# KNOWLEDGE, ATTITUDE AND PRACTICES OF E-WASTE RECYCLING TOWARDS SUSTAINABLE WASTE MANAGEMENT IN MALAYSIA

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**KNOWLEDGE, ATTITUDE AND PRACTICES OF E-WASTE RECYCLING TOWARDS SUSTAINABLE WASTE MANAGEMENT IN MALAYSIA**

## ABSTRACT

E-waste is defined as any electrical and electronic appliances that are no longer in use, unwanted, no longer functioning, broken, obsolete, or ready to be discarded by their owner. The rapid generation of E-waste nowadays necessitates the attention of all stakeholders, particularly the general public as consumers. E-waste recycling is one of the environmentally friendly ways to handle E-waste. Hence, this study examines E-waste recycling among the public in Malaysia with five research objectives: (i) To analyze the current status of knowledge, attitude, and practices on E-waste recycling in Malaysia; (ii) To investigate the preferred sources of information on E-waste recycling among respondents; (iii) To investigate the relationship between demographic variables and current status of knowledge, attitude, and practices on E-waste recycling in Malaysia; (iv) To analyze the relationship between knowledge, attitude, and practices on E-waste recycling among respondents; and (v) To explore the satisfaction level of the public pertaining to the currently available E-waste management services in Malaysia. The data collection was conducted using a questionnaire survey with a total of 3,015 respondents. The data is analyzed using the Statistical Package for the Social Sciences (SPSS). Based on the analysis conducted, knowledge related to the Environmental Quality Act 1974 (EQA 1974) and disposal activity is not satisfactory, with the percentage of respondents being less than 70.0%. As for the attitude section, most respondents agreed that convenient facilities (84.5%) and incentives (78.3%) would boost their participation in E-waste recycling. It is also illustrated that most respondents are interested in upgrading their appliances to the latest features and design, which could potentially increase the generation of E-waste. Hence, the public is required to manage their unwanted appliances properly. Moreover, selling and repairing E-waste are the most preferred practices, as

agreed by 72.6% of respondents. Note that 64.3% of respondents agreed that the internet is the most preferred source of information on E-waste. However, the utilization of various sources of information is also required to ensure that the public can obtain information despite their various demographic background. Two demographic variables, age and occupation, are significantly related to knowledge, attitude, and general practices sections. Meanwhile, income and residential location are significantly ($p$-value < 0.05) related to knowledge and attitude. Educational background is reported to be significantly ($p$-value < 0.05) related and consistent with knowledge and disposal practices on E-waste recycling. This study also discovered that knowledge, attitude, and practices are reported to be significantly ($p$-value < 0.05 (< 0.001)) related to one another. Most respondents who have demonstrated high levels of knowledge and attitude have moderate levels of practice. However, about 38.5% of respondents are unsatisfied with the current facilities and management of E-waste disposal in their area. This research makes several contributions to encourage the sustainable management of E-waste among the public.

**Keywords:** Attitude, E-waste, Knowledge, Practices, Public

**PENGETAHUAN, SIKAP DAN AMALAN KITAR SEMULA *E-WASTE* KE ARAH PENGURUSAN SISA LESTARI DI MALAYSIA**


**ABSTRAK**

*E-waste* ditakrifkan sebagai sebarang peralatan elektrik dan elektronik yang tidak lagi digunakan, tidak diingini, tidak lagi berfungsi, rosak, usang atau sedia untuk dibuang oleh pemiliknya. Penghasilan *E-waste* yang pesat pada masa ini memerlukan perhatian daripada semua pihak berkepentingan, khususnya masyarakat umum sebagai pengguna. Kitar semula *E-waste* merupakan salah satu cara mesra alam dalam usaha mengendalikan *E-waste.* Sehubungan dengan itu, kajian ini mengkaji kitar semula *E-waste* dalam kalangan orang ramai di Malaysia dengan menumpukan lima objektif kajian: (i) Menganalisis status semasa pengetahuan, sikap dan amalan kitar semula *E-waste* di Malaysia; (ii) Mengkaji sumber maklumat pilihan tentang kitar semula *E-waste* dalam kalangan responden; (iii) Mengkaji hubungan antara pemboleh ubah demografi dan status semasa pengetahuan, sikap dan amalan kitar semula *E-waste* di Malaysia; (iv) Menganalisis hubungan antara pengetahuan, sikap dan amalan kitar semula *E-waste* dalam kalangan responden; dan (v) meneroka tahap kepuasan orang ramai berkaitan dengan perkhidmatan pengurusan *E-waste* yang sedia ada di Malaysia. Pengumpulan data dijalankan menggunakan soal selidik dengan jumlah responden seramai 3,015 orang. Data tersebut dianalisis menggunakan perisian Pakej Statistik untuk Sains Sosial (SPSS). Berdasarkan analisis yang dijalankan, pengetahuan berkaitan dengan Akta Kualiti Alam Sekeliling 1974 (EQA 1974) dan aktiviti pelupusan adalah tidak memuaskan dengan peratusan responden adalah kurang daripada 70.0 peratus. Bagi bahagian sikap, majoriti responden bersetuju bahawa kemudahan yang selesa (84.5 peratus) serta insentif (78.3 peratus) akan meningkatkan penyertaan mereka dalam kitar semula *E-waste.* Ini juga menggambarkan bahawa kebanyakan responden berminat untuk menaik taraf peralatan mereka kepada ciri dan reka bentuk terkini, yang berpotensi dalam meningkatkan

penghasilan *E-waste*. Oleh itu, orang ramai perlu menguruskan peralatan yang tidak diingini dengan betul. Aktiviti menjual dan membaiki *E-waste* ialah amalan yang paling digemari seperti yang dipersetujui oleh 72.6 peratus responden. Tambahan lagi, 64.3 peratus responden juga bersetuju bahawa Internet merupakan sumber maklumat yang paling digemari tentang *E-waste*. Namun begitu, penggunaan pelbagai sumber maklumat juga diperlukan bagi memastikan maklumat dapat diperoleh orang ramai walaupun latar belakang demografi mereka berbeza. Dua pemboleh ubah demografi, yang dikenali sebagai umur dan pekerjaan, berkait secara signifikan (nilai-p <0.05) dengan bahagian pengetahuan, sikap dan amalan am. Sementara itu, pendapatan dan lokasi kediaman mempunyai perkaitan yang signifikan (nilai-p <0.05) dengan pengetahuan dan sikap. Latar belakang pendidikan dilaporkan berkait rapat dan konsisten dengan pengetahuan dan amalan pelupusan tentang kitar semula *E-waste*. Kajian ini juga mendapati bahawa pengetahuan, sikap dan amalan dilaporkan menunjukkan perkaitan yang signifikan (nilai-p <0.05(<0.001)) antara satu sama lain. Majoriti responden yang telah menunjukkan tahap pengetahuan dan sikap yang tinggi didapati mempunyai tahap amalan yang sederhana. Kajian ini juga mendapati bahawa 38.5 peratus responden tidak berpuas hati dengan pengurusan dan kemudahan pelupusan *E-waste* di kawasan mereka. Penyelidikan ini memberikan beberapa sumbangan sebagai usaha menggalakkan pengurusan mampan *E-waste* dalam kalangan orang ramai.

**Kata kunci**: Sikap, *E-waste*, Pengetahuan, Amalan, Orang Awam

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| | |
|---|---|
| KAP: | Knowledge, Attitude and Practices |
| DOE: | Department of Environment |

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# CHAPTER 1: INTRODUCTION

## 1.1 Introduction

Electrical and electronic waste (E-waste) can be defined as any electrical and electronic appliances that are discarded from various sources. This includes households, industries, and commercial entities since the appliances are no longer wanted, already broken, or no longer serve their purpose (Afroz et al., 2013; Tiep et al., 2015; Mahat et al., 2019; Madanhire et al., 2019). The volume of E-waste generation is increasing over time as the world's population grows, as well as worldwide technology and development. Electrical and electronic appliances have become a necessity in today's world. Besides, the constant advancement of science and technology in the modern world makes it almost impossible to drastically cut back on or completely stop using electronic and electrical appliances (Brindhadevi et al., 2023). However, the problem arises when undesired appliances are simply discarded, reducing the lifespan of E-waste and ultimately ending up in the waste stream. E-waste recycling is one of the most effective methods for recovering materials from appliances. It is also a way to protect the environment and human health. It is important for the public to understand, be aware, and practice the E-waste recycling activity as it will also create opportunities for a sustainable lifestyle for society. The first chapter of this thesis provides the background of the study and describes E-waste management, focusing on E-waste recycling activity in Malaysia. This is followed by the problem statement, research objectives, research questions, scope of study, significance of study, and thesis outline. The chapter concludes with a summary of the contents of each sub-chapter.

## 1.2 Background of Study

As the world population has grown, the number of people deciding to migrate to the city has increased due to economic factors and job opportunities, as stated by Razip et al. (2022). By 2050, it is estimated that two-thirds of the world's population will live in cities, leading to a 70% increase in greenhouse gas emissions and energy demand. In addition to the population growth, other factors such as modern lifestyles, technological advancement, economic growth, and urbanization have all led to an increase in the generation of waste (Bagwan, 2024; Owusu-Sekyere & Aladago, 2023; Sharma et al., 2023). Humans generate waste in their daily lives, contributing to global environmental hazards. Thus, proper and sustainable waste management is crucial as different types of waste necessitate distinct management approaches.

Recently, a new type of waste, namely electrical and electronic waste (E-waste), has entered the waste stream. Electrical and electronic waste (E-waste) can be defined as any electrical and electronic appliances that are discarded from various sources such as households, industries, and commercial entities since the appliances are no longer wanted, already broken, or no longer serve their purpose (Afroz et al., 2013; Tiep et al., 2015; Mahat et al., 2019; Madanhire et al. 2019). Household E-waste is divided into two categories: white goods and brown goods. White goods refer to large appliances such as microwaves, refrigerators, and washing machines. Hence, they are not portable, while brown goods refer to small appliances such as televisions, laptops, and computers (Khetriwal et al., 2009, in Kalana, 2010). E-waste contains toxic and hazardous materials, such as arsenic, barium, beryllium, cadmium, chromium, lead, mercury, and selenium. Hence, it is categorized as hazardous waste, which is also known as scheduled waste in Malaysia (Khetriwal et al., 2009 in Kalana, 2010; Afroz et al., 2013; Akhtar et al., 2014; Tiep et al., 2015; Department of the Environment [DOE] 2015; Razip et al., 2022;

Brindhadevi et al., 2023).

The generation of E-waste is due to several factors, such as the economic growth of the country, the population growth, and the shorter lifespan of electronic goods due to technological advancement (Kalana, 2010; Afroz et al., 2013; Kiddee et al., 2013; Shumon et al., 2014; Akhtar et al., 2014; Tiep et al., 2015; Borthakur & Govind 2017). For example, in Malaysia, the increase in ownership of electrical appliances such as air conditioners, mobile phones, and televisions has contributed to the increase in the nation's E-waste generation (Razip et al., 2022).

As mentioned earlier in the chapter, E-waste contains various toxic and hazardous materials and hence has the potential to pose a risk to the environment and human health. The effects of E-waste on the environment and human health are due to the release of heavy metals and flame retardants and the emission of toxic gases. Hence, a polluted environment, such as water pollution, soil pollution, and groundwater contamination, will eventually have a direct impact on human health through the food chain (Kiddee et al., 2013; Hendricks, 2012; Shumon et al., 2014). It is also likely to be a source of genetic modification and may cause cytogenetic harm to individuals exposed to contaminated E-waste (Brindhadevi et al., 2023). To reduce the impact of E-waste on the environment and human health, proper and sustainable E-waste management is crucial. E-waste management includes managing facilities, monitoring compliance with the law and legislation, public participation, and several other important issues.

In Malaysia, E-waste management is monitored by the Department of Environment (DOE) (Hazardous Substances Division 2008 in Tiep et al., 2015). The DOE is in charge of administering a law to manage E-waste enacted and passed by the parliament. The law,

which is entitled Environmental Quality (Scheduled Wastes) Regulations 2005, defines E-waste as follows:

> *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.*

Legislation on E-waste in Malaysia emphasises the prohibition of E-waste disposal in landfills. It is stated in the statute that E-waste must be recovered and recycled only at prescribed premises by registered recyclers (Environmental Quality Act, 1974).

There are two types of E-waste recyclers in Malaysia, namely, partial and full recyclers. Partial recyclers have less capacity and fewer facilities for recycling all the E-waste and are more likely to be centres where reuse, separation, and dismantling activities are undertaken. In contrast, full recyclers can be defined as those that have a full capacity of material recovery facilities (MRF) to recycle all the E-waste that they receive (Babington et al., 2010). In 2010, 96 partial recyclers and 11 full recyclers for E-waste in Malaysia were assigned as licensed contractors by the DOE (Babington et al., 2010). In a more recent study, the number had increased to 128 partial recyclers and 18 full recyclers with the increased adaptation of various technologies for E-waste segregation, dismantling, and treatment process (Suja et al., 2014). However, in 2020, the number of partial ecyclers reduced to 40; meanwhile, the number of full recyclers increased to 21 facilities (DOE, 2020).

The Malaysian DOE also initiated household E-waste collection points for all states in Malaysia. For example, in Kuala Lumpur, there are 12 collection points, 33 collection

points in Selangor, and nine collection points in Negeri Sembilan. However, there are no collection points located in the Port Dickson District, Negeri Sembilan (DOE 2015). The number of E-waste collectors in Kuala Lumpur has increased to 15 collection points, and there are 34 collection points in Selangor. Meanwhile, as for Negeri Sembilan, the collection points were reduced to only six as of October 2020 (DOE, 2020).

As mentioned earlier, as stated in the Environmental Quality (Scheduled Wastes) Regulation 2005, E-waste must be recovered and recycled only at prescribed premises. However, the implementation of this law is limited to E-waste generated from industrial activities. Thus, E-waste from households would commonly end up in inappropriate landfills (Shumon et al., 2014). E-waste recycling is one of the best options to manage this issue properly. E-waste recycling can be defined as reprocessing and reusing electrical and electronic equipment. This will help protect the environment and human health from E-waste pollution since E-waste could contaminate the water resources due to toxic leachate (Conserve Energy Future, 2018).

E-waste recycling begins with segregating the waste (Yusof et al., 2011). Therefore, E-waste must be identified and disposed of separately from household waste (Sivathanu et al., 2016). Once the E-waste has been segregated, it can be further categorised depending on whether it can be reused or not (Jaiswal et al., 2015). Recycling of E-waste also helps reduce the mining activities required to obtain raw materials via the recovery process. Several engineering technologies are able to extract materials in E-waste, such as iron, copper, and aluminium, which can then be reused (Rezaul et al., 2014; Kiddee et al., 2013). The recycling technologies of E-waste will convert the E-waste into a secondary resource of raw materials (Rhee, 2016). For example, plastic and precious metals can be extracted from mobile phones and television boards (Hagelukan, 2006 in Lou &

Mativenga, 2017). E-waste recycling is also one of the effective methods to preserve the environment, reduce the impact on human health, recover precious materials economically, and ensure supply stability is through the practices of E-waste recycling activity (Zhang et al., 2017; Buechler et al., 2020; Northey, 2020).

Recycling also plays an important role in conserving energy; for example, the recycling of 1 million laptops can save energy that is equal to the annual electricity consumption of 3,657 US houses (EPA, 2014 in Jaiswal et al., 2015). Creating the Tokyo 2020 Olympic medal out of unwanted electrical and electronic appliances, for example, was an innovative project (Northey, 2020). This approach has the potential to save up to 4,806,959 MJ of energy, which equates to a 424-tonne reduction in carbon dioxide emissions. NTT Docomo collected 6.21 million used mobile phones, and 1,621 Japanese municipal authorities collected a total of 78,985 tonnes of E-waste to construct the gold, silver, and bronze medals for the athletes (Northey, 2020).

While effective legislation and efficient recycling facilities act as two pivotal components in managing E-waste, public participation also plays an important role. Knowledge, Attitude, and Practices (KAP) can be used to identify public participation in E-waste recycling. For example, Afroz et al. (2013) highlighted that a low level of knowledge of an individual may affect their public participation in E-waste recycling. For example, this KAP approach highlighted the level of information about E-waste that the public understands, as well as the public's intention and participation in managing E-waste on a daily basis. It will be easier to design a framework for sustainable E-waste management with the availability of information and output that specifically highlight the current situation regarding E-waste management among the public. This will help to improve E-waste management gradually.

## 1.3 Problem Statements

E-waste is a global environmental issue currently, as the increasing volume of E-waste globally has risen to 4.6 metric tonnes annually, significantly influenced by the increased affluence and the industrialization of technology of the global population (Kalana, 2010; Afroz et al., 2012; Kiddee et al., 2013; Madanhire et al., 2020; Azizi et al., 2023). In Malaysia, the Global E-waste Monitor Report 2017 projected that each individual generates approximately 8.8 kg of E-waste (Yong et al., 2019). E-waste generation and improper management eventually affect the environment and human health due to the components of E-waste that contain toxic and hazardous materials. Toxins released into the environment will harm humans due to soil, groundwater, and air contamination. Among the significant threats are cholera, plague, and smallpox (Afroz et al., 2013; Akhtar et al., 2014; Sivathanu, 2016; Shahzadi, 2018; Deniz et al., 2019; Rautela et al., 2021). Humans require a healthy environment to survive. If the state of the environment deteriorates, human productivity in everyday activities will definitely decrease. The following additionally reduces a country's productivity and undermines its economic capability.

Malaysians' increased ownership of appliances such as televisions, air conditioners, and mobile phones has contributed to the country's rising E-waste generation (Razip et al., 2022). Since E-waste generation is one of the fastest in solid waste management in conjunction with mineral resource scarcity and increased consumption rates, efficient E-waste collection has been critical in urban environments (Kang et al., 2020). It is important to deal with sustainable E-waste management through the participation of the public as consumers of those electrical and electronic appliances. One of the ways to manage E-waste is through E-waste recycling activity. This approach helps to promote the circular economy, and everyone has responsibility from the beginning until the end of the lifespan of appliances. Thus, the volume of E-waste in landfills can be reduced, reducing

the impact on the environment and human health, as well will be able to help in creating a sustainable community (Terazono et al., 2006; Afroz et al., 2012; Barloa et al., 2016; Schill & Shaw 2016; Tesfaye et al., 2017; Thi Thu Nguyen et al., 2019).

KAP is the fundamental approach that proposed a dynamic between understanding, awareness, and action towards information (Schwartz, 1976; Eckman & Walker, 2008; Salerno et al., 2014). This study implemented the KAP approach to determine what needs improvement to ensure that Malaysian communities can recycle their E-waste more effectively. Implementing this cost-effective and resource-conserving study will shed light on the areas where information remains insufficient for the public to grasp the significance of sustainable E-waste management.

In addition, it is important to ascertain what information is still missing and discourages people from recycling their electronic waste. Also, we need to determine how the sources of information could help the public to receive better information and increase their knowledge. The results of the public's attitude toward E-waste recycling among respondents will highlight the current attitude of the entire community, whether it is inclined to be a positive or negative attitude. It also provides the projection of this public group to support and practice sustainable E-waste management, such as recycling unwanted electrical and electronic appliances. If the general public has a positive attitude towards E-waste, this will encourage good practice. The output of practices on E-waste recycling will help identify the current practices on E-waste recycling among Malaysians.

## 1.4 Research Objectives and Research Questions

E-waste and the public are related to one another as the public is the key consumer of electrical and electronic appliances; the public also plays an important role and

responsibility in handling E-waste at the end of its lifespan. Thus, this study aims to highlight the E-waste recycling activity among the public using questionnaire surveys. The following are the four objectives in relation to the research questions of this study.

**Research objective 1:** To analyze the current status of knowledge, attitude, and practices on E-waste recycling in Malaysia.

*(Research question 1)* What is the current status of knowledge, attitude, and practices on E-waste recycling among respondents?

**Research objective 2:** To investigate the preferred sources of information on E-waste recycling among respondents.

*(Research question 2)* What are the preferred sources of information on E-waste recycling among respondents?

**Research objective 3:** To investigate the relationship between demographic variables and the current status of knowledge, attitude, and practices on E-waste recycling in Malaysia.

*(Research question 3)* Which demographic variables are significantly associated with the current status of knowledge, attitude, and practices on E-waste recycling in Malaysia?

**Research objective 4:** To analyze the relationship between knowledge, attitude, and practices on E-waste recycling among respondents.

*(Research question 4)* What is the relationship between knowledge, attitude, and practices on E-waste recycling among respondents?

**Research objective 5:** To explore the satisfaction level of the public pertaining to the currently available E-waste management services in Malaysia.

*(Research question 5)* What is the level of satisfaction among the public regarding the available E-waste management services?

## 1.5 Scope of Study

This section starts with a description of the general purpose of conducting this study. E-waste is one type of waste that is generated by the public through different sources, such as households and industries. E-waste should not be taken for granted at the end of its lifespan. The public, as key consumers, is responsible for handling the E-waste in a sustainable manner. One of the sustainable methods is practicing E-waste recycling. Hence, the scope of this study is the recycling of E-waste among the public in Malaysia at the household level using the KAP model theory as a tool.

The respondents of this study are public aged 18 years old and above with different demographic backgrounds who lived in Kuala Lumpur, Selangor, or Port Dickson, Negeri Sembilan. These three locations have their own characteristics, for example, based on the geographical factors and economic activities; hence, the output from these three different study areas will reflect the situation in other locations that share the same characteristics. This study aims to determine the current status of KAP on E-waste recycling for household E-waste since there are no specific guidelines regarding household E-waste compared to industrial E-waste.

## 1.6 Significance of the Study

Advances in technology and product design have reduced the life cycle of electrical and electronic equipment (EEE). For instance, mobile phones, in particular, have become

necessary. However, people are changing their gadgets more often than they used to since they are now more than just a tool for survival—they are status symbols, fashion statements, and means of communication. Beyond the challenge of the growing amount of E-waste generated, there is also the problem of E-waste being improperly disposed of and treated, which eventually ends up in landfills. Disposing of E-waste in landfills causes environmental pollution and health problems. Furthermore, E-waste contains precious secondary materials. Thus, there needs to be a proper recovery channel for E-waste, which will lead to a circular economy and help reduce mining activity to extract virgin materials.

E-waste has been discussed in previous studies both at the international and local levels. E-waste is a global environmental hazard that requires special handling at every level. E-waste is being discussed in various aspects, including the technology requirement for E-waste disposal, industrial E-waste management, the circular economy of E-waste, willingness to pay for E-waste services, and E-waste management at the public level. In order to acknowledge the current way forward of sustainable E-waste management among the public, this study provides a discussion on E-waste recycling in Malaysia, focusing on the KAP model theory as a tool.

The study focused on assessing public knowledge, attitude, and practices on E-waste recycling. As an example, how does the public manage their E-waste, focusing on the recycling activity? The aim of this social study is to provide insight into the current state of E-waste recycling among the public in Malaysia. The analysis will help to improve the current policy, increase the monitoring, and educate the public towards achieving sustainable consumption. This approach can help reduce the volume of E-waste, prevent environmental pollution, and reduce health risks to the public.

## 1.7 Thesis Outline

In total, there will be seven chapters for this thesis. Each chapter will start off with an introduction and end with a conclusion that summarize the entire chapter. The outline of this study is as follows.

**Chapter 1** will introduce the general information related to E-waste and provide the background to the study, namely, E-waste definition, the generation of E-waste, management of E-waste, the cause and effects of E-waste generation, and hence, the sustainable approach to managing E-waste. This chapter also highlights the problem statements, research objectives, research questions, scope of the study, and significance of the study. At the end of this chapter, a conclusion is stated to summarize the direction of this study.

**Chapter 2** is the follow-up of the previous chapter. This chapter comprises nine sections, including the introduction, followed by a definition of E-waste, issues with E-waste, E-waste generation, current E-waste status among Southeast Asia countries, E-waste management in Malaysia, laws and legislation on waste management in Malaysia, the causes of E-waste generation, the effects of E-waste generation, the recycling approach in managing the E-waste, and the advantages of E-waste recycling. This chapter will be closing with a summary of the entire chapter in the conclusion section.

**Chapter 3** is the continuation of the literature review from the previous chapter. This chapter focuses on the KAP model theory as a tool. This chapter includes detailed information regarding KAP, beginning with the concept, history, definition, usage, advantages, criticisms, and examples from previous studies. In the conclusion section of this chapter, the summary of the entire chapter will be highlighted.

**Chapter 4** will provide the methodology and explain the flow of the study in order to achieve the research objectives. This chapter includes the conceptual framework of the study, study areas, respondents, instruments, pilot study, data collection approach, research design, and data analysis. It also underlines the limitations of the study. The last section of this chapter will summarize the overall methodology involved throughout this study.

**Chapter 5** presents the analysis and results, which will report the findings based on the objectives of the study. This chapter is sorted by the research objectives of this study, with the introduction of the chapter, report on the demographic background of the respondents, the KAP on E-waste recycling among respondents, the relationship with demographic variables, the effectiveness of sources of information related to E-waste, and the satisfaction level of E-waste services among respondents. Then, the conclusion section concludes the overall findings from this chapter.

**Chapter 6** is the extension of Chapter 4, also known as the discussion chapter. This discussion section illustrates and discusses the output of the study based on the literature review, as it links back to Chapter 2, the literature review. This chapter also gives the implications, solutions, and suggestions to improve the current situation, as revealed by the study. In Chapter 5, the discussion is also sorted by the research objectives, similar to Chapter 4. The flow of the discussion is according to the analysis and results in the previous chapter. The final part of this chapter will summarize the entire discussion.

**Chapter 7** is the final chapter of this study. This chapter will conclude all the findings of this study with a summary of the entire study. In addition, this chapter provides limitations of the study, suggestions, and recommendations for future research related to E-waste

recycling. Hence, this chapter will be the closure for this entire study. This final chapter will enable readers to understand the entire study in the simplest manner and increase their knowledge of E-waste as a global environmental issue.

## 1.8 Conclusion

Overall, this chapter has stated the basic idea of this study. In the following chapter, chapters two and three, the literature review will discuss in detail the idea of this study through the findings of the previous study.

# CHAPTER 2: SUSTAINABLE E-WASTE MANAGEMENT

## 2.1 Introduction

E-waste ranges from very small parts of equipment to huge electrical and electronic appliances. Nowadays, the volume of E-waste is rapidly increasing globally (Tiseo, 2023). E-waste is harmful to the environment and public health due to the toxic and hazardous materials it contains. Uncontrolled and unsustainable consumption of electrical and electronic appliances will lead to an increasing volume of E-waste. This is due to technological advancements and increasing purchasing power, which leads to reduced life cycles of appliances. In order to overcome the issues related to E-waste, E-waste recycling should be addressed formally because proper technology, management, premises, and facilities are important to reduce its consequences on the environment and public health. E-waste recycling by the public refers to sending E-waste to a proper facility rather than keeping it at home or selling it to scrap dealers. The chapter will start with a detailed review of the background of E-waste, focusing on the definition of E-waste, generation of E-waste, current E-waste status, management of E-waste, legislation in managing E-waste, and the issues, causes, effects, and recycling approach towards E-waste.

## 2.2 Definition of E-waste

Electrical and electronic waste (E-waste) refers to those electrical and electronic appliances or goods that are ready to be discarded as well as already discarded by their end consumers. This E-waste is not necessarily broken, but as long as its useful period has come to an end and is refused or no longer needed by the owner for any discarded electronic devices, components, substances, and materials, also known as E-waste. This E-waste can also be defined as those appliances that have already been used, are no longer

functioning, are obsolete, and have already achieved their maximum lifespan from various sources such as commercial entities, households, and industries (Afroz et al., 2013; Tiep et al., 2015; Mahat et al., 2019; Madanhire et al. 2019).

The European Union (EU) Directive describes E-waste as the disposal of electrical or electronic devices containing all their parts, whether usable or broken, at the time when they are discarded. Under the EU Directive, consumer equipment, electrical and electronic equipment, IT and telecommunication equipment, large household appliances, lighting equipment, medical equipment, recreation and sports equipment, small household appliances, and electronic toys are all categorised as E-waste, while large-scale stationary industrial equipment is excluded from this categorisation. The Basel Convention stated that there is a variety of discarded electrical and electronic appliances, namely consumer electronics such as computers and mobile phones, and large household appliances such as air conditioners and refrigerators (Suja, 2014).

Electrical and electronic equipment (EEE) is dependent on electromagnetic fields or electric currents in order to work properly (UNEP, 2007 in Grant et al., 2013; Gazete, 2012 in Deniz et al., 2019) and is designed for usage within a range that does not exceed 1000 volts for alternating current (AC) and 1500 volts for direct current (DC) (Deniz et al., 2019). When EEE has been discarded without any intention to reuse it because it is unwanted, old, at the end of its life, and no longer valuable to its owner, this equipment is considered E-waste (StEP Initiative, 2014 in Balde et al., 2017; UNEP, 2007 in Liang & Sharp, 2016). E-waste includes a wide range of appliances such as mobile phones, television sets, refrigerators, discarded computers, entertainment equipment, and office electronic equipment (Balde et al., 2017; Nagajothi & Felixkala, 2015). All equipment or parts are included. However, any rejected or scrap material from the manufacturing

process is not considered E-waste (Pramila et al., 2012). According to Borthakur and Govind (2017), E-waste is a complex stream of waste that requires particular management, and, as a result, it has become a global concern. Table 2.1 shows the definitions of E-waste in a few South East Asia (ASEAN) countries.

**Table 2.1: Definition of E-waste in South East Asia (ASEAN) countries**

| Countries | E-waste definition |
|---|---|
| Brunei | E-waste is any scrap electrical and electronic devices hence defined and categorized by the Basel Convention. |
| Cambodia | E-waste is defined as electrical and electronic equipment that is no longer used but is still able to function and in good form. |
| Indonesia | Electronic goods (E-waste) from households, commercial activities, and offices that no longer function and/or are no longer used.<br><br>Hence, used electrical and electronic equipment (UEEE), including computers and monitors, has been defined as electronic goods that still function (proven by certificate), whose lifetime is not more than five years, new technology with LCD and LED monitors (definitely not CRT), must be in one complete set, and must be imported in proper packaging. |
| Laos | E-waste is electrical and electronic equipment that cannot be used anymore, while Used EEE is second-hand electrical and electronic equipment that can still be used. |
| Malaysia | Based on First Schedule Environmental Quality (Scheduled Wastes) Regulations 2005 (code SW 110), as stated, *E-waste is 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.* |
| Myanmar | Waste Electrical and Electronic Equipment (WEEE) or E-waste is a term used to describe all sorts of electrical and electronic equipment (EEE) and its parts disposed of as waste by the owner with no intention of reuse. All components, subassemblies, and consumables that are part of the equipment (such as TVs, PCs, refrigerators, air conditioners, washing machines, and mobile phones) at the time the equipment becomes waste are considered |

| Countries | E-waste definition |
|---|---|
| Myanmar | E-waste. E-waste includes used electronics designated for reuse, resale, salvage, recycling, or disposal. Myanmar has yet to create legal frameworks for E-waste disposal, but currently, E-waste is regulated and controlled under the Basel Convention. |
| Philippines | Discarded electrical and electronic equipment that contains hazardous components such as hexavalent chromium, polybrominated biphenyls (PBBs), polybrominated diphenyl ethers (PBDEs), lead, cadmium, and mercury, including its tools. |
| Singapore | Based on the Basel Convention (A1180), as stated:<br><br>*Waste electrical and electronic assemblies or scrap containing components such as accumulators and other batteries included on list-A, mercury switches, glass from cathode-ray tubes and other activated glass and PCB-capacitors, or contaminated with Basel Convention Annex I constituents (e.g., cadmium, mercury, lead, polychlorinated biphenyl) to the extent that they possess any of the characteristics contained in Basel Convention Annex III.* |
| Thailand | Hazardous Substance Act B.E 2325(1992) No. 2.18<br><br>No. 5.2 (chemical waste category):<br>*Electrical and electronic assemblies or scrap (not including scrap from electric power generation) containing such as accumulators and other batteries, mercury switches, glass from cathode-ray tubes and other activated glass, and PCB-capacitors, or contaminated with Cadmium, Mercury, Lead Polychlorinated Biphenyl.*<br><br>No. 5.3 (used electrical and electronic appliances category):<br>*E-waste such as refrigerators, TVs, radios, videos, clothes dryers, rice cookers, kettles, microwaves, ovens, telephones, facsimiles, telegraphs, calculators, typewriters, copy machines, mobile phones, computers, printers, arcade games etc., for reuse or modify, repair, improve, remanufacture for originally intended use or sorting for disposal are exemption for a permit and a register but importing conditions for used electrical and electronic equipment is required.*<br><br>*Used EEEs means Electric and Electronic Equipment that is used but still workable and can be kept in its original form or repaired, modified, or reconditioned in order to be used for its original purposes.* |

| Countries | E-waste definition |
|---|---|
| Timor-Leste | According to Article 7 of Decree-Law 2/2017 Urban Solid Waste Management System, E-waste is included in the definition of recoverable waste, as stated:<br><br>Recoverable waste is defined as all waste that is capable of being selected and whose transformation leads to useful ends, such as packaging, paper and cardboard, glass, used tyres, scraps, batteries, electrical and electronic equipment, and used cooking oils. |
| Vietnam | There are no specific E-waste management regulations in Vietnam. Instead, all E-waste is treated as hazardous waste under the hazardous waste legal framework. Based on Circular 12/2011/TT-BTN&MT on hazardous waste management, E-waste is considered hazardous waste. |

**Sources: Ministry of the Environment Government of Japan (2016); Nguyen (n.a); Secretariat of the Pacific Regional Environment Programme (2020)**

Based on the definitions set out in Table 2.1, it can be concluded that E-waste is any electrical and electronic equipment from offices, households, and commercial activities that can no longer be used and has been discarded, which can also be considered scrap materials. Discarded electrical and electronic equipment contains toxic and hazardous materials, as stated in First Schedule Environmental Quality (Scheduled Wastes) Regulations 2005 (code SW 110), Environmental Quality Act 1974 (EQA 1974) and Basel Convention (code A1180).

