 48*, 1-24. https://doi.org/10.1007/s11165-016-9602-2

Tanujaya, B., Prahmana, R., & Mumu, J. (2023). Likert Scale in Social Sciences Research: Problems and Difficulties. *FWU Journal of Social Sciences, 16*, 89-101.

Wang, Z., Guo, D., Wang, X., Zhang, B., & Wang, B. (2018). How does information publicity influence residents' behaviour intentions around e-waste recycling? *Resources, Conservation and Recycling, 133*, 1-9.

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.* 151-166.

Yuan, P., Mun, N., & Rajendran, S. (2019). A Study on Barriers to Implement E-Waste Management. *E3S Web of Conferences, 136*, 02026.

Zamani. Z (2016). *Malaysia's Recycling Rate is Still Low*. thesun.my.

Zhao, Z.-Y., Li, W.-B., Wang, P.-Y., Tao, H.-Y., Zhou, R., Cui, J.-Y., Zhang, J., Tian, T., Zhao, X.-Z., Wang, Y.-B., & Xiong, Y.-C. (2023). *Farmers' participation into the recovery of waste agricultural plastic film: An application of the Theory of Planned Behavior. Waste Management, 169*, 253-266.