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E-Waste Management Systems in Shah Alam City: Household Awareness and Behavior

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Abstract
E-waste management has grown in importance in the current technology-based world when the use of electronic equipment is increasing and making the switch to sustainable management more difficult. E-waste generation in Malaysia increased significantly between 1981 and 2020, and it is anticipated that this trend will continue in the years to come. In order to lessen risks to public health and the environment and to increase the reuse, recycling, and recovery of valuable e-waste resources, several governments have been compelled to adopt and enforce environmentally friendly management. However, constraints such as household awareness and behavior make government policies more difficult to implement. Therefore, determining household awareness of and behavior toward e-waste management systems in Shah Alam city is the purpose of this paper. A screening form sent to households based on the specified criteria resulted in 10 participants being selected for the survey in January 2022. The results of the study showed that household awareness and behavior regarding e-waste management in Shah Alam have become complicated due to the generation, separation, and recycling aspects. As a long-term sustainability approach, this study highlights the need for encouraging environmentally friendly practices and educating people on how to minimize electronic waste while still fulfilling household needs.
Keywords: Awareness, Behaviour, Constraints, Environmental, E-waste Management.

Introduction

Malaysia's population growth has prompted waste to increase, which has resulted in a massive concern (Ali et al., 2018; Izzati et al., 2020; Kalana, 2010; Samsudin & Don, 2013; Yong et al., 2019). According to projections, the population will reach 32.7 million in 2021 and 37.4 million in 2030 as cities continue to grow (Ali et al., 2016; Bong et al., 2017). It resulted in an excessive amount of municipal solid waste (MSW) creation, which ensures effective management (Aja & Al-Kayiem, 2014; Ali & Ho, 2021). MSW is a broad term that refers to a variety of solid wastes generated by cities and municipalities as a result of consumer activities, such as electronic, biodegradable, and composite waste, as well as medical waste (Magutu & Onsongo, 2011; Noor et al., 2020). In Malaysia, MSW is currently produced and processed at a rate of 25,000 metric tonnes per day, or 0.5-1.9 kilogram per capita per day (Aja & Al-Kayiem, 2014; Ghani, 2021). A significant portion of the country's e-waste is generated as a

result of population increase, fast urbanization, and high demand for electronic gadgets, as well as their final disposal at the end of their useful life (EoL) (Almulhim, 2022; Attia et al., 2021; Miner et al., 2020).

E-waste, also known as electronic waste, has existed in Malaysia since the 1940s when electrical devices were first introduced (Alias, 2015). Any electronic device that is no longer functional, has expired, or has been discarded by its user is referred to as "e-waste" (Ogbenna et al., 2018; Priya, 2018; Rani et al., 2021). This category includes all significant electrical and electronic devices, including televisions, washing machines, laptops, and computers (Prueksasit et al., 2020). Around 20 to 50 million tonnes of electronic waste are reportedly dumped annually throughout the world (Dato, 2014), and the United Nations estimates that e-waste makes up roughly 5% of municipal waste. According to DOE (2022) study data, Malaysia would create 24.5 million units of e-waste by 2025 and is predicted to generate around 365,000 tonnes of e-waste per year (Hakim, 2022) (Figure 1). E-waste typically originates from a range of sources, including industry and household e-waste (Osman, 2016). Due to the industry's historical reliance on electronic equipment to increase production efficiency, it used to be the primary producer of e-waste. But today, households are primarily responsible for the rise in e-waste (W. Wang et al., 2017).

Based on the number of electronic appliances purchased from the market, household e-waste is anticipated to be much larger (DOE, 2020) and primarily disposed of via the informal sector as they prefer to rid of their e-waste by selling it to a second-hand dealer or simply throwing it away (Osman, 2016). If this e-waste is not properly disposed of, both the environment and human health are at risk (Priya, 2018; Senawi & Sheau-ting, 2020; Vildan, 2017). Previous researchers have agreed that household awareness and behavior are one of the major contributions to poor E-WMS (Almulhim, 2022; Attia et al., 2021; Kalana, 2014; Mahat et al., 2019; Tiep et al., 2015). Therefore, determining household awareness of and behavior toward e-waste management systems (E-WMS) in Shah Alam city is the purpose of this paper. The government, society (households), and other related stakeholders will gain further advantages from this study's findings as they work to address Malaysia's e-waste issues through planning, management and legislation. The government can put policies into practice and apply them in housing areas with the backing of all stakeholders to lessen consequences on environmental and human health due to e-waste issues. The household can alter their approach to properly managing e-waste and adopt sustainable e-waste management in the future to lower e-waste generation. In short, this paper is significant for assisting the government in meeting the SDGs by 2030.