Regardless of the topic or situation, definition is essential. It is necessary to develop a precise definition of E-waste in order to distinguish the many types of discarded materials. E-waste is regulated under the Environmental Quality Act 1974 in Malaysia, and it is managed and supervised by the Department of Environment. There is one question regarding the definition of E-waste in this present study. This is to find out how well-versed respondents are regarding the definition, which is the foundation of understanding.

## 2.3 Issues on E-waste

Over the years, increasing spending power and technology in Malaysia has led to greater usage of EEE (Babington et al., 2010; Deniz et al., 2019). Washing machines are the lowest contributors to E-waste (Shumon et al., 2014). Whenever a new product is added to the market, older products will eventually be added to the E-waste stream (Umair et al., 2015). Televisions and mobile phones represent small and larger consumer electronic products (Milovantseva & Saphores, 2013). E-waste is a major environmental concern nowadays due to the increasing usage of electronics, leading to rapid growth and huge generation of E-waste (Kalana, 2010; Song et al., 2012; Kiddee et al., 2013; Afroz et al., 2013; Akhtar et al., 2014; Shumon et al., 2014; Tiep et al., 2015; Borthakur & Gowind, 2017; Abdeelbasir et al., 2018; Deniz et al., 2019).

E-waste is valuable; nonetheless, it is a concern due to the harmful compounds it contains (Sepúlveda et al., 2010 in Umair et al., 2015). E-waste is generated by different sectors: for example, the industrial, institutional, household, and business sectors (Shumon et al., 2014). The life cycle of EEE, from material extraction and components to product manufacture, energy requirements and disposal of products, causes a number of issues (Darby & Obara, 2005), which are increasing in importance due to the poor management structure regarding E-waste (Shumon et al., 2014; Cesaro et al., 2018; Deniz et al., 2019), such as illegal dumping and landfilling (Kalana, 2010; Afroz et al., 2013; Shumon et al., 2014; Tiep et al., 2015), lack of strategies for minimizing the volume of E-waste and ways to prevent its continual increase (Afroz et al., 2013). Disorganized disposal methods for E-waste and low disposal technology to process it are further examples of poorly structured strategies for managing E-waste (Afroz et al., 2013; Tiep et al., 2015). Unauthorized import of E-waste, rapid local production of E-waste, indiscriminate and inadequate disposal of E-waste, lack of monitoring of unauthorized E-waste recycling,

poor public awareness of the negative effects of E-waste, and poor ability to pay for formal E-waste disposal are those issues related to E-waste (Afroz et al., 2012).

E-waste contains numerous different toxic and hazardous substances (Abeliotis et al., 2006; Aydin, 2011) and various metals (Aydin, 2011), such as lead, mercury, arsenic, cadmium flame, hexavalent chromium, selenium, arsenic, copper, iron, platinum, silver and brominated flame retardants are used in electrical and electronic equipment (Abeliotis et al., 2006; Aydin, 2011). Manufacturing of EEE involves a number of hazardous components, chemicals, and processes (EU, 2003 in Darby & Obara, 2005).

Establishing E-waste management is vital, and it should include numerous pillars, such as raising public awareness, boosting collection facilities in public areas, establishing government rules, and introducing economic incentives (Tesfaye et al., 2017). According to Darby and Obara (2005), the general understanding of the E-waste issue is part of the problem because the public does not receive adequate information on how to handle and dispose of E-waste (Kalana, 2010). As a result, the public has neglected waste management at the individual level (Barloa et al., 2016).

## 2.4 E-waste Generation

Globally, Asia generates the highest quantity of E-waste, at about 24.9 million metric tonnes, followed by the Americas, at 13.1 million metric tonnes; Europe, at 12 million metric tonnes; Africa, at 2.9 million metric tonnes, and Oceania, at about 0.7 million metric tonnes (Akon-Yamga et al., 2021). This adds up to a total of 53.6 million metric tonnes of E-waste generated in 2019. In total, only 20% of the global E-waste is collected and recycled, while about 70% of E-waste is not reported (Akon-Yamga et al., 2021).

Electric and electronic waste releases heavy metals, flame retardants, and chemicals into the water and soil (Hendricks, 2012 in Shumon et al., 2014). When it is dumped into a landfill, it will cause groundwater contamination. At the same time, incineration will emit toxic gases into the atmosphere, and the recycling of E-waste will expose hazardous substances to the environment (Kiddee et al., 2013). The toxic pollutants released in these ways directly impact living things through the food chain, especially in communities near E-waste recycling and dumping facilities (Kiddee et al., 2013). E-waste currently represents one to three percent of global municipal waste, according to Borthakur and Govind (2017). According to Forti et al. (2020) in The Global E-waste Monitor 2020, with an average of 7.3 kg per capita, E-waste generation in 2019 was 53.6 million metric tonnes. This figure is predicted to increase to 74.7 million metric tonnes by 2030. The volume of E-waste globally between 2010 and 2019 is illustrated in Figure 2.1.

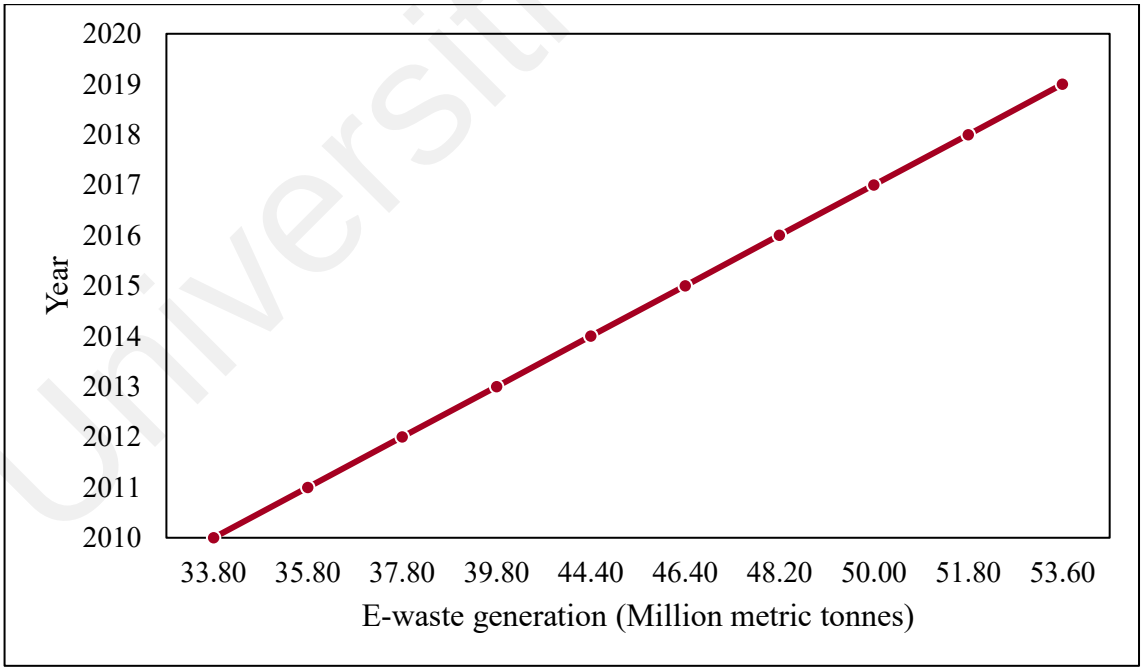


**Figure 2.1: Volume of E-waste reported globally between 2010 and 2019**
**Source: Tiseo (2023)**

Based on Figure 2.1, the volume of E-waste globally has risen by an increment of between

1.8 and 4.6 metric tonnes each year as a result of the economic growth of the country, population growth, and the decreased lifespan of electronic goods due to technological advancements, hence leading to more waste being generated by local industries and households, as well as imported from other countries (Kalana, 2010; Afroz et al., 2012; Kiddee et al., 2013; Madanhire et al., 2019). With a population of approximately 28 million, Malaysia produces about 18,000 tons of waste every day. Approximately 10 to 15 percent of E-waste is generated from the total generated scheduled waste (DOE, 2009; Suja, 2014).

According to the DOE (2015), household E-waste mostly ends up in the informal sector, meaning that the authorities have no chance to collect proper data on the actual volume of household E-waste generation in Malaysia. However, the actual volume of household E-waste generated is estimated to be much higher, given the public consumption of electrical and electronic appliances. Subsequently, a question about awareness of E-waste generation in Malaysia is highlighted in the questionnaire survey in the present study. It is critical to emphasise the public's general awareness since, from this perspective, it may be concluded that the public is aware of global environmental issues. As a result, it can serve as a starting point for the general public to engage in sustainable consumption practices when utilising electrical and electronic appliances. E-waste management in Malaysia began only in 2005, and it is still in its infancy (Andeobu et al., 2021). As a result, the data on the volume of E-waste generated in Malaysia were first reported formally in 2006. The projected volume of E-waste generated in the coming years has also been forecasted. According to the Japan International Cooperation Agency, JICA (2014), despite the fact that various figures exist, it is essential to quantify the generation volume based on recent data. According to Terazano et al. (2006) in Alias et al. (2014), due to the severe absence of precise and trustworthy data on E-waste generation in most

countries, it is challenging to ascertain the true picture of E-waste stream flow. Table 2.2 sets out the E-waste generation specifically in Malaysia based on the availability of the data.

**Table 2.2: Volume of E-waste generated in Malaysia**

| Year | E-waste generation (metric tonnes) | Sources |
|---|---|---|
| 2006 | 40275 | Afroz et al. (2012) |
| 2007 | 52718 | |
| 2008 | 102809 | |
| 2009 | 134036 | |
| 2010 | 163340 | Jaibee et al. (2015) |
| 2011 | 152722 | |
| 2012 | 78278 | Haron (2015b) |
| 2013 | 52978 | |
| 2014 | 232000 | Baldé et al. (2015) |
| 2015 | *926986 | Nair (2018) |
| 2016 | 280000 | Baldé et al. (2017) |
| 2017 | 76886 | Yong et al. (2019) |
| 2018 | *1031175 | Nair (2018) |
| 2019 | 364000 | Forti et al. (2020) |
| 2020 | *1119155 | Nair (2018) |

**Projection of E-waste generation*

Herat (2021) stated that 'The Global E-waste Monitor' as reported by Forti et al. (2020), Baldé et al. (2017), and Baldé et al. (2015) are the most reliable and recent statistics for the E-waste generation. This is because E-waste generation data are mostly estimated through the prediction of appliances' lifespan or based on the sales data for most countries (Herat 2021). According to Alias et al. (2014), the generation of E-waste is thought to be greater than previously reported. However, the exact numbers could not be notified to the Department of Environment Malaysia (DOE) because the E-waste goes to different disposal channels, such as the informal recycler or the landfill. For example, in 2006, it was estimated that Malaysia generated approximately 652,909 metric tonnes of E-waste,

but only 6.17% of that volume was reported to the DOE.

Referring to Table 2.2, the volume of E-waste generation for these five years has increased from 40,275 metric tonnes in 2006 to 163,340 metric tonnes in 2010. There was a decrease in the volume of E-waste generation reported from 163,340 metric tonnes in 2010 to 52,978 metric tonnes in 2013. According to Yong et al. (2012), in 2012, E-waste was reported as one of the top six scheduled waste streams generated in Malaysia. However, the decrease in E-waste generation between 2010 and 2013 results from the growing trend of moving electrical and electronic industries from Malaysia to countries with cheaper labour rates, such as Thailand and Vietnam (Ismail & Hanafiah, 2019).

Subsequently, there was a sharp increase in the generation in 2014, as reported about 232,000 metric tonnes. The volume of E-waste generated between 2015 and 2020 exhibits variation in numbers. For 2015, 2018, and 2020, there were no reported data on the generation of E-waste in Malaysia. Instead, the projected E-waste generation for these three years is reported in Table 2.2. For planning and management purposes, it is vital to acquire information about the compositions and quantities of e-waste (Ismail & Hanafiah, 2019). Even if for years 2015, 2018, and 2020, the E-waste generation is only reported by utilising projected E-waste generation, according to Ismail and Hanafiah (2019), projection numbers of E-waste are also crucial core information for effective E-waste management. Nevertheless, Yong et al. (2019) concluded that the reported E-waste generation comes primarily from industrial sources, leaving out E-waste generation from households.

Tiep et al. (2015) highlighted that mobile phones and rechargeable batteries are the largest contributors to E-waste generation. Meanwhile, DOE (2020) reported that air

conditioners, mobile phones, personal computers, refrigerators, televisions, and washing machines are commonly discarded in Malaysia. Management of E-waste through recycling, disposal, collection, and segregation mechanisms is not well established in Malaysia, leading to a rise in E-waste (Kalana, 2010; Tiep et al., 2015). In an email exchange with a representative from Pertubuhan Amal Seri Sinar on 29th October 2019, it was discovered that since recycling bins were installed throughout Selangor and Kuala Lumpur, the volume of E-waste collected each month ranges from 1,000 kg to 6,000 kg.

### *2.4.1 Rapid Generation of E-waste*

Due to the economic transition from agricultural to industrial socio-economics in the 1980s, Malaysia's population is increasingly living in urban areas and adopting a modern lifestyle. As time passes, the advancement of technology, particularly the development of electrical and electronic appliances, motivates the public to upgrade their devices. All of these factors cause domestic E-waste consumption to rise, which then leads to diminishing the lifespan of current devices or equipment, hence leading to an increase in E-waste generation. The rise in the quantity of E-waste may have an impact on the environment and human health if it is not properly handled (Herat, 2007; Williams et al., 2008; Afroz et al., 2012; Afroz et al., 2013; Haron & Othman, 2016; Mahat et al., 2019).

Technology innovation and market expansion have led to the generation of electrical and electronic equipment (Abeliotis et al., 2006; Nduneseokwu et al., 2017), while the rapid growth of electronic industries and changing consumer culture have led to an increase in consumer purchasing (Afroz et al., 2013). Nowadays, the electronics industry is the world's fastest-growing manufacturing sector; hence, the consumption of EEE has become a key issue in economic development (Sivathanu, 2016).

The electrical and electronics industry in Malaysia helps contribute to the Gross Domestic Product (GDP), job creation, and external trade (Wan, 2016). Its rapid growth contributes to large numbers of employment opportunities (Borthakur & Gowind, 2017). This strong performance industry grew about 13.3% during the first seven months of 2014 and is expected to grow further in the future (Wan, 2016). However, even though EEE enhances the quality of life and works as an everyday essential, its usage contributes to the generation of E-waste (Sivathanu, 2016).

Rapid development in the electrical industry (Wang et al., 2016) and enhancement in technology (Soo & Doolan, 2014) mean that electrical and electronic products are continually upgraded (Wang et al., 2016) as the development of new technology leads to appliances becoming cheaper and easier to use (Akhtar et al., 2014). EEE is important to the modern human lifestyle (Babington et al., 2010), and upgrades to patterns (Akhtar et al., 2014), features, and style (Soo & Doolan, 2014) work as factors encouraging people to replace these products thus shortening their lifespan (Kiddee et al., 2013; Zeng et al., 2013 in Umair et al., 2015) and increasing the quantity of E-waste by increasing production and consumption across the globe (Jang, 2010; Zhong & Huang, 2016). For example, the number of mobile phones and computers is increasing every year (Nnorom & Dsibanjo, 2008 in Umair et al., 2015).

Basically, technological advancement, product lifespan, urbanisation, and industrialisation are the key components that increase the generation of E-waste globally (Deniz et al., 2019). According to previous studies, each type of electronic appliance has a different lifespan. For instance, a computer's lifespan is between two and six years, a mobile phone between 18 and 24 months, a color television and an air conditioner's between eight and ten years, a washing machine's lifespan is about ten years, and a

refrigerator's lifespan is between 13 and 16 years (Afroz et al., 2013; Lundstreadt, 2011 in Umair et al., 2015; Milovanstseva & Saphores, 2013). The proportion of mobile phones as E-waste has increased from 16% to 88% of the total volume of E-waste over a period of 15 years; however, the recycling rate is only about 8% (Milovanstseva & Saphores, 2013).

### *2.4.2 Effects of E-waste Generation on the Environment and Human Health*

E-waste consists of about 60 elements from the periodic table that are either considered heavy metals or organic chemicals, namely arsenic, beryllium, brominated flame retardants (BFR), cadmium, chromium, cobalt, gold, iron, lead, manganese, mercury, niobium, phthalates, platinum, polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs), polychlorinated dibenzodioxins and dibenzofurans (PCDD/PCDFs), polycyclic aromatic hydrocarbons (PAHs), polyvinyl chloride and titanium (Babington et al., 2010; Jang, 2010; Xu et al., 2015; Tiep et al., 2015; Sivathanu, 2016; Balde et al., 2017; Xavier et al., 2018). Besides, printed circuit boards are needed as an essential part of most Electrical and Electronic Equipment (Abdeelbasir et al., 2018). Table 2.3 tabulates the composition of elements found in electrical and electronic appliances.

**Table 2.3: The composition of electrical and electronic appliances**

| | **Car electronics** | **Keyboards** | **Personal computers** | **Printed Circuit Boards** | **Typical Copper ore** |
|---|---|---|---|---|---|
| **Aluminium, Al** | - | 18 | 11 | 3 | - |
| **Antimony, Sb** | 0.08 | 0.3 | 0.5 | 0.06 | |
| **Bismuth, Bi** | 0.01 | <0.00 | <0.0004 | 0.17 | - |
| **Copper, Cu** | 20 | 13 | 7 | 25 | 0.8 |
| **Gold, Au** | 0.007 | 0.05 | 0.001 | 0.008 | 0.00001 |
| **Iron, Fe** | 5 | 3 | <0.1 | 5 | - |
| **Lead, Pb** | 1 | 0.3 | 1.5 | - | - |

| | Car electronics | Keyboards | Personal computers | Printed Circuit Boards | Typical Copper ore |
|---|---|---|---|---|---|
| **Nickle, Ni** | 0.3 | 0.16 | 0.2 | 0.5 | - |
| **Palladium, Pd** | - | 0.0002 | 0.0004 | - | 0.04 |
| **Silver, Ag** | 0.12 | 0.05 | 0.009 | 0.3 | 0.00034 |
| **Zinc, Zn** | 1 | 3 | 1.2 | 1.5 | 0.12 |

**Source: Madanhire et al. (2019)**

When toxins such as arsenic, mercury, and cadmium are released into the atmosphere, they are harmful to life, contaminating the water, air, and soil. Some electrical and electronic equipment contains polychlorinated biphenyls (PCBs), which have carcinogenic effects (Mahat et al., 2019). Heavy metals found in landfill leachates and open burning of wires and cables cause the release of persistent organic pollutants (POPs). Both heavy metals and POPs are contained in electrical and electronic products (Terazono et al., 2006). The health impacts of some of the toxic and hazardous substances in E-waste are tabulated in Table 2.4.

**Table 2.4: Health impacts from the toxic and hazardous substances in E-waste**

| Toxic and hazardous substances in E-waste | Health impact |
|---|---|
| Beryllium | Can cause lung cancer, berylliosis, and skin disease |
| Brominated flame retardants | Can cause hormonal disorders |
| Cadmium | Can cause risk to the kidneys<br>Can reduce hormone production<br>Can lead to infertility |
| Chromium | Can cause allergic reactions, carcinogenic, genotoxic, mutagenetic, lung failure, and reproductive development anomalies |
| Lead | Can damage the nervous system, brain, reproductive system, and kidneys<br>Can cause blood disorders<br>Can reduce hormone production |

| Toxic and hazardous substances in E-waste | Health impact |
|---|---|
| Lead | Can lead to infertility |
| Mercury | Can damage the foetuses,<br>Can cause brain and kidney damage<br>Can affect the central nervous system<br>Can lead to impaired hearing and vision<br>Can lead to developmental delays and deficits in children<br>Can affect the immune system and the cardiovascular system |
| Polychlorinated biphenyls (PCBs) | Can cause cancer in animals and cause liver damage in humans |
| Polyvinyl chloride | Can cause respiratory problems |
| Polybrominated diphenyl ethers (PBDEs) | Can cause hormonal disorders |
| Polychlorinated dibenzodioxins and dibenzofurans (PCDD/PCDFs) | Can cause infantile autism, changes in sex ratio at birth, reproductive toxicity, obesity, and type II diabetes |

**Sources: Kiddee et al., (2013); Xu et al., (2015); Awasthi et al., (2016)**

When E-waste is not properly disposed of, leachate containing high concentrations of heavy metals, dissolved and suspended organic substances, and inorganic compounds enter the environment, resulting in these toxic substances being found in blood, hair, human milk, and urine (Kiddee et al., 2013). Based on Table 2.4, it can be seen that E-waste has a health impact on the surrounding community and workers involved in informal E-waste recycling activities. The consequences of E-waste on human health are worsened by informal recycling and management. For example, effluent and residue are being disposed of in landfills and discharged into surrounding drains, lakes, oceans, and rivers. This will pollute the air, groundwater, land, and water. Furans and dioxins, in particular, cause air pollution, while soil pollution caused by heavy metals has similar effects to aquatic pollution, groundwater pollution, surface water pollution, and marine pollution. Human health will be threatened as a result of the absorption, ingestion, and inhalation of these pollutants (Shahzadi, 2018; Rautela et al., 2021).

The irresponsible disposal of E-waste causes serious environmental pollution because it contains over 1,000 different substances, including toxic heavy metals and organic compounds (Abdeelbasir et al., 2018). When the E-waste is not properly pre-treated during the waste management phase, its hazardous material content causes environmental problems (Babington et al., 2010). Environmental pollution occurs when burning in acid baths causes the E-waste to be exposed directly to the environment (Shumon et al., 2014). Besides, if E-waste such as DVDs, CDs, and Blu-ray discs are managed by incineration, this will lead to the release of toxic gases. Cracked and broken plasma TVs, monitors, or LCD and CRT screens are also harmful (Deniz et al., 2019). Releasing toxic substances from E-waste contaminates and pollutes the soil, groundwater, and air (Afroz et al., 2013; Akhtar et al., 2014; Deniz et al., 2019), all of which will affect human health (Sivathanu, 2016). Increasing volumes and improper disposal of E-waste create the potential for high levels of hazardous materials, toxic substances, and heavy metals, posing a significant threat to the environment and human health due to infectious diseases, namely cholera, plague, and smallpox.

E-waste needs to be collected and recycled properly in order to avoid the loss of valuable resources and to prevent the spread of hazardous substances to the environment as well as human health (Deniz et al., 2019; Umair et al., 2015). For example, up to 17 times more gold can be extracted from E-waste than from gold ore, and 40 times more copper can be extracted from E-waste than from copper ore. In this study, the knowledge section of the KAP questionnaire includes two questions about the effects of E-waste on the environment and human health. It is crucial to determine whether the general public understands the consequences of E-waste in order to raise awareness, which will increase their willingness to participate in sustainable E-waste management at the individual as well as the household level.

## 2.5 Waste Management Hierarchy

In this era of modernization, electrical and electronic appliances are important for human beings for a variety of daily purposes. Hence, a proper management system and strategy must be implemented to ensure unwanted appliances are not left unattended. As stated in Cole et al. (2019), E-waste has special end-of-life requirements since it is a complex product to begin with.

The waste management hierarchy can be defined as a ranking system for waste management based on which options are significantly best for the environment (ISM Waste & Recycling, 2021; Department of Environment Food and Rural Affairs, 2011). All types of waste should refer to the waste management hierarchy in order to manage the waste. According to ISM Waste and Recycling (2021), Cole et al. (2019), and the Department of Environment Food and Rural Affairs (2011), the preferable management option is the prevention stage, which is also known that at this stage, the product is still categorized as non-waste. Meanwhile, the least preferred method would be landfilling disposal. This waste management hierarchy offers five options for managing waste, and since E-waste contains valuable but dangerous materials, it must be properly managed. Hence, the waste management hierarchy, which has been discussed in the context of traditional waste management, can also be applied to E-waste management in order to maximize the advantages while minimising the negative consequences (Cole et al., 2019; Gunarathne, 2015). The waste management hierarchy emphasises the importance of reducing pollution by practicing waste prevention, followed by reuse, recycling, and treatment as preferred waste disposal strategies over landfilling (Modoi & Mihai 2022). Figure 2.2 shows the waste management hierarchy.

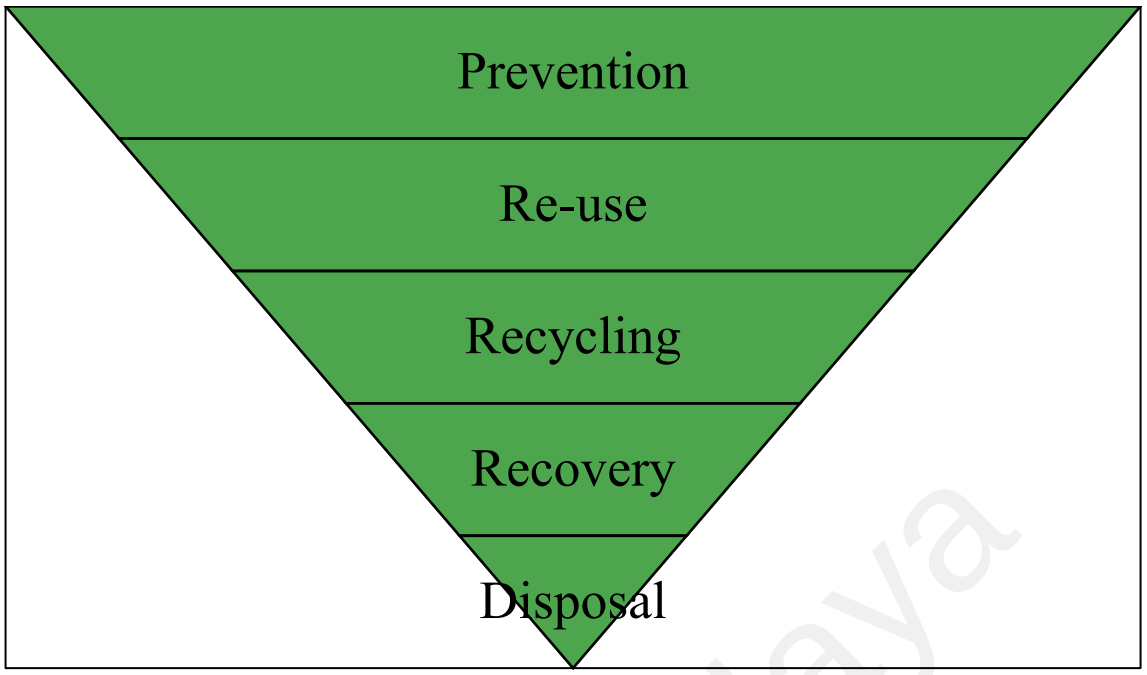


**Figure 2.2: The waste management hierarchy**
**Sources: Cole et al. (2019); DEFRA (2011); ISM Waste & Recycling (2021)**

This lopsided hierarchy emphasises how the top options of waste management are more desirable and environmentally as well as socially sustainable than the bottom options (Gunarathne, 2015). In accordance with the waste management hierarchy, managing waste through the preventative stage is the most favorable and has the least impact on the environment. According to ISM Waste and Recycling (2021), practicing this step will prevent the generation of waste, and eventually, the number of waste disposals that end up in landfills will also be reduced. This principle is also able to reduce toxic and hazardous materials (Cole et al., 2019). Madanhire et al. (2019) stated that this prevention step is also linked to cleaner manufacturing at the manufacturing stage. This preventative approach is the ideal one for managing E-waste because there will be no E-waste to manage if E-waste generation can be reduced. However, in this modern and digitalized era, the public is interested in purchasing the most sophisticated, recent, and technologically advanced appliances, making reducing E-waste a difficult option unless a sustainable consumption and disposal culture is reconsidered (Gunarathne, 2015). Arif and Afroz (2013) highlighted that E-waste management should focus on practicing the

prevention approach by promoting equipment redesign and replacing the potentially harmful components in E-waste to better control the negative effects of E-waste. Naik and Eswari (2022) also emphasise that through this approach, sustainable E-waste management is achievable. As the usage of electrical and electronic appliances reduces, the E-waste generation will also be reduced. This resulted in both energy and resource conservation that typically needed to produce electronic goods.

The reuse step is the next principle in waste management. According to Cole et al. (2019) and ISM Waste and Recycling (2021), this step is prioritized in the waste management hierarchy when waste is produced. This will enable products to last longer through reuse. As a result, this will lessen the environmental effects by decreasing the growth of waste that ends up in landfills. In addition, encouraging reuse benefits society by making products more accessible to low-income households. Cleaning, fixing, and refurbishing products will considerably improve the number of products that can be reused. A significant reuse option is not included in the statutory framework. In managing E-waste, the reuse approach entails reusing unwanted electrical and electronic appliances for the same or a different purpose since E-waste contains many components that can be reused (Gunarathne, 2015).

The legal framework does not address reuse options, while recycling is a waste management approach. As stated in Abalansa et al. (2021) and Cole et al. (2019), the law states that recycling waste calls for special care and treatment. David et al. (2019) stated that recycling is a process of converting old and unwanted items into a new version with similar or different purposes. This is similar to what was highlighted in Conserve Energy Future (2018), which stated that recycling activity can be defined as reprocessing and reusing waste. The segregation process is the first phase and key in the waste recycling

process. According to Kihila et al. (2021), the segregation process at source will be a potential way to ensure the success of the waste recycling, recovering, and reuse approach. For example, E-waste recycling will assist in recovering valuable items such as metals as this activity converts the device streams into material streams, just like recycling in general (Gunarathne, 2015). This shows that recovering valuable materials can be done through the recycling approach. Moreover, E-waste recycling is one of the environmentally sound ways to address the significant environmental tonnage of E-waste in developed and developing countries (Abalansa et al., 2021; Cole et al., 2019). According to the ISM Waste and Recycling (2021), recycling is the most environmentally friendly approach to waste disposal because it helps to produce a new product while reducing the number of raw materials required. Additionally, as referred to by Madanhire et al. (2019) and Naik and Eswar (2022), recycling activity not only decreases the need for raw materials but also reduces the use of energy while extracting raw materials.

As we navigate downward, the waste management hierarchy, next to recycling, is the recovery step. In contrast to recycling, which implies the possibility of reusing materials in the same sort of execution, waste recovery could also be defined as energy recovery (Modoi & Mihai 2022). As stated previously in ISM Waste and Recycling (2021), for any waste that cannot be recycled, recovery would be the best option. This option might be feasible to transform waste into energy, and among the benefits are reduced carbon emissions and reduced reliance on fossil fuels. Although E-waste is categorized as hazardous waste, it also has much potential for value recovery compared to other types of waste. An example of E-waste recovery is separating the plastic fraction because E-waste also includes polymers of various grades, some of which carry toxins Ilankoon et al. (2018). Modo and Mihai (2022) stated that the E-waste recovery approach involves a number of phases, each of which serves a purpose. It starts with the collection stage, then

proceeds to a physical pre-treatment stage, and finally, it recovers as many resources as it can using several procedures.

The final stage of waste management, waste disposal, will be covered in this sub-chapter. According to the hierarchy, the disposal method is the least desirable and is also thought to pose the greatest environmental threat. The ISM Waste and Recycling (2021) stated that the waste disposal method is the most expensive and least environmentally friendly choice. This kind of waste management results in undesirable products being dumped in landfills. According to Madanhire et al. (2019), landfilling should begin with a pre-treatment process in order to prevent leachates or runoff. If the protocol is not followed, there is a danger of detrimental exposure to the environment and human health. This waste management approach would not be able to recover any energy and thus would not provide any economic benefit (Department of Environment Food and Rural Affairs, 2011). Similar to any waste that ends up in landfills, E-waste also has a risk of leaching, for example, from batteries and electronic circuits, which release acids and heavy metals. E-waste that ends up in landfills is described as a toxic time bomb since the leachate may be released into the environment naturally after several years and then may reach both fresh water and groundwater (Sivaramanan, 2013).

## 2.6 E-waste Management in Malaysia

E-waste management systematically regulates and monitors electrical and electronic appliances when they are no longer needed and thrown away. The most effective method must result in fewer risks to environmental health while also being able to appreciate the value of waste resources (Madanhire et al., 2019). In Malaysia, electrical and electronic appliances are apparently reported to be one of the major contributors to the solid waste stream (Azad et al., 2017), as well as one of the main scheduled wastes

generated in Malaysia in 2012 (Yong et al., 2019). There are two main E-waste streams in Malaysia, namely industrial and household E-waste (Razip et al., 2022). In Malaysia, the Department of Environment (DOE) manages all the environmental issues, including E-waste, that began to evolve in 2005 (Nurul Aini et al., 2016). According to Yong et al. (2019), DOE specifically classified household E-waste into six types, namely air conditioners, mobile phones, personal computers (including laptops and desktops), refrigerators, televisions (including flat screens and CRTs), as well as washing machines.

