ATTITUDE ON E-WASTE RECYCLING AMONG THE PUBLIC IN SELANGOR

Sikap Masyarakat Awam terhadap Kitar Semula Sisa Elektronik di Selangor

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ABSTRACT *Electrical and electronic waste (E-waste) is the definition of those appliances that are already used, broken, and ready to be discarded by the user. The public is seen as the backbone in ensuring the success of E-waste management through recycling activity. Hence, this cross-sectional study determined the attitude toward E-waste recycling activity among 813 respondents around Selangor. Upon completion of the chi-square analysis, there was a significant p-value <0.05 between the level of attitude among respondents with gender and educational background variables. Respondents with higher educational backgrounds and female respondents generally have a high level of attitude compared to other demographic backgrounds. It reflects that other groups of respondents require room for improvement to ensure that every group of publics achieve a high level of attitude over time. Since attitude is one of the factors that will help to improve public participation in E-waste recycling activity, this study can be used as the baseline for various stakeholders to create awareness and provide adequate information on E-waste recycling.*

Keywords*:* Attitude, E-waste, Public, Recycling, Selangor.

1. Introduction

Development and globalisation demand that everyone use electrical and electronic appliances in their daily lives. As time passes, these appliances become a necessity, resulting in an increase in demand and causing this sector to grow at a rapid pace. Variations in design and functions lead consumers to replace their appliances before the exact time, leading to a decrease in lifespan. E-waste is the term used to describe unwanted electrical and electronic appliances. Electrical and electronic waste (E-waste) can be defined as electrical and electronic appliances that have already been used, discarded, and are ready to be disposed of from commercial areas, industries,

Geografi Vol.13 (1), 131-148
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and households (Afroz et al., 2013; Tiep et al., 2015). E-waste contains arsenic, barium, beryllium, cadmium, chromium, and other types of valuable materials that are somehow able to pose a risk to the environment and human health via groundwater contamination and food chain if the E-waste is mismanaged (Kiddee et al., 2013; Akhtar et al., 2014; Tiep et al., 2015). E-waste is one of the global environmental issues as E-waste has been alarming globally due to its generation nowadays where; according to the Department of Environment, (DOE, 2024) estimated that the generation of E-waste in Malaysia will be up to 24.5 million units in 2025. There are a few factors that have driven the rise of E-waste, namely, economic growth, population growth, rapid technologies, and rapid urbanisation (Kalana 2010; Afroz et al., 2013; Akhtar et al., 2014; Shumon et al., 2014; Tiep et al., 2015; Borthakur & Govind, 2017). In Malaysia, generally, E-waste is underlined in the Environmental Quality Act 1974, on the First Schedule Environmental Quality (Scheduled Wastes) Regulations 2005 (code SW 110). E-waste can be defined as waste from electrical and electronic assemblies containing components such as accumulators, mercury switches, glass from cathode-ray tubes and other activated glass or polychlorinated biphenyl-capacitors, or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyl. In addition, starting in January 2008, E-waste in Malaysia was prohibited from being exported, and there will be no E-waste can be imported for disposal purposes (de Oliveira et al., 2012). According to Kalana (2010), based on the Environmental Quality Act 1974, it is clearly stated that no one can simply dispose of E-waste in landfills, where E-waste can only be recycled and recovered at the prescribed premises. Despite the legislation approach to E-waste, it only focuses on the industrialisation sector, and there are still no specific laws and regulations for handling E-waste for the household. This is one of the things that makes the management of E-waste challenging. Besides legislation, E-waste can be managed through recycling activity as E-waste contains precious materials that can be reused to reduce the amount in landfills. Hence, it will help to reduce the impact of groundwater pollution due to toxic leachate as well as to reduce the mining activity by obtaining secondary resources instead of using raw materials, which will be able to conserve energy (Yusof et al., 2011; Jaiswal et al., 2015; Rhee, 2016).

