E-waste management awareness in the community: Knowledge, attitude, and practices

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Abstract: E-waste refers to the discarded electronic devices, components, and materials used in their production or operation. Reducing e-waste generation helps conserve resources and decreases the energy extracted from the earth. One effective approach to tackling this issue is by promoting awareness about sustainable e-waste disposal practices within the community. This study aims to identify the level of E-waste disposal awareness among the Teluk Kemang Port Dickson community, disposal methods and the impact on the environment. The method in this research study is through the collection of data from previous studies, interviews and a questionnaire instrument were used to obtained feedback by non -probability sampling technique using convenience sampling. The result indicates that only 37% of participants are aware of e-waste management practices and the most common e-waste that are disposed is a cable 81.3%. The factor of e-waste disposal amongst the residents, where 28.2% are because of obsolete products, 52.5% end of a product's life span, 65.4% damaged items and finally 33.3% because of the appearance of cheaper/better alternatives. The research reveals that 45.1% of them dispose e-waste at any available places, 41.4% switch it with new one, 38.8% donating it to charities, 28.8% of them sell their e-waste to a recycler and 26.3% of the residents dispose it at the designated place such as the e-waste disposal center. This findings and issues studied can be used as a reference for the government, non-governmental organisations, the authorities and the community to develop a more sustainable community life.

Keywords: *E-waste disposal awareness, e-waste disposal knowledge, e-waste disposal practices, e-waste management system*

1.0 INTRODUCTION

E-waste, also referred to as electronic waste or WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (WEEE), includes obsolete or discarded electrical and electronic devices. It originates from leftover materials in electronics manufacturing, parts from repair shops, outdated devices from businesses, governments, institutions, and households, as well as smuggled obsolete electronics.

Globally, many countries, including Malaysia, lack comprehensive legislation for managing e-waste from residential areas. While Malaysia has the Environmental Quality (Scheduled Wastes) Act 2005 for industrial e-waste, it does not cover household waste. This highlights the need for a sustainable e-waste management system at the household level.

Although Malaysia has established a solid legal framework for regulating e-waste, its implementation at the residential level remains limited compared to international standards. To strengthen its system, Malaysia can look to global examples such as Japan, the EU, and South Korea, which emphasize accessible household collection services, enforce producer responsibility that extends to consumers, and promote public awareness through education and incentive programs. By adopting a more integrated, community-oriented strategy, Malaysia can effectively mitigate the environmental impact of residential e-waste.

1.1 Problem Statement

Improper disposal of electronic goods can lead to negative implications for both the environment and human health (Kalana, 2010). For example, mobile phones discarded into trash bins that end up in landfills will release Polynuclear Aromatic Hydrocarbons (PAHs), which are chemicals produced when

exposed to high temperatures, and these chemicals will cause air pollution (Hibbert & Ogunseitan, 2014). The accumulation of electronic and electrical goods can lead to issues such as health effects, impacts on wildlife, and environmental pollution. This undoubtedly becomes a problem for a country to manage given the hazardous materials present in these goods. For instance, e-waste can contain potential environmental pollutants such as Lead/Plumbum (Pb), Anyimony (Sb), Mercury (Hg), Cadmium (Cd), Nickel (Ni), Polybrominated Diphenyl Ethers (PBDEs), and Polychlorinated Biphenyls (PCBs) (Robinson, 2009). If disposed of by burning (incineration), pollutants such as dioxins, furans, Polycyclic Aromatic Hydrocarbons (PAHs), Polyhalogenated Aromatic Hydrocarbons (PHAHs), and hydrogen chloride can be produced. Statistics show that the composition of e-waste from households is increasing. According to a study conducted by Good Earth Consultants in 2009, e-waste generated from households was 700,000 tons (Tiep et al., 2015). This indicates an increase in the amount of e-waste from households.

1.2 Objectives of study

The objectives of this study are:

i- To assess the level of awareness and recycling behavior related to e-waste among Telok Kemang residents
ii- Identify analyse disposal patterns and key factors influencing e-waste disposal among residents.
iii- To propose a strategies plan for an effective e-waste management system in the community

This study seeks to enhance understanding of e-waste awareness and disposal practices in Teluk Kemang, supporting the creation of focused policies. It also aims to shed light on the environmental and health consequences of inadequate e-waste management in the area.