The legislation of E-waste is under the Environmental Quality (Scheduled Wastes) Regulations 2005 that been introduced in August 2005 which highlighted E-waste under code SW110 in the First Schedule (Azad et al., 2017; Nurul Aini et al., 2016). This regulation follows the "cradle to grave" waste management concept, which strictly regulates the generation, storage, transportation, treatment, and disposal of scheduled wastes. It is further emphasised that all recycling, recovery, and disposal activities must be carried out in an environmentally sound manner at designated or licenced sites and that the discharge of any E-waste into landfills or waterways is absolutely prohibited (Alias et al., 2014). In order to identify the components and characteristics of E-waste, a set of guidelines, namely the "Guidelines for the Classification of Used Electrical and Electronic Equipment," has been introduced and published by the DOE (Nurul Aini et al., 2016) to classify the components and features of E-waste to assist exporters, importers, relevant agencies and waste generators in distinguishing between E-waste as well as other types of waste (Azizi et al., 2023). Guidelines and regulations are important aspects in managing E-waste as those working as a guide for the E-waste generator in managing unwanted appliances, especially at the disposal stage. The monitoring and enforcement by the responsible bodies will be easier to conduct with specific rules and regulations related to E-waste. However, in Malaysia, there is currently no legislative structure or system

established to handle household E-waste. Meanwhile, industrial E-waste is being managed by the legislative framework enacted by the governments (Yong et al., 2019; Kang et al., 2020; Razip et al., 2022). According to Razip et al. (2022), despite the fact that the Department of Environment (DOE) has produced regulations on E-waste, the majority of it continues to be disposed of in landfills and incinerators, resulting in negative impacts on the environment.

Malaysia has a dual position in E-waste trading as both an importer and an exporter of E-waste. Malaysia's geographical position, which lies in the centre of the foreign E-waste trading route, makes it an enticing destination for E-waste trading (Afroz et al., 2012). Malaysia, like other developing countries, has become an appealing destination for E-waste from more affluent nations, with the majority of it managed in an unsustainable manner, resulting in substantial environmental and health consequences (Azizi et al., 2023). However, as a signatory to the Basel Convention since 1993, the import and export of E-waste into and out of Malaysia is strictly regulated and requires prior written approval from the Director General of the DOE (Alias et al., 2014; Azizi et al., 2023). According to the Malaysia national report of the Eighth Regional 3R Forum in Asia and the Pacific (9-12 April 2018), no data on E-waste generation is available in Malaysia, and the monitoring basis for E-waste in Malaysia is inadequate. In addition, the report emphasises that the number of E-waste recyclables per year is unavailable. The lack of exact numbers and reports on E-waste collection and generation leads to a lack of monitoring activity (Razip et al., 2022). One of the reasons for this is social and legislative constraints when household E-waste in Malaysia is not regulated by a legal framework. Therefore, it has been difficult to maintain an inventory of household E-waste, and its material flows cannot be easily predicted (Yong et al., 2019). The E-waste flow in Malaysia shows that E-waste takes separate routes depending on its components and is

collected by licenced contractors: for example, Alam Flora Sdn Bhd and SWM Environment Sdn Bhd (DOE, 2018). Aside from the fact that E-waste can be harmful to the environment and human health, on a positive note, these wastes can offer a solution to the shortage of raw resources. The extraction of valuable materials can be done by conducting E-waste recycling as this process requires three main steps, namely: (1) collecting, (2) classifying and disassembling, and (3) end-processing (Herat, 2021).

According to Nurul Aini et al. (2016), under the Environmental Quality (Prescribe Premises) (Treatment Disposal Facilities for Schedule Waste) Regulations 1989, every recovery facility that was created and run by a private company needs to be registered with the Department of Environment Malaysia (DOE). All of these recovery facilities are in charge of collecting, transporting, disassembling, classifying, re-marketing, as well as making sure that hazardous items are disposed of safely. E-waste recyclers in Malaysia come in two types: partial recyclers and full recyclers. Partial recyclers are more likely to be centred on reuse, separation, and dismantling activities because material recovery facilities (MRF) have less ability to recycle all the E-waste. Full recyclers are those who have the MRF capacity to recycle all of the E-waste that they receive (Babington et al., 2010). Table 2.5 shows the number of E-waste licensed contractors around Malaysia in 2008 and 2020. However, according to Azad et al. (2017), these recycling companies, also known as "E-waste contractors," only collected E-waste from large institutions and industries based on yearly contracts.

**Table 2.5: Number of E-waste licensed contractors around Malaysia in 2008 and 2020**

| States | Number of licensed contractors | | | |
|---|---|---|---|---|
| | Partial recyclers | | Full recyclers | |
| | 2008 | 2020 | 2008 | 2020 |
| Johor | 8 | 9 | 2 | 6 |
| Kedah | 16 | 4 | 1 | 2 |
| Kelantan | - | 1 | - | - |
| Kuala Lumpur | 4 | 1 | - | - |
| Labuan | - | - | - | - |
| Melaka | 10 | 4 | 2 | 3 |
| Negeri Sembilan | 3 | 1 | 1 | 1 |
| Perak | 2 | 2 | - | - |
| Perlis | - | - | - | - |
| Pulau Pinang | 25 | 9 | 4 | 7 |
| Putrajaya | - | - | - | - |
| Sabah | - | - | - | - |
| Sarawak | 5 | 1 | - | 1 |
| Selangor | 23 | 6 | 1 | 1 |
| Terengganu | - | 2 | - | - |
| **TOTAL** | 96 | 40 | 11 | 21 |

**Sources: Babington et al. (2010); Hazardous Substances Division (2020)**

Based on Table 2.5, it can be seen that the number of partial recyclers decreased from 96 facilities in 2008 to only 40 facilities in 2020. Only the state of Johor increases in numbers from 8 to 9 facilities within 12 years. Meanwhile, Kedah, Kuala Lumpur, Melaka, Negeri Sembilan, Pulau Pinang, Sarawak, and Selangor show a decrease in the number of facilities. As for Kelantan and Terengganu, both states got new facilities in 2020 compared to the null partial recyclers facility in 2008. The partial recyclers facility in Perak remains the same in number throughout the 12 years. However, there is no partial recycler facility located in Labuan, Perlis, Putrajaya, or Sabah. As for the full recyclers licensed contractors, the numbers have increased from 11 to 21 within 12 years. Among all states,

as referred to Table 2.5, only Johor, Kedah, Melaka, Negeri Sembilan, Pulau Pinang, Sarawak, and Selangor have full recycler facilities (Babington et al., 2010; Hazardous Substances Division, 2020).

According to Suja et al. (2014), full recyclers are unable to conduct their work at maximum capacity due to the shortage of E-waste since E-waste recycling is practised less by Malaysians. Due to an unorganised and complicated disposal channel, household E-waste was less collected, with only a small volume able to be sent off to recovery facilities, as the public tends to sell or simply dispose of their unwanted appliances (Nurul Aini et al., 2016). However, as shown in Table 2.5, the number of partial E-waste recyclers has decreased over the last 12 years, while the number of full E-waste recyclers has increased. Due to increasing efficiency in recovering the materials, the number of full recyclers or full recovery facilities has grown over time because the partial recyclers are only partially involved in material recovery operations, and the E-waste still needs to be sent off to the full recovery facilities (Ismail & Hanafiah 2019; Soo et al., 2013). As stated by Yong et al. (2019), in Malaysia, the full recovery facilities usually collect the E-waste on their own, primarily industrial waste, or purchase the dissembled E-waste such as copper wires from partial recyclers. Thus, according to Razip et al. (2022), the material recovery facilities in Malaysia are more likely to receive a greater amount of E-waste from industry than from households.

For industrial E-waste, the management makes proper use of recovery facilities, but household E-waste generally ends up in inappropriate landfills (Shumon et al., 2014). Only authorised or accredited collectors who have complied with the standards, as well as requirements set forth by the DOE and other pertinent agencies, are permitted to collect household E-waste (Razip et al., 2022). For example, Malaysia has several

organisations and companies that provide E-waste recycling services for the public, for example, UrbanR Recycle+, SOLS Tech, Pertubuhan Amal Seri Sinar (PASS), Taiwan Buddhist Tzu-Chi Foundation Malaysia, T-Pot Electrical & Electronics and others. The public can simply take their E-waste to these organisations' specific E-waste bins or collection centres. Although the significance of establishing a regulated E-waste management framework has been generally recognised, progress on legislation, the collection system, and the development of formal recycling facilities has been gradual (Afroz et al., 2012). Effective strategies for waste collection and increasing the number of disposal sites and facilities are important in managing this waste (Barloa et al., 2016). Waste management, like the E-waste recycling system, is also in its early phases. There are several shortcomings in the management and disposal control systems for electronic appliances. This situation can be overcome by raising public consciousness regarding sustainable E-waste management to overcome the poor behaviour of Malaysians towards E-waste recycling (Mahat et al., 2019). Sustainable waste management with good strategies is important to reduce the impact of E-waste on the environment. Low-cost techniques are used in recovering metal, and without appropriate control systems during the recycling of E-waste, health problems will arise among workers and people living close to recycling plants (Terazono et al., 2006). In Malaysia, the management of waste is based on the level of toxicity (Aja et al., 2016). Currently, there are still no specific laws and regulations for the handling of household E-waste. Environment Quality (Household Scheduled Waste) Regulation 202x is currently in progress and has yet to be published. According to Razip et al. (2022), it is currently being reviewed by the Attorney General's Chambers (AGC) of Malaysia, and the items covered include air conditioners, mobile phones, personal computers, refrigerators, televisions, and washing machines. As a result, the Environmental Quality Act of 1974, which focuses on industrial E-waste, can be used as a guideline for managing and disposing of E-waste

at the household level. Malaysia's DOE underlines this E-waste in the Environmental Quality (Scheduled Wastes) Regulations 2005 First Schedule (Regulations 2) under code SW 110, which applies to 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. This regulation clearly states that no one can simply dispose of E-waste in landfills: E-waste can be recycled and recovered only at the prescribed premises (Kalana, 2010).

In the E-waste management stream, all manufacturers, retailers, consumers, recyclers, and policy-makers are responsible for managing E-waste and need to take part (Liang & Sharp, 2016; Thukral & Singh, 2023) in order to ensure that E-waste is handled properly to reduce its impact on the environment and human health. For example, producers are responsible for ensuring that post-consumer goods are treated and discarded in a sustainable manner by the application of the EPR strategy, then consumers should participate in recycling programmes, which could be an aid in increasing the recycling rate (Azizi et al., 2023). Besides, to reduce the rise in E-waste, the Environmental Quality Act (Scheduled Waste) Regulations 2005 replaced the 1989 Regulations by controlling the transboundary movement of E-waste and implementing recycling programs (Haron, 2015a). In this study, a section on knowledge of laws and regulations related to E-waste is included in the questionnaire survey to determine whether or not the public acknowledges the related information. There are also current acts, guidelines, regulations, and orders governing scheduled and hazardous waste, including E-waste. Table 2.6 shows the legislative framework related to E-waste in Malaysia, as listed by the Department of Environment. Despite the establishment of standards and legislation

for E-waste in Malaysia that DOE has issued, there is no guidance on how E-waste is managed at the individual level (Jayaraman et al., 2019; Azizi et al., 2023).

**Table 2.6: Legislative framework related to E-waste in Malaysia**

| Act/Guidelines/Order/Regulation | |
|---|---|
| **Act** | Environmental Quality Act 1974 (ACT 127) |
| **Guidelines** | Guidelines for Classification of Used Electrical and Electronic Equipment 2010 (Second Edition) |
| **Orders** | Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 2015 |
| | Environmental Quality (Prescribed Premises) (Scheduled Waste Treatment and Disposal Facilities) Order 1989 |
| | Environmental Quality (Prescribed Premises) (Scheduled Waste Treatment and Disposal Facilities) Order 2006 |
| | Environmental Quality (Prescribed Conveyance) (Scheduled Wastes) Order 2005 |
| | Customs (Prohibition of Imports) Order 2012 |
| | Customs (Prohibition of Exports) Order 2012 |
| **Regulations** | Environmental Quality (Licensing) Regulation 1977 |
| | Environmental Quality (Scheduled Wastes) Regulation 2005 |
| | Environmental Quality (Prescribed Premises) (Scheduled Waste Treatment and Facilities) Regulation 2006 |

## 2.7 The Current E-waste Generation and Management in South East Asian Countries

In this sub-chapter, the current E-waste management and generation in Cambodia, Laos, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, and Vietnam are listed. This is based on the Ninth Regional 3R Forum in Asia and the Pacific that was conducted by the United Nations Centre for Regional Development (UNRCD). This forum is conducted in 2019 with the theme of '3R as a Way for Moving towards Sufficiency Economy – Implications for SDGs'. Table 2.7 shows the approach taken by the top management from every country in managing the E-waste.

**Table 2.7: The current approach in managing E-waste by the top management in South East Asian Countries**

| Countries | Details and approach to managing E-waste |
|---|---|
| Cambodia | There are some regulations in Cambodia regarding activities that have a negative impact on the environment and human health, but there are none regarding E-waste management. As a result, the existing laws are ineffective in enforcing E-waste activities, and there is no formal inventory of E-waste generation in this country. The informal E-waste recycling activity is additionally highly active in Cambodia, which has resulted in a significant impact on the environment and human health. To address this issue, the Ministry of Environment Cambodia recently developed the Guideline on Environmental Sound Management of Waste Electrical and Electronic Equipment in collaboration with the Ministry of Environment Korea (Xavier et al., 2021; Herat, 2021). |
| Laos | The volume of E-waste in the Lao People's Democratic Republic (Laos) is increasing. This E-waste comes from different sources, such as houses and offices, and in order to properly manage and reduce the quantity of E-waste, the Hazardous Chemical Strategy (2020) and the Action Plan (2006-2010) served as the guidelines to overcome the environmental issue at the national level, starting from production, usage, disposal and importing to the county. |
| Myanmar | Myanmar generates relatively little E-waste, as most usable electrical and electronic equipment is kept by shops, repaired by the public, and sold to second-hand shops. For example, the 28th street market in Yangon is a popular trading market for usable electrical and electronic equipment. However, the government has formulated the National Waste Management Strategy and Master Plan (2018-2020), which is divided into short-term, mid-term, and long-term planning, to ensure that there are proper laws and legislation regarding E-waste management. |
| Philippines | Since E-waste is a global environmental issue, the Philippines has experienced a substantial increase in domestic consumption of electrical and electronic appliances, resulting in a significant E-waste problem. Due to the lack of formal recycling facilities, the informal sector handles most of the E-waste. The Metropolitan Manila Development Authority has over 2300 registered and unregistered junkshops. In this country, there is no formal inventory of E-waste generation. In accordance with Republic Act (RA) 6969, the Department of Environment and Natural Resources has published |

| Countries | Details and approach to managing E-waste |
|---|---|
| Philippines | Environment and Natural Resources has published "Guidelines on the Environmentally Sound Management (ESM) of Waste Electrical and Electronic Equipment (WEEE)" (Alam et al., 2019 in Herat 2021; Herat 2021). |
| Singapore | Singapore's E-waste management highlights public awareness of E-waste recycling by providing E-waste recycling bins for small E-waste items and specific recycling bins for toner cartridges. Its target was that by 2021, Extended Producer Responsibility (EPR) would be implemented, whereby the producers of batteries, ICT equipment, lamps, large appliances, and solar panels would be responsible for collecting and treating their own E-waste. |
| Thailand | In Thailand, a National Waste from Electrical and Electronic Equipment (WEEE) Strategy (2014-2021) has been implemented, with a focus on the voluntary programme for separating and collecting WEEE, together with several responsible bodies, such as the Bangkok Metropolitan Administration (BMA). As regards legislation on E-waste management, the government is currently drafting the WEEE Law, as there are no specific laws and regulations regarding E-waste.<br><br>Hazardous Substance Act B.E 2325(1992) No. 2.18 under No. 5.2 (chemical waste category) addresses electrical and electronic assemblies or scrap (except for scrap from electrical power generation) containing items such as accumulators and other batteries, mercury switches, glass from cathode-ray tubes and other activated glass, and PCB-capacitors, or contaminated with Cadmium, Mercury, Lead Polychlorinated Biphenyl.<br><br>The same Act, No. 5.3 (used electrical and electronic appliances category) also states that E-waste for reuse or modification, repair, improvement, remanufacturing for the originally intended use or sorting for disposal is exempt from permits and registration, but importing conditions for used electrical and electronic equipment are required. It is estimated that in Thailand, E-waste generation is increasing by up to 1000 units every year for each type of electrical and electronic appliance, as the highest generation of E-waste comes from mobile phones. |
| Timor-Leste | E-waste is also a concern in Timor-Leste, especially when imported to the country, such as computers, televisions, and radios. However, there is no proper |

| Countries | Details and approach to managing E-waste |
|---|---|
| Timor-Leste | management of this type of waste, and PDTOL, an Australian company, is solely responsible for collecting E-waste in Timor-Leste. |
| Vietnam | The quantity of hazardous waste generated is about 850,000 tons every year, and there are about 124 licensed companies managing and treating this hazardous waste, with a capacity of about 1.3 million tons every year. In order to manage its E-waste, Vietnam uses a circular on guiding capacity and management of hazardous waste, the implementation of Trade Law, and issuance of a List of Hazardous Substances. The Vietnamese government also banned the import of second-hand appliances (Arora, 2008). According to Borthakur and Govind (2017), the majority of Vietnamese people prefer to store their E-waste at home because of its value.<br><br>The Prime Minister of Vietnam signed Decision No. 50/2013/QD-TTg in August 2013, which requires enterprises that manufacture or import electrical and electronic appliances to oversee the collection, transportation, and processing of e-waste. This decision has been superseded by the Prime Minister's Decision No. 16/2015/QD-TTg, which took effect on July 1, 2016. The Vietnamese government is currently revising E-waste regulations in order to improve the efficiency of EPR implementation (Herat 2021). |

Overall, most of the listed countries highlighted legislation that related to hazardous waste as an approach to managing the E-waste. As for Timor-Leste country, there is no specific legislation highlighted; instead, the E-waste is being managed by an Australian company named PDTOL. Both Malaysia and Thailand currently use the existing legislation related to E-waste and are drafting suitable legislation to manage E-waste. For Malaysia, the Department of Environment (DOE) is currently drafting the Environment Quality (Household Scheduled Waste) Regulation 202x, focusing on household E-waste. Meanwhile, the Thai government is currently drafting legislation on E-waste management called WEEE Law.

The approach taken by Singapore's stakeholders in providing bins for small E-waste is also similar to the movement taken by Malaysia's stakeholders. As an example, DOE and the Malaysian Communications and Multimedia Commission (MCMC) provide E-waste recycling bins for small appliances such as mobile phones. Next, Vietnam and Malaysia share a similar approach to providing a licenced company. This is in order to manage and treat the E-waste in general. Each country highlighted its own strategy to tackle the issue of E-waste. Besides, to manage the E-waste sustainably.

## 2.8 Recycling Approach in Managing E-waste

Recycling is defined as the process of using part or all of a product to produce a new product. Recycling activities in which the public can participate comprise handing in unwanted or broken products to recyclers or collectors (Chibunna et al., 2013). According to Kelly et al. (2006) in Chibunna et al. (2013), public involvement is important to ensure the success of the recycling programme, which does not depend on technology alone. About 30,000 tons of waste are reported every day, but in 2015, only 5% of this waste was recycled ("Waste Management in Malaysia: In the Dumps", 2015). However, the recycling rate increased to 17.5% in 2016, although the rest still ends up in landfill ("Low awareness on recycling among Malaysians," 2017). Based on the report, it can be seen that the recycling rate is still low, with a lack of participation from the public (Jekria & Daud, 2016). According to Malik et al. (2015), recycling rates and involvement from the public depend on demographics, local conditions, and cultural situations.

E-waste is one of the various waste categories that should be addressed at the household level. The consumer is responsible for sending any unwanted electrical and electronic appliances to the retailer or the authorized collector, according to the Department of Environment Malaysia (2020). This is to cultivate the concept of sustainability in every

consumer, as well as to create a closed-loop material system for managing E-waste (Gurauskienė, 2008; Tanskanen, 2012). E-waste needs to be segregated at the source before the consumer decides how to dispose of those unwanted appliances. The source segregation technique will prevent any hazardous and chemical contamination. Besides, it is also affordable and practical, which is beneficial for recycling and other forms of proper waste management (Siddiqi et al., 2020). In order to determine if segregation at the source is being practiced by the public or not, there is one question in the current study that relates to the practices of segregation towards those unwanted appliances. According to Gurauskienė (2008), information and education are the primary tools for raising awareness and encouraging people to develop the habit of E-waste segregation from other types of waste.

Recycling supports sustainability (Fuller et al., 1996 in Schill & Shaw, 2016), which is a route to achieve a sustainable consumer society (Schill & Shaw, 2016). Recycling is the best solution to overcome the current increase in waste (Jekria & Daud, 2016), which is becoming a present issue and not only one for the future (Schill & Shaw, 2016). Recycling programmes are conducted to reduce the volume of waste generated in landfills and to create a material cycle society (Malik et al., 2015). Recycling also helps to reduce the consumption of raw materials and the volume of energy used (Conserve Energy Future, 2018).

People who are concerned about the environment are more likely to recycle (Domina & Koch, 2002 in Jekria & Daud, 2016). Encouragement of citizens and public education can help design household recycling processes (Babaei et al., 2015). As well as solid or household waste, user-generated E-waste should also be recycled. As discussed above, E-waste is a source of human exposure to environmental pollutants. If it is not safely

managed, it can cause respiratory problems, lung cancer, and many other health problems (Awasthi et al., 2016). Improvements in waste recycling, collection, and treatment using an environmentally friendly and energy-efficient approach will help to encourage a healthy environment and economics (Tesfaye et al., 2017).

E-waste contains numerous non-decomposable toxic metals and hazardous chemicals, together with precious metals, special metals, and valuable materials. E-waste contains significant quantities of engineering materials that can be used through evolving and available technology. If E-waste can be recycled, this will eventually lead to reduced carbon emissions, increase environmental protection (Zhong & Huang, 2016), reduce the emission of greenhouse gases, conserve natural resources, and help to reduce the usage of landfills (Thi Thu Nguyen et al., 2019). It was reported that in 2016, E-waste collection comprised about 44.7 million metric tons (Mt); however, only 20% of this quantity was recycled using appropriate procedures and methods (Deniz et al., 2019). One of the solutions to dispose of E-waste is through recycling activity (Haron, 2015b). This is in order to recover valuable materials and treat the waste appropriately (Abeliotis et al., 2006).

However, in Malaysia, the establishment and management of E-waste is still at a critical point, as only a few retailers and manufacturers have participated in raising public awareness of the issue of E-waste (Shumon et al., 2014). Thus, public awareness, perception, and behaviour toward disposing of E-waste are important in ensuring a successful E-waste management programme (Borthakur & Gowind, 2018) and also in order to reduce the environmental impact of E-waste. Involvement from consumers is the key to success in E-waste recycling activity, as well as the availability of infrastructure, education, and information from the collective system, mass media, municipalities, and

retailers, which serve as a good support system (Abeliotis et al., 2006). Hence, policy and public services are part of the key to success in aiming to increase the rate of E-waste recycling (Thi Thu Nguyen et al., 2019). Since E-waste contains a variety of valuable materials, such as plastics, metals, glass, and cables (Kasper et al., 2015), industrial and research processes are being applied to reuse and recover all of these valuable materials (Wang & Xu, 2014).

Recycling E-waste brings a number of advantages: it helps avoid the disposal of concentrated materials and reduces the disposal of E-waste in landfills (Realff et al., 2004). Separating waste at the earliest stage (Stoeva & Alriksson, 2017) prevents E-waste from being dumped directly into landfills (Shumon et al., 2014). The wealth of a country can be measured by how many mobile phones it discards (Hoornweg et al., 2013). Hence, E-waste recycling also helps in creating sustainable production and consumption (Realff et al., 2004). Recycling E-waste also has economic value (Wang & Xu, 2014; Widmer et al., 2005 in Kasper et al., 2015) by providing a secondary source of metals (Kasper et al., 2015). For example, white goods such as refrigerators and cookers have high percentages of metal content (Abeliotis et al., 2006), which can help in fulfilling the global demand for metals (Zhang et al., 2012). E-waste contains rich metals such as aluminium, copper, and gold that should be recovered. This opportunity is often referred to as urban mining. This is aimed at reducing the amount of raw material mining required to create new products since mining activities cause environmental pollution and deplete resources. Urban mining is a strategy that will replace virgin material mining as well as reduce the number of unwanted appliances in landfill and resource wastage (Wath et al., 2010; Zoeteman et al., 2010; Ongondo et al., 2011; Yong et al., 2019). Recycling E-waste as a whole is an environmentally friendly solution that will help reduce the pollution and energy used (Babington et al., 2013). As an example, metal extraction from E-waste

requires about 10-15% of the total energy required for metal extraction from mining concentrates (Tesfaye et al., 2017).

E-waste recycling also reduces the emission of greenhouse gases. For example, recycling 10 kg of Aluminium will save 90% of energy and prevent the emission of Carbon Dioxide and Sulphur Dioxide, thus reducing the extraction of Bauxite (Kumar et al., 2017 in Tesfaye et al., 2017). As a whole, recycling E-waste leads to the conservation of raw materials and saves energy, but in order to achieve these advantages, E-waste must be recycled using proper procedures and methods (Deniz et al., 2019). However, informal E-waste recycling, such as incineration, practiced in open-air spaces and landfilling, will mix E-waste with other types of waste. These activities could contaminate water and land, thus affecting human health (Shumon et al., 2014). Other backyard or informal recycling examples that can damage the environment and human health include acid leaching to recover precious metals, unprotected melting of plastics, open burning for other types of metals, and dumping hazardous residuals. All these activities lack control measures (Nduneseokwu et al., 2017). Besides, EEE in the second-hand market undergoes simple repair, refurbishment, and upgrading, and hence can work as before. However, this equipment still does not meet the latest technical standards and may cause harm to the user (Wang et al., 2011).

End-of-life electrical and electronic appliances must be controlled through a proper process to reduce the negative impacts of E-waste. Hence, E-waste recycling is a good strategy to recover resources and manage E-waste to reduce the environmental impact compared to disposal through landfill or incineration. Globally, recycling activities are focused primarily on economic capacity in the Asian and African countries. In these countries, E-waste is treated as yet another type of recyclable object, and the process is

usually performed without proper environmentally friendly procedures, often by illegal recycling operators working informally outside the main business circle (Robinson, 2009; Afroz et al., 2012; Mahat et al., 2019). To increase recycling activity among the public, the quality of recycling services should be emphasised to increase recycling performance (Haron & Othman, 2016). Nonetheless, all sectors that are interested in E-waste management should consider moving management choices to the top of the waste management hierarchy to prevent and minimize E-waste (Afroz et al., 2012). The real incentives for the proper disposal of an electronic product are the costs and benefits (Terazono et al., 2006). E-waste recycling is a strategy that the general public could use to increase the lifespan of their discarded appliances and make better use of components before they end up in landfills. There are questions about knowledge, attitude, and practices related to E-waste recycling activity in the present study's questionnaire survey in order to determine the current level of E-waste recycling among the public.

### *2.8.1 Advantages of E-waste Recycling*

Recycling has become important to the public and the economy, as E-waste is a business opportunity due to its valuable materials, such as gold, palladium, platinum, and silver (Suja, 2014). Through recycling activity, the volume of waste sent to landfills will be decreased, eventually conserving resources and reducing the amount of energy released from the Earth (Mahat et al., 2019). It is important to enlighten the public about the benefits of E-waste recycling. As a result of the increased awareness, the public will be more aware of the importance of E-waste recycling in the context of socioeconomics. Following that, questions about the advantages of E-waste recycling are included in the questionnaire survey in this study.

*2.8.1.1 Circular Economy*

The circular economy is an approach in which the economy is regenerative and restorative (MacArthur, 2013 in Birloaga & Veglio, 2017), recovering hazardous, highly toxic and valuable noble metals and materials from E-waste (Birloaga & Veglio, 2017) to protect the environment and provide economic opportunities such as the ability to create jobs globally (Abalansa et al., 2021; Laeequddin et al., 2022; Park et al., 2010 in Awasthi et al., 2018). Employment opportunities are made possible by the circular economy; for instance, the recycling of waste results in more jobs that receive adequate wages when compared to waste management in landfills and incinerators. Another example of a job opportunity is allowing municipal sorting and disassembly before transporting the E-waste to specialized recycling companies (Golsteijn & Valencia Martinez, 2017).

A circular economy helps to reduce and conserve the usage of primary raw materials (Birloaga & Veglio, 2017; Awasthi et al., 2018). Hence, this approach helps to reduce waste management issues and close loops in a sustainable way (Abalansa et al., 2021; Awasthi et al., 2018; Islam et al., 2017 in Awasthi et al., 2018). When it comes to E-waste, a well-developed circular economy demands that items last longer in order to reduce consumption and also aims to keep E-waste at the highest value as well as utilize it at all times for as long as possible (Abalansa et al., 2021; Lee et al., 2017; MacArthur, 2013 in Birloaga & Veglio, 2017). The circular economy is an eco-industrial development thought and theory (Geng et al., 2012 in Awasthi et al., 2018). The implementation of a circular economy will assist in the flow of resources in closed-loop economic operations (Modoi & Mihai, 2022). This closed-loop refers to post-consumption waste, and it is necessary to employ the reuse approach (Naik & Eswari, 2022). When this principle is applied, it helps recover precious metals from E-waste. E-waste can offer an important secondary resource that can be used in many applications (Birloaga & Veglio, 2017).

At a global scale, E-waste is shipped, landfilled, stockpiled, and recycled in developing countries such as Pakistan (Umair et al., 2015). Pakistan recycles this waste informally: it is manually dismantled, burned, dipped in acids in order to extract precious metals such as gold, and then dumped (Umair et al., 2015). While the recycling of E-waste is desirable, such informal recycling activity should not be practiced. Moreover, shipping of E-waste from developed countries to developing countries has also been restricted by the Basel Convention through the Control of Transboundary Movements of Hazardous Wastes and their Disposal, as this activity will harm the public and the environment because the E-waste will be processed in inefficient and dangerous conditions (Sthiannopkao & Wong 2013; Vidal, 2013). On the other hand, Dell, an American multinational computer technology company, recycles gold and turns it into new motherboards, which will eventually help reduce environmental damage (Dell, 2018). This shows that Dell is practicing the circular economy in their business. According to Modoi and Mihai (2022), the circular economy influences the entire life cycle of products by preserving resources in the economy and encouraging sustainable consumption. The transition from linear to circular economies necessitated a fundamental shift, such as new business models, informational campaigns, financial incentives, and stringent restrictions (Ali & Shirazi, 2022).

For a transition to a circular economy, sustainable waste management must be achieved. Every product marketed in this circular economy must be long-lasting, recyclable, separable, and upgradeable. (Cole et al., 2019). Implementing E-waste recycling is one of the sustainable solutions for controlling the rising volume of electronic waste. In addition, effective E-waste recycling is necessary to create an optimistic circular economy (Abalansa et al., 2021; Modoi & Mihai, 2022). E-waste recycling, according to Modoi and Mihai (2022), is crucial since this sort of waste is classified as hazardous waste because it

contains a complex mixture of resources and is one of the fastest-growing waste streams. E-waste recycling allows valuable materials to be recovered, which reduces raw material mining activities and helps to prevent the landfilling of unwanted appliances, creating job possibilities in this field. It can be observed that a sustainable approach to E-waste recycling will eventually reflect the success of the circular economy. According to Golsteijn and Valencia Martinez (2017), in order to ensure the success of the circular economy requires both short- and long-term approaches; strengthening network building and communication with municipalities, retailers, and consumers are among the steps that may be taken in the short-term. Besides, the effectiveness of the collection system can be increased by raising awareness and trust in it. Then, in the long run, the quality of the recycled material is the key to closing the loop further.

*2.8.1.2 Urban Mining*

E-waste is an emerging and global issue from developing countries to industrial nations (Awasthi et al., 2018 in Xavier et al., 2018). E-waste consists of valuable materials (Zhuang et al., 2015 in Xavier et al., 2018) that can be used in clean energy technology, such as photovoltaic cells, wind turbines, and hybrid vehicles (Xavier et al., 2018). These valuable elements from E-waste can be recovered via several developing techniques (Cui & Zhang, 2008; Priya & Halt, 2017 in Xavier et al., 2018). These recovery strategies are also known as urban mining, which can be defined as mining activities that take place in urban areas (Krook, 2010 in Xavier et al., 2018). It is additionally referred to as an innovative method used to recover valuable materials from electrical and electronic waste (Abalansa et al., 2021).

Through these activities, E-waste is turned into a valuable resource, contributing to sustainable development (Arora et al., 2017 in Xavier et al., 2018) and works as an

important tool for the circular economy (Xavier et al., 2018). Increasing demands for metal and decreasing primary resources are among the challenges in producing valuable metals (Tesfaye et al., 2017). Urban mining activities are able to produce rare and base metals with a higher economic value than natural ore metals, as they are up to 50 times higher in concentration (Tay et al., 2013 in Xavier et al., 2018). For example, Abalansa et al. (2021) stated that the value of gold is 13% lower when urban mining on E-waste is used instead of virgin mining of ores.

Besides, mining activities are highly costly, and most developed countries no longer have any mineral reserves (Tilton 1999 in Xavier et al., 2018), so urban mining can be a good opportunity to overcome the cost and to ensure the continuity of stocks of valuable materials. Urban mining aims to repurpose precious metals into new secondary active products, which also helps to increase the lifetime of these products. Economically, urban mining is controlled by several factors, such as land availability, raw product price, labour cost, technology, recycling numbers, financial resources, government subsidies, waste management principles, and waste collection and disposal costs (Park et al., 2017). Urban mining reduces natural resource extraction, energy consumption, and waste generation, which all contribute to a reduction in the global carbon footprint (Abalansa et al., 2021).