Department of Environment (DOE) has initiated fixed recycling centres (FRC) and mobile recycling centres (MRC) in a few states in Malaysia, namely Selangor, Kuala Lumpur, Melaka, Johor, Negeri Sembilan and Pulau Pinang (DOE, 2018). Apart from FRC and MRC by DOE, there are a few other approaches from the Malaysian Communications and Multimedia Commission (MCMC), Pertubuhan Amal Seri Sinar (PASS), Taiwan Buddhist Tzu-Chi Foundation Malaysia, UrbanR Recycle+, SOLS Tech, and T-Pot Electrical & Electronics that also provide recycling facilities for the public to send off their E-waste. Aside from legislation and facilities, public participation also plays an important role in practising sustainable waste management. As a waste generator, the public should take responsibility for managing their E-waste. Hence, this will help improve the environmental quality

(Afroz et al., 2013). Public participation with aid from the government, stakeholders, and NGOs will produce a good output. End-of-life management strategies such as E-waste recycling will help to lessen the environmental impact of metal refining and mining in the manufacture of electrical and electronic appliances (Buechler et al., 2020). Focusing on E-waste recycling, this activity will not only give an advantage towards the environment but, with the engagement of various parties able to create a material cycle society and, throughout this approach also, will create an economic opportunity via circular economy (Malik et al., 2015; Awatshi et al., 2018). According to Saxena et al. (2018), an individual's attitude will lead to processing, analysing, and deciding if this individual is provided with adequate knowledge. However, when a community does not have equal access to knowledge, this results in a group of publics who are better informed than others. With the adaptation of the Attitude part from the Knowledge, Attitude, and Practices (KAP) survey-based theory, the current status of public participation in E-waste recycling activity around Selangor has been measured. Aside from being a survey-based theoretical study, the KAP study also aimed to collect information on what a certain group knows, believes, and does regarding a specific topic (Tabash et al., 2016). Attitude is how an individual feels and thinks, which relates to his beliefs, emotions, knowledge, and values. It is important to highlight an individual's attitude as it might help change their current habit. Besides the attitude that can help to measure the current awareness, it is also considered as an outcome or response based on the information received (Babei et al., 2015; Darby & Obara, 2005; Launiala, 2009; Tukiman et al., 2021).

2. Literature Review

2.1 Recycling as a part of the waste management hierarchy

Modernisation necessitates proper management of electrical and electronic appliances for daily use. E-waste, a complex product, requires special end-of-life requirements, as noted by Cole et al., (2019), highlighting the importance of effective strategies to prevent unattended appliances. The waste management hierarchy is a ranking system based on the most environmentally friendly options, ensuring that all types of waste are managed according to this hierarchy, according to ISM Waste and Recycling (2021) and the Department of Environment Food and Rural Affairs (2011). The waste management hierarchy emphasises pollution reduction through waste prevention, followed by reuse, recycling, and treatment as preferred disposal strategies over landfilling. Recycling waste requires specific attention and handling, according to the legislation (Abalansa et al., 2021; Cole et al., 2019). Recycling is the process of turning outdated and discarded materials into new ones with comparable or different uses, according to David et al. (2019). This is equivalent to the point made in Conserve Energy Future (2018) that recycling is the process of reprocessing and

Geografi Vol.13 (1), 131-148
ISSN 2289-4470 /eISSN 2462-2400

reusing waste. The first and most important step in the waste recycling process is segregation. The segregation procedure at the source will be one possible method to guarantee the effectiveness of the waste recycling, recovery, and reusing strategy, suggest Kihila et al. (2021). For instance, recycling E-waste can help recover valuable materials like metals since, like recycling in general, it turns device streams into material streams (Gunarathne, 2015). This demonstrates that the recycling strategy may be used to recover valuable resources. Additionally, recycling E-waste is a sustainable solution to the substantial environmental tonnage of E-waste in both developed and developing nations (Abalansa et al., 2021; Cole et al., 2019). Recycling is the most ecologically responsible method of disposing of waste since it creates new products while using less raw resources, according to the ISM Waste and Recycling (2021). Furthermore, recycling activities not only lessen the requirement for raw materials and the energy used to extract them, as mentioned by Madanhire et al. (2019) and Naik and Eswar (2022).

2.2 E-waste recycling and the national goals

According to Conserve Energy Future (2018), Fuller et al. (1996), Jekria and Daud (2016), Malik et al. (2015), and Schill and Shaw (2016) – Consumers are in charge of transporting unwanted electronics and electrical appliances to merchants or collectors as part of the household waste category known as "E-waste." Recycling promotes sustainability and works to create a sustainable community. It is the most effective way to combat the current waste growth, which is becoming a problem for now rather than just the future. Recycling initiatives lower the amount of waste that ends up in landfills, promote a material cycle society, and utilise less energy and raw resources. The implementation of E-waste recycling activity among the public will help to achieve the national goal of sustainable waste management. The Sustainable Development Goals (SDG) 2030, the Twelfth Malaysia Plan (2021–2025), and Net Zero by 2050 align with this. To achieve sustainable long-term economic growth, the Twelfth Malaysia Plan (2021–2025) aims to transform the nation by tackling social problems and obstacles. A cleaner and more sustainable environment is another goal of this national strategy. The country's production rises when the environment is safe and well-maintained, and this is linked to the economic system.