2.0 LITERATURE REVIEW

The increasing demand for electronics has resulted in a substantial rise in e-waste, much of which is improperly discarded, particularly within households. This improper handling not only contributes to environmental degradation through soil and water contamination but also poses health risks to communities. Despite existing regulations, many households lack awareness or access to proper disposal channels, highlighting a critical gap in effective e-waste management."

The awareness elements which are knowledge, attitudes and practices of e-waste management, are important in order to establish a cost-effective and environmentally friendly management system, as stated by Norazli et al. (2015). Govindan & Soleimani (2017) discussed advances in sustainable approaches for metal recovery from e-waste, emphasizing the role of green technologies and microorganisms in the extraction process. The current approaches for noble meal recovery from e-waste are reviewed. Green technologies as alternatives of conformist approaches are discussed and it is contribution of microorganisms to recover noble metal from e-waste is highlighted.

Next, Li& Achal (2020) represents a major health and environmental threat, especially in Asian countries of e-waste, Only 25% of e-waste is recycled in formal recycling centers with adequate protection for workers. Most of e-waste pollutants leached into the land and water and release toxic substances. Effective e-waste management and its eco-remediation technologies are important. Zeng et al. (2020) found that elevated lead (Pb) levels from e-waste in PM2.5, dust, water, and soil have severe health impacts, particularly on children in China. Genetic damage caused by e-waste Pb may

have a profound impact on offspring. The growth and development of children in Guiyu need early intervention.

According to Mahmod et al. (2020), e-waste is one of the fastest-growing waste streams globally, with an estimated 1.11 million metric tons produced in 2020 due to the surge in electronic and electrical waste. Improper recycling of e-waste releases harmful substances like lead and mercury, posing serious health risks. Despite these dangers, e-waste also offers opportunities for wealth creation through the extraction of valuable materials such as gold and silver.

Lin et al. (2022) discuss the dangers of toxic chemicals from unregulated e-waste recycling, highlighting pollutants like cadmium (Cd), lead (Pb), PBDEs, and PCBs found in local food at e-waste sites. Dietary exposure to these chemicals is linked to increased body burdens. These toxins contribute to various health issues, including cardiovascular, digestive, and respiratory diseases. The availability of epidemiological data from e-waste recycling areas is essential, and further research on the health impacts of these toxicants, particularly on younger populations, is necessary.

While some countries struggle with public understanding of e-waste, others show stronger awareness. For instance, in Ningbo, China, a majority of people surveyed were knowledgeable about recycling and environmental labels, as shown by their correct disposal practices (Huang et al., 2006). In contrast, studies in other regions, such as those by Okoye and Odoh (2014) and Sivathanu (2016), revealed that although participants claimed awareness of e-waste management, they often failed to demonstrate a deeper understanding when assessed further.

This pattern is also evident in Malaysia. Research conducted in cities like Kuala Lumpur and Shah Alam found that although many citizens acknowledged the environmental issues caused by electronic waste (Afroz et al., 2012; Akhtar et al., 2014; Kalana, 2010), they lacked the knowledge to dispose of such waste properly. Even after the introduction of regulated waste separation systems such as those implemented in Selangor under the Solid Waste and Public Cleansing Management Act 2007 many individuals were still unclear about the correct disposal procedures.

Research on e-waste disposal awareness within this community is essential to identify the factors that affect knowledge, attitudes, and practices. The findings can serve as a valuable reference for the government, NGOs, authorities, and the community in promoting more sustainable living practices.