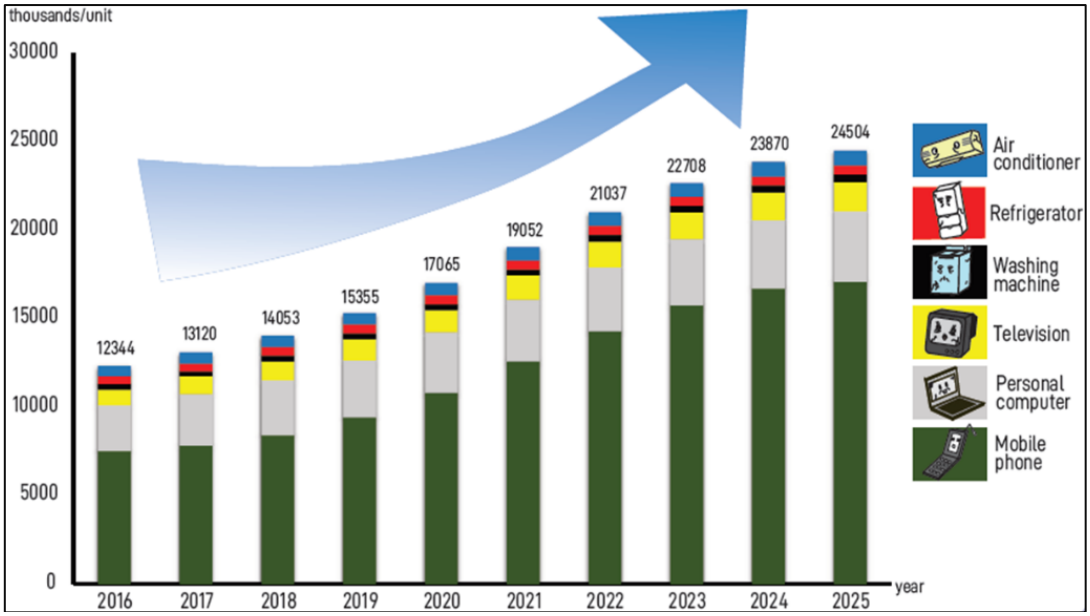

Figure 1. Projection of E-waste Generation in Malaysia
Source: DOE (2022)

Literature Review

Electronic waste, often known as e-waste, is the term for the users' dumped electrical and electronic devices that have reached the end of their useful lives or are no longer desired by the users (Mahat et al., 2019; Mmereki et al., 2016; Ogbenna et al., 2018; Priya, 2018). Large household appliances (freezers, washers, microwaves, etc.), small household appliances (vacuum, toasters, grinders, etc.), IT and telecommunication equipment (mobile phones, computers, laptops, etc.), consumer equipment, lighting equipment, and other items can all be classified as part of the ten categories that make up e-waste (Khan et al., 2019; Shad et al., 2021). When referring to managing e-waste flows, which include generation, collection, transportation, recovery, and disposal, it is important to note that improper management of these flows can have a negative impact on the environment and human health due to hazardous substances contained in e-waste (Mmereki et al., 2016). Lead, mercury, beryllium, cadmium, arsenic, polyvinyl chloride (PVC), brominated (BFR), are among the hazardous substances that will create a huge impact on human health and the environment when it is exposed to them (Prasad et al., 2019). Consequently, e-waste management systems (E-WMS) are essential for tackling the issue.