Chapter 8 of the Twelfth Malaysia Plan (2021–2025) highlights the need to promote green growth for resilience and sustainability. A new household E-waste policy will be implemented, along with the wider producer responsibility for E-waste that the Twelfth Malaysia Plan aims to achieve. Global planning must be carried out concurrently with the creation of a national plan. SDG 2030 is being followed in the development of this twelfth Malaysian plan. For instance, SDGs 11: Sustainable Cities and Communities and 12: Responsible Consumption and Production are parallel to waste management planning. Each stakeholder, including NGOs, the commercial sector, and the general public, must be involved in sustainable waste management at the national level. This will assist in achieving

SDG-11's objectives, which is to concentrate on municipal and other waste management to lessen the environmental impact on cities by 2030, in addition to supporting the national aim. In addition, two of SDG-12's objectives must be met: (i) reducing waste creation through reuse, recycling, reduction, and prevention and (ii) ensuring that the general population is adequately informed about sustainable development and how to coexist peacefully with the environment. A nation will eventually help to improve the global environmental condition by 2030 if it does this.

Additionally, the public has to be encouraged to recycle E-waste right away. This is because the general populace uses electrical and electronic devices till they turn into E-waste. Because such undesired appliances are harmful and poisonous, they cannot be thrown away. They must be disposed of to guarantee that valuable elements from E-waste may be recovered through recycling activities. E-waste should be segregated at the source, such as the house. The general public should thereafter send E-waste to an authorised mobile E-waste container or a formal recycling centre.

Achieving Net Zero by 2050 would greatly benefit from this public involvement. Recycling and other sustainable E-waste management practices, for instance, would significantly cut greenhouse gas emissions using less energy. The need for virgin resources is decreased when recycled materials are used to create new items. By doing this, greenhouse gas emissions from the mining or exploiting virgin materials are decreased. Additionally, using recycled resources to make items requires less energy than using raw materials.

3. Study Area

Selangor is one of the 13 states in Malaysia located in the central part of the west coast of Peninsular Malaysia, bordered by Perak in the north, Negeri Sembilan in the south, Pahang in the east, and Straits of Malacca in the west (Portal Rasmi Kerajaan Negeri Selangor, 2018; Portal Rasmi Jabatan Perangkaan Malaysia, 2019). Selangor has nine districts, namely, Gombak, Hulu Langat, Hulu Selangor, Kuala Langat, Kuala Selangor, Sabak Bernam, Sepang, Klang, and Petaling, with a total population of 5,462,141 (Portal Rasmi JPBD Negeri Selangor, 2017). Figure 1 shows the map of Selangor.

Geografi Vol.13 (1), 131-148
ISSN 2289-4470 /eISSN 2462-2400

Figure 1. *Maps of Selangor*
Source: Authors

Selangor was declared the first developed state in Malaysia in 2005 and contributed 22.7% of the Gross Domestic Product (GDP) to the National economy in 2016 (DOSM 2017; Portal Rasmi Kerajaan Negeri Selangor 2018). Selangor's performance is contributed by a few economic sectors, namely, services supported by business services, communication, finance and insurance, real estate, retail, and wholesale. In contrast, manufacturing sectors are supported by electrical and electronic, motor vehicles, and transportation (Abdullah, 2017). As Selangor is growing rapidly through urbanisation, population, and economics, it is not excluded from facing the issue of waste management. Portal Rasmi JPBD Negeri Selangor (2017), as reported by Selangor, generated about 4,800 tons of waste per day, and this number is expected to increase to 7,200 tons per day in 2035. Waste collection in Selangor is conducted every three to seven times a week and is managed by KDEB Waste Management (KDEB Waste Management, 2019). However, the figures reported are primarily connected to solid waste and do not directly address Selangor's existing E-waste management. Since there are no clear standards on how to treat household E-waste, it has become an issue in recent years. Household Schedule Waste Regulations

202X are still being developed and have yet to be released by the Department of the Environment. Aside from the legislation, E-waste must be managed properly by the general public. As a result, the purpose of this study is to examine the public's current attitude toward E-waste recycling in Selangor. This is a significant step in establishing a database and information about the current situation. E-waste management still has room for improvement not only in Selangor but throughout Malaysia.