3.0 METHODOLOGY

This study employs a quantitative research design with a questionnaire as the data collection tool. It is ideal for analyzing a predetermined sample from a specific population at a single point in time, even if the data collection period takes more than a day or a few weeks (Norizan et al. 2010). For the purpose of this research, data collection was carried out using a questionnaire aimed at assessing knowledge, attitudes, and practices related to e-waste management. Field researchers administered the survey in selected areas, including public spaces within Teluk Kemang, Port Dickson. Respondents were randomly selected among individuals who were literate and able to complete the survey. Questionnaires were distributed to respondents in the form google forms through email, group whatsapp, telegram and QR codes. A preliminary study was carried out to evaluate the questionnaire's clarity, consistency, and validity prior to its full-scale implementation.

3.1. Study area

The research was conducted within the consumer community residing in Teluk Kemang, Port Dickson **(Figure1).** This study focuses on household behavior in managing e-waste for selected households in Teluk Kemang Port Dickson area, identifying disposal methods and the impact on

the environment. Teluk Kemang was selected for its blend of urban and semi-urban communities, growing population, and coastal location, making it a key area for examining the environmental risks of improper e-waste disposal. The findings from this study hopefully will provide information and subsequently assist the Negeri Sembilan in planning better policies, regulations, or legislation in the future.

3.2. Target Population and Sampling Method

The study used a non-probability, convenience sampling method to select participants from the Teluk Kemang area. According to the Department of Statistics Malaysia (2020), the total population in the area is 16,672. Referring to the sample size table by Krejcie and Morgan (1971), the minimum required sample is 377 individuals. Accordingly, this study aimed to recruit 380 participants. All respondents were selected from the local community and were required to be household heads.

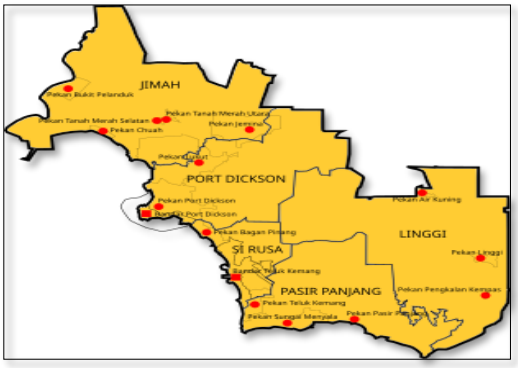

Figure 1: Study location of Teluk Kemang Port Dickson

3.3. Data Collection Instrument

The main tool for data collection was a questionnaire, which was structured into four distinct sections: respondent demographics, knowledge about e-waste management (including concepts and recycling), practices (such as disposal methods and influencing factors), and attitudes toward e-waste. An open-ended question was also included to gather suggestions on effective community-based strategies for managing e-waste. The questionnaire underwent a validity assessment by content experts from Universiti Pendidikan Sultan Idris (Hanifah et al., 2019). It demonstrated acceptable reliability, with a Cronbach's alpha value exceeding 0.7, aligning with the threshold suggested by Lance, Butts, and Michels (2006).

The data collection was analyzed using SPSS (Statistical Package for the Social Sciences) which is a software suite used for statistical analysis and data management.

Figure 2 Show the process flow of the study. It start from the extensive literature review and problem statement until consumer 's perception and behavior.