## 2.9 Conclusion

In conclusion, this chapter highlighted the background of E-waste in detail. The variations in how E-waste is defined and managed between nations were also brought to light. This is in order to compare with the current situation in Malaysia. Every aspect that is highlighted is important to understand E-waste at both global and national scales. The following chapter will focus on discussing KAP as a model theory in detail.

# CHAPTER 3: BACKGROUND OF KNOWLEDGE, ATTITUDE AND PRACTICES

## 3.1 Introduction

E-waste is a global environmental issue, and Malaysia is not excluded. The previous chapter discussed E-waste details such as generation, management, and the effects of E-waste generation. Given the presence of toxic and hazardous materials in each appliance, this type of waste requires extra attention and care in its management. It can be concluded that public awareness of E-waste should be promoted to consumers, as household E-waste in Malaysia currently lacks specific regulations. The Knowledge, Attitude, and Practices (KAP) survey model is used in this study to better understand how Malaysians currently recycle their E-waste. E-waste recycling is one of the management options that can recover valuable materials, thereby closing the material flow loop and ensuring that E-waste does not end up in a landfill. The public should also participate in E-waste recycling by segregating their E-waste at home and then sending it to a recycling centre or disposing of small appliances in recycling bins. Using KAP will help specify the details of current knowledge on how much information the Malaysian public knows about E-waste recycling. The application of KAP will then aid in understanding the individual's perceptions regarding E-waste recycling. In terms of practices, the application of KAP will be able to identify the current actions that the public has been taking in managing their unwanted electrical and electronic appliances. This entire chapter will focus on the concept of KAP, starting with the history and background of KAP as a survey model, the usage and application of KAP with research examples, the benefits of using the KAP survey model, as well as the criticisms and role of KAP in waste management research.

## 3.2 Knowledge, Attitude, and Practices (KAP) Background

KAP surveys were initially developed in the 1950s and are used widely for social science research in many countries. For example, they were used to understand the concept of family planning and how it was practiced by societies around the world, and they were also used in population studies. This continued during the 1960s and 1970s when Schwartz (1976) developed the KAP survey model, comprising KAP as the three elements of human behaviour change. KAP surveys have also helped with reporting human behaviour and community perspectives. Over time, KAP surveys have been widely used to collect information for social studies based on the demographic background (Cleland, 1973; Housmann-Muela et al., 2003; Launiala, 2009; Munderson & Aaby, 1992; Ratchliffe, 1976; Schopper et al., 1993 in Launiala, 2009).

At first, KAP studies were only conducted within small samples of the population, but they later expanded into large-scale demographic surveys. Starting from their focus on family planning in the 1950s, KAP surveys are now extensively used in studies with various backgrounds. KAP studies can help in collecting information and data based on the demographic background of the study population, which are the key measurements in analysing KAP related to the study field (Cleland, 1973; Housmann-Muela et al., 2003; Launiala, 2009; Munderson & Aaby, 1992; Ratchliffe, 1976; Schopper et al., 1993 in Launiala, 2009).

Knowledge can be defined as understanding, awareness, or familiarity within society, for example, facts, information, and descriptions of a particular subject of interest. Knowledge can be gained from education and experience of the society itself (Babaei et al., 2015). Universal truths and scientific facts form the foundation of knowledge, and this aspect was created to evaluate community knowledge in accordance with the study's

objectives (Ahmad et al., 2015; Launiala, 2009). Knowledge is used to highlight facts about the study field, and its items may be useful in assessing the level of knowledge across the study field's demographic background in order to evaluate the population's understanding. If their understanding is low, the researcher can suggest ways to increase their knowledge, and if their understanding is high, it shows that the study population has good exposure regarding the study field. However, knowledge might vary based on their demographic background, such as the level of education of the study population (Haron, 2015a).

Then, as for attitude, it is defined as the community's way of feeling or thinking about a person, object, or issue (Babaei et al., 2015; Petty & Cacioppo, 1981). It can be either positive or negative (Begum et al., 2009). Societal attitude cannot easily be changed, as it depends on how the knowledge and information are presented (Desa et al., 2011). Attitude plays a role in influencing action (Sivathanu, 2016). It is also interlinked with the person's values, beliefs, emotions, and knowledge (Pelto, 1994 in Launiala, 2009), contributing to changing their current habits (Darby & Obara, 2005). Attitude can also be defined as how a person has been brought up in relation to a certain situation or occasion. The attitude component is highlighted in order to determine how the study population thinks and feels regarding the study field. Attitude, whether positive or negative, also varies based on the demographic background of the study population. Attitude may be influenced by the person's surroundings and environment and influences their behaviour, habits, and actions toward the study field.

For the last component of KAP, the practice is defined as action based on the society's knowledge and attitude (Babaei et al., 2015). Knowledge will give insights into attitude, while both knowledge and attitude will give a picture of practices (Ahmad et al., 2015).

The practices component is used to determine how the study population behaves or acts towards the study field. As with knowledge and attitude, practices towards the study field may also vary based on the demographic background of the study population.

These three components are interrelated: knowledge will form attitude, and knowledge and attitude will form practices (Ahmad et al., 2015; Babaei et al., 2015). Knowledge does not necessarily lead to better practice (Ehrampoush & Moghudan, 2005 in Ahmad et al., 2015): even though the knowledge and attitude of the respondents are good, practices might still be low. The public might be aware of the highlighted matter, but they might not know what to do about it. According to El-Gilany et al. (2017), a lack of knowledge will eventually influence an individual's practices. Babaei et al. (2017) stated that attitudes and practices could be influenced by knowledge; thus, awareness, perceptions, and knowledge influence human attitudes, which might change the individual's behaviour (Akhtar et al., 2014). The relationship between each of these variables can be understood as a lack of knowledge that could ultimately influence practices. An individual's attitude also functions as a psychological and emotional driver of their practices, whether they are positive or negative (Fishbein & Ajzen, 1975 in Jekria & Daud, 2016; Madhukumar & Ramesh, 2012 in El-Gilany et al., 2017; Mathur et al., 2011). Desa et al. (2011) stated that, even though attitude is difficult to change, through increasing knowledge, attitude will eventually change over time. As this is also agreed by Akhtar et al. (2014), attitude is influenced by the individual's knowledge of the issue.

Demographic factors, such as education, age, and gender (Patchen, 2006 in Akhtar et al., 2014) and social influences (Song et al., 2012 in Akhtar et al., 2014) will influence knowledge and attitude (Patchen, 2006 in Akhtar et al., 2014). For example, people with a good educational background tend to have a better understanding of their roles toward

environmental issues compared to those without a good educational background (Jereme et al., 2015). Besides, practices to protect the environment are voluntary habits that are usually practiced amongst those from middle- and upper-class backgrounds (Hopper & Neilson, 1991 in Jereme et al., 2015). It can be seen that individuals with a good educational background and upbringing tend to have good practice related to the subject field. For example, Kalana (2010) highlighted that even though respondents in Shah Alam, Selangor have a good knowledge regarding E-waste, only a small percentage choose to practice sustainable E-waste management such as recycling. As stated in Desa et al. (2011), apart from knowledge, practices also depend on social and psychological factors. Then, Song et al. (2012) in Akhtar et al. (2014) discovered that a person's attitude towards environmental issues depends on their demographic background, such as gender, age, and educational background.

Overall, KAP can be defined as how populations across the globe understand, receive, and practice a particular subject (Launiala, 2009 in Ahmad et al., 2015). KAP studies can help identify whether the study population has received the correct information, whether they understand the subject field, whether they are willing to change their way of thinking, and whether they practically do so in a correct manner. All these questions will be answered with the aid of the KAP study method. They are more cost-effective and resource-conserving than other forms of social science, as they are narrowly oriented and limited in scope. KAP surveys are now a commonly used tool for the study of human actions when an environmental issue affects them. There is a dynamic relationship between information understanding, awareness, and action, where information becomes the driving force for behaviour change (Schwartz, 1976; Eckman & Walker, 2008; Salerno et al., 2014).

### 3.3 Application of the KAP Approach in Selected Studies

KAP studies have been used to gather information, provide data about a range of subjects, and provide insights into the current situation regarding specific matters. They can also be used to evaluate the effectiveness of programmes by measuring pre- and post-intervention scores (Launiala, 2009; Vandamme, 2009 in Ahmad et al., 2015; El-Gilany et al., 2017).

KAP surveys are an increasingly common technique for evaluating group psychology and practices related to environmental issues, as knowledge and attitudes work as unique predictors of public practice. Poor practices in maintaining good environmental conditions are due to a lack of knowledge and negative attitudes. Individual background also plays an important role in determining a person's KAP (Barloa et al., 2016). The differences in demographic background could impact the KAP of an individual. For example, individuals with higher education would have a better chance of having a good level of knowledge of the study topic (Al Ahdap, 2020). Ngwewondo et al. (2020) highlighted that having the factors that affect the KAP on the study topic would make it easier for the stakeholders to recognize the target population to tackle an issue.

KAP surveys work as a method to gather data from a specific population with different demographic backgrounds. KAP can be analysed using quantitative or qualitative analysis, depending on the research objectives. The KAP approach can be widely used to access society's viewpoints regarding a specific subject, which will help to underline which aspects of the demographic background are the main factors affecting the population's view regarding the particular subject. The KAP components regarding the study field may vary among the study population depending on their demographic background, such as gender, age, income, type of housing area, educational background,

marriage status, number of people in the household, and occupation. All of these demographic factors will be taken into account in this KAP study in order to assess the three components.

KAP surveys have been used to explore human behaviour in different fields, such as community development (IIDS, 2006 in Ahmad et al., 2015), education (Goutille, 2009 in Ahmad et al., 2015), health (Launiala, 2009 in Ahmad et al., 2015) and child protection (Holman, 2012 in Ahmad et al., 2015). They have also been used in the environmental field to create environmental awareness: for example, about solid waste disposal and recycling (Ehrampoush & Moghadam, 2005 in Ahmad et al., 2015), sustainable agriculture (Khoram et al., 2006 in Ahmad et al., 2015), wastewater management (Emanuel, 2010), land degradation, sustainable land (Akpinar-Elci & Roberts, 2011 in Ahmad et al., 2015), water, hygiene and sanitation (Sibiya & Gumbo, 2013 in Ahmad et al., 2015). KAP surveys in the healthcare field have been used to assess the effectiveness of laboratory safety and medical waste management before and after intervention programmes (El-Gilany et al., 2017). KAP studies in the solid waste management field have helped to prove that public segregation and recycling of waste are not sufficient (Babaei et al., 2015). Table 3.1 shows a compilation of various fields of study using the KAP research method in order to achieve their research objectives.

**Table 3.1: Example of a research study using the KAP method**

| Field of study | Study population | Conclusion | References |
|---|---|---|---|
| Sustainable practices | Public officers of the Malaysian Government. | Respondents showed good environmental knowledge and a positive attitude towards the environment. However, the sustainable practices among the respondents showed room for improvement. | Aini et al. (2006) |

| Field of study | Study population | Conclusion | References |
|---|---|---|---|
| Stormwater pollution | Households in Duluth Lakeside | The majority of respondents had a good understanding of the LSRP and were interested in learning more about it. The majority of respondents were also open to cost-share initiatives in order to mitigate stormwater management flow and participated in the LSRP, according to the findings of this study. | Ekman & Walker (2008) |
| Environmental communication | Students from Malaysia's 16 higher education institutions | This finding suggests that students have a good understanding of the environment. As a result, this may reflect the government's and educational institutions' ongoing efforts to promote sustainable development. It was also discovered that a high level of knowledge does not always imply a good level of practice since students' knowledge and practices were only weakly linked. Similarly, students' attitudes and practice variables had a weak relationship. | Ahmad et al. (2015) |
| Medical (Leptospirosis) | Final year students of selected courses in Universiti Putra Malaysia (UPM) | According to the findings of this study, there was a significant relationship between knowledge and race. There was also a significant relationship between attitude and gender, as well as between attitude and practices regarding Leptospirosis. The majority of the final-year students in this study had a moderate level of KAP toward Leptospirosis disease. | Bakar & Rahman (2015) |
| Food Nutrition | Respondents from six primary schools in Kuala Lumpur | The findings of this study showed that providing children with knowledge can help them establish a positive attitude and healthy practice toward whole grains, which can help manage childhood obesity by lowering the BMI z-score. There was a | Koo et al. (2015) |

| Field of study | Study population | Conclusion | References |
|---|---|---|---|
| Food Nutrition | Respondents from six primary schools in Kuala Lumpur | significant disparity between suggested and actual practices, as well as their overall consumption of whole grains. It shows that knowledge regarding whole grains was insufficient to change practices. | Koo et al. (2015) |
| Medical (diabetes) | Iranian type 2 diabetic patients | The majority of respondents were found to have a medium level of knowledge, attitude, and practises. Low diabetes awareness has a detrimental impact on self-management, resulting in a negative impact on overcoming the diabetes problem. | Mohammadi et al. (2015) |
| Work Safety Culture (WSC) | Academic and non-academic staff in the Faculty of Medicine and Health Sciences (FMHS), Universiti Putra Malaysia (UPM) | Appropriate knowledge and a positive attitude were shown to be crucial elements in defining good safety practices among the respondents in this study. Even though there was an association between employment characteristics and knowledge as well as attitude, these factors had no bearing on their safety practices. | Rosliza et al. (2015) |
| Food allergies | Food handlers in Penang | Most of the food handlers had moderate levels of KAP towards food allergy. Customers with food allergies will continue to be put at risk by the restaurant staff's poor understanding regarding food allergen risks, poor appropriate controls, lack of awareness, and inappropriate practices. | Shafie & Azman (2015) |
| Medical (dengue) | Community in Seberang Takir | The majority of respondents in this study had a good understanding of Malaysia's endemic dengue areas. It was also discovered that the community's attitude and, as a result, practices in combating the dengue outbreak was and | Aung et al. (2016) |

| Field of study | Study population | Conclusion | References |
|---|---|---|---|
| Medical (dengue) | Community in Seberang Takir | was significantly related to the availability of knowledge demonstrated. | Aung et al. (2016) |
| Medical (H5N1) | Physician working in western Java, Indonesia | Only a few doctors stated they had ever diagnosed seasonal influenza, pandemic influenza, or HPAI H5N1 in hospitalized patients. Outpatients and hospitalized patients had low influenza testing rates, and clinically diagnosed influenza patients received minimal antiviral treatment. However, the results may not be indicative of all doctors in the East Jakarta and Bogor districts, or throughout Indonesia. | Manggiri et al. (2017) |
| Food Handling | Students from various fields in AIMST private university campus. | The majority of respondents demonstrated good levels of knowledge, attitude, and perception in all areas. Significant correlations were found with the type of diet, level of education, and gender of the respondents. | Ali et al. (2018) |

Table 3.1 presents some examples of studies that used the KAP approach in their questionnaire surveys. Their conclusions indicate the levels of KAP based on the related study field. Besides, the levels of KAP components can be seen to be interrelated to one another and, based on the reported results, could then be used to identify causes in determining the level of KAP. In light of these causes, the reported results from the KAP method will be used to suggest how to improve KAP levels. Since KAP studies use the demographic background as the key in determining the social impact on the study field, their final outcomes will determine which aspects of the demographic background have positive impacts on the study field, which can then be used to suggest ways to improve KAP. As shown in Table 3.1, the KAP approach has been used in a variety of study fields and populations of various demographic backgrounds.

Focusing on sustainable practises, Aini et al. (2006) discovered that Malaysian government public officers had high levels of environmental knowledge and attitude. Based on the output, it shows that knowledge would be able to influence the attitude since those respondents who have a high level of knowledge also have a high level of attitude. However, the results show that respondents' sustainable practices still had room for improvement. This shows that individual practices are not only determined by knowledge and attitude but are also impacted by other external causes. As suggested by Mair and Jago (2010) in Myung (2018), there are barriers to practice in any study field: for example, practices for going green are not only related to awareness, knowledge, and skills but are also impacted by the operations timeframe, financial resources and lack of time.

Next, according to Ekman and Walker (2008), respondents in Duluth Lakeside had excellent knowledge of the research issue of stormwater pollution. It was also discovered that the respondents were interested in learning more and offered to help with the issue. This KAP study was able to determine respondents' preferences, responses, and opinions on the selected subject. Furthermore, it was able to establish whether the knowledge and exposure provided were adequate based on the study's outcome. As a result, the KAP study was able to draw attention to the importance of a certain issue among the general public.

Ahmad et al. (2015) focused on environmental communication as a subject of study. Students from different higher education institutions demonstrated a high level of knowledge. Respondents with a good educational background show a good level of knowledge related to the environment. This indicates that a good educational background will lead to a good level of knowledge. However, because of the weak association observed between knowledge and practice, it is identified that the degree of knowledge did not imply a good level of practice. The relationship between the attitude

and practice variables showed similar results. This output is similar to the findings reported by Aini et al. (2006), in which good levels of knowledge and attitude did not result in a good level of practice among respondents.

Numerous examples of studies in the medical field that use KAP are shown in Table 3.1. Bakar and Rahman (2015) revealed the levels and relationships of KAP among final-year students and identified which aspects of respondents' demographic backgrounds had a significant relationship with KAP regarding Leptospirosis. This shows that it is possible to present the level of knowledge, attitude, and practices among respondents, the relationships between variables, and significant associations with demographic variables.

In the same year, Koo et al. (2015) conducted a study on food nutrition involving respondents from six different primary schools in Kuala Lumpur. According to the findings, whole grain intake on a daily basis is not being followed as recommended, reflecting a lack of information. Respondents who share the same characteristics can be grouped as a unit, according to this study. Respondents from six different primary schools in Kuala Lumpur, for example, were assessed as a group in this study. It is also proposed that the present KAP study will be able to identify strategies to address the study topic or issue.

According to Mohammadi et al. (2015), the majority of Iranians diagnosed with type 2 diabetes had moderate levels of knowledge, attitude, and practises about their health condition. It was also suggested that in order to overcome the problem of diabetes, there must be improvements in managing health issues such as lifestyle and dietary intake. The KAP study was able to offer suggestions on how to improve as well as determine which characteristics needed to be improved.

Rosliza et al. (2015) conducted a study among academic and non-academic staff in the Faculty of Medicine and Health Science (FMHS), Universiti Putra Malaysia (UPM). This study highlighted that in order to have a good level of practice, an individual needs to have good levels of knowledge and attitude. Besides, this study found an association between occupational characteristics and knowledge as well as attitude. However, the association did not affect the safety practices.

Shafie and Azman (2015) conducted a study on food allergies, with food workers in Penang as participants. According to the findings, the majority of respondents had moderate levels of knowledge, attitude, and practices regarding food allergies. It is vital that food handlers understand and are aware of food allergy situations in order to take precautions and not put customers with food allergies at risk. One of the most essential aspects of KAP research is that it aids in determining where an issue originates.

Next, Aung et al. (2016) published a study in the medical field, specifically on dengue fever. According to the survey, the majority of respondents in Seberang Takir had an excellent understanding of areas where dengue fever was endemic. Positive attitudes and practices in coping with dengue outbreaks were also linked to good knowledge. This study demonstrates the significance of KAP variables since this will help explain how these variables connect. This result is similar to that reported by Rosliza et al. (2015).

Manggiri et al. (2017) conducted a KAP study in the medical field among physicians working in Western Java, Indonesia. Only a small percentage of physicians were familiar with, comprehended, and were aware of seasonal influenza, pandemic influenza, or HPAI H5N1. Because only a small percentage of respondents had high levels of knowledge, attitude, and practice, the findings could be seen to reflect the entire community of

physicians. However, using the figures and percentages from this KAP study, it is possible to evaluate the current situation.

Based on the examples of the application of the KAP survey that have been tabulated in Table 3.1 in medical-related fields. Usually, the output of the level of KAP will be the same. For example, according to Aung et al. (2016), respondents who have a high level of knowledge regarding dengue fever will eventually have a good level of attitude and practice. The similarities also can be seen in studies conducted by Manggiri et al. (2017) on influenza, Shafie & Azman (2015) on food allergies, and others. This proves that, in the medical field, KAPs are directly influenced by one another. Meanwhile, in other study fields, it can be seen that a good level of knowledge will eventually result in a good level of attitude but not necessarily a good level of practice. It demonstrates that additional factors should be considered to boost the level of practice.

Using the KAP survey, it will be possible to comprehend how each component of KAP can have an impact on one another. The particular issue or problem that needs to be addressed will then be highlighted. The current KAP level additionally provides an overview of what is currently occurring in the study area and among the study's population. Demographic factors are also a crucial component of the KAP study as they can be used to determine which respondents need special attention to solve the problem and develop solutions. By utilizing the KAP survey, Owojori et al. (2022) emphasised that it works as an analytical tool to report the current Knowledge, Attitude, and Practices of the public regarding the selected issue, then provide an understanding of the current situation in order to plan for a strategy to overcome the selected issue, and it also works as an instrument to evaluate any initiatives or interventions that have been applied to solve the selected issue. To summarize, the KAP survey can identify the current situation, and the

information can then be used to develop strategies as well as assess the effectiveness of those strategies. When a KAP survey is used, the result is more organised and simpler to comprehend.

### 3.4 Advantages of KAP Studies

Stone and Campbell (1984) and Bhattacharyya (1997) in Launiala (2009) have highlighted several advantages of using KAP as a method for gathering data and information. KAP studies are easily designed and interpreted and report quantifiable data that can be easily presented. They also allow researchers to generalise from a small sample to a wider population with a cross-cultural component. The KAP approach can help to determine the level of KAP of the study population regarding the study field. Since the levels of these three components may vary based on respondents' demographic background, the levels of KAP can be useful output for stakeholders and for the media when seeking to tackle issues related to the study field. The use of the KAP study method can also help in measuring the effectiveness of approaches taken toward the study field.

### 3.5 Criticisms of KAP Studies

However, there are also some arguments against the KAP approach. Schopper et al. (1993) and Smith (1993) in Launiala (2009) argued that KAP studies cannot provide information about sensitive issues, while Hausmann-Muela et al. (2003) and Nichter (1993 in Launiala, 2009) claimed that the KAP approach can only determine people's knowledge and practices in general, and not on their actual day-to-day practices. There are arguments against the validity, reliability, and measurement of KAP studies regarding the opinion and attitude items. However, in order to measure the public's awareness, willingness, understanding, and participation in selected matters, KAP studies are acceptable (Launiala, 2009; Vandamme, 2009 in Ahmad et al., 2015). According to

Mifsud (2012) in Ahmad et al. (2015), qualitative methods can be a good way to overcome the study gap by providing a better understanding of the relationship between KAP items. Combining both quantitative and qualitative methods will help in increasing the validity of a KAP study (Launiala, 2009).

### 3.6 Role of KAP Approach in Waste Management

Waste is any material that is no longer wanted or needed and is thrown away. The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) classifies waste into four types: agricultural waste, hazardous waste, industrial waste, and municipal solid waste. Examples of agricultural waste include agricultural crop residues, agro-industrial by-products, and livestock waste. Hazardous waste can be identified as waste that contains toxic and hazardous materials, including electrical and electronic waste, as well as by-products from agricultural activity, health-care facilities, hospitals, industrial activity, manufacturing processes, and nuclear establishments. Industrial solid waste includes abrasives, ceramics, cloth, glass, leather, metals, oils, paper, paints, plastics, packaging materials, sludge, stones, straw, solvents, resins, rubber, wood, and waste from food processing. Finally, the major components of municipal solid waste include food waste, glass, metal, paper, plastic, and rags.

In Malaysia, on 1 September 2011, the government introduced the Solid Waste and Public Cleansing Management Act 2007 (Act 672), which has been implemented in stages. So far, only Perlis, Kedah, Pahang, Kuala Lumpur, Putrajaya, Negeri Sembilan, Melaka, and Johor are managing their waste based on Act 672. According to this Act, there are two types of waste: recyclable and residual waste. Bulky waste, bottles, cans, electrical and electronic waste, garden waste, papers, and plastics are examples of recyclable waste. Examples of residual waste are contaminated materials, diaper disposal, food waste, and

kitchen waste. People are required to separate waste based on the type at the source. As waste is increasing due to the rising population and economic factors, the enforcement of Act 672 is one way to manage and help reduce waste. Solid waste generation in Malaysia has increased over time as a result of rapid urbanisation and population growth. To date, total waste generation has climbed to 33,000 tonnes per day. This equates to 1.17 kg per person every day (Iacovidou & Siew Ng 2021).

It is essential for the public to engage in E-waste recycling activities since the public is also a consumer. In ensuring the effectiveness of E-waste recycling, public participation is as important as the legislation and technical capacity in managing and reducing waste. In order to develop a sustainable strategy for handling E-waste, the public must share responsibility with other stakeholders, such as the government and producers. As a result, through a regulatory framework, the public must actively participate and be knowledgeable about the sustainable E-waste movement (Iqbal et al., 2015; Saritha et al., 2015; Borthakur & Govind, 2017; Awasthi et al., 2018; Yong et al., 2019, Madanhire et al., 2019; Islam et al., 2021). According to Borthakur and Govind (2017), significant disparities in public participation in E-waste management exist across demographic variables. Understanding this dynamic is essential to improve E-waste management. Various demographic characteristics result in different E-waste management behaviours among the public. Public participation can be acknowledged and determined through conducting research related to waste management either quantitatively or qualitatively. The KAP approach has been widely used in the environmental field, specifically in studies of waste management. Table 3.2 shows examples of KAP studies of waste management.

**Table 3.2: Examples of KAP studies of Waste Management**

| Type of waste | Study population | Conclusion | References |
|---|---|---|---|
| Biomedical waste | Dental healthcare personnel in dental colleges | The findings of this study underlined that there was a significant difference in knowledge scores based on year of study and educational qualification. Faculty members had a better level of knowledge compared to dental students. It was also shown that even though the majority of respondents had high levels of attitude, they had low levels of knowledge and practices towards biomedical waste. This suggests that a special focus is needed for dentists in managing biomedical waste, which should be compulsory in the dental curriculum and through a continuation of the dental programme. | Sanjeev et al. (2014) |
| Solid waste | Abadan residents | The majority of respondents in Abadan had inadequate levels of knowledge and practices towards solid waste segregation activity. It was also observed that the majority of the respondents were dissatisfied with the current management of solid waste collection; hence, they were unwilling to pay for the services. It was suggested that infrastructure and awareness are both important to encourage the public to conduct solid waste management. | Babaei et al. (2015) |
| Biomedical waste | Health Care Workers | Respondents in this study reported a higher level of awareness compared to other studies. It was suggested that a proper training schedule, as well as monthly assessments, were required in order for | Hiremath et al. (2016) |

| Type of waste | Study population | Conclusion | References |
|---|---|---|---|
| Biomedical waste | Health Care Workers | healthcare workers to maintain good biomedical waste management. | Hiremath et al. (2016) |
| Health care waste | Health and sanitary workers | This study highlighted that in order to increase the levels of KAP among health and sanitary workers, regular training on managing healthcare waste is required. Policies regarding healthcare waste in both public and private hospitals are also required to improve the current management policy. | Kumar et al. (2016) |
| Pharmaceutical waste | Healthcare staff | Through an intervention study, the KAP was improved to a satisfactory level. This is due to the educational programme conducted among the healthcare staff. Improvements in the level of practice can be achieved through the improvement of knowledge and attitude as well as the availability of resources. | Tabash et al. (2016) |
| Health care waste | Health Care Workers | The analysis found that demographic variables affect the KAP of the respondents in managing healthcare waste. In addition, the results indicated a good level of KAP among respondents; however, continuing education is required for healthcare workers in order to maintain and improve their awareness over time. | Kumar et al. (2018) |
| Municipal solid waste | Highland residents | Most of the respondents had high levels of knowledge, neutral levels of attitude and moderate levels of practice. Young respondents aged 20 and below needed a special focus from the local authority in promoting solid waste management. This group of respondents required | Laor et al. (2018) |

| Type of waste | Study population | Conclusion | References |
|---|---|---|---|
| Municipal solid waste | Highland residents | adequate information and knowledge through a suitable medium. | Laor et al. (2018) |
| Solid waste | Authorities and residents | Most respondents had a good level of knowledge regarding solid waste issues. It was highlighted that awareness, educational background, and level of income were the keys for an individual to have good knowledge. However, the lack of available facilities and inadequate experience lead to illegal dumping as well as improper practices by the respondents. | Seng et al. (2018) |
| E-waste | Public | Respondents had low levels of knowledge and practices towards E-waste management and stored huge volumes of E-waste. This study suggested that a training programme is required to improve awareness among the public about how to manage their E-waste. It also stated that mass media, manufacturing companies, and electrical and electronic appliances suppliers would be good media to encourage the public and provide adequate information. | Davoudi et al. (2018) |
| Solid waste | Kermanshahi women | The majority of respondents had good levels of knowledge and attitude, but low levels of practices towards solid waste management. More than 50 percent of the respondents tended to conduct solid waste recycling activities at home. It was also shown that respondents were not satisfied with the current collection services, which had room for improvement in ensuring that the public would conduct proper waste management. Therefore, in order to ensure | Almasi et al. (2019) |

| Type of waste | Study population | Conclusion | References |
|---|---|---|---|
| Solid waste | Kermanshahi women | the success of solid waste management, proper planning, support, adequate information, and knowledge related to the field must be provided via publication and investigation. | Almasi et al. (2019) |

For example, Sanjeev et al. (2014) conducted a study on biological waste management. Faculty members and dental students from Kothamangalam's Dentistry College were among the respondents. Individuals who come into contact with biomedical waste may be exposed to risk. As a result, this study was essential to determine the KAP of dental care personnel regarding biomedical waste management. According to the findings, respondents' overall attitudes toward biomedical waste management were positive, but their knowledge and practices were inadequate. Furthermore, faculty members had higher scores than dentistry students, indicating that educational background and type of occupation have a considerable impact on knowledge levels in linked subject fields. This KAP study highlighted the respondents' levels of knowledge, attitude, and practices, allowing stakeholders to recognize which variables require extra attention in order to improve. Furthermore, it produced substantial results with demographic characteristics that identified the group of respondents who needed to improve their knowledge, attitude, and practices in the studied field. It is clear from this study that respondents' attitudes are unaffected by their knowledge. Despite the fact that knowledge about biological waste management is limited, the attitude is positive. However, this study demonstrates that knowledge influences the practice level, as both knowledge and practice levels are low. This study also used demographic variables such as educational background and occupation as essential factors influencing respondents' level of knowledge, attitude, and practices.

Babaei et al. (2015) conducted a study to investigate levels of knowledge, attitude, and practices on solid waste management. The management approach used in this study involved collecting, reducing, recycling, segregating, and willingness to pay. The association between demographic variables and KAP toward solid waste management was also highlighted in this KAP study. Despite the fact that respondents in Abadan City had a positive attitude, the survey indicated that their knowledge and practices were inadequate. According to the findings, age, educational background, gender, and type of occupation were all statistically significant in determining solid waste recycling, segregation, and willingness to pay. KAP is a framework for determining current levels of knowledge, attitudes, and practices, as well as the demographic relationships between the variables. As a result, this output can identify the group of respondents who require additional focus in order to improve public solid waste management. This result is similar to Sanjeev et al. (2018) despite the type of waste and research area being different. However, the result suggests that respondents' attitudes are not impacted by knowledge. However, knowledge influences the level of solid waste management practices. This study also focuses on how demographic factors influenced solid waste recycling activity.

A study conducted by Hiremath et al. (2016) in India used a KAP model to determine the level of KAP regarding biomedical waste among healthcare workers (HCWs) with the aim of protecting the health of HCWs and the environment. Biomedical waste can be defined as waste generated during diagnosis, immunization, treatment, or any research activities related to animals or humans that are contaminated with human fluids and waste generated from testing and production of biologicals. This type of waste needs proper management in order to reduce environmental contamination and risks to human health, especially that of HCWs. It was found that levels of knowledge were not significantly related to any demographic background variables. Hence, this study gives some insights

into the need for proper training in handling biomedical waste and monitoring from the biomedical waste committee to increase the level of KAP among HCWs. The relationship between KAP variables and demographic background is important for determining which groups of respondents need particular attention.

KAP is also suitable for assessing the effectiveness of a programme (Vandamme, 2009 in Ahmad et al., 2015). The study conducted by Kumar et al. (2016) aimed to evaluate the training of health and sanitary workers on healthcare waste management. This study took place in Pakistan over about 18 months in order to determine respondents' KAP through training. Globally, hospitals generate between 0.5 and 2.0 kg of waste per bed per day, including tools such as blades, human body parts, syringes, and waste contaminated with blood, vomit, and body secretions, which need to be properly managed and disposed of. The results of this study showed that health and sanitary workers' levels of KAP towards waste management significantly improved after they had undertaken the training. This study shows that training with an innovative approach is one of the most effective strategies in managing hospital waste: with the aid of KAP theory, the effectiveness of training can be easily reported.

The effectiveness of educational programmes can be assessed using the KAP approach to assess participants' improvement. For example, a study on pharmaceutical waste management in Gaza, Palestine, by Tabash et al. (2016) aimed to determine the levels of KAP through three stages of intervention. Pharmaceutical waste can be defined as contaminated, expired, spilt, or unused pharmaceutical products, vaccines, and drugs that have been discarded and need to be properly disposed of. Participants showed poor knowledge at the pre-intervention stage, which improved to a moderate level during the post-intervention phase, and tests conducted six months later reported a satisfactory level

of knowledge among the participants. The level of attitude was positive at the pre-intervention stage and increased during the post-intervention and follow-up tests. However, practices at the pre-intervention and post-intervention stages were poor, although they increased to a satisfactory level at the six-month follow-up stage. Based on this research, it is clear that the KAP approach can be applied in a variety of ways. Evaluating whether knowledge, attitude, or practices demand a specific focus will make it easier to identify the core problems and find ways to overcome them.