E-WMS that is appropriate involves a variety of stakeholders, including households, e-waste collectors, e-waste recovery facilities, and e-waste disposal. Industrial and household e-waste are the two major sources of e-waste in Malaysia (Yong et al., 2019). The electrical and electronic waste industry, often known as industrial e-waste, is regulated by the Environmental Quality (Scheduled Waste) Regulation 2005 (EQSWR 2005), as specified in the Environmental Quality Act 1974, through the "e-SWIS" manifest system, while the Department of the Environment (DOE) is implementing effective household e-waste generated by households, complete with a legislative framework, at the moment (DOE, 2020). According to the EQSWR 2005 regulations, e-waste cannot be disposed of in landfills (EQA, 1974). As opposed to this, e-waste must be recycled and recovered at facilities that have been approved or licenced, and it can only be disposed of in places that are authorised and in a sustainable manner (Suja et al., 2014). Only industrial e-waste is now properly managed (Osman, 2016) (Figure 2). Unlike industrial e-waste, the status of household e-waste is still

undefined due to the wide range of e-waste disposal choices available before the e-waste is recovered (Figure 3). Based on prior studies, household awareness and behaviour posed the greatest obstacle as a result of these problems. (Kalana, 2010; Mahat et al., 2019; Mapa et al., 2018; Suja et al., 2014; Tiep et al., 2015).

According to Almulhim (2022), one of the key criteria in constructing a long-term strategy E-WMS, which is vital in developing economically and environmentally sustainable management, is raising household awareness. Additionally, a number of research have examined how to raise household knowledge and behaviour concerning e-waste (Chi et al., 2014; Islam & Huda, 2020; Shad et al., 2021; Teck, 2013). Changing people's behaviours and raising their understanding of the environmental problem that e-waste presents have been the main strategy utilised in e-waste management. Consumers' changing attitudes and behaviours will significantly contribute to the management of e-waste dumping, the improvement of recycling techniques, and the reduction of e-waste (Kalana, 2010; Mahat et al., 2019; Soo et al., 2013). However, there are still insufficient steps being done to ensure the effective handling of e-waste in Malaysia (Rautela et al., 2021), and the action should be comprehensive in every way. Therefore, the generation, separation, storage, recycling, collection, transportation, recovery, and disposal are key components in E-WMS to assess how the country has adopted effective management and practises, not just in Malaysia but in all the other countries across the world (Ismail & Hanafiah, 2019; Mmereki et al., 2016).

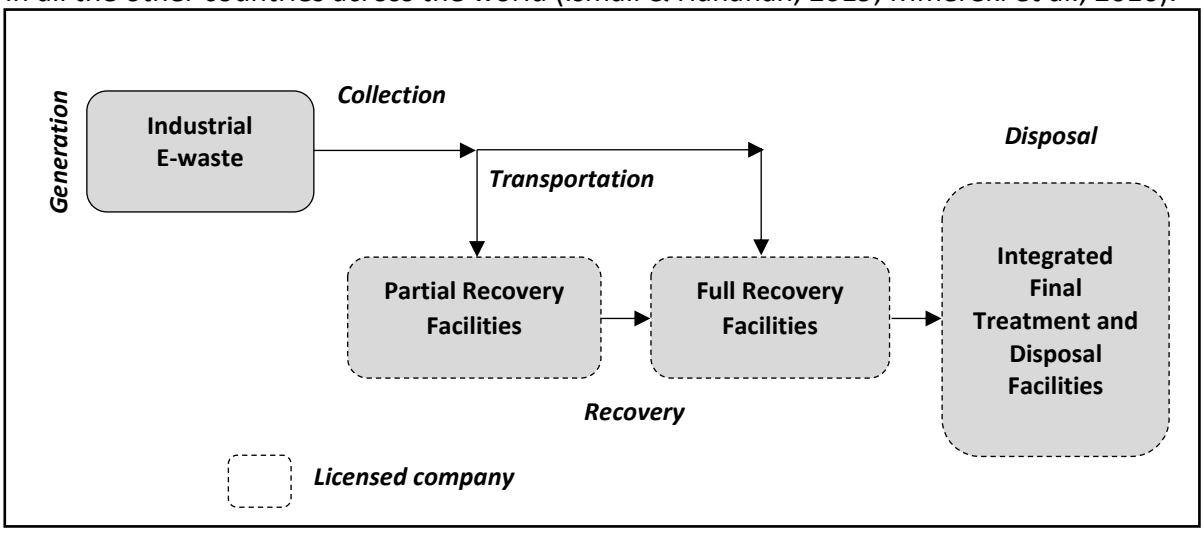

Figure 2. Industrial E-WMS in Malaysia
Source: Osman (2016)