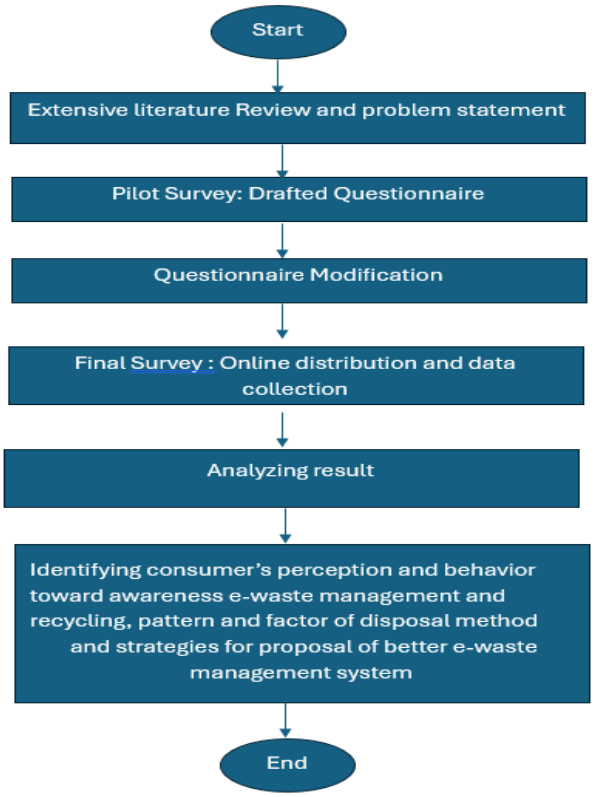

Figure 2: Process flow of the study

Table 1
Survey section description as below

Survey Section	Description
Section 1	The sociodemographic section included questions related to the respondent's gender, age category, highest level of education attained, household size, and total monthly household income.
Section 2	E-waste management (concept and recycling)
Section 3	E-waste management practices and attitudes (disposal method of the respondents and factor of e-waste disposal)
Section 4	Open ended questions : Strategies for an effective e-waste Management System in the community

4.0 FINDING AND DISCUSSION

4.1 E-waste management knowledge (awareness about the e-waste concept and e-waste recycling

To assess consumers' knowledge of e-waste recycling, it was essential to first understand their perception of the concept of e-waste. When respondents were asked about the

terminology/concept of e-waste, only 10% believed that they had high awareness, whereas the highest percentage of 22% believed that they had no idea, followed by 37% who had low awareness about e-waste and 31% with medium awareness. When respondents were asked about their familiarity with e-waste recycling, about 51.6% stated that they were not familiar. Besides, when respondents were asked about their awareness of specialized e-waste recycling centres, 81.8% were not aware of any centres dedicated to E-waste collection and recycling. It can be summarize that lack of Public Education Campaigns is the reason to this lack of knowledge and low awareness on the process of recycling. A detailed summary of all the above results is illustrated in the bar charts in Figure 3 to Figure 6.

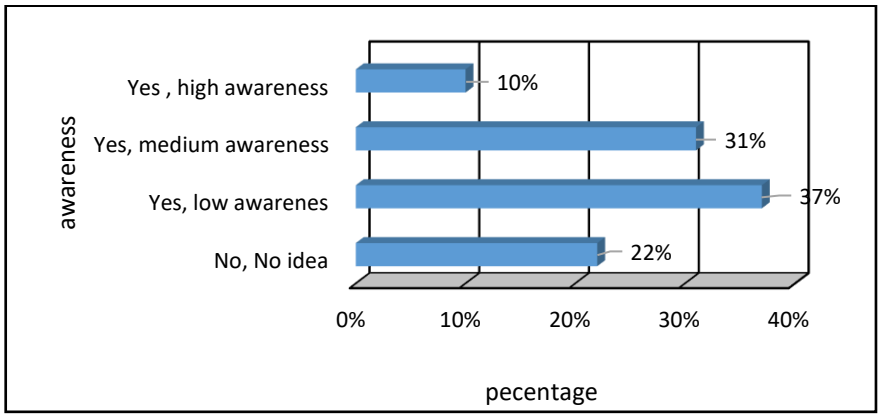

Figure 3: Awareness of the concept of electronic waste (e-waste)