4. Research Methodology

4.1 Sampling and conducting survey

This cross-sectional study primarily focused on determining the attitude toward E-waste recycling among the public in Selangor based on their demographic background. To determine the present level of attitude toward E-waste recycling, the study conducted a questionnaire-based survey with 813 sample respondents who were residing in Selangor. The data collection was conducted through the face-to-face method as it is an effective way. Besides, the response rate of face-to-face data collection is up to 98% (Huang et al., 2006; Vidanaarachchi et al., 2006; Zhuang et al., 2008; Babaei et al., 2015).

4.2 Instrument

A set of questionnaires-based surveys consisting of two parts, namely **Part A:** *Demographic Background* and **Part B:** *Attitude on E-waste Recycling,* have been distributed to the public in Selangor. Demographic background, gender, age, educational level, and occupation were underlined in this section. The demographic background is an important element in determining the association with the level of attitude among the public in the particular study area (Castagna et al., 2013 & Chu et al., 2016 in Almasi et al., 2019). As for Part B, there were seven questions related to attitudes toward E-waste recycling which all questions were adopted from the previous study conducted by Vicente and Reis (2007); Kalana (2010); Wang et al. (2011); Ghani et al. (2013); Babaei et al. (2015); Tiep et al. (2015); Sivathanu (2016); Stoeva and Alriksson, (2017); Almasi et al. (2019). The variables used for the assessment of attitude were about the management of E-waste as well as participation in managing the E-waste by focusing on recycling and segregation activities. Each variable was classified into yes or no responses.

Geografi Vol.13 (1), 131-148
ISSN 2289-4470 /eISSN 2462-2400

4.3 Research design and data analysis

A quantitative methodology approach is used in this study based on the method of questionnaires-based survey and application of statistical analysis. Statistical analysis was done using Statistical Package for Social Science (SPSS – version 23). The level of attitude toward E-waste recycling among respondents in Selangor was calculated and reported in percentage (%). To determine the association between demographic background and level of attitude toward E-waste recycling, they were calculated using the p-value. All the calculated descriptive data and chi-square analysis data have then been tabulated.

5. Findings and Discussion

5.1 Demographic background of respondents in Selangor

The first part of the questionnaire survey underlines four questions on demographic variables, namely, gender, age, educational background, and occupation. Table 1 reported the frequency and percentage of demographic background of respondents in Selangor.

Table 1.
Demographic background of respondents in Selangor (N=813)

Demographic background		Frequency	Percentage (%)
Gender	Male	321	39.5
	Female	492	60.5
Age	< 24 years old	308	37.9
	25-34 years old	334	41.1
	35-44 years old	98	12.0
	45-54 years old	48	5.9
	> 55 years old	25	3.1
Educational background	Higher Education	635	78.1
	High School	174	21.4
	Primary School	3	0.4
	No Formal Education	1	0.1
Occupation	Government Sector	110	13.5
	Private Sector	353	43.4
	Self Employed	91	11.2
	Housewife	39	4.8
	Student	211	26.0
	Pensioner	9	1.1

Source: Data collection

From the total of 813 respondents, most respondents were female (60.5%), and male respondents reported about 39.5%. Table 1 shows that respondents aged between 25

and 34 years old make up the highest percentage of up to 41.1%, while the least respondents aged more than 55 years old cover only 3.1% of the total 813 respondents. Meanwhile, 78.1% of the total respondents have a higher education background, and it was also discovered that 353 (43.4%) of respondents work in the private sector.

5.2 Level of attitude on E-waste recycling

It is important to determine the public's attitude to acknowledge their behaviour and ways to encourage them. Hence, there is a link between pro-environmental attitudes and recycling behaviour (Singhirunnusorn et al., 2017). In this study, there were seven questions related to attitude toward E-waste recycling, namely, *(Question 1)* segregation of waste, *(Question 2)* participation in recycling campaign, *(Question 3)* incentive given due to participation, *(Question 4)* willingness to send off the E-waste to the collection centre, *(Question 5)* upgrading electrical and electronic devices, *(Question 6)* willingness in reducing the E-waste, and *(Question 7)* managing the E-waste only if it is convenience. Each of the questions was given a score suggested by Padilla and Trujillo (2018). For positive attitude will be given 1 mark, and for each negative attitude will be given 0 mark. For respondents that score between 0 and 3 marks, it is underlined as a low level of attitude, and scores between 4 and 5 marks a moderate level of attitude. Respondents who score 6 to 7 marks have a high level of attitude. Questions 3, 5, and 7 underline negative attitudes as respondents were only willing to recycle if incentives were given and convenience. Besides, upgrading electrical and electronic devices is considered a negative attitude as it will increase the amount of E-waste. Table 2 reported the total frequency and percentage of respondents based on their level of scores.