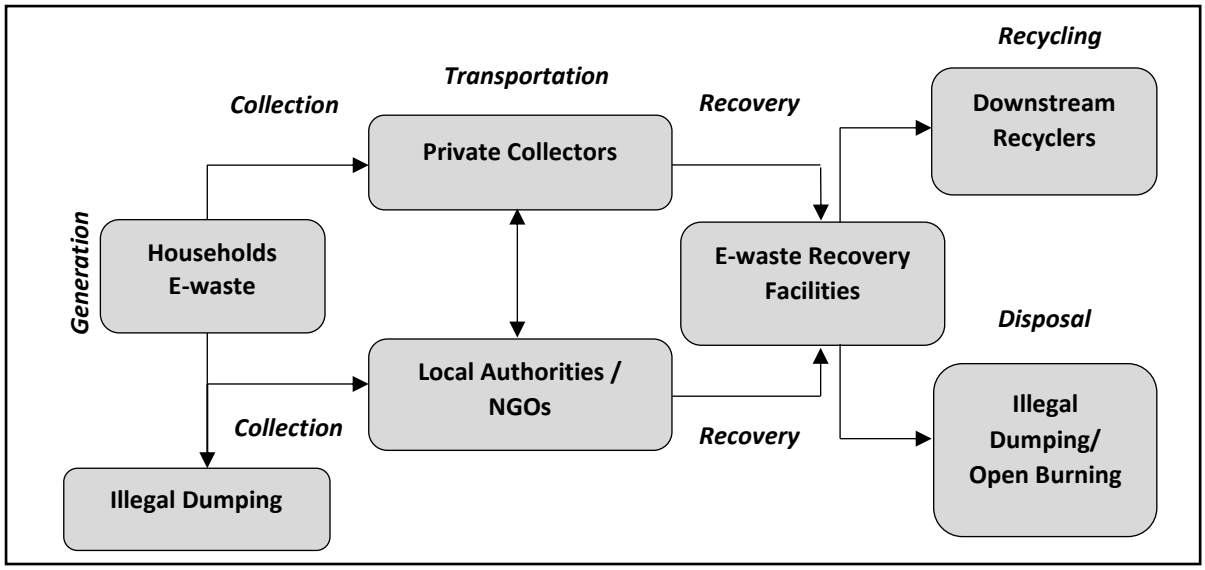

Figure 3. Household E-WMS in Malaysia
Source: Adapted from DOE (2020)

Methodology

A qualitative methodology was employed in the study of household E-WMS in Shah Alam city to determine household awareness and behaviour towards E-WMS. A semi-structured interview with 10 household representatives in Section U2 of Shah Alam city was done in January 2022 to gain a more in-depth understanding of the issues. Shah Alam city's Section U2 was chosen as the study location due to facilities provided by the local authority, such as e-waste collection points, recycling centres, and e-waste programmes, which are more concentrated in this area. Purposive methods were used to recruit participants until theme saturation was reached. Purposeful sampling was conducted utilizing previous ideas about the sample's needed features. Thus, the screening form used to choose participants based on the criteria specified produced 10 participants as a result. Participants must have generated e-waste (IT and telecommunication) and have lived in landed housing in Shah Alam for more than five years in order to meet the criteria. A number of inquiries regarding waste generation, separation, and recycling practices were asked of the participants. The interview was recorded, transcribed, and analysed for thematic contents using Atlas. ti software. This study presents household awareness and behaviours regarding the generation, separation, and recycling of e-waste in the city of Shah Alam based on the data collection method. Participant selection is depicted in Figure 4 below.