Globally, hospitals produce infectious waste which pollutes the environment and presents a risk to human health. Hospital waste is the second most dangerous waste in the world and can pose a risk to attendants, hospital workers, and patients; hence, all the waste generated should be managed properly to reduce infection risk (Kumar et al., 2018). Kumar et al.'s (2018) study on healthcare waste management (HCWM) showed that occupation had a significant relationship with KAP in HCWM. This KAP study also reported a linear relationship between knowledge and practices; however, it found no correlation between knowledge and attitude. Even though technically, knowledge will reflect attitude and behaviour, this study shows otherwise. The association between knowledge, attitude, and practice variables is essential in a KAP study, which is conducted to determine how the variables affect one another. The usage of KAP theory in this study indicated that the levels of education and experience affect the management of HCWM among health workers in the hospital. This study emphasises the relationship between demographic variables and respondents' level of knowledge, attitude, and practices in order to demonstrate the significance of demographic variables in influencing these factors. This result signifies the relationship between the knowledge, attitude, and practice variables themselves, in addition to the general level of knowledge, attitude, and practice.

Besides HCWM, municipal solid waste (MSW) management is another concern in managing waste. MSW is defined as scrap materials generated from municipal services and households (Laor et al., 2018). Laor et al. (2018) conducted a KAP study regarding MSW among highland residents in Thailand, which found that age and education were significantly related to the level of KAP. The authors reported that the level of knowledge among the respondents was high and that they had a neutral attitude regarding MSW and moderate levels of practice. In Thailand, 52% of collected waste is properly managed, and the rest is disposed of through open dumping and burning. In order to achieve proper MSW management, local government infrastructure is important, but other factors, such as knowledge, behaviour, public concern, and public participation, are also essential. The KAP model is one of the instruments that can be used to determine the factors influencing public behaviours through detailed theory-based surveys. This study focuses on the level of knowledge, attitude, and practises of solid waste management. It also emphasises the significant relationship between respondents' level of knowledge, attitude, and practices with the demographic variables. It is then discovered that, while the level of knowledge is high, the level of attitude and practises is not. The results demonstrate that attitudes and practices are influenced not only by knowledge but also by differences in demographic variables among respondents.

Since solid waste management has become a global issue, given the volume of waste generated nowadays, Seng et al. (2018) conducted a KAP study in Phnom Penh, Cambodia, to determine knowledge of waste issues, attitudes towards solid waste management and practices of illegal dumping in Phnom Penh. The findings indicated that education level and awareness of health effects had a positive influence on individuals' knowledge of waste problems, while economic factors influenced both knowledge and attitude. Adequate knowledge cannot lead to good practice if the collection service is

inaccessible and insufficient. In this study, KAP was used to determine aspects with room for improvement in order to increase the effectiveness of solid waste management, such as training programmes, improved collection services by policy-makers and service providers, and alternative ways to collect the waste. This includes community-based waste management, as well as the public willingness to pay for solid waste management. This research also focuses on the level of knowledge, attitude, and practices regarding solid waste management. It is also determined how demographic variables influence knowledge, attitude, and practices. It can be seen that respondents' educational backgrounds influence their level of knowledge. However, a high level of knowledge did not result in a high level of practice. The findings were similar to those described in Laor (2018). This highlights the possibility that other external circumstances may have an impact on the respondents' level of practice. This study found a substantial correlation between demographic factors and knowledge, attitude, and practice levels, indicating that demographic variables are essential in defining an individual's knowledge, attitude, and practice level.

Davoudi et al. (2018) conducted a KAP study on E-waste in Yazd City. They reported that knowledge was moderate, attitude was good, and practices were moderate. The level of knowledge increased as the education level increased, demonstrating the importance of training and education. Besides, the level of education was significantly related to occupation, with clerks having the highest knowledge. The level of attitude was positive among clerks and housewives and was higher among workers compared to self-employed people. Using KAP instruments, we can identify which demographic information influences the level of KAP in order to find suitable recommendations to manage E-waste properly. Proper E-waste management leads to good environmental protection, increases job opportunities, and reduces the usage and production of raw materials. According to

the findings of this KAP study, attitude is unaffected by knowledge levels and, therefore, is unable to have an impact on practice levels either. Nonetheless, a moderate level of knowledge leads to a moderate level of practice. This study also revealed that respondents' levels of knowledge, attitude, and practices differ depending on their educational background and occupation.

Almasi et al. (2019) conducted a study among Kermanshahi women to examine their KAP towards solid waste management, as well as their relationships with various demographic variables. The focus of the study was on solid waste management, specifically the reduce, reuse, and recycle (3R) strategy. The outcomes of this study revealed that the overall levels of knowledge and attitude toward solid waste management were good, but their practices were lacking. This is because other external factors may have an impact on the practices. According to this output, adequate knowledge of the 3R concept is necessary. Furthermore, effective planning and assistance from the local government are essential to increase public motivation towards solid waste management through campaigns, monetary rewards, and available infrastructure. According to the findings, the level of knowledge can influence the level of attitude. However, neither level of knowledge nor attitude can directly influence Kermashahi women to have a good level of solid waste management practices.

The previous studies mentioned in this sub-chapter were used as references and recommendations for conducting this study in order to bridge the gap in the literature, provide information, and contribute knowledge. As highlighted, KAP research is widely used in managing different types of waste, as this is a global issue. When waste management uses KAP as a research instrument, it will be able to determine which demographic factors influence KAP levels. Besides, it will be able to give insights into

which study variables influence the study instruments and how they are related to one another. The KAP approach can produce valuable output and thus allow researchers to suggest ways to overcome issues. KAP studies can also be used to evaluate whether training and education interventions are helping to increase levels of KAP towards the study topic. Workshops and programs on environmental conservation and waste management should be coordinated to enable the public to become environmentally conscious (Barloa et al., 2016). The findings of this study will allow current levels of KAP to be identified. Earlier studies have focused on E-waste as a research topic in order to learn more about the present situation among the general public in the study area. This study's output is essential for determining respondents' current levels of awareness about E-waste recycling. E-waste management in Malaysia is still in its infancy at the household and individual level. Furthermore, since the Environment Quality (Household Scheduled Waste) Regulation 202x is still in development and has yet to be released, this study can contribute to policymakers' design of the regulations based on current public awareness.

The examples of KAP studies on waste management discussed in this chapter show that KAP represents a good methodology since such studies have a structured approach. As a result, the output will be able to determine the respondents' current level of knowledge, attitude, and practices, reflecting the current conditions in the case of waste management. Based on the results, stakeholders will be able to create a strategy to address this environmental issue. Furthermore, it can be observed that KAP studies are relevant and appropriate for use in any field of research. The ways in which the above examples deliver their results are similar. To begin, each study typically presents the respondents' level of knowledge, attitudes, and practices related to the study topic, followed by the relationship and the association of variables with the respondents' demographic background. Since E-waste has become a global concern, it is critical for policymakers and researchers to

address this issue in sufficient detail (Borthakur & Govind, 2017). The number of publications has risen and fallen over the years, but articles are still being actively produced, demonstrating the importance of E-waste as a research issue. Between 1994 and 2014, there were around 419 study publications that focused on 'Consumer' and 'Attitude' factors in relation to E-waste. As a result, it is critical to determine the existing status around the globe in order to handle this global issue: the present study is thus vital in addressing and contributing to current knowledge.

## 3.7 Conclusion

In conclusion, this chapter has explained the background of the study in detail, examined the KAP concept that will be used as a tool in this study, and discussed previous studies that have explored E-waste both locally and internationally. This chapter provides an explanation of KAP as a tool and explains how a KAP survey will be utilized throughout this study to determine the current E-waste recycling rate among respondents. To improve E-waste recycling, it is necessary to gain a better understanding of public perception toward E-waste: this will be achieved in this study using the KAP approach. The following chapter will discuss the methodology for the entire study in detail.

# CHAPTER 4: METHODOLOGY

## 4.1 Introduction

This chapter has been divided into 11 sub-chapters, including the introduction and the conclusion of the chapter. The next part, after the introduction of this chapter, focuses on the conceptual framework, which illustrates the idea of the entire study. The following sub-chapter has emphasized the study areas in terms of geographical backgrounds, economic activities, and waste management. The respondents of this study have been further described and justified in the participants' section. Next, the following sub-chapter emphasizes the development of the instrument used in this study. The pilot study output is then reported in the following sub-chapter. The data collection for this entire study has been highlighted in the next sub-chapter, followed by the research design and data analysis. For the following sub-chapter, ethical considerations for this study have also been clarified. On top of that, the limitation of this study has been further elaborated as well. Last but not least, the conclusion of this chapter has been further justified in the final sub-chapter.

## 4.2 Conceptual Framework

This chapter begins with an illustration of the conceptual framework. The conceptual framework acts as a major guide of this study in order to understand how the variables are mapped out and connected to each other, thus emphasizing the key concepts of this study. Figure 4.1 portrays the diagram of the conceptual framework of this study. The conceptual framework starts with the main key concept of E-waste. In this era of globalization and modernization, technology has become a priority as human beings depend on electrical and electronic appliances daily. The production and consumption of

electrical and electronic appliances have been increasing throughout time. However, due to the short lifespan of these electrical and electronic appliances, the volume of E-waste in the waste stream has shown a significant increase over time. As a global environmental issue, it has become inevitable for Malaysia to get away with the issue of E-waste. The classification of E-waste has been divided into two: industrial E-waste and household E-waste.

The E-waste management for the industrial sector is governed by the Environmental Quality (Scheduled Wastes) Regulations 2005 in the Environmental Quality Act 1974. According to the regulations, industrial E-waste is currently under the supervision of the Department of Environment (DOE) through a system named "Electronic Scheduled Waste Information System" or e-SWIS. The key factor in industrial E-waste is the manufacturer producing electrical and electronic appliances.

On the other hand, household E-waste has highlighted the key actor, referring to the public as the key consumer. The Environmental Quality (Scheduled Wastes) Regulations 2005 in the Environmental Quality Act 1974 is currently used as the guideline for managing E-waste accordingly. Other than that, the non-legislation part also plays a vital role in managing E-waste. Advocacy, facilities, information, public participation, and reward have been discovered to be among the crucial elements of the non-legislation part. For the listed non-legislation elements, they are being used as the study variables along with the KAP as a tool.

As documented in the literature, KAPs are related to one another. The knowledge will help to increase the level of attitude and practices. At the same time, the attitude would also be able to increase the level of practice, which has been considered an assumption

and has been further investigated in this study. The demographic variables of the respondents, also known as the study input, have been assumed to have a relationship with the KAP variables. The demographic variables include gender, age, educational background, marital status, number of households, occupation, income, type of housing, and residential location. Besides that, information also plays a vital role in increasing the level of KAP among the public. On top of that, sources of information such as television, radio, the internet, posters, newspapers, family, friends, talks, and educational institutions have become important mediums to convey messages. Apart from that, the public's satisfaction level with the available E-waste services has also been highlighted as the input of this study. Satisfaction level regarding E-waste services is an important output in order to have the check and balance on the existing services and how to improve them.

Currently, Malaysia is making progress in establishing household E-waste management rules and regulations. However, there has been a lack of current baseline studies to report on E-waste handling or management, especially on E-waste recycling activity among the public. Other than that, the lack of strategies from the stakeholders in handling and managing the E-waste among the public has become an issue as well. By keeping the focus on encouraging sustainable consumption and production of E-waste together with reducing the volume of E-waste in the waste stream, the output of this study would have a high possibility to serve as a guideline and reference for the responsible bodies such as the government, NGOs and private sector on how to increase the sustainable management of E-waste. The output of this study would also provide insight into the most suitable source of information to convey the message related to E-waste to the public. This would provide an action plan to enhance the public's E-waste recycling activity through legislation, management, and services.

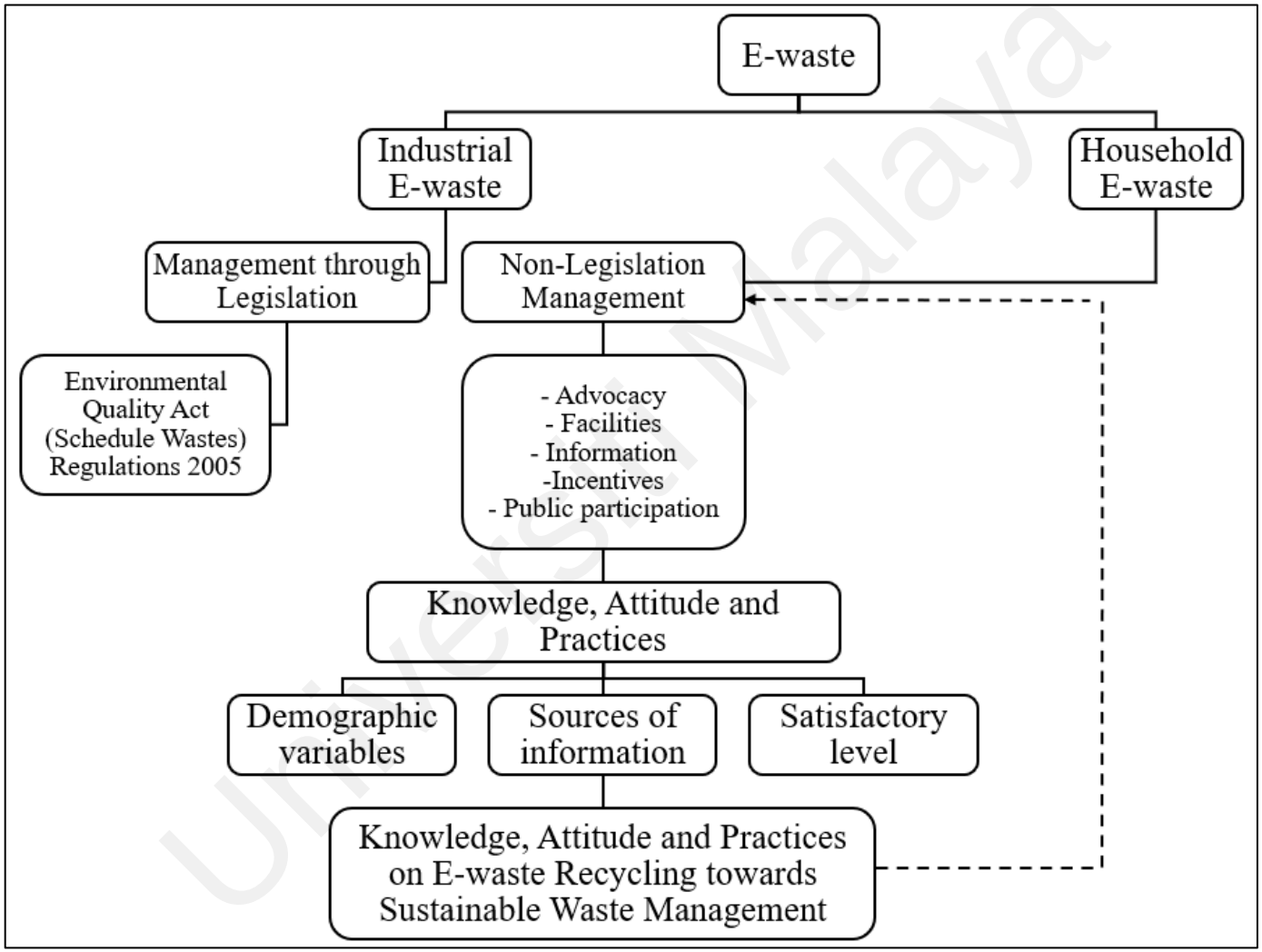


**Figure 4.1: Conceptual framework for the study**

## 4.3 Study Areas

E-waste is a global environmental issue with a high possibility of impairing the public due to its toxicity and hazardous materials. It is important to raise the public's concern about this issue. Using KAP as a tool, the study on E-waste recycling has already been conducted and investigated in three study areas located on the West Coast of Peninsular Malaysia: Kuala Lumpur, Selangor, and Port Dickson. This study can be considered a baseline study in relation to E-waste recycling among the Malaysian public. Hence, it begins with the west coast area since the capital of Malaysia, Kuala Lumpur, is located in the west coast area.

First, Kuala Lumpur is an example of a densely populated area in which the whole area is an urban area under the jurisdiction of the federal government. Then, as for Selangor, it is an example of an area with economic concentration. It is a fast-developing area with a high population. In Selangor, there are both urban and rural areas that are under the jurisdiction of the state government. Meanwhile, Port Dickson, Negeri Sembilan, a sub-urban area under the jurisdiction of local authority and this district, is projected to be developed. Selecting these three study areas can be a good help in representing the management of the federal government, state government, and local authority in Malaysia regarding E-waste management. In addition, one of the demographic variables considered in this study is the study areas, generally referred to as residential locations. This helps to highlight whether or not E-waste is an environmental issue limited to a certain area.

Therefore, any location around Malaysia that shares similar geographical, socio-demographics, and related characteristics would be able to adopt the findings of this study for reflection purposes as it shares similar output. In this sub-chapter, the geographical backgrounds, economic activities, and waste management of each study area will be

further elaborated (Refer to sub-chapters 4.31 until 4.33). For the geographical backgrounds, the related information such as the location, climate report, population, and management of the study area have been the core information to be highlighted. As for the economic activities, the information on the GDP of the study area and the development and economic activities carried out by the public have been particularly reported. The waste management section has emphasized the current waste management for each study area as well as the Act that has been used in that particular study area to manage the waste. Figure 4.2 presents the location of these three study areas.

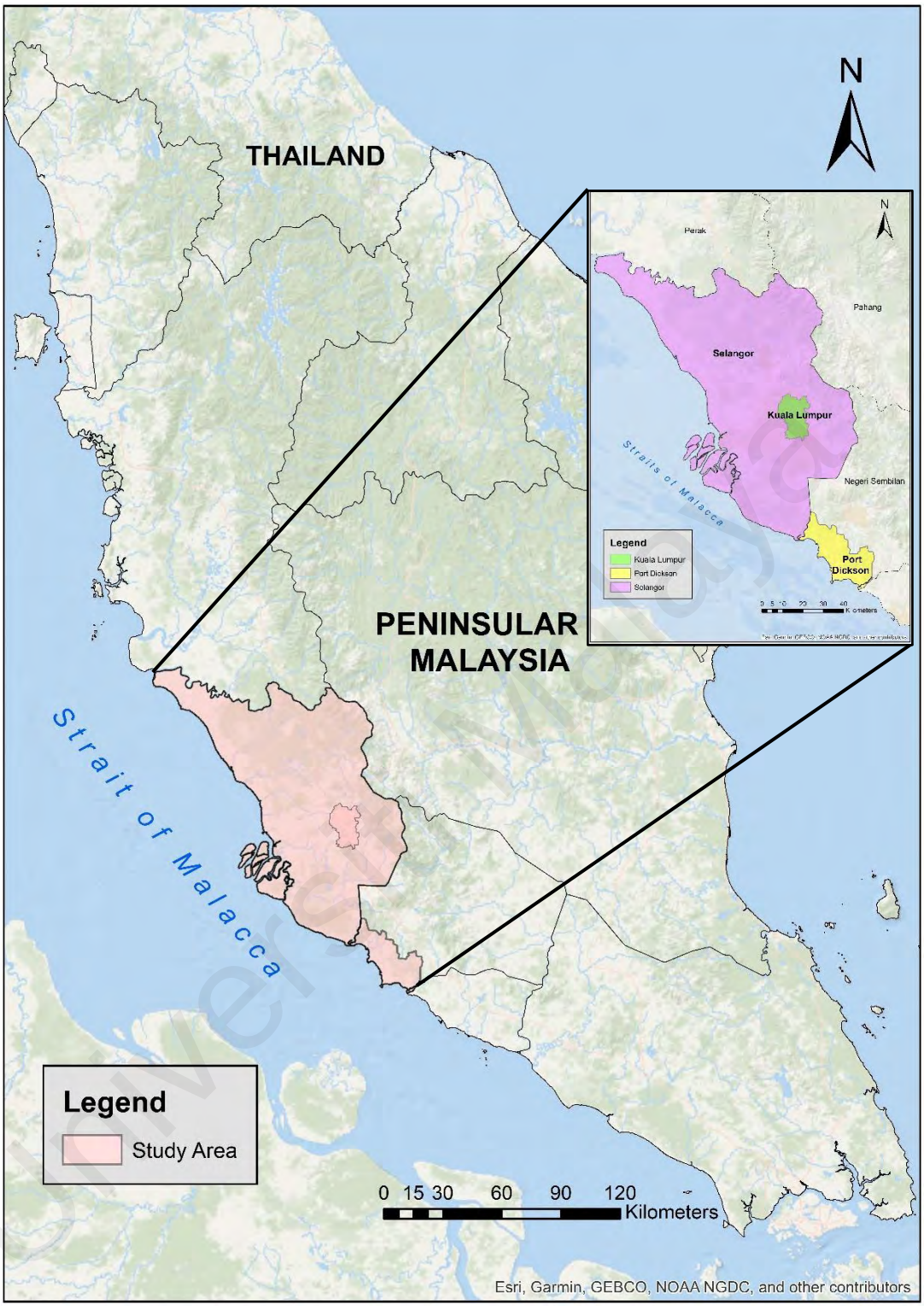


**Figure 4.2: Location of the three study areas**

### *4.3.1 Port Dickson, Negeri Sembilan*

#### *4.3.1.1 Geographical Background*

Port Dickson (2.5225°N, 101.7963°E) is located in Negeri Sembilan. The size of Port Dickson is about 580.53 km² (State Government of Negeri Sembilan Official Portal, 2017). As a tropical climate area, Port Dickson reported an annual temperature between 21°C and 32°C, with a humidity range between 80% and 90%, and also reported an annual rainfall of 2,381 mm (Praveena et al., 2016 in Praveena et al., 2018). Based on the report in "My Census 2020", that been prepared by the Department of Statistics Malaysia, the population of Port Dickson currently is about 131,764. The population growth rate in Port Dickson is 1.0% between 2018 and 2019 (Department of Statistics Malaysia, 2020). Port Dickson consists of five main parts: Mukim Jimah, Mukim Linggi, Mukim Port Dickson, Mukim Pasir Panjang, and Mukim Si Rusa (Pejabat Daerah dan Tanah Port Dickson, 2023). The management of Port Dickson falls under the jurisdiction of Majlis Perbandaran Port Dickson. Located about 90 kilometres from Kuala Lumpur, Port Dickson's coastline consists of 18 kilometres facing the Straits of Malacca (Praveena et al., 2018 & Abdullah et al., 2017), which joins the Indian Ocean to the Pacific Ocean as well as the South China Sea (Praveena et al., 2018). The coastal road, about 22 kilometres long, is parallel to the Port Dickson coastline, connecting this tourism destination to the Malacca and Seremban districts (Abdullah et al., 2017). Figure 4.3 demonstrates the location of Port Dickson.


**Figure 4.3: Maps of Port Dickson, Negeri Sembilan**

#### *4.3.1.2 Economic Activities*

In the National Strategic Plan for Solid Waste Management, Port Dickson is listed as one of the significant tourist towns due to its tourism activities. The listed tourism towns are tourist-dependent, which means that these towns possess the ability to contribute towards the economic growth in the region they are located. In the context of Port Dickson, tourism activity would increase the GDP of Negeri Sembilan (National Solid Waste Management Department, 2005). Historically, Port Dickson has been known as a tourist area since the colonial era (Abdullah et al., 2017). Up until now, Port Dickson is still one of the active beach tourism destinations in Malaysia (Praveena et al., 2018) besides shipping, refineries, and coastal zone constructions (Khairunissa et al., 2012; Praveena et al., 2011, in Yi & Kannan, 2016). According to Abdullah et al. (2017), Rancangan Tempatan Port Dickson has been focusing on the development of Port Dickson as a sustainable tourism area, in which Port Dickson to be divided into three main corridors: tourism corridor in Zone 1, industrial corridor in Zone 2 and agriculture corridor in Zone 3. This development plan has involved Port Dickson town, Tanjung Agas, Seremban-Port Dickson highway, and rural areas in Port Dickson. The wellness zone, about 61 kilometres long and stretches from Lukut to Pasir Panjang, was established by the Malaysian Industrial Development Authority (MIDA) in 2007 (Nair et al., 2016).

#### *4.3.1.3 Waste Management*

In terms of waste management, Port Dickson is one of the areas in Malaysia that has implemented the Solid Waste and Public Cleansing Management Act 2007 (Act 672). Under this legislation, waste management has been fully privatized and managed by the Solid Waste and Public Cleansing Management Corporation (SWCorp). However, the generated waste has been mixed and not segregated according to its types (Majlis Perbandaran Port Dickson, 2018). Starting in 2015, every premise needs to segregate its

waste into a few categories, such as paper, plastics, and food waste (Majlis Perbandaran Port Dickson, 2018). The recyclable and bulky waste will be collected once a week, whereas the residual waste will be collected twice a week (Majlis Perbandaran Port Dickson, 2018). According to Act 672, E-waste has been categorized under the 'others' type of waste, which needs to be segregated and disposed of in a green plastic bag (Majlis Perbandaran Port Dickson, 2018).

### *4.3.2 Selangor*

#### *4.3.2.1 Geographical Background*

Selangor (3.0738°N, 101.5183°E) is one of the 13 states in Malaysia, with a size of about 7,931 km² (Portal Rasmi Kerajaan Negeri Selangor, 2018). Selangor reported an annual temperature between 21°C and 32°C (Ahmad & Hashim, 2007), with a humidity range between 60% and 80% (World Weather Online, 2019). According to Jabatan Pengairan Dan Saliran, in 2017, the annual rainfall was about 2,185 mm. As reported by the Department of Statistics Malaysia (2020), the population in Selangor is about 6,500,000, with an estimated population growth of 0.5% (Department of Statistics Malaysia, 2021). Selangor consists of nine districts: Gombak, Hulu Langat, Hulu Selangor, Kuala Langat, Kuala Selangor, Sabak Bernam, Sepang, Klang, and Petaling. Each district in Selangor is under the management of the local authority. Selangor is 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 (Portal Rasmi Kerajaan Negeri Selangor, 2018), and the Straits of Malacca in the West (Portal Rasmi Jabatan Perangkaan Malaysia, 2019). Figure 4.4 portrays the map of Selangor.


**Figure 4.4: Maps of Selangor**

*4.3.2.2 Economic Activities*

In 2005, Selangor was declared the first developed state in Malaysia (Portal Rasmi Kerajaan Negeri Selangor, 2018). In 2017, Selangor was reported as the highest contributor of Gross Domestic Product (GDP) to the National economy, about 23.0% (DOSM, 2018). As reported in The Performance of State's Economy by the Department of Statistics Malaysia (2018), the contribution of GDP by the Selangor state in 2017 increased to 23%, demonstrating a high ability to grow at a faster pace of about 7.1%. Selangor's performance has been contributed by the economic sectors such as services, as supported by business services, communication, finance and insurance, and real estate. Other than that, retail and wholesale recorded growth of 6.8%, whereas the growth of the manufacturing sector has been up to 7.9%, as supported by electrical and electronic, motor vehicles, and transportation. The electrical and electronic (E&E) manufacturing sector in Selangor has contributed about 22%, created over 177,000 jobs, and attracted more than RM 35 billion in investments (Abdullah, 2017). On top of that, the agricultural sector, stimulated by fisheries and oil palm activities, has also increased up to 13.1%, whereas the construction sector growth also demonstrates a growth of 8%.

*4.3.2.3 Waste Management*

The implementation of the Solid Waste and Public Cleansing, Management Act 2007 (Act 672) in Malaysia was approved by the parliament in 2007. However, it was only being enforced on the 1st of September 2011. The privatization of waste management has been enforced in order to ensure that better service is provided. However, Selangor is one of the states in Peninsular Malaysia that does not implement Act 672 (Alias et al., 2018). According to Abas and Wee (2014), Selangor does not implement this Act due to the dissatisfaction of their local authorities regarding the private services and the operational cost. As a whole, the waste generated in Selangor recorded about 4,800 tonnes per day,

and it is expected to increase to 7,200 tonnes per day in 2035 (Jabatan Perancangan Bandar dan Desa Negeri Selangor, 2017). The waste collection in Selangor is managed by KDEB Waste Management, with the frequency of the waste collection service to be conducted every three to seven times per week, depending on the residential area (KDEB Waste Management, 2019).

### *4.3.3 Kuala Lumpur*

#### *4.3.3.1 Geographical Background*

Kuala Lumpur (3.0852°N, 101.4143°E) is the capital city of Malaysia. The size of Kuala Lumpur is about 243 km² (Portal Rasmi Jabatan Perangkaan Malaysia, 2019), located at the centre of Selangor state, at the confluence of Sungai Klang and Sungai Gombak (Ibrahim & Samah, 2011). Kuala Lumpur is a hot and humid city (Ibrahim & Samah, 2011) with an annual temperature between 27°C and 33°C (Nor & Abdullah, 2018). As reported by Jabatan Pengairan Dan Saliran in 2017, the annual rainfall in Kuala Lumpur is about 3,018 mm. The population of Kuala Lumpur is estimated to be about 1,750,000 people, with a population growth estimated at 1.1% (Department of Statistics Malaysia, 2021). The population has increased by 27% since 1990, and it is expected to increase to 2.2 million by 2020 (Kuala Lumpur City Hall, 2004, in Nor & Abdullah, 2018). Kuala Lumpur consists of eight main parts: Mukim Ampang, Mukim Batu, Mukim Cheras, Mukim Hulu Klang, Mukim Kuala Lumpur, Mukim Petaling, and Mukim Setapak (Portal Rasmi Pejabat Pengarah Tanah dan Galian Wilayah Persekutuan, 2020). The supervision and jurisdiction of Kuala Lumpur are managed by Dewan Bandaraya Kuala Lumpur (DBKL). This Federal Territory is located in the middle of Selangor (Portal Rasmi Jabatan Perangkaan Malaysia, 2019). Figure 4.5 manifests the map of Kuala Lumpur.

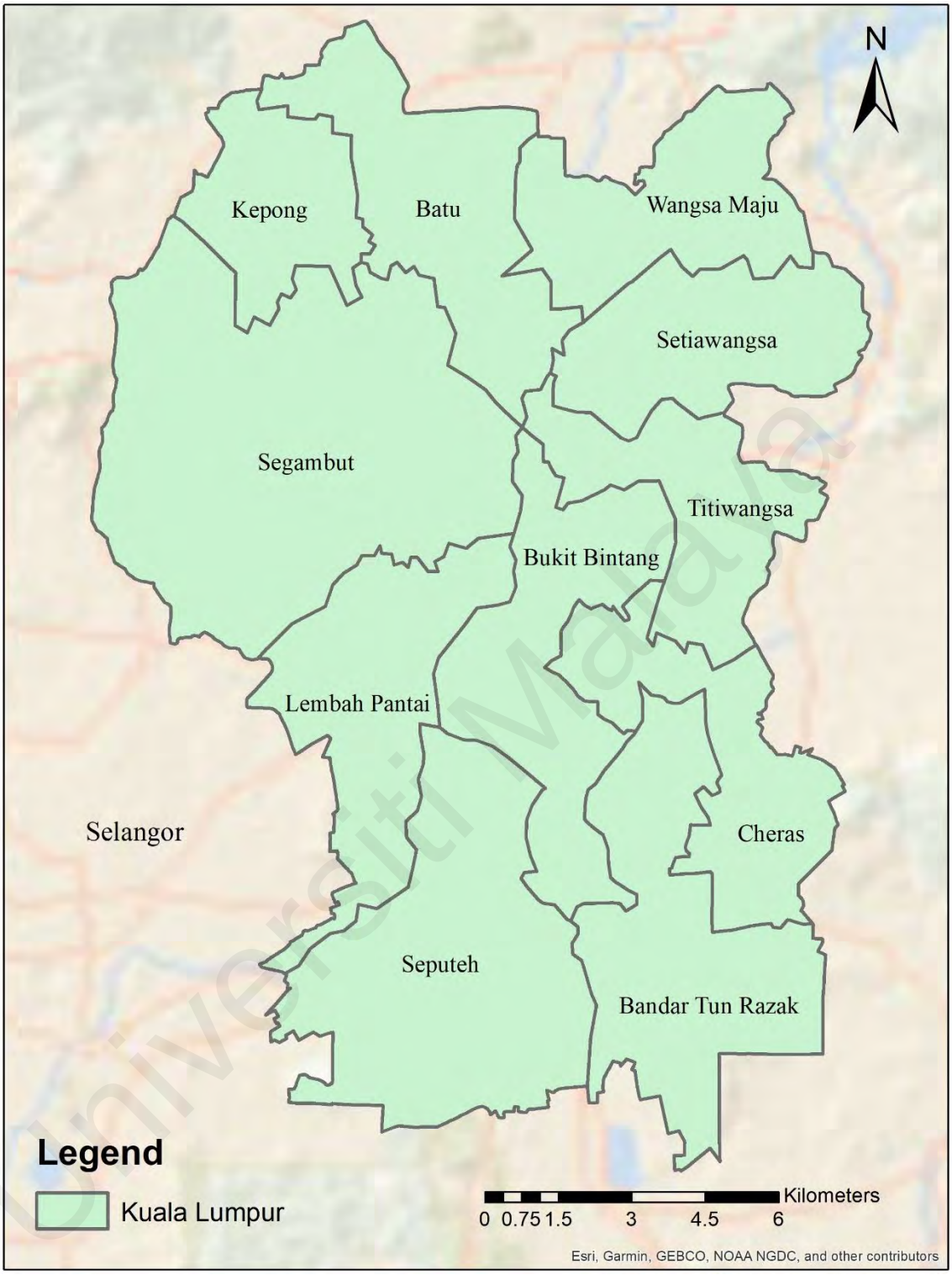


**Figure 4.5: Maps of Kuala Lumpur**

*4.3.3.2 Economic Activities*

Being a small settlement (Gullick, 2015), Kuala Lumpur has become the capital city of Malaysia despite being listed among the top urban destinations in Southeast Asia (Amir et al., 2015). Kuala Lumpur functions as a development center for the nation with its various activities such as banking, cultural, commercial, educational, financial, political, religious, and sports (Mohit et al., 2010). As reported in The Performance of State's Economy by the Department of Statistics Malaysia (2018), the contribution of GDP by the Federal Territory of Kuala Lumpur in 2017 was about 15.6% and demonstrated the ability to grow at a faster pace of about 7.4%. Kuala Lumpur's performance has been driven by some economic sectors, such as services supported by business services, communication, finance and insurance, and professionals. Retail and wholesale recorded growth of 6.6%, whereas the growth of the construction sector has been up to 12.8%, as supported by civil engineering, special trade, and residential buildings.