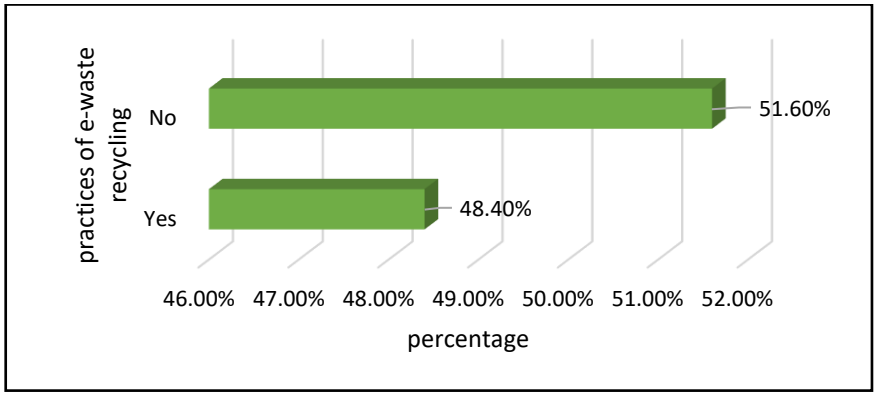

Figure 4: Awareness of the practice of e-waste recycling

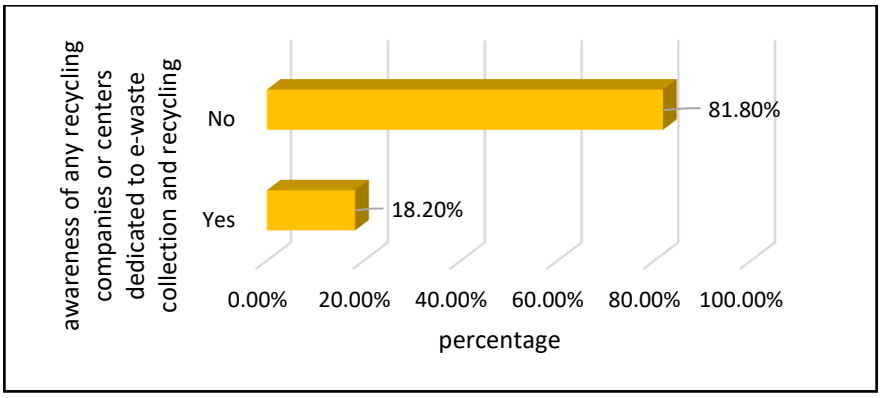

Figure 5: Awareness of any recycling companies or centres dedicated to e-waste collection and recycling

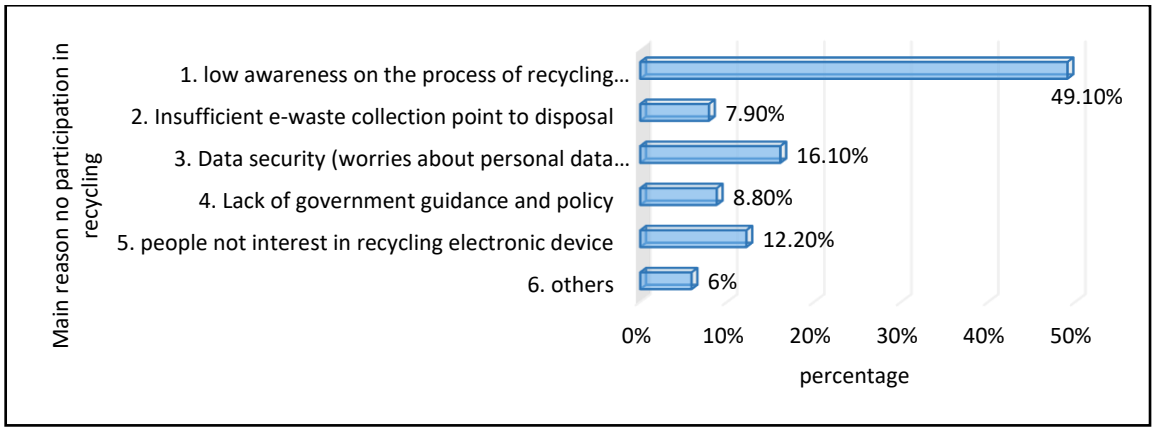

Figure 6: Opinion about consumers' main reason or no participation in e-waste recycling

4.2 E-waste management practices (disposal method of the respondents and factor of e-waste disposal)

4.2.1 Types of e-waste that are disposed

Table 2
Types of e-waste that are disposed

Types of e-waste	Frequency	Percentage
Smartphones	63	52.5%
Television	38	31.3%
Battery / Rechargeable batteries	87	72.5%
Electric Toys	50	41.3%
Kitchen/home appliances	38	31.3%
Laboratory equipment	12	10%
Computer monitors, printers, scanners, keyboards, computer mouse	53	43.8%
Cables	98	81.3%
Beauty devices	24	20%