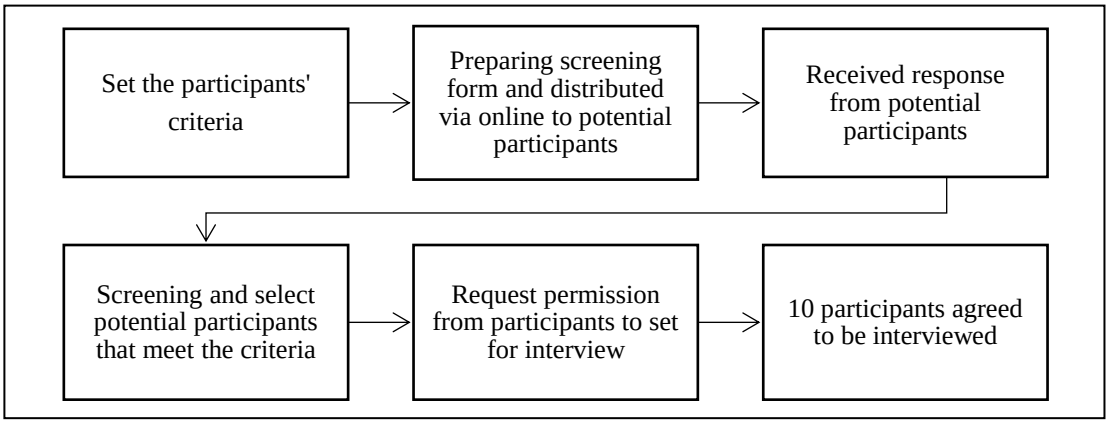

Figure 4. Process of Selecting Participants
Source: Authors (2022)

Results

10 participants were interviewed. Most of the participants were between the age of 40 to 50 years and 60% were male. All the participants experienced discarding the e-waste in Shah Alam city. The transcripts of the interviews were analysed, and three major themes linked to household awareness and behavior toward the e-waste management system in Shah Alam city were revealed; (1) waste generation, (2) waste separation, and (3) waste recycling. During the interview, several questions focusing on e-waste management related to household awareness and behaviour in Shah Alam city were asked of participants. Their responses are depicted in Table 1, Table 2, and Table 3 below.

Table 1
Participant's Responses to Household's Awareness and Behaviour (Waste Generation)

Question	Quotation References (Atlas.ti)	Answers
What types of e-waste were discarded, and how did you discard your e-waste?	1:1	"I have to discard computers and laptops that have major broken."
	1:10	"I discard it with other waste because I feel lazy to go to the recycling centre even though that place is not too far, but I just feel lazy. I don't repair it because the repair price is high, so I discard it."
	1:18 (Participant 1, Quotation 1, 10, 18)	"As a normal local, if we just need to discard only one or two items such as laptops, we just discard them in bins mixed with other waste."
	2:1 (Participant 2, Quotation 1)	"I have discarded mobile phones before this, discarded as usual in waste bins, put in plastic together with other solid waste, and the waste truck will collect every Monday or Wednesday."

3:6 (Participant 3, Quotation 6)	"Before this, I discarded my phone that had major broken with other waste in the general waste bin. Usually, I keep at home for items that have minor broken before I send them to shop for repair or trade-in."
4:1 (Participant 4, Quotation 1)	"I have all IT and telecommunication equipment. I have discarded one computer in the past two years. I send it to the recycling centre."
5:1 5:2 (Participant 5, Quotation 1, 2)	"My monitor is sold to people who come to the house." lack of understanding of the people. "There is one I send to the disposal centre in a box, and some I just put in used storage."
6:1 6:10 6:6 (Participant 6, Quotation 1, 10, 6)	"For items such as CPUs, monitors, and keyboards, I try to sell them first at a shop that accepts ICT items that take a relatively reasonable price. The closest shop is in Cyberjaya. But sometimes, I give it away for free with the price offered. For example, my monitor can be RM 5 if it needs to be repaired. If the item is outdated, I'll give it to them." "But I know we can send our e-waste to a neighbourhood recycling centre in U2. There is a collection run there. People that aware they will know, for people who aren't aware they don't know." "It's just a matter of getting a little reward if we send it to the store. If we send it directly, we won't get anything. A reward is like one item can get RM 5 is quite okay."

7:2 7:6 7:15 (Participant 7, Quotation 2, 6, 15)	"I have discarded mobile phones. For a laptop, I have one that is broken, but I keep it in my house." "If broken, I try to repair it first unless it cannot be fixed anymore or the cost for repair are too expensive and not worth it for repair, and then I'll throw it away." "Mobile phones that I discarded are mixed with other dry waste from my house such as old fabric, box, paper, etc."
8:1 (Participant 8, Quotation 1)	"I have discarded mobile phones and laptops." "If it's a minor broken handphone and laptops, I'll send it to repair at shops. If major, I'll throw it as it cannot be used anymore, and it's no point to keep."
9:2 (Participant 9, Quotation 2)	"Discard laptop in waste bins."
10:1 10:3 (Participant 10, Quotation 1, 3)	"I have discarded my laptop and mobile phone because it has major broken. I put it in a garbage bag. It's not worth money to repair because the repair price is high." "I decided to buy a new one than repair it because we don't know if repair how long these items will work again."