*4.3.3.3 Waste Management*

Growing as the fastest metropolitan area in Asia, Kuala Lumpur is also facing environmental problems due to development and urbanization (Ibrahim & Samah, 2011). Waste management issue has become one of the most serious environmental problems faced by Kuala Lumpur. The total waste generated in Kuala Lumpur, as reported by Saeed et al. (2008), is about 3.478 tonnes per day. The waste composition consists of glass, metals, paper, plastic, textiles, wood, and other types. Besides Port Dickson, Kuala Lumpur has also implemented privatization in waste management by enforcing Act 672. Previously, the waste management was conducted by the Kuala Lumpur City Hall, DBKL. Through the enforcement of Act 672, Solid Waste and Public Cleansing Management Corporation, SWCorp has taken responsibility for managing the waste (Kuala Lumpur City Hall, 2019). Under the supervision of SWCorp, Alam Flora has

become the concession company responsible for running the collection of waste in Kuala Lumpur (Alam Flora, 2015).

## 4.4 Respondents

The wide range of appliances that offer various functions, designs, and technologies has led the public to keep upgrading their electrical and electronic appliances on a regular basis. In this sub-chapter, the involvement of the public as the participants in this study would be further justified. The participants for this study consisted of the public from Port Dickson, Selangor, and Kuala Lumpur. By focusing on the public aged 18 years and above from different demographic backgrounds, this study is similar to the prior studies related to E-waste by Kalana (2010), Akhtar et al. (2014), and Sivathanu (2016). According to Kalana (2010), the categorization of the public aged 18 years and above has been made due to income factors. At the age of 18 years and above, the public in this range of age has usually come up with their own income and possess the ability to buy any electrical and electronic appliances on their own.

As this is a cross-sectional study, the participants are chosen based on the inclusion and exclusion characteristics of the study, as highlighted in Setia (2016). The public that fits these three characteristics is those who participated in this study, aged 18 years and above, are Malaysian, and live either in Kuala Lumpur, Selangor, or Port Dickson, Negeri Sembilan. Additionally, according to Deakin Universiti (2024), a larger sample size provides more power; however, a minimum of 60 respondents is advised for a cross-sectional study; thus, it is still dependent on the research questions of the study itself. As for the sampling size, Israel (1992) highlighted that there are four ways to choose the sampling size, namely: the usage of the census for a small population, imitating the sample size of a similar study, using published tables, and applying the formula to

calculate the sample size. However, the use of census is not a suitable method since those three study areas have large populations. Hence, the other three approaches will be discussed as follows:

### *4.4.1 Determining sample size from previous studies*

The ranges and limitations regarding the number of respondents are still being taken into account by referring to the previous cross-sectional study on KAP and any related E-waste management studies. Both justifications are tabulated in Table 4.1(a) and 4.1(b). Considering the number of respondents in both tables, this study initially calculated the respondents to be about 800 to 1,200. However, the total number has been finalized to be 3015 respondents at the end of data collection based on the participation and response from the public.

**Table 4.1(a): Number of respondents on previous cross-sectional studies on KAP**

| Title | Number of respondents | References |
|---|---|---|
| Knowledge, Attitude and Practices on Diabetes among Type 2 Diabetic Patients in Iran: A Cross-Sectional Study | 100 | Mohammadi et al. (2015) |
| Knowledge, Attitude and Practice on Leptospirosis Among Undergraduate Students in University Putra Malaysia | 170 | Bakar & Rahman (2015) |
| Knowledge, Attitude and Practice Regarding Work Safety Culture Among Staffs in The Faculty of Medicine and Health Sciences, Universiti Putra Malaysia | 215 | Rosliza et al. (2015) |
| Knowledge, Attitude and Practice of Healthy Eating and Associated Factors among University Students in Selangor, Malaysia | 282 | Hasan et al. (2015) |
| A KAP Study on Food Safety and Hygiene among Private University Students in Kedah State, Malaysia | 869 | Ali et al. (2018) |

**Table 4.1(b): Number of respondents on previous studies regarding E-waste management**

| Title | Number of respondents | References |
|---|---|---|
| Electrical and Electronic Waste Management Practice by Households in Shah Alam, Selangor, Malaysia | 300 | Kalana (2010) |
| Willingness and Behaviour Towards E-waste Recycling for Residents in Beijing City, China | 1173 | Wang et al. (2011) |
| Survey and Analysis of Public Knowledge, Awareness and Willingness to Pay in Kuala Lumpur, Malaysia: A Case Study on Household WEEE Management | 350 | Afroz et al. (2013) |
| Household Perception and Recycling Behaviour on Electronic Waste Management: A Case Study of Kuala Lumpur, Malaysia | 250 | Akhtar et al. (2014) |
| E-waste Management Practices of Households in Melaka | 345 | Tiep et al. (2015) |

### *4.4.2 Determining sample size from published tables*

According to the table to determine the sample size based on a given population (Refer to Appendix A) suggested in Krejcie and Morgan (1970), if the population size is about 75000, the suitable sample size would be 382 respondents, then if the population size is about 1,000,000, the suitable sample size would be 384 respondents. Hence, based on the population size of Kuala Lumpur, Selangor and, Port Dickson, Negeri Sembilan, the sample size by applying Krejcie and Morgan (1970), is between 382 and 384 respondents for each study area. Then, as for the published table by Yamane (1967) (Refer to Appendix B), with the assumption of confidence level is 95%, population proportion (*P*) is 0.5, precision € is ± 5%, and the population is more than 100,000, the suggested sample size is 400 for each study areas. Hence, as referred to in both published tables, the total number of respondents should be between 1,146 and 1,200. However, based on public engagement and response, the total number of respondents at the completion of data

collection was 3,015.

### *4.4.3 Determining sample size by applying the formula*

Another approach to determining the sample size is by applying the formula that has been suggested by Krejcie and Morgan (1970) as well as Yamane (1967). Both formulas are listed as follows:

(i) Krejcie and Morgan (1970):

$$s = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)},$$

Where;

$s$ = sample size
$X^2$ = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841)
$N$ = population size
$P$ = the population proportion (assumed to be .50 since this would provide the maximum sample size)
$d$ = the degree of accuracy expressed as a proportion (.05)

(ii) Yamane (1967):

$$n = \frac{N}{1 + N(e)^2},$$

Where;

$n$ = sample size
$N$ = population size
$e$ = level of precision

As calculated by applying formula (i), the sample size for Kuala Lumpur is 384.02, and then as for Selangor, it is 384.08, meanwhile, for Port Dickson, Negeri Sembilan, it is about 382.98. By applying formula (ii), the sample size for Kuala Lumpur is 399.91, Selangor is 399.98, and then for Port Dickson, Negeri Sembilan is 398.79. According to these two formulas, the suggested number of respondents for this study was between 1151 and 1199. Based on the public's willingness to participate in the questionnaire survey, the final total number of respondents in this study was 3,015.

## 4.5 Instruments

For every research conducted, an instrument will be the tool of the research as it will be used to collect the data and achieve the research objectives together with the research questions. This cross-sectional study has adopted a questionnaire survey method as the study instrument. According to Olsen and St George (2004), a cross-sectional study is a well-known and common study design that can collect information about two variables at the same time based on the study's interest. Setia (2016) highlighted that this cross-sectional study simultaneously measures the exposure and outcome and is suitable for conducting a population survey. Hence, a set of questionnaire surveys was created and designed based on adaptations from previous studies on the scientific literature related to waste management. Upon completion, the questionnaire survey was distributed to the respondents within the selected study areas. The development of the items was then adjusted according to the objectives of the study.

The questionnaire consists of six major sections, focusing on Section A (demographic background), Section B (knowledge of E-waste recycling), Section C (attitude of E-waste recycling), Section D (practices of E-waste recycling), Section E (sources of information on E-waste recycling) and Section F (the satisfaction level of the public on E-waste management). The number of questions varies according to the sections. Ten questions were set under the demographic background section, followed by fourteen questions in the knowledge section. Seven questions were set under the attitude section, followed by ten questions under the practices section. Finally, ten questions were listed under the sources of information, and two questions were set under the satisfaction level of the public towards the existing E-waste services. According to Sharma (2022), in order to increase the response rate of respondents, their attention, and their interest, the questionnaire survey must consist of 25 to 30 questions and thus be completed within 30

minutes. Despite the total of 53 questions in this study, the majority of the questions are brief, simple to comprehend, and can be finished in under 30 minutes.

### *4.5.1 Demographic Background Questions*

For section A, the demographic variables in this study have been adopted from previous studies on waste management that have utilized KAP as a tool and previous studies that have specifically discussed E-waste. As highlighted in Castagna et al. (2013), Chu et al. (2016), and Almasi et al. (2019), demographic variables are the core elements of the KAP study. Hence, Table 4.2 tabulates nine demographic variables, highlighting gender, age, educational background, marital status, household size, occupation, income, residential type, and the location of residence for this study. The references to acknowledge the sources of adaptation have been included as well.

In this questionnaire, the gender variable has been both male and female, with five categories of age groups that comprised of the respondents aged 18 to 19 years old, 20 to 29 years old, 30 to 39 years old, 40 to 49 years old, and; 50 years old and above. For educational background, there are four categories: higher education, secondary education, primary school, and no formal education. Next, there are three groups of marital status: single, married, and others, either divorced or not related. There are six groups of choices for the number of households: one person, two people, three people, four to six people, and more than six people.

For the occupation variables, there are the government sector, private sector, self-employed, housewife, student, and pensioner. This has been followed by the income of the respondents in Malaysian Ringgit, which comprised five groups of choices: less than RM 1,500, between RM 1,501 and RM 3,000, between RM 3,001 and RM 4,500, more

than RM 4,501, and an option of not related. For the residential type, there are six choices: apartment or flat, twins or bungalow, terrace, condominium or service apartment, townhouse, and traditional house. As for the location of the residential area, there are three options, as stated in the study areas: Kuala Lumpur, Selangor, Port Dickson, and Negeri Sembilan.

**Table 4.2: Checklist of demographic backgrounds from previous studies**

| Demographic items | References | | | | |
|---|---|---|---|---|---|
| | Abeliotis et al. (2006) | Chibunna et al. (2013) | Babaei et al. (2015) | Laor et al. (2017) | Seng et al. (2018) |
| Gender | ✓ | | ✓ | ✓ | |
| Age | ✓ | ✓ | ✓ | ✓ | ✓ |
| Educational background | ✓ | ✓ | ✓ | ✓ | ✓ |
| Marital status | | | | | ✓ |
| Household numbers | | | | | ✓ |
| Occupation | | ✓ | ✓ | | ✓ |
| Income | ✓ | ✓ | | ✓ | |
| Residential type | | | | | |
| Residential location | | | | | |

### *4.5.2 Knowledge on E-waste Recycling Questions*

The following sub-chapter, which deals with the knowledge of E-waste recycling, is highlighted in Section B of the questionnaire. There were 14 questions formulated to analyse the knowledge of E-waste recycling in Malaysia among the respondents. From the listed 14 questions, knowledge questions have been divided into five main groups of questions: definition and background of E-waste, effects of E-waste generation, advantages of E-waste recycling, rules, laws, and regulations related to E-waste management, as well as activity on disposal of E-waste. The questions were fully

measured using the nominal scale (Yes or No). The questions have been adopted from the previous studies from 2007 until 2018, as tabulated in Table 4.3.

**Table 4.3: Knowledge questions from previous studies**

| Questions | References |
|---|---|
| *Definition and background of E-waste* | |
| **K1** Definition of E-waste | Bhat & Patil (2014)<br>Subhaprada & Kalyani (2017)<br>Azodo et al. (2017) |
| **K2** The content of electrical and electronic equipment | Song et al. (2012)<br>Tarawneh & Saidan (2013)<br>Bhat & Patil (2014)<br>Akhtar et al. (2014)<br>Azodo et al. (2017)<br>Juyal et al. (2018) |
| **K3** Current generation of E-waste in Malaysia | Akhtar et al. (2014) |
| *Effects of E-waste generation* | |
| **K4** Effects of E-waste on the environment; and<br>**K5** Effects of E-waste on public health | Vicente & Reis (2007)<br>Song et al (2012)<br>Chibunna et al. (2013)<br>Akhtar, et al. (2014)<br>Bhat & Patil (2014)<br>Islam et al. (2016)<br>Sivathanu (2016)<br>Azodo et al. (2017)<br>Subhaprada & Kalyani (2017) |
| *Effects of E-waste generation* | |
| **K4** Effects of E-waste on the environment; and<br>**K5** Effects of E-waste on public health | Subhaprada & Kalyani (2017)<br>Borthakur & Govind (2018)<br>Juyal et al. (2018) |
| *Advantages of E-waste recycling* | |
| **K6** Advantages of E-waste recycling towards the environment and public health | Chibunna, et al. (2013)<br>Ahmad, et al. (2015)<br>Islam et al. (2016) |
| **K7** Advantages of E-waste recycling towards the mining activity | Vicente & Reis (2007)<br>Chibunna, et al. (2013)<br>Babington, et al. (2013)<br>Tarawneh & Saidan (2013)<br>Ahmad, et al. (2015) |

| Questions | References |
|---|---|
| *Rules, laws and regulations related to E-waste management* | |
| **K8** Act and legislation on E-waste in Malaysia | Wang, et al. (2011)<br>Azodo et al. (2017)<br>Subhaprada & Kalyani 2017 |
| **K9; K10** Segregation and disposal of E-waste | Malik, et al. (2015)<br>Babaei, et al. (2015)<br>Azodo et al. (2017)<br>Iyer et al. (2018) |
| *Activity on disposal of E-waste* | |
| **K11; K12** The correct location to dispose the E-waste | Kalana (2010)<br>Wang, et al. (2011)<br>Tiep, et al. (2015)<br>Sivathanu (2016)<br>Ghani, et al. (2013)<br>Stoeva & Alriksson (2017)<br>Subhaprada & Kalyani (2017) |
| **K13** Trade-in services of E-waste | Tiep et al. (2015) |
| **K14** Reward through E-waste recycling activity | Sakholthaman & Sharp (2016) |

### *4.5.3 Attitude on E-waste Recycling Questions*

In order to establish the research objectives and questions, this sub-chapter has highlighted the questions regarding the attitude toward E-waste recycling in Section C. There were seven questions for this sub-chapter in order to analyse the attitude toward E-waste recycling in Malaysia among the respondents. Similar to the knowledge section, the questions highlighted in section C were fully measured using the nominal scale (Yes or No). All questions in the attitude section have been adopted from the previous studies between the years of 2007 and 2017, as tabulated in Table 4.4.

**Table 4.4: Attitude questions from previous studies**

| Questions | Sources |
|---|---|
| **A1** Upgrading electrical and electronic appliances due to trend | Kalana (2010)<br>Afroz et al. (2012)<br>Rafia et al. (2013)<br>Tiep et al. (2015) |
| **A2** Recycling campaign | Babaei et al. (2015) |
| **A3** Waste segregation | Afroz et al. (2012)<br>Tarawneh & Saidan (2013)<br>Babaei et al. (2015)<br>Amouei et al. (2016)<br>Azodo et al. (2017)<br>Stoeva & Alriksson (2017) |
| **A4** Sending the E-waste to the nearest collection center | Wang et al. (2011)<br>Song et al. (2012)<br>Afroz et al. (2013)<br>Tarawneh & Saidan (2013)<br>Ghani et al. (2013)<br>Stoeva & Alriksson (2017)<br>Sivathanu (2016) |
| **A5** Incentives on recycling activity | Vicente & Reis (2007) |
| **A6** Facilities of E-waste recycling | Vicente & Reis (2007)<br>Kalana (2010)<br>Rafia et al. (2013)<br>Stoeva & Alriksson (2017) |
| **A7** Reducing the amount of E-waste generated | |

### *4.5.4 Practices on E-waste Recycling Questions*

In this sub-chapter, the questions on the practices of E-waste recycling are highlighted. There was a total of ten questions, which were divided into two major groups and questions: general practices and disposal practices. The questions on practices were fully measured using the nominal scale (Yes or No), similar to the knowledge and attitude questions. The questions have been developed from the adaptation of previous studies between the years of 2007 and 2018. The questions and sources are tabulated in Table 4.5.

**Table 4.5: Practices questions from previous studies**

| Questions | References |
|---|---|
| *General practices* | |
| **P1** Segregate | Bhat & Patil (2014)<br>Malik, et al. (2015)<br>Xiao et al. (2017) |
| **P2** Store | Abeliotis, et al. (2006)<br>Kalana (2010)<br>Wang et al. (2011)<br>Song et al. (2012)<br>Afroz et al. (2012)<br>Tiep et al. (2015) |
| **P3** Encouragement in proper management of E-waste | Vicente & Reis (2007)<br>Akhtar et al. (2014)<br>Tan et al. (2017) |
| *Disposal practices* | |
| **P4** Sell | Darby & Obara (2005)<br>Kalana (2010)<br>Wang et al. (2011)<br>Song et al. (2012) |
| **P5** Trade in | Bhat & Patil (2014)<br>Tiep et al. (2015)<br>Borthakur & Govind (2018) |
| **P6** Sending off to authorized collection centre | Kalana (2010)<br>Wang et al. (2011)<br>Afroz et al. (2012) |
| *Disposal practices* | |
| **P7** Sending off to scrap collector | Abeliotis et al. (2006)<br>Kalana (2010)<br>Wang et al. (2011)<br>Tiep et al. (2015) |
| **P8** Donate | Darby & Obara (2005)<br>Abeliotis et al. (2006)<br>Kalana (2010)<br>Song et al. (2012)<br>Afroz et al. (2012)<br>Tarawneh & Saidan (2013)<br>Tiep et al. (2015)<br>Nduneseokwu & Appolloni (2017) |

| Questions | References |
|---|---|
| **P9** Repairing | Kalana (2010)<br>Tiep et al. (2011)<br>Nduneseokwu & Appolloni (2017)<br>Borthakur & Govind (2018) |
| **P10** Simply disposed | Abeliotis et al. (2006)<br>Wang et al. (2011)<br>Tiep et al. (2011)<br>Song et al. (2012)<br>Afroz et al. (2013)<br>Nduneseokwu & Appolloni (2017) |

### *4.5.5 Sources of Information on E-waste Recycling*

Information is the key to providing knowledge to any group of people. Sources of information act as educational tools that will enhance the public's awareness of waste management (Malik et al., 2015). Hence, the sources of information have also been considered in this study to assess the effectiveness of the information on E-waste recycling towards the KAP of the respondents. In this sub-chapter, the respondents were given the option to choose more than one type of information source. The respondents can also fill in other types of sources that were not highlighted in this section. In this sub-chapter, the questions were measured using the nominal scale (Yes or No) for ten sources: television, radio, internet, poster, newspaper, family, friends, talk, educational institution, and one open-ended answer for other sources that have not been stated. The listed sources of information have also been adopted from the previous studies in 2015 and 2017, as tabulated in Table 4.6.

**Table 4.6: Checklist of sources of information from previous studies**

| Sources of information | References | | |
|---|---|---|---|
| | Malik et al. (2015) | Ahmad et al. (2015) | Laor et al. (2017) |
| Television | ✓ | ✓ | |
| Radio | | ✓ | ✓ |
| Internet | ✓ | ✓ | ✓ |
| Poster | | | ✓ |
| Newspaper | ✓ | ✓ | ✓ |
| Family | | ✓ | |
| Friends | | ✓ | |
| Talk | ✓ | | |
| Educational institution | | ✓ | |
| Others | | ✓ | ✓ |

### *4.5.6 Satisfaction level of the public on E-waste management*

At the end of the questionnaire survey, the highlight of section F was related to the public's satisfaction level towards E-waste services in their residential area. The satisfaction level of the public towards the existing services is one of the most important keys to be highlighted upon the completion of this study. This information has been beneficial in contributing towards sustainable E-waste management in the future by providing the information to the stakeholders. There were two questions in this section. First, the respondents were asked about their satisfaction level regarding the existing E-waste services using a nominal scale (Yes or No). The second question deals with open-ended responses from the respondents pertaining to their satisfaction level. The respondents can write their feedback for any dissatisfaction as well as suggested improvements. Public satisfaction with waste management service items was adopted by Babaei et al. (2015), Stoeva and Alriksson (2017) and Seng et al. (2018).

## 4.6 Pilot Study

Upon completion of the questionnaire, a pilot study was conducted on 271 respondents in Port Dickson, who were later excluded from the whole sample size. A pilot study is important in order to determine the possible outcomes and problems regarding the protocols, methods, and instruments (Van Teijlingen & Hundley, 2002) that might arise from the research. Hence, the amendment based on the pilot study output can be used in the actual study (Hassan et al., 2006). The selection of respondents in the pilot study has been made based on a cross-sectional approach together with the application of the formula suggested in Viechtbauer et al. (2015) as follows:

$$n = \frac{\ln(1-\gamma)}{\ln(1-\pi)},$$

Where;

$n$ = number of respondents
$\gamma$ = level of confidence
$\pi$ = problem probability

With the implementation of 0.95 as the level of confidence and 0.05 as the problem probability, the suggested number of respondents for the pilot study was 58.4 respondents, or, to be rounded up, 58 respondents. However, a higher number of respondents were used for the pilot study in order to improve the accuracy of the data pertaining to the study population. Of 271 respondents, 53.5% were female and 46.5% were male. The highest number of respondents based on the age category has been focused on 18 to 19 years old, which was reported to be about 15.5%. It was followed by the age category of 50 to 54 years old, with 15.1% of respondents. The lowest age category reported has been focused on 40 to 44 years old, with 7.0% of respondents. Besides that, the highest percentage of respondents based on the educational background category has been highlighted towards high school, which reported about 53.9%, followed by 31.4% of respondents with higher education, 9.2% of respondents with primary education background as well as 5.5% of respondents with no formal education background. Another

item that has been recorded was the marital status of the respondents in Port Dickson, with 62.7% reported to be married, followed by 33.9% reported to be single. For household numbers, most respondents consisted of an average of five people in their house. About 78.2% of the respondents reported their type of residence as terraced houses, which accounts for the highest percentage among all the listed types of residential. On top of that, with regard to occupation, 30.3% of respondents reported working in the private sector.

## 4.7 Data Collection Approach

Data collection begins after the questionnaire survey and pilot study processes are completed. To begin, the questionnaire survey is distributed to the general public in Port Dickson, Selangor, and Kuala Lumpur, with a total of 1,500 questionnaires distributed in each study area. In the process of distributing the questionnaires, the distribution was about three times more than the suggested sample size. A large number of questionnaires has been distributed among the public; this is in order to increase the sample size to the suggested number of respondents required (Refer to sub-chapter 4.4). According to Cornish (2006) and Andrade (2020), bigger sample sizes will yield more accurate results because they more closely represent the population value. Furthermore, some issues, such as "non-response" and "missing data," should be considered when conducting the study, particularly when humans are involved (Cornish, 2006).

Throughout the data collection process, a cross-sectional study approach is used, and data is collected door-to-door at the shopping mall, recreational area, or any public area. The respondents will be chosen based on the inclusion criteria, which are as follows: Malaysians must be at least 18 years old, live in one of the study areas (Port Dickson, Selangor, or Kuala Lumpur), and be willing to participate in this study. A consent form is given to the respondents before they begin to answer in order to obtain their permission

to use their demographic background and input from their answers for research purposes. To ensure the respondents' confidentiality, personal information such as their name, identification number, email address, and phone number were not collected. The hardcopy questionnaire survey was then given to each of the respondents to answer, and once completed, the questionnaire survey was returned for cleaning and keying in.

## 4.8 Research Design and Data Analysis

This research utilizes a questionnaire survey as a research tool to investigate the current state of E-waste recycling activity, the sources of E-waste information, and public satisfaction with E-waste management and services. The questionnaire survey is being developed, followed by the pilot study. After the pilot study is completed, data collection begins. The data is gathered using a cross-sectional approach, and 1,500 hardcopy questionnaires are distributed in each study area. Only 1,266 Port Dickson respondents, 813 Selangor respondents, and 936 Kuala Lumpur respondents completed the questionnaire survey, for a total of 3,015 respondents.

This cross-sectional data collection approach is being conducted in residential areas as well as public areas such as shopping malls and recreational parks. Following the completion of the data collection via questionnaire survey, the collected data underwent a "cleaning process," in which any incomplete questionnaires were removed, followed by the key-in process using Statistical Package for Social Science (SPSS) version 23. All the collected data was reported and analysed using statistical tests. The quantitative analysis method is used for data analysis. According to Hughes (1997), Punch (1998), and Hughes (2012), the quantitative approach is the best choice because it is numerical, making it more objective and scientific. Furthermore, by implementing a quantitative approach, the

data could be easily interpreted and analysed (Best & Khan 1989; Hughes 2012). The summary of data analysis for this study has been portrayed in Table 4.7.

**Table 4.7: Summary of data analysis for this study**

| Research Objectives | Research Questions | Data Analysis |
|---|---|---|
| *RO1:*<br>To analyse the current status of knowledge, attitude and practices on E-waste recycling in Malaysia | *RQ1:*<br>What is the current status of knowledge, attitude and practices on E-waste recycling among respondents? | Descriptive analysis |
| *RO2:*<br>To investigate the preferred sources of information on E-waste recycling among respondents | *RQ2:*<br>What are the preferred sources of information on E-waste recycling among respondents? | Descriptive analysis |
| *RO3:*<br>To investigate the relationship between demographic variables and current status of knowledge, attitude and practices on E-waste recycling in Malaysia | *RQ3:*<br>Which demographic variables are significantly associated with the current status of knowledge, attitude and practices on E-waste recycling in Malaysia? | Chi square analysis |
| *RO4:*<br>To analyse the relationship between knowledge, attitude and practices on E-waste recycling among respondents | *RQ4:*<br>What is the relationship between knowledge, attitude and practices on E-waste recycling among respondents? | Descriptive analysis<br>Chi square analysis |
| *RO5:*<br>To explore the satisfaction level of the public pertaining to the currently available E-waste management services in Malaysia | *RQ5:*<br>What is the level of satisfaction among the public regarding the available E-waste management services? | Descriptive analysis |

Table 4.7 shows the summary of data analysis according to the listed research objectives and research questions. Firstly, for research objective one, in order to analyse the current

status of KAP on E-waste recycling among respondents, questions in Sections B, C, and D are being analysed. Each of the questions was given two options – Yes and No. Thus, respondents can only choose one specific answer. The percentage of each answer was then presented using a bar graph. Every question is also explained and discussed based on the previous studies related to E-waste. Using this descriptive analysis will assist in providing a general summary as well as characterising the collected data (Larson, 2006; Kaliyadan & Kulkarni, 2019).

Next, in order to achieve research objective (2), section E in the questionnaire survey underlined all the sources of information. Then, the respondents need to choose their preferred sources of information regarding E-waste. Respondents were given the option of Yes or No for each source of information and could choose more than one source of information. It is important to discover the preferred sources of information as it works as the medium to provide the information and knowledge to the public. The percentage of respondents for each source of information on E-waste is presented in percentage form using a bar graph. The output is then explained and discussed according to the previous studies that highlight sources of information on E-waste.

In order to investigate the relationship between the demographic variables and KAP on E-waste recycling in Malaysia, a chi-square analysis is being conducted. As stated in McHugh (2013), chi-square analysis is a statistical method for comparing observed and expected values. It will aid in better understanding and interpretation of the relationship. This type of analysis is also adaptable when dealing with data from two or more groups. Each of the questions in sections B, C, and D were tested using chi-square analysis with each of the demographic variables. This statistical analysis is conducted using Statistical Package for Social Science (SPSS) version 23. The results were then tabulated (Refer to

Table 5.5 to 5.12). For any questions on the KAP of E-waste recycling that have a significant p-value less than 0.05 with the demographic variables, it will reflect that there is a relationship between items. Every output of the analysis was then discussed by comparing it with the results of previous E-waste studies that also applied chi-square analysis.

Research objective (4), highlighted in this study, is mainly to determine the relationship between the KAP of E-waste recycling among respondents. The data analysis for this research objective used descriptive analysis, cross-tabulations, and the chi-square analysis. The results are tabulated (Refer to Tables 5.1 to 5.15). To begin, once data entry is complete, for every question that answered Yes in Sections B, C, and D, the respondents will be given 1 point, and for every question that answered No, the respondents will be given 0 points. This is as suggested in Ahamad and Ariffin (2018), Saadia et al. (2010), and Wen et al. (2021). For the knowledge section, the maximum total score would be 14 since the total number of questions is 14. Then, the highest total score for respondents in the attitude section is 7, which indicates a total of seven attitude questions. As for the practices section, the highest total score would be 10. This is equivalent to the ten questions for practices on E-waste recycling. Then, each respondent will have the total scores for the KAP, and respondents will be grouped based on the total scores according to low, moderate, and high levels of KAP. The group for the total scores of KAP on E-waste is as tabulated in Table 4.8.

**Table 4.8: Level of scoring based on the total scores**

| | | Total scores grouping | | |
|---|---|---|---|---|
| | | **Knowledge (K)** | **Attitude (A)** | **Practices (P)** |
| **Level of scoring** | **Low** | 0-4 | 0-3 | 0-5 |
| | **Moderate** | 5-9 | 4-5 | 6-7 |
| | **High** | 10-14 | 6-7 | 8-10 |

Using the tabulation of KAP based on total scores and level of scoring, the cross-tabulations are being applied and conducted in the Statistical Package for Social Science (SPSS) version 23. Cross-tabulations have been shown by Blanchet and Pennec (1993) and Wildemuth (2009) to transform the descriptive method into an explanatory value. The link between the factors was also stated in this two-way table, which helped researchers interpret how the study area's population differs depending on its demographic background (Blanchet & Pennec, 1993; Wildemuth, 2009). From the cross-tabulations as well, the chi-square analysis is also displayed with a significant p-value of less than 0.05. According to Wildemuth (2009), chi-square can help to identify the relationship between two variables even though chi-square is not able to highlight the nature of the relationship.

The last research objective to be achieved is the exploration of the public's satisfaction with the current E-waste management and services. In order to achieve this research objective, descriptive statistics are being utilized. The percentage of respondents that are satisfied and unsatisfied are then tabulated in frequency as well as in percentage form. The discussion is made according to the literature and previous studies. All comments written by dissatisfied respondents were also keyed into SPSS. Those comments were

divided into four major groups based on the keywords of the comments. Then, the percentage of respondents based on the keywords is displayed using a bar graph.

## 4.9 Ethical Consideration

Upon completion of the questionnaire, it has been submitted together with the research proposal to the University of Malaya Research Ethics Committee (UMREC) for ethical review purposes. A consent form has been provided to the respondents of this study. Besides that, in order to ensure the confidentiality of the respondents' feedback, their personal details, such as name, identification card number, and telephone number, were not collected and included in the questionnaire. The proof of ethical confirmation is attached in Appendix C.

## 4.10 Limitation of Study

A few limitations arose while conducting the study, as highlighted in this section. In order to overcome the limitations, the following measurements were taken into consideration:

1. There was limited information and data related to E-waste in Malaysia, such as the generation of E-waste. Therefore, the information needed was collected from previous studies of similar niches.
2. The field survey and the observation at the E-waste disposal centres under the government and private companies, as well as the NGOs' E-waste collection facilities, should be done to ensure that they provide the best service for the public to send off unwanted appliances. However, due to budget constraints, this approach has been replaced with collecting information via the related organisations' official websites.

3. There was limited information in the body of literature focusing on the KAP of E-waste. Therefore, any related literature, ranging from local to foreign, that discussed related topics has been included in the study.
4. Another limitation has been related to the incomplete questionnaire survey by the respondents. During the data collection, there were several situations that caused the respondents to be unable to complete the questionnaire due to time constraints. This happened when the data collection was collected at the train and bus station. The respondents had to rush to get on public transport, leaving the questionnaire incomplete. Besides that, several respondents did not take the questionnaire seriously when they skipped certain questions, such as age. This has led to an increase in budget and also wastage of paper.

## 4.11 Conclusion

In summary, this chapter has discussed the details of how this study was conducted. The key concepts of this study have been elaborated comprehensively in the conceptual framework section. The study areas highlighting Kuala Lumpur, Selangor, Port Dickson, and Negeri Sembilan have been discussed thoroughly based on their geographical backgrounds, economic activities, and waste management. The information regarding the participants, instruments, pilot study, data collection approach, research design and data analysis, ethical consideration, and the limitations of the study have been well-justified in each section. The following chapter will present the analysis that provides answers to the research objectives and research questions.