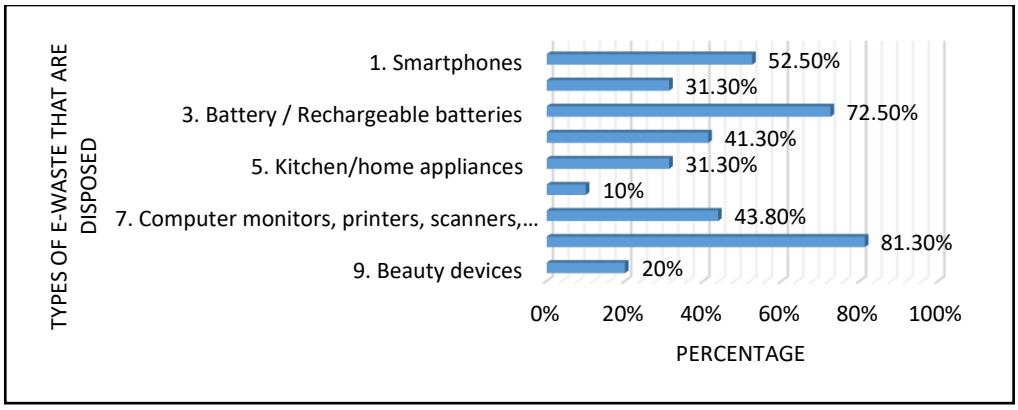

Figure 7: Types of e-waste that are disposed by respondent

Figure 7 shows the results of the types of e-waste that are disposed of where the top three most common E-waste are cables at 81.3%, batteries at 72.5%, and smartphones at 52.5%.

4.2.2 Factor of e-waste Disposal

Table 3
Factor of e-waste disposal

Factor	Frequency	Percentage
Obsolete Products	34	28.2%
End of a product's life span	63	52.5%
Damaged Items	78	65.4%
Better alternatives	40	33.3%

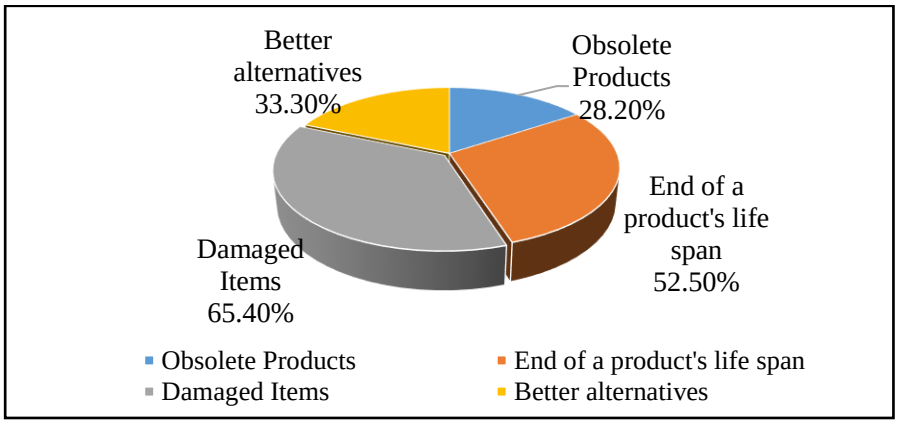

Figure 8: The factor of e-waste disposal

Figure 8 shows the results for the factor of e-waste disposal amongst the residents of Port Dickson District, where 28.2% is because of obsolete products, 52.6% because the end of a product's life span, 65.4% because of damaged items and finally 33.3% because of the appearance of cheaper/better alternatives. This shows that the highest factor of e-waste disposal is because of damaged items. These factors play a crucial role in determining the effectiveness of e-waste disposal systems, and addressing them is essential for minimizing the health risks and environmental linked to e-waste.

4.2.3 Disposal Method of e-waste

Figure 9 shows the results regarding how the respondents from Port Dickson dispose of their e-waste where 45.1% of them dispose it at any available places. The improper disposal of e-waste by 45.1% of individuals leads to significant environmental and health risks. In contrast, best practices in e-waste management focus on creating accessible collection systems, promoting recycling, safeguarding environmental health, and raising public awareness. By adopting these best practices, communities can significantly reduce the harmful impact of e-waste on the environment and human health. Then, 28.8% of them sell their e-waste to a recycler, 26.3% of the residents dispose it at the designated place such as the e-waste disposal center and 41.4% switch it with new one.