Table 2.
Level of attitude on E-waste recycling among the public in Selangor.

Scores	Mean±SD	Total Frequency	Percentage	Level of scores
0-3	4.27±0.971	121	14.9%	low
4-5		615	75.6%	moderate
6-7		77	9.5%	high

Source: Data collection

The questionnaire output, which was administered and reported in Table 2 it was noted that 121 (14.9%) from 813 respondents in Selangor have a low level of attitude regarding E-waste recycling, 615 (75.6%) have a moderate level of attitude that reported the highest percentage, and only 77 (9.5%) from the total respondents have a high level of respondents. It can be seen from this that the majority of respondents have a moderate level of attitude. According to Mannetti (2004); Barr (2007); Akil et al., (2015); Padilla and Trujillo (2018), attitude will eventually impact the behaviour

Geografi Vol.13 (1), 131-148
ISSN 2289-4470 /eISSN 2462-2400

of a person. Those individuals who already have a positive attitude toward E-waste recycling can be a positive influence and role model for others in their communities. Respondents must have adequate information and knowledge for low and moderate scores, which will encourage them to be pro-environmentalists. For example, according to Padilla and Trujillo (2018), the willingness of the public to separate their waste can be influenced by internet usage. The internet is one of the common sources of information nowadays. It is essential for each member of society to engage in social interaction as a means of sharing information and raising awareness. Information should be obtained from various sources, including print and digital. Besides that, convenience is also important in increasing the attitude of respondents. As suggested by Nixon and Saphores (2009), even though a group of people are less concerned about the environment, that group of people will eventually recycle if they find it convenient for them to do so. This study has shown that the majority of the respondents in Selangor, 82.8%, agreed that they are only willing to manage the E-waste if it is convenient, such as collection at home or in the workplace. The remaining percentage of respondents do not mind if there is no collection at home or in the workplace. The respondents willingly recycle their E-waste.

5.3 Association between demographic background and level of attitude

According to Lopez-Mosquera et al. (2015) and Padilla and Trujillo (2018), demographic variables are able to measure the differences in the level of attitude among the public. Singhirunnusorn et al. (2017) stated that educational background and gender did not show significant differences in the level of attitude. Meanwhile, in this study, as referred to in Table 3, both educational background and gender, which underline P-value <0.05, demonstrate significant differences in the level of attitude, reported 0.042 and 0.012, respectively.

Table 3.
Association between demographic background and level of attitude toward E-waste recycling among the public in Selangor.

Demographic background	P-value	Remarks
Gender	0.012	Significant
Age	0.059	Not significant
Educational background	0.042	Significant
Occupation	0.554	Not significant

Source: Data collection

It was discovered that females tend to have high levels of attitude scores between 6 and 7 marks, and about 76.6% of the total respondents with high levels of attitude were female. This result differs from the study by Owusu et al. (2013), where male respondents in Ghana reported having a high level of attitude toward waste recycling. However, from the total respondents that scored between 0 and 3 marks,

females also tend to have a lower level of attitude than males. It was proved that 53.3% of respondents with a low attitude level were female. The differences between these two situations might be influenced by other factors that can be investigated more. When comparing male and female respondents, female respondents show a more positive attitude toward E-waste recycling. The explanation behind this must be that women are more concerned about environmental issues, particularly those affecting households. Females pay more attention and focus than males. However, comparable data show that when compared to male respondents, female respondents in Selangor have a lower level of attitude. Based on this, it is clear that within the same female community, there are two distinct groups with opposing attitudes regarding E-waste recycling. This situation is similar to that suggested by Saxena et al. (2018). When knowledge is not spread evenly, there will be a group of people who are better informed than others. A study conducted by Sivannatham and Govindarajan (2020) discovered that female respondents have a better attitude toward E-waste management than male respondents. However, gender variables do not have an association with the attitude variable. Even though the descriptive analysis showed a similar output to the present study, the association reported otherwise.