# CHAPTER 5: RESULTS

## 5.1 Introduction

This study focuses on investigating the Knowledge, Attitude, and Practices (KAP) regarding E-waste recycling among the public in Port Dickson, Selangor, and Kuala Lumpur. This study is conducted not only to understand the KAP of E-waste recycling but also to strategize effective action to tackle the E-waste issue. In order to achieve the output of the study, five research objectives with a total of five research questions were addressed. The questionnaires were divided into six main sections: demographic variables, knowledge about E-waste recycling, attitude towards E-waste recycling, practices of E-waste recycling, sources of information on E-waste recycling, and one section related to the respondents' satisfaction towards E-waste management in their residential areas. There were nine questions related to demographic variables and 14 questions on knowledge about E-waste recycling, divided into five sub-groups. Meanwhile, there were seven questions on attitudes towards E-waste recycling, ten questions related to practices on E-waste recycling, with two sub-groups, and ten questions regarding sources of information on E-waste recycling. It also includes two questions related to the level of satisfaction with current provisions for E-waste. The demographic background of the respondents is presented in Table 5.1, followed by the results of the five research objectives. The following chapter will discuss the findings of the study.

## 5.2 Demographic Background of The Respondents

The first section of the questionnaire highlights the demographic background of respondents in selected residential locations, namely Port Dickson, Selangor, and Kuala

Lumpur. Among the 3015 respondents, 42.0% (1,266) were from Port Dickson, 31.0% (936) from Kuala Lumpur, and the remaining 27% (813) were from Selangor. There are nine questions related to the demographic background, including the residential locations. Of those respondents, 44.1% were male and 55.9% were female.

In terms of age, it was divided into five groups, with most respondents aged 20 to 29 years old (42.6%). The next question on demographic background is regarding the educational level of respondents, who were divided into four groups: no formal education, primary school, secondary school, and higher education, which reported the highest percentage of respondents (52.5%). In the demographic background, questions also include a question on the marital status of the respondents, with three different choices of answers. It is identified that fifty percent of the respondents were married, and this resulted in the majority group of respondents.

Regarding household numbers, the largest group, accounting for 55.5% of respondents, had between four and six people in their households. There were six choices of answers given to the question on occupation among respondents, with the highest percentage of respondents working in the private sector (38.4%). Next, in the income section, most respondents (30.3%) chose not to disclose their income for privacy and security purposes. For the type of house, the majority of the respondents lived in terrace houses (51.6%). Table 5.1 shows the demographic background of the respondents.

**Table 5.1: Demographic background of the respondents (N=3015)**

| Demographic background | | Frequency | Percentage (%) |
|---|---|---|---|
| Gender | Male | 1329 | 44.1 |
| | Female | 1686 | 55.9 |
| Age (years old) | 18 - 19 | 270 | 9.0 |
| | 20 - 29 | 1284 | 42.6 |
| | 30 - 39 | 608 | 20.2 |
| | 40 - 49 | 462 | 15.3 |
| | 50 dan above | 391 | 13.0 |
| Educational background | Higher Education | 1583 | 52.5 |
| | Secondary School | 1217 | 40.4 |
| | Primary School | 127 | 4.2 |
| | No Formal Education | 88 | 2.9 |
| Marital status | Single | 1428 | 47.4 |
| | Married | 1507 | 50.0 |
| | Widowed/Divorced/Separated | 80 | 2.7 |
| Household numbers | 1 person | 208 | 6.9 |
| | 2 persons | 235 | 7.8 |
| | 3 persons | 224 | 7.4 |
| | 4 - 6 persons | 1673 | 55.5 |
| | 7 persons and above | 675 | 22.4 |
| Occupation | Government Sector | 305 | 10.1 |
| | Private Sector | 1159 | 38.4 |
| | Self Employed | 427 | 14.2 |
| | Housewife | 379 | 12.6 |
| | Student | 647 | 21.5 |
| | Pensioner | 98 | 3.3 |
| Income (RM) | 1500.00 and below | 642 | 21.3 |
| | 1501.00 - 3000.00 | 800 | 26.5 |
| | 3001.00 - 4500.00 | 390 | 12.9 |
| | 4501.00 and above | 268 | 8.9 |
| | Not stated | 915 | 30.3 |
| Types of houses | Apartment/ Flat | 840 | 27.5 |
| | Twins/Bungalow | 164 | 5.4 |

| Demographic background | | Frequency | Percentage (%) |
|---|---|---|---|
| Types of houses | Terrace | 1555 | 51.6 |
| | Condominium/ Service apartment | 135 | 4.5 |
| | Townhouse | 56 | 1.9 |
| | Traditional house | 265 | 8.8 |
| Residential location | Selangor | 813 | 27.0 |
| | Kuala Lumpur | 936 | 31.0 |
| | Port Dickson | 1266 | 42.0 |

## 5.3 The Current Status of Knowledge, Attitude and Practices on E-waste Recycling among Respondents

This section is divided into three main sub-sections: KAP on E-waste recycling among respondents. Those questions are labelled as K for knowledge, A for attitude, and P for practices. For every sub-section, the output of each KAP question in the questionnaire survey is illustrated in a bar graph. This is to highlight the current status of KAP on E-waste recycling among 3015 respondents in general.

### *5.3.1 Knowledge on E-waste Recycling among Respondents*

In order to determine the respondents' knowledge about E-waste recycling, questions on the definition, effects, advantages, rules, and activity of E-waste were developed. A total of 14 items for the knowledge section with the choices of 'Yes' and 'No.' All items are tabulated by group in Table 5.2.

**Table 5.2: List of Knowledge questions based on group**

| Questions group | Knowledge questions | |
|---|---|---|
| *1. Definition and background of E-waste* | **(K1)** | I know E-waste can be defined as electrical and electronic equipment (EEE) that are unwanted and would like to be disposed |
| | **(K2)** | I know Electrical and electronic equipment (EEE) contain toxic and hazardous materials |
| | **(K3)** | I know E-waste is rapidly increasing in Malaysia |
| *2. Effects of E-waste generation* | **(K4)** | I know E-waste has harmful effects to the environment |
| | **(K5)** | I know E-waste has harmful effects to the human health |
| *3. Advantages of E-waste recycling* | **(K6)** | I know E-waste recycling helps to protect the environment and public health |
| | **(K7)** | I know E-waste recycling helps to preserve the raw materials |
| *4. Rules, law and regulations related to E-waste management* | **(K8)** | I know E-waste is stated in Environmental Quality (Scheduled Wastes) Regulations 2005 First Schedule (Regulations 2) under code SW 110 by the Department of Environment (DOE) |
| | **(K9)** | I know E-waste cannot be disposed together with domestic waste |
| | **(K10)** | I know E-waste can be recycled and recovered only at the prescribed premises |
| *5. Activity on disposal of E-waste* | **(K11)** | I know the nearest authorized E-waste collection centre |
| | **(K12)** | I know there is a telecommunication network operating company that provide a place to dispose of 'E-waste' |
| | **(K13)** | I know there are phone and computer manufacturer companies that provide trade-in the old goods while buying new goods |
| | **(K14)** | I know there is a distributor or seller of electrical and electronic products that provide reward when I dispose the 'E-waste' through his company |

*5.3.1.1 Definition and Background of E-waste*

For the first part, regarding respondents' knowledge of E-waste recycling, there were three questions related to the definition and background of E-waste. Firstly, in question K1, the majority of the respondents (82.4%) agreed that E-waste is defined as electrical and electronic equipment (EEE) that is unwanted and needs to be disposed of. However, 17.6% did not agree with this definition of E-waste. It is important to acknowledge the

definition of E-waste as the first step in getting more knowledge related to E-waste. In question K2, 84.7% of the total respondents agreed that they knew that electrical and electronic appliances contain toxic and hazardous materials, while the remaining 15.3% did not know about this.

For question K3, this study sought to determine respondents' knowledge regarding E-waste generation these days. Almost three-quarters of respondents (73.6%) knew that E-waste generation is rapidly increasing in Malaysia, indicating that most respondents have good knowledge of this issue. However, the remaining 26.4% reported that they had no knowledge about the generation of E-waste in Malaysia. Figure 5.1 shows the percentage of respondents' answers to knowledge questions related to the definition and background of E-waste.

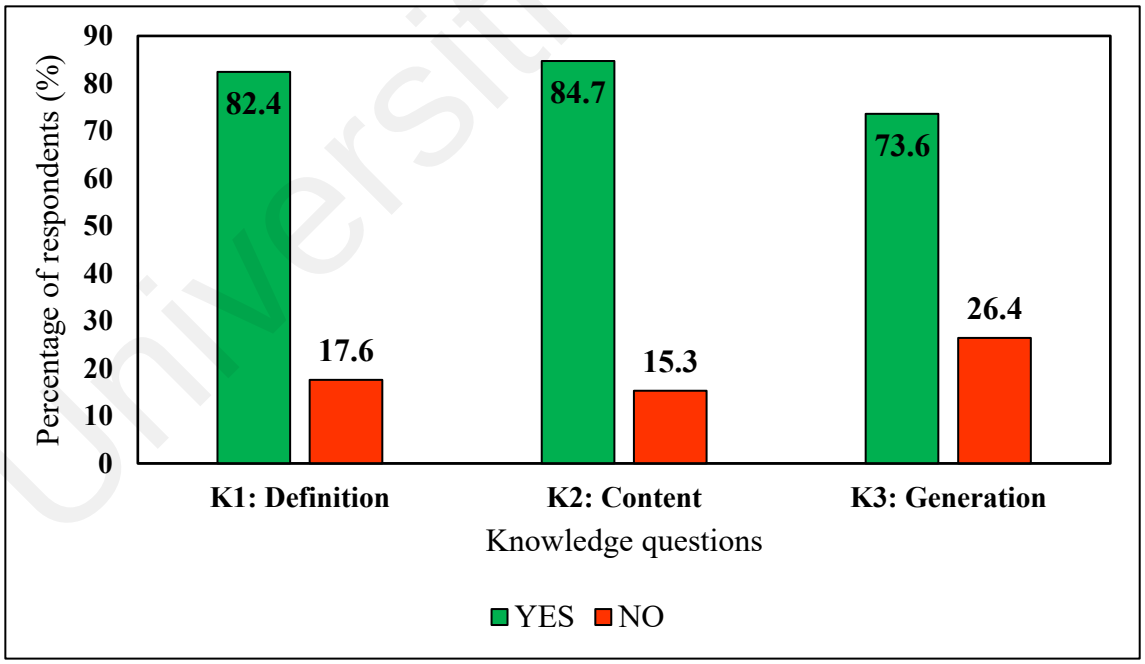


**Figure 5.1: Knowledge on the definition and background of E-waste**

Based on the output, respondents have a good knowledge of the definition of E-waste, as well as an understanding of the content in electrical appliances. Besides, most respondents

knew that E-waste generation is rapidly increasing in Malaysia. In general, more than 70% of the total respondents have a good knowledge of the definition and background of E-waste. According to the results of the analysis, a good level of understanding of the definition and background of E-waste among the respondents will eventually make it simpler for the stakeholders to resolve the related issue brought on by E-waste in Malaysia.

*5.3.1.2 Effects of E-waste to Environment and Human Health*

The next questions in this knowledge section are related to the effects of E-waste generation. Two questions focused on respondents' knowledge about the effects of E-waste on the environment (K4) and human health (K5). For question K4, 82.4% of the total respondents reported that they knew that E-waste is harmful and able to affect the environment. This indicates that most of the respondents had good knowledge of this issue.

As for question K5, 78.4% of the total respondents knew that E-waste is harmful and able to affect human health. This indicates that the majority of respondents have good knowledge about the effects of E-waste. Figure 5.2 shows the percentage of respondents' knowledge about the environmental and human health effects of E-waste.

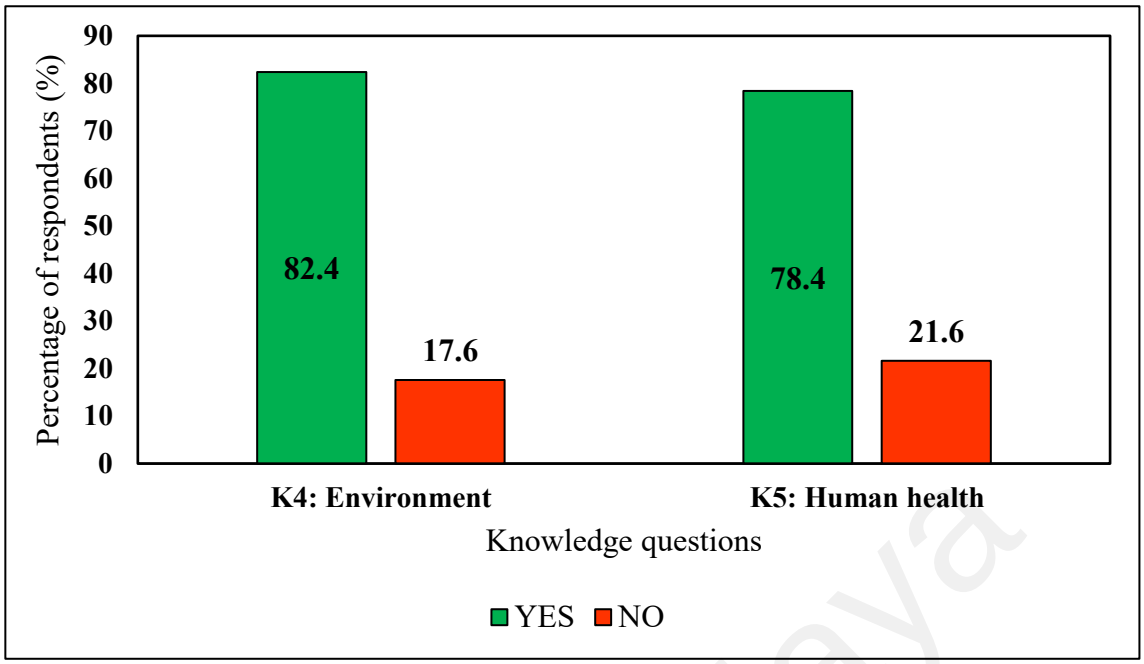


**Figure 5.2: Knowledge on the effects of E-waste**

Based on the knowledge questions in terms of the effects of E-waste on the environment and human health, more than 70% of respondents have good knowledge of this. However, the percentage of respondents who knew the effects of the environment is higher than that of human health.

*5.3.1.3 Advantages of E-waste Recycling*

As shown in Figure 5.3, about 87.0% of the total respondents also knew that E-waste recycling provides an advantage for the environment and human health, as this activity is able to create a better environment and contribute to a good level of human health and also works as an aid to sustainable consumption among the public. However, a minority of the respondents, about 13.0%, did not know about the advantages of E-waste recycling activity.

In the following question, K7 reported that the majority of the respondents (78.8%) knew that E-waste recycling helps preserve raw materials, while the remaining 21.2% did not

know this. While most respondents knew of both of these advantages, there is still room for improvement in providing information to the public about how E-waste recycling can help preserve raw materials. Figure 5.3 represents the percentage of respondents' knowledge regarding the advantages of conducting E-waste recycling.

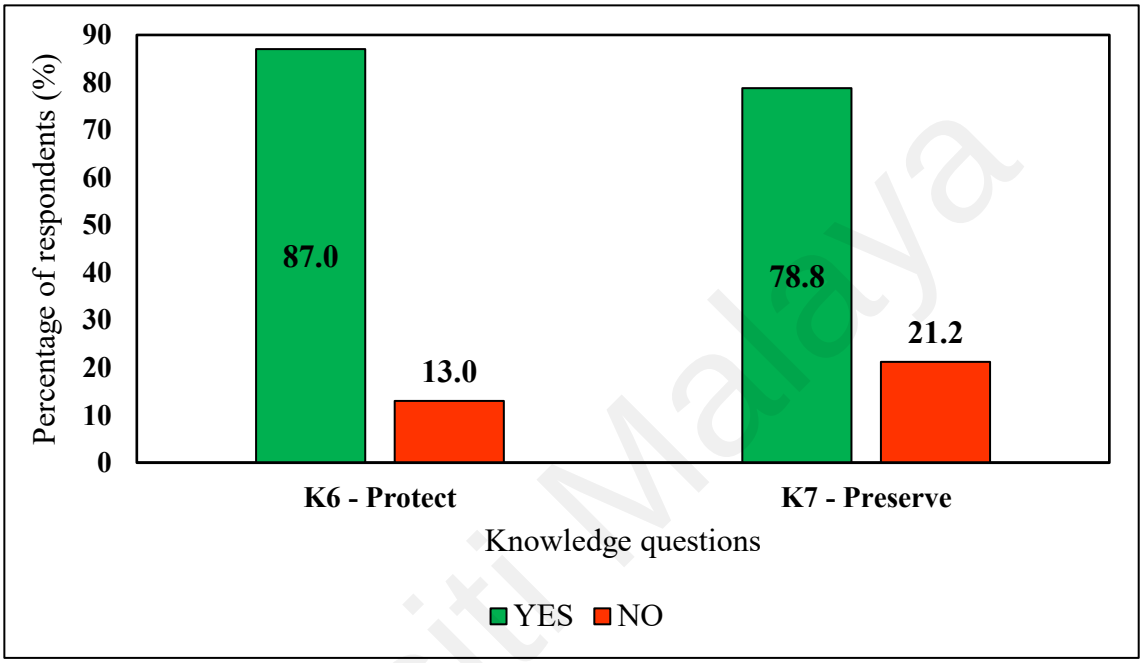


**Figure 5.3: Knowledge on the advantages of E-waste recycling activity**

Based on questions K6 and K7, respondents who represent Malaysia from three different study areas knew that E-waste recycling would protect the environment and human health as well as preserve raw materials. The output also concludes that there is good knowledge among respondents as the percentage is more than 70%.

*5.3.1.4 Rules, Law and Regulations Related to E-waste Management*

Good management requires a systematic way to handle unwanted electrical and electronic appliances. Law, rules, regulations, and guidelines are important factors to consider before conducting any activity. Similarly, E-waste is also governed by specific laws, rules, regulations, and guidelines in order to manage its activities. Particularly, questions

K8, K9, and K10 focused on determining the percentage of respondents who knew about E-waste law, rules, regulations, and guidelines and the total percentage that did not have information regarding this matter. Figure 5.4 presents the percentage of respondents that chose 'Yes' and 'No' for questions K8, K9, and K10.

In question K8, respondents were asked if they were aware that E-waste is stated in Environmental Quality (Scheduled Wastes) Regulations 2005 First Schedule (Regulation 2) under code SW 110 by the Department of Environment (DOE). It was found that only 61.4% of the total respondents knew about this, while the remaining 38.6% did not. This shows that the public need to be well-informed regarding environmental law. Improvement is needed, even though the output shows that most respondents knew about these regulations.

For question K9, most of the respondents (80.5%) knew that E-waste could not be disposed of together with domestic waste. On the other hand, 19.5% of the total respondents did not have knowledge of this matter. In this section, the respondents were also asked questions regarding their knowledge about recycling and recovery of E-waste.

The majority of the respondents (82.0%) in question K10 knew that E-waste could be recycled and recovered only at the prescribed premises, whereas the remaining 18.0% did not have knowledge of this.

For the knowledge questions related to the rules, laws, and regulations on E-waste, it can be seen that the majority of the respondents have good knowledge of K9, the segregation of E-waste, and K10 on the designated place to dispose of the E-waste with the reported percentage more than 80%. It shows that the respondents have good knowledge that E-

waste cannot simply be disposed of. Activity on E-waste recycling must begin with segregation at the source, and then it must be disposed of in the designated place. Meanwhile, EQA 1974 is not well recognized by the respondents, and this shows that respondents do not have knowledge of question K8.

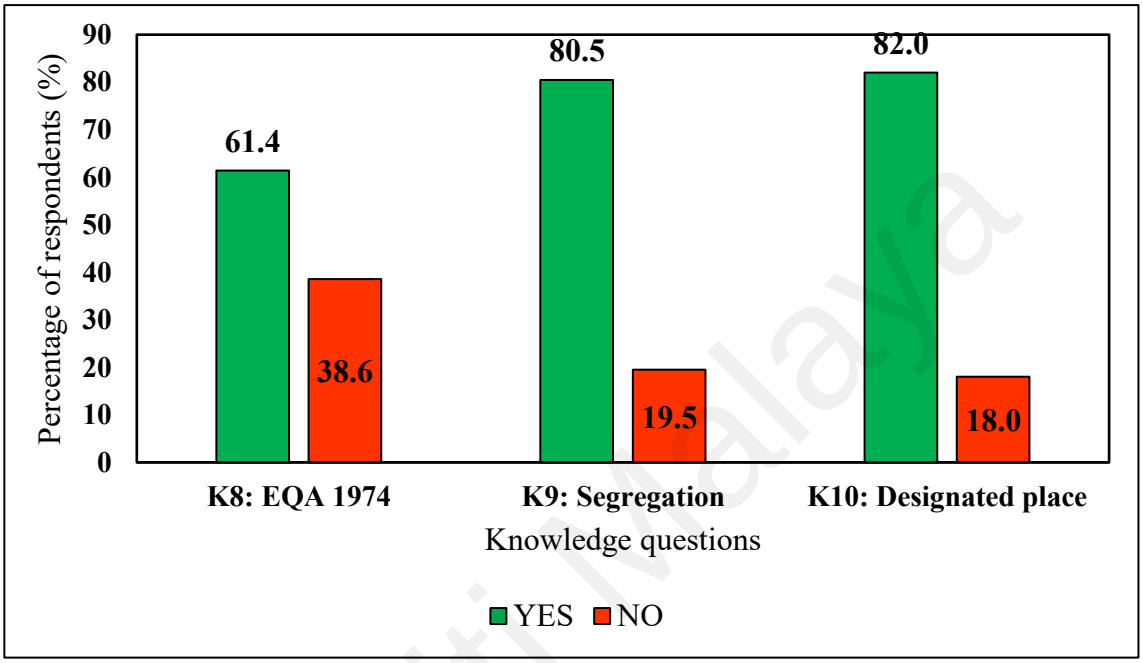


**Figure 5.4: Knowledge on the rules, law and regulations related to E-waste**

*5.3.1.5 Activity on Disposal of E-waste*

Besides the law, rules, regulations, and guidelines, E-waste recycling needs to be supported by elements such as proper facilities, attractive incentives, and appropriate approaches from stakeholders. In this section, questions K11, K12, K13, and K14 sought to determine respondents' knowledge regarding E-waste disposal.

For question K11, the majority of the respondents (67.1%) did not know the location of the nearest authorized E-waste collection centre to their homes. Only 32.9% of the total respondents knew this. This finding is a clear indicator that the public does not have sufficient information regarding authorized collection centres. Improvement is needed, as discussed in the following chapter. This alarming situation needs to be overcome by

highlighting the locations of recycling centres around the neighbourhood. The list of authorized collection centres in Kuala Lumpur, Selangor, and Negeri Sembilan that are listed by the Department of Environment can be referred to in Appendix D.

Similar to K11, question K12 reported that most respondents (55.5%) did not know that there is a telecommunication network operation company that provides a place to dispose of E-waste. The remaining 44.5% of respondents knew about this. Malaysian Communications and Multimedia Commission (MCMC) has developed an initiative to deal with mobile E-waste among consumers. MCMC provides information related to E-waste on its website, such as the background of E-waste, the impact of E-waste, and E-waste management. As well as providing this information and promotional materials, MCMC also provides mobile E-waste collection boxes in collaboration with shops, schools, Telco outlets, and universities.

As mentioned in question K12, there are telecommunications companies that provide mobile E-waste collection in partnership with MCMC. However, this information is not well publicized. In Negeri Sembilan, mobile E-waste can be sent to selected Celcom, Courts, Digi, and U-Mobile stores in Seremban. However, this might be a problem for residents of Negeri Sembilan who live outside of Seremban. Selangor residents can send mobile E-waste to selected Altel, Celcom, Courts, Digi, TM, and U-Mobile stores, as collection services are provided in almost every district in Selangor. Similarly, residents in Wilayah Persekutuan Kuala Lumpur can send mobile E-waste to selected Celcom, Courts, Digi, Maxis, TM, and U-Mobile stores. The details of mobile E-waste collection boxes listed by the MCMC in collaboration with telecommunication network providers can be referred to in Appendix E.

Trade-in is the exchange of used items as part of payment of a new item. It is one approach that will help to increase the lifespan of electrical and electronic appliances. In order to fulfil this approach, an individual must know where to trade in used appliances. Question K13 shows that the majority (66.9%) of the total respondents knew that phone and computer manufacturer companies provide trade-in of old goods when buying new goods.

Rewards or incentives also motivate consumers to recycle their E-waste. Question K14 sought to determine public knowledge of these rewards. Of the total respondents, only 48.0% knew that distributors or sellers of electrical and electronic appliances provide rewards when consumers dispose of their E-waste through the distributor company. The majority (52.0%) did not know about this. Figure 5.5 shows the percentage of respondents who have knowledge about E-waste disposal activities.

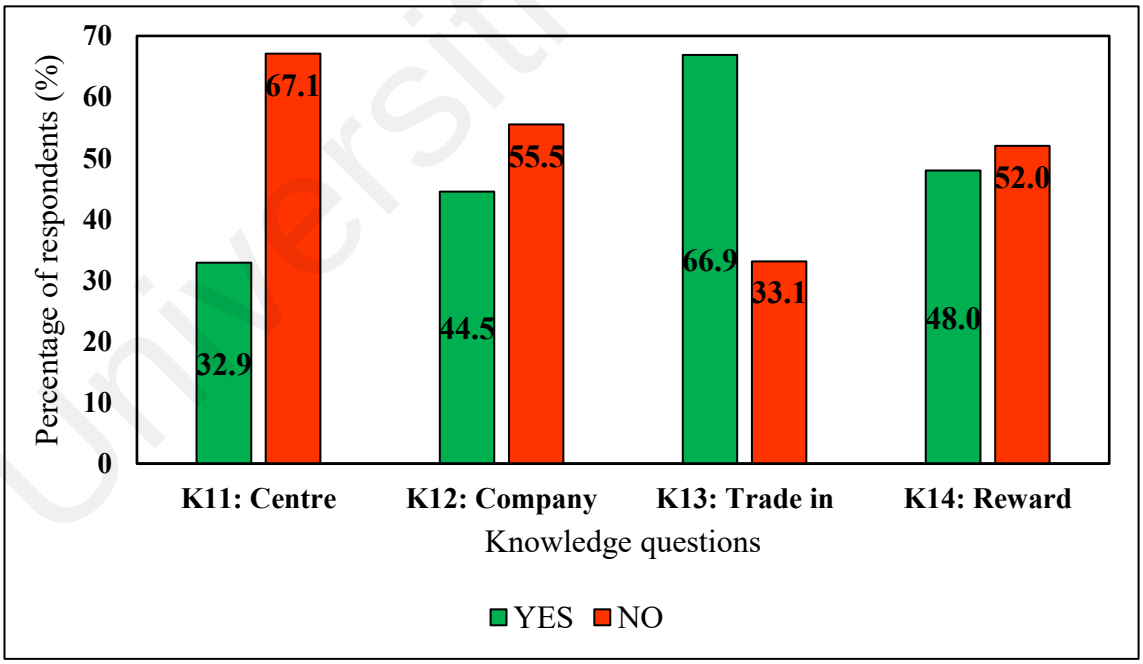


**Figure 5.5: Knowledge on the disposal of E-waste**

Based on their knowledge of E-waste disposal, respondents currently lack knowledge related to the location of the recycling center and the services provided by the

telecommunication company that provides a place to dispose of the E-waste. Respondents were also unaware and knew about the reward provided by the distributor or seller of electrical and electronic appliances when consumers disposed of their E-waste through his company. The only question that represents good knowledge is regarding the trade-in services.

#### *5.3.1.6 Overall Findings on Knowledge of E-waste Recycling*

As a result, less than 70% of the total respondents knew about the EQA 1974 and those questions related to the disposal of E-waste. It shows that the stakeholders, such as policymakers and NGOs, should provide adequate information effectively to the public. This is because information is the key to increasing the knowledge. In addition, even though respondents have good knowledge that E-waste recycling helps protect the environment and human health (K6), only 32.9% of the total respondents knew the nearest authorized E-waste collection centre (K11). Therefore, the public will not be able to conduct E-waste recycling in a proper manner as the public does not know the exact location to dispose of or send off their E-waste. Hence, the government should focus on informing the public about the availability of these centres. Even though more than 70% of respondents are well-informed about E-waste recycling, it is still important for the public to be adequately informed about E-waste legislation and enforcement, as well as where to dispose of their E-waste.

### *5.3.2 Attitude on E-waste Recycling among Respondents*

The seven questions in the attitude section require “Yes” or “No” responses. All questions are tabulated based on the group in Table 5.3.

**Table 5.3: List of Attitude questions**

| Attitude questions | |
|---|---|
| **(A1)** | I do not care if my gadget is up to date |
| **(A2)** | I am ready to participate in E-waste recycling campaign |
| **(A3)** | I am ready to segregate between household waste and E-waste |
| **(A4)** | I am willing to send off my E-waste to the nearest authorized E-waste collection center |
| **(A5)** | I am ready to recycle the E-waste if incentive is provided |
| **(A6)** | I am only willing to dispose of 'E-waste' if there is a home or workplace collection facility |
| **(A7)** | I am ready to reduce the amount of E-waste generated by myself |

*5.3.2.1 Findings of Respondents' Attitude on E-waste Recycling Activity*

For question A1, respondents were able to provide answers to this statement: I do not care if my gadget is up to date. Analysis of the data gathered has shown that only 42.4% of the respondents agreed that they do not intend to change their electrical and electronic appliances. However, most respondents (about 57.6%) tend to upgrade their appliances based on trends.

Campaigns can be used to promote sustainable practices in the community. Particularly in this section, question A2 highlighted respondents' willingness to take part in E-waste recycling campaigns. The majority (82.8%) of the total respondents in this study chose 'Yes' in response to the question that asked whether they were ready to participate in an E-waste recycling campaign. The remaining 17.2% indicated that they were not ready to take part.

For question A3, I am ready to segregate between household waste and E-waste. About 88.5% of the total respondents indicated that they were willing to segregate their waste, while the remaining 11.5% were not. Another step that can be taken among E-waste

consumers is to send off their E-waste to the collection centre. Question A4 highlighted that the majority (about 82.6%) of the total respondents indicated that they were willing to send off their E-waste to the nearest authorized collection centre, reflecting a good attitude among respondents. However, the remaining 17.4% were not ready or willing to conduct this approach.

In this study, for question A5, I am ready to recycle my E-waste if incentives are provided, 78.3% of respondents chose 'Yes,' indicating that they agreed that incentives would motivate them to recycle their E-waste. The remaining 21.7% did not consider incentives as a priority in encouraging them to conduct this activity.

Besides incentives, facilities for E-waste disposal are also considered motivations and catalysts for consumers in conducting E-waste recycling. Of the total respondents in this study, only 15.5% were willing to dispose of E-waste without any home or workplace collection facility, as underlined in question A6. However, the majority (84.5%) were only willing to dispose of their E-waste if the facilities were available.

Question A7, I am ready to reduce the amount of E-waste generated by myself, focuses on the Reduce element. The majority (85.8%) of the total respondents answered 'Yes' to this question, while the remaining 14.2% chose 'No,' indicating that this group of respondents was not ready to conduct this practice. Figure 5.6 shows the percentage of respondents based on questions about their attitudes toward recycling E-waste that were addressed.