Table 4
How do the respondents dispose of e-waste?

Factor	Frequency	Percentage
At designated places/E-waste disposal centre	33	26.3%
At any available places	54	45.1%
Donating them to charities, school or others	47	38.8%
Sell it to a recycler	35	28.8%
Burn / Incinerate	12	10.0%
Dustbin	1	0.8%
Keeping them in a store/outdoors	25	21.2%
Switch it with new one	49	41.4%
Giving them to friends or relatives	23	19.6%

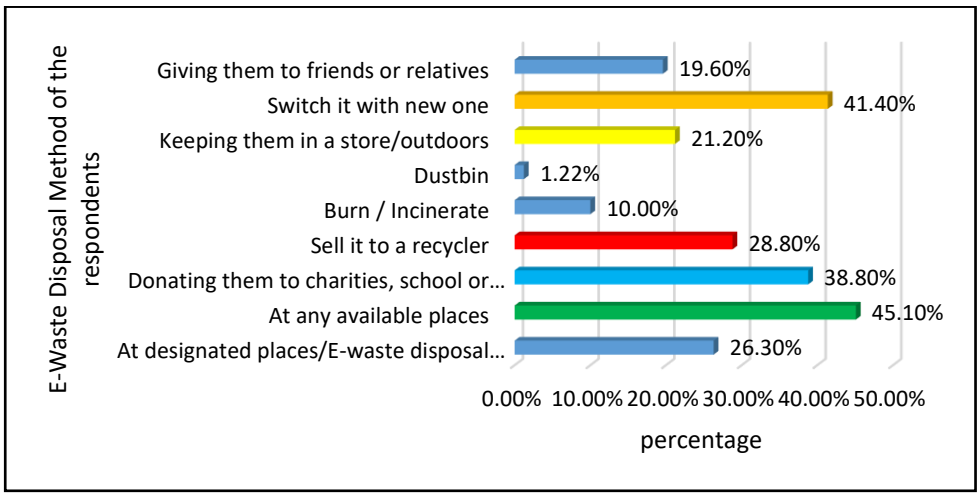

Figure 9: How do the respondents dispose of e-waste

4.3 Strategies for an effective E-Waste Management System in the community

By open ended question, some of the suggestion by respondent for an effective e-waste management system in community are:

- Minimizing waste generation
- Maximizing reuse of items
- Recycling materials for recovery and reuse
- Composting organic waste
- Implementing regulatory policies
- Developing strategies for recycling and reuse.

5.0 CONCLUSION AND RECOMENDATION

The results of this study show that the e-waste disposal method that is often practised by respondents is to sell such goods as used appliances. This is followed by swapping them with new appliances, dropping them off at a recycling centre, keeping them in a store/outdoors, donating to charities, schools or others, disposing of them together with other trash, giving them to friends or relatives, and lastly, the method least used by the respondents is to sell them to classic/old item collectors.

The results showed that while the community's knowledge and attitudes toward e-waste management were at a moderate level, their actual disposal practices remained poor. The community's awareness appears to have benefited from early initiatives by government bodies and private organizations in Negeri Sembilan, which played a role in enhancing understanding and shaping attitudes in Teluk Kemang, Port Dickson.

Since 81.8% were unaware of e-waste recycling centres, it is crucial to emphasize the need for improved dissemination of information regarding available recycling options. Effective communication strategies, such as public awareness campaigns, clear signage, and community outreach, are essential to educate the public on proper e-waste disposal methods. Ensuring that people are aware of accessible recycling centers will help mitigate the environmental and health risks associated with improper e-waste disposal. The study outlines broad strategies such as "reduce, reuse, recycle," but it could benefit from including more practical solutions

Therefore, the collection of information on the public's actual knowledge, attitudes and practices in managing e-waste are a need for the country to improve the process of information dissemination and also examine the constraints imposed by the community on the implementation.

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