Source: Authors (2022)

According to participant responses, P2 (2:1), P3 (3:6), P7 (7:2), P8 (8:1), and P10 (10:1), the majority of participants have generated mobile phones. However, the majority of them disposed of the things improperly by placing them in waste bins with other waste, such as P1 (1:10), P2 (2:11), P3 (3:6), P7 (7:15), P8 (8:2), and P10 (10:1) did. As a result, their behavior and manner of disposing of the items reveal a lack of awareness regarding waste management.

Table 2
Participant's Responses to Household Awareness and Behaviour (Waste Separation)

Question	Quotation References (Atlas.ti)	Answers
Did you separate e-waste from other wastes before being collected or discarded?	1:5 (Participant 1, Quotation 5)	"I don't do waste separation as it has not been enforced yet. If no separation, you'll be charged for a compound."
	2:5 (Participant 2, Quotation 5)	"No. I discarded it as usual in waste bins with other solid waste."
	3:3 (Participant 3, Quotation 3)	"I'm not separating the E-waste; I usually mix all waste."
	4:1 (Participant 4, Quotation 1)	"Yes. Usually, I separated those items from other waste."
	5:5 (Participant 5, Quotation 5)	"I do separation for waste. I used to think that many did not cooperate because people didn't have time when they were on the ground. The management cost is relatively high."
	6:8 (Participant 6, Quotation 8)	"Usually, I separated kitchen appliances. But, electronic items are rarely. Waste like bottles I put down beside the waste bins because it's heavy for the contractor to lift the bins if I put everything in the bins."
	7:4 (Participant 7, Quotation 4)	"No. I put it together in a garbage bag with other waste from my house, but not mixed with food waste, just dry waste. Then the contractor will come to pick up the waste as usual."
	8:4 (Participant 8, Quotation 4)	"No. I only do separation for bottles, plastic, and aluminium. Other waste I just mix."
	9:6 (Participant 9, Quotation 6)	"I'm not separating because I only have two trash cans in my house. So, I put everything in that."
	10:5 (Participant 10, Quotation 5)	"No. I discard those items in garbage bags mixed with other waste, but only dry waste like plastic, bottles, etc."

Source: Authors (2022)

According to the responses in Table 2, P1 (1:5), P2 (2:5), P3 (3:3), P6 (6:8), P7 (7:4), P8 (8:4), and P9 (9:6) acknowledge that they do not separate their e-waste before throwing it out. These responses demonstrate the absence of household waste separating practices. Even the local authority has already informed the community about waste separation. Previous research has shown that some residents separated during collection but not all of them

provide additional support for the separation issue (Mapa et al., 2019).

Table 3
Participant's Responses to Household's Awareness and Behaviour (Waste Recycling)

Question	Quotation References (Atlas.ti)	Answers
Did you practice recycling the e-waste that you discarded?	1:9 (Participant 1, Quotation 9)	"For e-waste, I don't practice recycling."
	2:5 (Participant 2, Quotation 5)	"No, but I know the place for recycling, one at Section U2 (recycling collection point) and another at Section U13."
	3:5 (Participant 3, Quotation 5)	"No, I don't practice recycling for E-waste."
	4:5 (Participant 4, Quotation 5)	"Yes. Usually, we always repair those items once they break. If those items cannot be repaired, I send them to the recycling point Section U2."
	5:9 (Participant 5, Quotation 9)	"I'm not sending E-waste to recycle centre."
	6:12 (Participant 6, Quotation 12)	"No. Because I rarely discard e-waste and the quantity when I discard is not much only one or two items. Thus, I just discard it like other waste."
	7:12 (Participant 7, Quotation 12)	"No, but I think the E-waste campaign has been provided."
	8:7 (Participant 8, Quotation 7)	"No. Usually, I throw all waste together in the same garbage bag or the boxes I left in front of my house except for bottles, plastic, and aluminium. I separated them."
	9:8 (Participant 9, Quotation 8)	"No, I never send E-waste to the recycling point. Because the quantity is very small, like one or two items, I just discarded them in the waste bin."
	10:8 (Participant 10, Quotation 8)	"No. Because I rarely discard the e-waste and the quantity when I discard is not much, only one or two items."