In terms of educational background, respondents with higher educational backgrounds reported the highest percentage of respondents who have a high level of attitude. Reportedly, 84.4% of 77 respondents who have a high level of attitude were from higher educational backgrounds. This result is consistent with Zen et al. (2014) study that also underlines respondents with higher educational backgrounds tend to have positive environmental attitudes. However, the results differ from the study by De Feo and De Gisi (2010) and Padilla and Trujillo (2018), which underlined that higher education levels did not impose a high level of attitude. According to the findings, individuals with a higher educational background had a more positive attitude toward E-waste than those with a lower educational background. This is due to disparities in the amount of knowledge and information received by an individual based on their level of education. The exposure, surroundings, and community all have an influence, resulting in varied levels of attitude depending on the level of education. Furthermore, Nanath and Kumar (2021) stated that at a higher level of education, there is an integration of sustainability in the curriculum, student life and outreach activities.

Attitude works as a psychological emotion that determines how an individual feels and thinks about something, either positively or negatively (Babaei et al., 2015; Jekria & Daud, 2016). This study reveals that several members of the public in Selangor have a higher educational background. Also, females, in general, have a high level of attitude toward E-waste recycling. The level of attitude toward E-waste recycling among the public in Selangor as a whole was still at a moderate to low level. It was proved that the public in Selangor willingly segregates their waste, would like to take part in a recycling campaign, willingly send off their E-waste to the collection centre, and have the intention to reduce their E-waste generation. All

Geografi Vol.13 (1), 131-148
ISSN 2289-4470 /eISSN 2462-2400

this is considered a positive attitude that will help encourage the public to practice sustainable E-waste management practically. However, the public also needs incentives and facilities to boost their intention to participate in E-waste recycling activities. The study conducted by Malik et al. (2015) revealed some factors that lead the public not to segregate and recycle their waste, namely, distance from their houses to recycling centres, limited spaces and bins at source, and time constraints. Besides, in this era of technology and modernisation, the public in Selangor tends to upgrade their electrical and electronic equipment due to features and style, which is considered an attitude that might increase the amount of E-waste. This negative attitude can be improved by adequate knowledge and information regarding the importance of E-waste recycling, the effects of mismanagement of E-waste, the location of the E-waste recycling centre, and any information related to E-waste. Attitude can be changed with adequate knowledge and information as attitude is related to feelings, issues, or objects (Petty & Cacioppo, 1981; Desa et al., 2011). All the related information must be delivered from various sources because the public has different backgrounds and prefers different types of medium of information. Responsibility bodies such as government, stakeholders, and NGOs also play an important role in providing the public with information related to E-waste recycling.

6. Conclusion

In conclusion, the study was able to acquire information on public attitudes toward E-waste recycling in Selangor. Overall, the findings reveal that the majority of respondents have a moderate level of attitude, with the capacity to raise their attitude to a high level from time to time. However, it took the cooperation of various stakeholders, namely the consumer, collectors, local authorities, manufacturers, NGOs, policymakers, and retailers to accomplish this. Even though it is difficult to efficiently deal with E-waste, particularly household E-waste, for which no legal framework has yet been established, the issue must be treated seriously. Information must be available for the public to grasp in ways that foster a good attitude among the general public. E-waste information should be made available in various media and through educational campaigns. Aside from information and knowledge, discoverable convenience should be considered seriously to increase public participation in E-waste recycling. Convenience must be measured regarding the recycling centre's location, accessibility, and distance. According to the data, the majority of female respondents, as well as those with a higher level of educational background, reported showing a positive attitude. The study's findings also show that gender and educational background have significant p-values regarding attitudes toward E-waste recycling. It is recommended to highlight which demographic background reported significantly since this will aid in determining which group of the public requires extra attention in improving their attitude toward E-waste recycling. The responses to the public's attitude toward E-waste recycling are useful in recognising the current condition among the public. Policymakers, for

example, can use the findings to develop a legal framework for household E-waste management, particularly in terms of creating a recyclable consumer. Lastly, to comply with health regulations, every household should be encouraged to separate, transport, and choose recycling as a disposal method. This is to ensure, preserve, and improve environmental and human health in the future by limiting the effects of E-waste.

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Author Contribution Statement
Amirah Sariyanti & Tengku Adeline Adura Tengku Hamzah: Conceptualization, methodology, reviewing and editing.

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The author's confirm that the data supporting the findings of this study are availability within the article.

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