Source: Authors (2022)

According to Table 3's replies from the participants, P1 (1:9), P2 (2:5), P3(3:5), P5 (5:9), P6 (6:12), P7 (7:9), P8 (8:7), P9 (P9:8), and P10 (10:8) acknowledge that they do not regularly recycle their e-waste. As a result, Shah Alam city's recycling programme can be said to still be insufficient, which places limitations on and presents difficulties for waste reduction. This issue is also reinforced by an earlier study, which shows that Malaysians' negative attitudes regarding recycling e-waste are the main cause of the country's e-waste problems (Kalana, 2010; Mahat et al., 2019; Tiep et al., 2015).

Discussion

The biggest obstacles for E-WMS are household awareness and behaviour. Waste management won't be successful unless households are aware of it and behave well. These difficulties came about as a result of participants' comments regarding their e-waste disposal

methods and recycling procedures. The e-waste produced by households in Section U2 (a landed urban neighbourhood) comes from IT and communications equipment. Their e-waste disposal practises can be deemed bad because some of them continue to dump broken items in the waste bin with general waste due to inadequate e-waste storage. E-waste storage is currently provided in Shah Alam city in recovery facilities and a recycling collection point for short-term storage. E-waste storage is not provided by the local authorities in residential areas. Additionally, households still don't practise separation very often because they enjoy mixing waste in the available general waste bins without separation. Although Section U2's recycling centre offers facilities for residents to dispose of their e-waste, not all of the residents are aware of their availability, which has a negative impact on the amount of e-waste that is recycled. Environmentally friendly practices must be applied at all levels in order to address these issues and guarantee that the risk of e-waste may be kept to a minimum. To make waste collection easier, waste separation must be made a mandatory practice in the home. To avoid waste mismanagement, every household must separate their waste from their house according to waste classifications. Imposing a compound on people who do not exercise separation, on the other hand, is important to ensure that the items are not discarded wrongly. Since some individuals enjoy engaging in activities that can result in a reward, such as receiving vouchers, the community should be rewarded for recycling by the local government. The results are summarised in Table 4.

Table 4
Summary of Results

Household's Awareness and Behaviour Challenge
• Households still discard e-waste in regular waste bins, and some are stored at home. [P1 (1:10), P2 (2:11), P3 (3:6), P7 (7:15), P8 (8:2), P10 (10:1)]
• During the collection, some of the residents are doing separation, and some are not. [P1 (1:5), P2 (2:5), P3 (3:3), P6 (6:8), P7 (7:4), P8 (8:4), P9 (9:6)]
• Households lack recycling practices as they think the number of their items to be discarded is less, and they prefer throwing them in regular waste bins than going to a recycling centre to send one or two items. [P1 (1:9), P2 (2:5), P3 (3:5), P5 (5:9), P6 (6:12), P7 (7:9), P8 (8:7), P9, (9:8), P10 (10:8)]

Source: Authors (2022)

Limitation

The limitations of the study should be considered when interpreting these results. The study setting is a large urban area with a high population density. As this study focuses on household awareness and behaviour, using the current methodology may not be effective to represent the whole city's response to household e-waste management. Therefore, it is recommended to use mix method approach to improve this study in future.

Conclusion

It is impossible to prevent individuals from utilizing electrical technology because it is vital in our daily life. However, it can be avoided if users dispose of objects after they are no longer needed. To address household knowledge and behavior on the E-WMS in Shah Alam City, environmentally friendly practices must be implemented at all levels to ensure that the risk of e-waste is kept to a minimum. Households can, for example, return any worn electronic devices to the seller, replace old electronic items when purchasing new ones, and send them

to recycling centers. Computers, for example, must be maintained on a regular basis in order to extend the life of electronic goods or to purchase used but still use electronic equipment. Furthermore, the local government must boost the number of e-waste recycling bins for mobile phones and increase community awareness campaigns about e-waste dumping and its environmental impact. Indeed, in order to achieve sustainable waste management and to prevent our country from continuing to dump e-waste that might harm the environment and human health, these policies must be adopted by local authorities with the collaboration of all stakeholders involved in E-WMS. However, as responsible consumers, we must lead the way in adopting a sustainable and ethical lifestyle. The more concerned we are about environmental protection, the more secure and productive our lives will be.

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