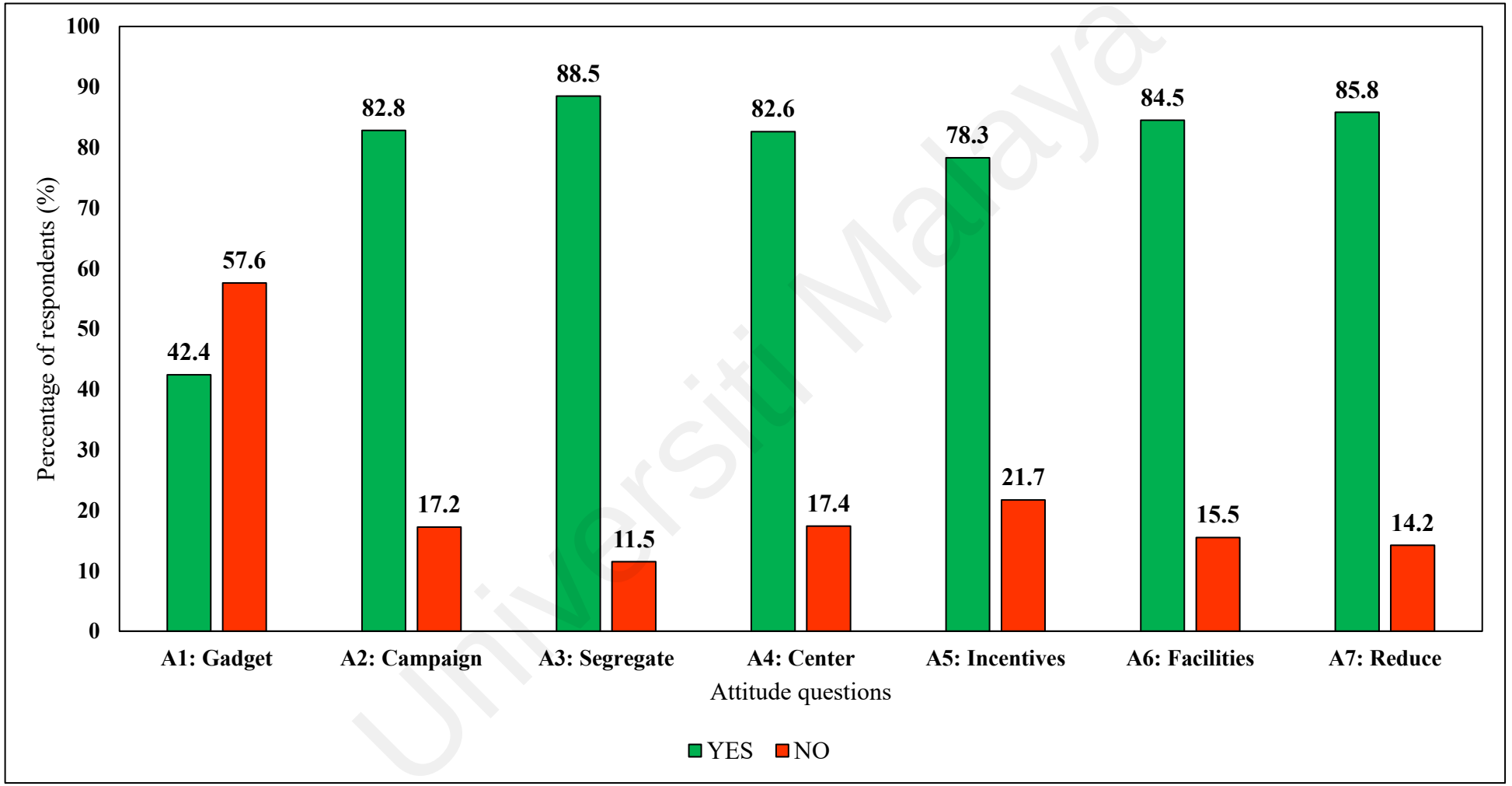


**Figure 5.6: Percentage of respondents agreed for each attitude questions**

*5.3.2.2 Overall Findings of Attitude of E-waste Recycling*

For the questions regarding the attitude toward E-waste recycling, it can be seen that the majority of the respondents have a good attitude. They are ready and willing to segregate the E-waste, reduce their E-waste generation, and participate in E-waste recycling campaigns. Based on the results, it can also be highlighted that respondents as consumers consider both facilities and incentives before conducting the E-waste recycling as the percentage shows more than 70% of the total respondents agreed on both statements. Meanwhile, the lowest percentage in this attitude section shows that the respondents do not care if their gadgets are up to date. This shows that even though most of the respondents reflect a good attitude towards E-waste recycling, electrical and electronic appliances still play an important role to the public, and they still require the appliances to follow the trend. Due to the fact that the respondents appear to have a positive attitude towards E-waste, it is essential for responsible bodies such as the government, private sector, and NGOs to accommodate the public with various campaigns followed by providing the public with incentives in order to increase their participation rate.

### *5.3.3 Practices on E-waste Recycling among Respondents*

The questionnaire contained ten items to determine the respondents' practices on E-waste recycling. Respondents were given the choices of 'Yes' and 'No,' and all items are tabulated based on groups in Table 5.4.

**Table 5.4: List of practices questions based on group**

| Questions group | Practices questions | |
|---|---|---|
| *1. General practices* | **(P1)** | I do not dispose my E-waste together with other types of waste |
| | **(P2)** | I do not store my E-waste at home |
| | **(P3)** | I encourage my family members to practice proper E-waste disposal |

| Questions group | Practices questions | |
|---|---|---|
| *2. Disposal method* | **(P4)** | I sell my E-waste as a used item |
| | **(P5)** | I trade-in with new goods |
| | **(P6)** | I send off my E-waste to the nearest authorized E-waste collection centre |
| | **(P7)** | I send off my E-waste to the scrap collection center |
| | **(P8)** | I donate my E-waste that is still in a good condition |
| | **(P9)** | I am practicing to repair my broken electrical and electronic appliances |
| | **(P10)** | I do not simply throw out my broken electrical and electronic appliances |

*5.3.3.1 General Practices Regarding the E-waste*

This section specifically reports and discusses respondents' practices regarding E-waste recycling. The ten questions in this section are divided into two groups: general practices and disposal methods. Figure 5.7 reports the percentage of respondents based on their general practices, which are based on three questions, P1 to P3 (refer to Table 5.4), and Figure 5.8 reports the percentages of respondents based on their chosen disposal methods, which are based on seven questions in this section P4 to P10 (refer Table 5.4).

For question P1, I do not dispose of my E-waste together with other types of waste, 59.5% of the total respondents agreed that they did not dispose of their E-waste together with other types of waste but rather segregated it. The remaining 40.5% of the respondents tended to dispose of their E-waste with other types of waste. For question P2, I do not store my E-waste at home; only 42.7% of the total respondents reported that they do not store their E-waste at home, while the majority of the respondents (57.3%) were inclined to do so.

In order to determine whether respondents encouraged their family members, question P3 asked, I encouraged my family members to practice proper E-waste disposal. Most of the

respondents in this study (78.0%) encouraged their family members to practice proper E-waste disposal. However, the remaining 22.0% did not encourage their family members in this way.

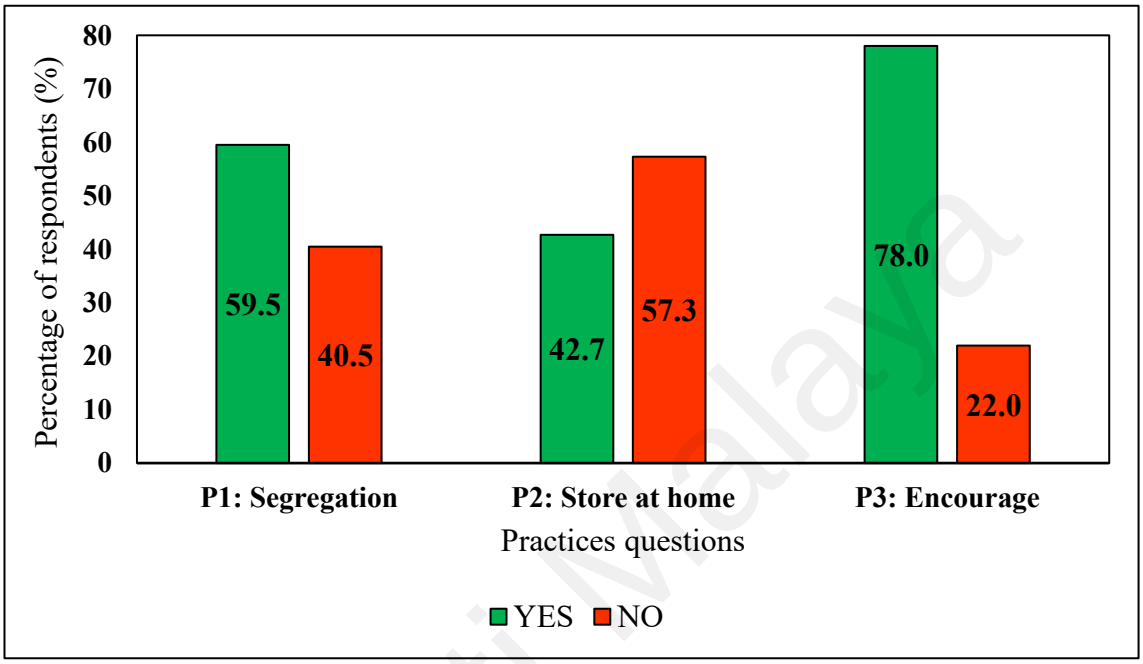


**Figure 5.7: Percentage of respondents on the general practices regarding the E-waste**

Based on the general practices towards E-waste, segregation of E-waste at source is still in moderate percentage. Meanwhile, the percentage of respondents who choose to store their E-waste at home is still bigger than the percentage of respondents who choose otherwise. It can be concluded that segregation and stockpiling of E-waste at home needs room for improvement. The public must have adequate knowledge and, thus, information that E-waste must be segregated before disposal. Then, stockpiling E-waste at home is not an appropriate method for managing the E-waste. More than 70% of respondents agreed that they encouraged their family members to practice proper E-waste disposal. This indicates good movement and practices to ensure each household properly manages its E-waste.

*5.3.3.2 Disposal Practices of E-waste*

The second section of the Practices on E-waste Recycling part of the questionnaire contained seven questions related to methods of disposal of E-waste. Figure 5.8 reports the percentages of respondents who practiced each of these disposal practices. Ranked from the most to the least frequently conducted, these practices are as follows: sell or repair (72.6%), trade-in (69.6%), donate (61.6%), send off to formal collection centre (60.7%), send off to a scrap collection centre (58.9%) and simply throw away (45.7%).

For question P4, I sell my E-waste as used items, 72.6% of the total respondents reported positively, whereas 27.4% did not conduct this option. In question P5, I trade in for new goods, 69.6% of respondents agreed that they trade in their unwanted electrical and electronic appliances, while the remaining 30.4% did not conduct this practice.

Sending E-waste to designated facilities is one of the sustainable practices that consumers can use. In this study, there were two questions related to this: question P6, I send off my E-waste to the nearest authorized E-waste collection centre, and question P7, I send off my E-waste to the scrap collection centre. For question P6, 60.7% of the total respondents agreed that they send off their E-waste to the nearest authorized collection centre. In comparison, the remaining 39.3% indicated that they did not practice this E-waste disposal method. For question P7, 58.9% of respondents chose to send their E-waste to the scrap collection centre, while the remaining 41.1% did not use this disposal method.

In response to question P8, I donated my E-waste which is still in good condition, highlighted that 61.6% of respondents used this approach, while the remaining 38.4% did not choose donation to dispose of their E-waste. Then, as for the responses to question P9, I repair my broken electrical and electronic products, underlined that the majority of

respondents (72.6%) chose to repair their used electrical and electronic appliances. In comparison, the remaining 27.4% did not practice this disposal method.

E-waste should be managed properly; hence, sustainable practices start from the consumers' decisions as to how they are going to dispose of such waste. Question P10, I do not simply throw out my broken electrical and electronic items, revealed that only 45.7% do not simply throw away their used appliances and hence might choose other disposal options. The majority (54.3%) choose to simply throw out their E-waste. Previous studies also underlined that this practice had been conducted from time to time in different study areas, even though this disposal method is not a sustainable method for managing E-waste.

Upon completion of the analysis of this particular section on the disposal practices of E-waste among respondents, it can be seen that the majority of respondents choose either to sell or to repair their E-waste. This indicates a percentage of more than 70% of the total of 3015 respondents. These two options have economic values so that they can be an opportunity for the public as a consumer. As for the other E-waste disposal methods, the percentage of respondents is moderate. It is also reported that less than 50% of respondents do not simply dispose of their unwanted electrical and electronic appliances.

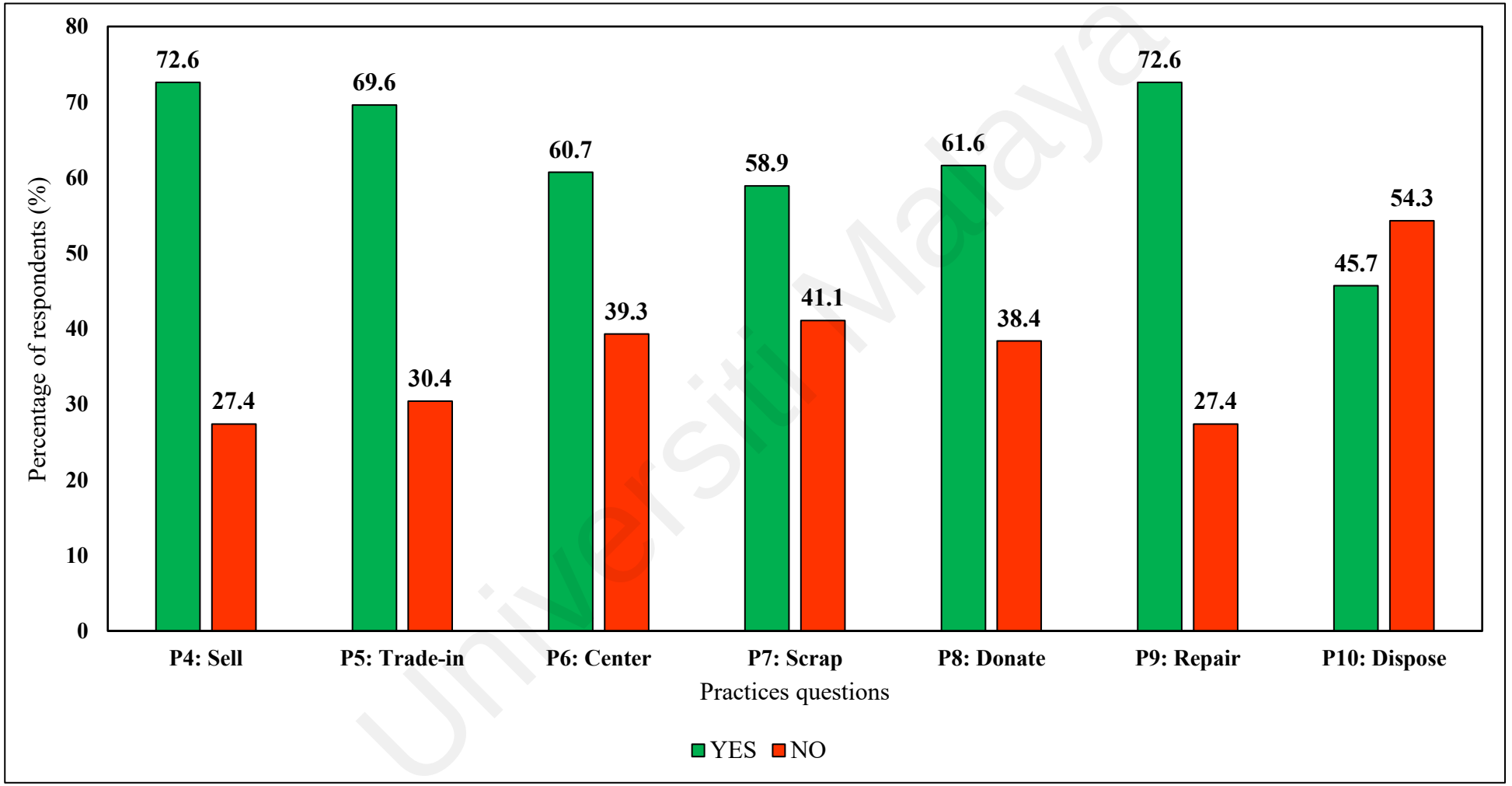


**Figure 5.8: Percentage of respondents for the disposal practices of E-waste**

*5.3.3.3 Overall Findings of Practices of E-waste Recycling*

To summarize, only question P3 on the encouragement towards family members, as well as question P4 – selling option and question P9 – repairing option as the disposal of E-waste illustrates a high percentage highlighted more than 70%. This indicates that only that group of respondents are currently practicing them. Meanwhile, the rest of the questions regarding the E-waste recycling practices show moderate and low percentages among respondents.

The percentage of respondents who do not simply dispose of their E-waste, as well as the respondents who choose not to store their unwanted appliances at home, indicate a low percentage. However, the disposal of E-waste through trade-in, sending it off to a collection centre (either authorized or scrap), and donating illustrates 50% and above. Respondents practice different disposal approaches moderately. Hence, it is based on the type of E-waste that is decided to be disposed of by its owner.

The majority of respondents prefer to extend the life of electrical and electronic appliances before discarding them. This is an example of good practice among respondents. The three most popular disposal practices are selling, repairing, and trading, all of which have an economic value that can attract users. This is in contrast to donating, sending to an authorized collection centre, or scrapping, all of which provide no economic benefit. The lowest percentage of respondents chose not to simply dispose of their E-waste. However, it was also identified that 718 of them chose to stockpile their E-waste at home, which will not maximize the potential of those unwanted appliances.

## 5.4 Preferred Sources of Information on E-waste among Respondents

In this study, the respondents were asked to choose which sources of information related to E-waste they had used. This section included a question on Your sources of E-waste information and listed nine potential sources, namely television, radio, the Internet, posters, newspapers, family, friends, talks, educational institutions, and 'others,' for which respondents could write down their own sources of information related to E-waste. Respondents were given the option to choose more than one answer, giving a Yes or No response.

Figure 5.9 shows that the Internet was the most frequently used source of information regarding E-waste (64.3%). This percentage was followed by television (59.7%), friends (46.4%), radio (43.3%), educational institutions (42.7%), newspapers (38.8%), family members (38.5%), posters (31.2%), talks (27.6%), and other sources (16.0%).

The highest percentage highlighted in Figure 5.9 is the Internet, as 64.3% of respondents indicated that they had used the Internet as a source of information regarding E-waste. In this era of globalization and modernization, the Internet is highly likely to be the best option for delivering messages or information to the public (Kalana, 2010). Information related to E-waste in Malaysia can be found on the Internet via the Official Portal of Scheduled Waste Management, which is managed by the Department of Environment (DOE). Information specifically related to mobile E-waste is available on the Malaysian Communications and Multimedia Commission (MCMC) website. Apart from that, online reading materials such as journals are also available for the public to read to find information related to E-waste. Social media platforms such as Facebook provide information regarding E-waste simply by typing 'E-waste' into the search section, which will locate all postings and pages related to E-waste, such as ERTH: E-waste Recycling.

This percentage is followed by the television, which was used by 59.7% of the respondents as a source of information about E-waste. Information such as the effects of E-waste, ways to dispose of E-waste, E-waste campaigns, and all related information can be conveyed via prime-time news bulletins such as 'Buletin Utama TV3', as well as through informational programmes such as 'Aduan Rakyat' and 'Selamat Pagi Malaysia.' This finding demonstrates that television is still a relevant medium to convey information to the public, even though the Internet is much more popular nowadays.

Next, friends were used as sources of information, which indicates that 46.4% of respondents agreed that they used friends as a source of information regarding e-waste. This percentage was followed by radio, which was chosen as a source of information by 43.3% of the respondents. Next, the educational institutions were chosen by 42.7% of the respondents as a source of information related to E-waste.

Newspapers were the next in line, with 38.8% of the total respondents indicating that they used them as sources of information on E-waste. This study considers both electronic and printed newspapers. In Malaysia, news related to E-waste can be found on Berita Harian, Harian Metro, New Straits Times, Sinar, The Malay Mail, The Sun, The Star, and Utusan, in both printed and online versions. Examples of newspaper headlines found through the Malaysian Communications and Multimedia Commission (MCMC) and the Department of Environment (DOE) media archived in both Bahasa and English language between the years 2015 and 2022 are listed in Appendix F. Based on this, it can be seen that the information related to E-waste has been highlighted and promoted in the local newspaper. Hence, the public will be able to get some ideas regarding the E-wase through reading. The topic includes the thread of E-waste generation as well as the impact of the E-waste recycling approach.

Next, family was selected as a source of information related to E-waste by 38.5% of the respondents. Then, 31.2% of the respondents chose posters as a source of information related to E-waste. Posters, flyers, or brochures are considered effective ways to provide information due to the short, precise, and colourful presentation that will attract attention from the public. The next source of information on E-waste was talks, which were used by 27.6% of respondents. Talks or public lectures are considered community services and are part of the effort to provide information to the public.

The least chosen by the respondents was the 'others' option: only 16.0% of the total respondents chose this option. As "others" was also chosen as sources of information by respondents, the given answer is social media, such as Instagram and Facebook. In addition, the pamphlet and questionnaire survey were also mentioned as sources of information. Furthermore, some respondents attempted to learn about E-waste through journal reading and observation.

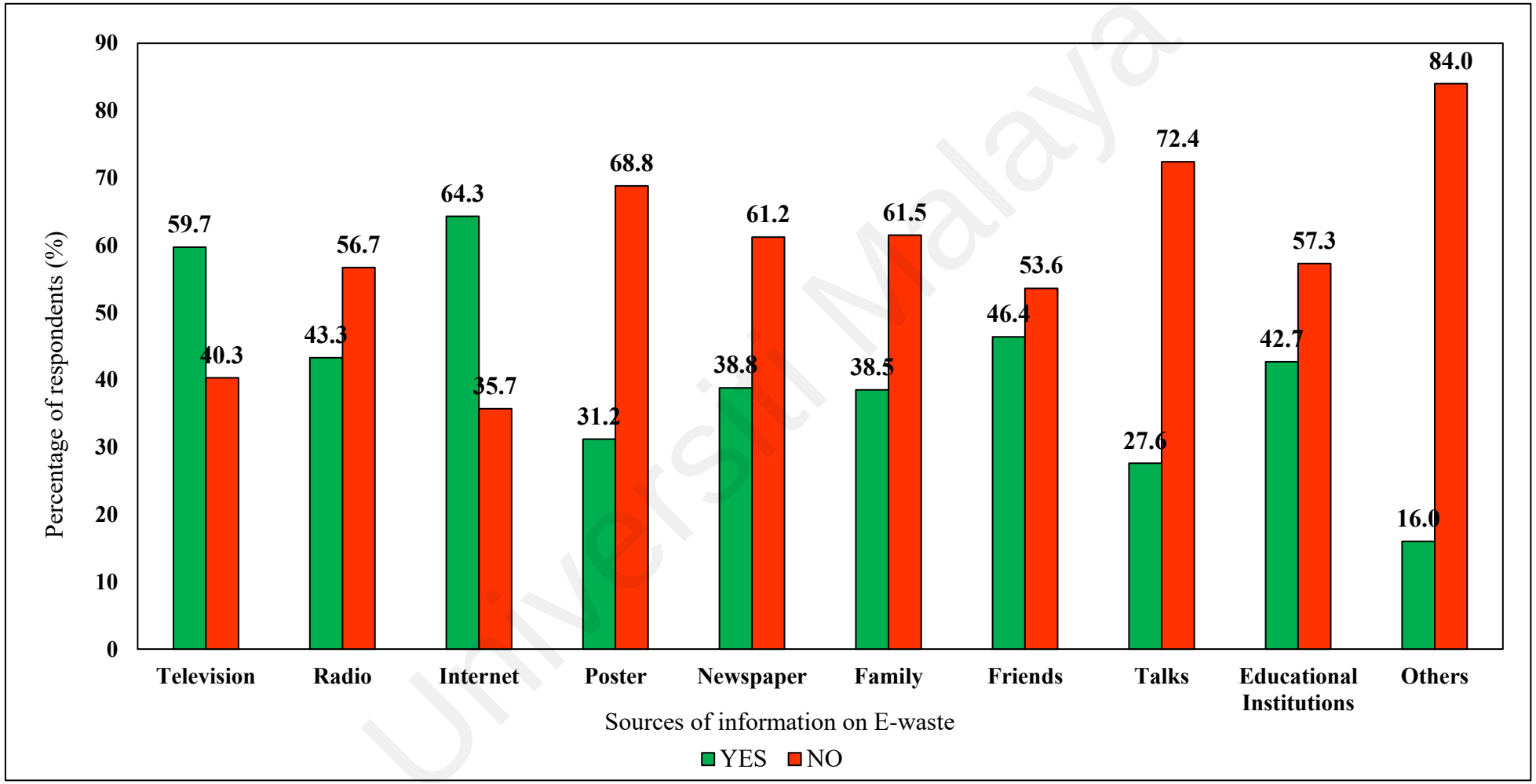


**Figure 5.9: Percentage of respondents' preferred sources of information on E-waste**

## 5.5 The Relationship between The Demographic Variables and Knowledge, Attitude and Practices among Respondents

Each question in the KAP section was examined for its relationship to each demographic variable. If the p-value is less than 0.05, it indicates an association between the demographic variable and the KAP question. Otherwise, it indicates no association.

### *5.5.1 Relationship between Demographic Variables and The Definition and General Background on E-waste*

For the knowledge definition and general background on E-waste, all demographic background variables reported p-values of less than 0.05 except for gender, for which there was no significant relationship with questions K1 and K3. This includes the marital status and household size, which did not show a significant relationship with question K2. Table 5.5 shows the chi-square analysis between demographic variables and knowledge questions on the definition as well as the background on E-waste.

**Table 5.5: Chi-square analysis between demographic variables and knowledge questions**

| Demographic variables | | Knowledge questions | | |
|---|---|---|---|---|
| | | **K1** | **K2** | **K3** |
| Gender | Chi-square | 1.582 | 5.878 | 3.390 |
| | df | 1 | 1 | 1 |
| | P-value | 0.208 | 0.015 | 0.066 |
| Age | Chi-square | 119.851 | 61.451 | 55.933 |
| | df | 4 | 4 | 4 |
| | P-value | <0.001 | <0.001 | <0.001 |
| Educational background | Chi-square | 271.444 | 230.659 | 128.496 |
| | df | 3 | 3 | 3 |
| | P-value | <0.001 | <0.001 | <0.001 |
| Marital status | Chi-square | 59.685 | 2.650 | 22.121 |
| | df | 2 | 2 | 2 |

| Demographic variables | | Knowledge questions | | |
|---|---|---|---|---|
| | | **K1** | **K2** | **K3** |
| Marital status | P-value | <0.001 | 0.266 | <0.001 |
| Number of households | Chi-square | 31.858 | 7.648 | 28.686 |
| | df | 4 | 4 | 4 |
| | P-value | <0.001 | 0.105 | <0.001 |
| Occupation | Chi-square | 155.742 | 83.744 | 83.981 |
| | df | 5 | 5 | 5 |
| | P-value | <0.001 | <0.001 | <0.001 |
| Income | Chi-square | 91.823 | 33.833 | 75.162 |
| | df | 4 | 4 | 4 |
| | P-value | <0.001 | <0.001 | <0.001 |
| Type of houses | Chi-square | 79.402 | 37.998 | 82.388 |
| | df | 5 | 5 | 5 |
| | P-value | <0.001 | <0.001 | <0.001 |
| Residential location | Chi-square | 292.263 | 76.158 | 86.117 |
| | df | 2 | 2 | 2 |
| | P-value | <0.001 | <0.001 | <0.001 |

### *5.5.2 Relationship between Demographic Variables and The Effects of E-waste*

Regarding knowledge of the effects of E-waste, both questions K4 and K5 revealed a significant relationship with p-values of less than 0.05 for all demographic variables except for gender and size of household. This indicates that respondents' understanding of the effects of E-waste could not be differentiated based on gender or number of households. Table 5.6 shows the chi-square analysis between demographic variables and the knowledge of respondents regarding the effects of E-waste.

**Table 5.6: Chi-square analysis between demographic variables and knowledge questions**

| Demographic variables | | Knowledge questions | |
|---|---|---|---|
| | | **K4** | **K5** |
| Gender | Chi-square | 0.058 | 1.677 |
| | df | 1 | 1 |
| | P-value | 0.810 | 1.95 |
| Age | Chi-square | 33.748 | 15.366 |
| | df | 4 | 4 |
| | P-value | <0.001 | 0.004 |
| Educational background | Chi-square | 99.337 | 72.597 |
| | df | 3 | 3 |
| | P-value | <0.001 | <0.001 |
| Marital status | Chi-square | 12.134 | 6.494 |
| | df | 2 | 2 |
| | P-value | 0.002 | 0.039 |
| Number of households | Chi-square | 6.622 | 7.246 |
| | df | 4 | 4 |
| | P-value | 0.157 | 0.123 |
| Occupation | Chi-square | 56.581 | 62.076 |
| | df | 5 | 5 |
| | P-value | <0.001 | <0.001 |
| Income | Chi-square | 96.414 | 78.984 |
| | df | 4 | 4 |
| | P-value | <0.001 | <0.001 |
| Type of houses | Chi-square | 54.121 | 42.020 |
| | df | 5 | 5 |
| | P-value | <0.001 | <0.001 |
| Residential location | Chi-square | 76.311 | 26.630 |
| | df | 2 | 2 |
| | P-value | <0.001 | <0.001 |

### *5.5.3 Relationship between Demographic Variables with The Advantages on E-waste Recycling Activity*

Based on the chi-square analysis, responses to question K6 reported a significant relationship with p-values of less than 0.05 for all demographic variables except for gender and household size. This indicates that respondents' understanding regarding the advantages of E-waste recycling towards protecting the environment and human health could not be differentiated based on gender or number of households. For question K7, the relationship with all demographic variables was significant. Table 5.7 describes the chi-square analysis between demographic variables and the knowledge questions.

**Table 5.7: Chi-square analysis between demographic variables and knowledge questions**

| **Demographic variables** | | **Knowledge questions** | |
|---|---|---|---|
| | | **K6** | **K7** |
| Gender | Chi-square | 0.325 | 16.075 |
| | df | 1 | 1 |
| | P-value | 0.569 | <0.001 |
| Age | Chi-square | 70.756 | 89.795 |
| | df | 4 | 4 |
| | P-value | <0.001 | <0.001 |
| Educational background | Chi-square | 219.381 | 74.269 |
| | df | 3 | 3 |
| | P-value | <0.001 | <0.001 |
| Marital status | Chi-square | 6.852 | 10.583 |
| | df | 2 | 2 |
| | P-value | 0.033 | 0.005 |
| Number of households | Chi-square | 5.055 | 11.893 |
| | df | 4 | 4 |
| | P-value | 0.282 | 0.018 |
| Occupation | Chi-square | 83.860 | 110.312 |
| | df | 5 | 5 |
| | P-value | <0.001 | <0.001 |

| Demographic variables | | Knowledge questions | |
|---|---|---|---|
| | | K6 | K7 |
| Income | Chi-square | 61.843 | 115.457 |
| | df | 4 | 4 |
| | P-value | <0.001 | <0.001 |
| Type of houses | Chi-square | 66.276 | 42.447 |
| | df | 5 | 5 |
| | P-value | <0.001 | <0.001 |
| Residential location | Chi-square | 82.419 | 67.886 |
| | df | 2 | 2 |
| | P-value | <0.001 | <0.001 |

*5.5.4 Relationship between Demographic Variables with the Rules, Law and Regulation Related to E-waste Management*

Based on the chi-square analysis, Table 5.8 shows the relationship between the knowledge questions regarding rules, laws, and regulations related to E-waste management and demographic variables. Gender had p-values greater than 0.05 for questions K8, K9, and K10. In contrast, marital status had p-values greater than 0.05 for questions K8 and K9, while the number of households had a p-value greater than 0.05 for question K10. The remaining demographic variables reported p-values of less than 0.05, indicating a significant relationship with responses to all three questions.

**Table 5.8: Chi-square analysis between demographic variables and knowledge questions**

| Demographic variables | | Knowledge questions | | |
|---|---|---|---|---|
| | | K8 | K9 | K10 |
| Gender | Chi-square | 1.822 | 1.288 | 0.040 |
| | df | 1 | 1 | 1 |
| | P-value | 0.177 | 0.256 | 0.842 |
| Age | Chi-square | 33.410 | 41.034 | 61.114 |
| | df | 4 | 4 | 4 |

| Demographic variables | | Knowledge questions | | |
|---|---|---|---|---|
| | | **K8** | **K9** | **K10** |
| Age | P-value | <0.001 | <0.001 | <0.001 |
| Educational background | Chi-square | 95.132 | 164.642 | 188.540 |
| | df | 3 | 3 | 3 |
| | P-value | <0.001 | <0.001 | <0.001 |
| Marital status | Chi-square | 4.401 | 2.316 | 10.021 |
| | df | 2 | 2 | 2 |
| | P-value | 0.111 | 0.314 | 0.007 |
| Number of households | Chi-square | 25.006 | 16.336 | 7.213 |
| | df | 4 | 4 | 4 |
| | P-value | <0.001 | 0.003 | 0.125 |
| Occupation | Chi-square | 27.933 | 61.691 | 115.311 |
| | df | 5 | 5 | 5 |
| | P-value | <0.001 | <0.001 | <0.001 |
| Income | Chi-square | 40.733 | 31.430 | 55.710 |
| | df | 4 | 4 | 4 |
| | P-value | <0.001 | <0.001 | <0.001 |
| Type of houses | Chi-square | 76.702 | 44.638 | 57.839 |
| | df | 5 | 5 | 5 |
| | P-value | <0.001 | <0.001 | <0.001 |
| Residential location | Chi-square | 170.064 | 54.916 | 69.725 |
| | df | 2 | 2 | 2 |
| | P-value | <0.001 | <0.001 | <0.001 |

### *5.5.5 Relationship between Demographic Variables with Activity on The Disposal of E-waste*

Questions related to knowledge of activity on the disposal of E-waste (K11, K12, K13, and K14) are reported in Table 5.9. Based on the analysis conducted, responses to questions K13 and K14 showed a significant relationship, and the p-value was less than 0.05 with all demographic variables. Meanwhile, for responses to question K11, there was a significant relationship, as reported, with the p-value less than 0.05 with all demographic variables except for the type of house (p = 0.073). Similarly, question K12

also showed a significant relationship, as the p-value was less than 0.05 with all demographic variables except for marital status (p = 0.220).

**Table 5.9: Chi-square analysis between demographic variables and knowledge questions**

| Demographic variables | | Knowledge questions | | | |
|---|---|---|---|---|---|
| | | **K11** | **K12** | **K13** | **K14** |
| Gender | Chi-square | 58.214 | 9.111 | 14.201 | 7.447 |
| | df | 1 | 1 | 1 | 1 |
| | P-value | <0.001 | 0.003 | <0.001 | 0.006 |
| Age | Chi-square | 45.247 | 25.164 | 88.057 | 55,560 |
| | df | 4 | 4 | 4 | 4 |
| | P-value | <0.001 | <0.001 | <0.001 | <0.001 |
| Educational background | Chi-square | 18.414 | 51.849 | 94.889 | 28.401 |
| | df | 3 | 3 | 3 | 3 |
| | P-value | <0.001 | <0.001 | <0.001 | <0.001 |
| Marital status | Chi-square | 29.476 | 3.030 | 11.838 | 27.834 |
| | df | 2 | 2 | 2 | 2 |
| | P-value | <0.001 | 0.220 | 0.003 | <0.001 |
| Number of households | Chi-square | 19.133 | 24.085 | 29.257 | 43.903 |
| | df | 4 | 4 | 4 | 4 |
| | P-value | 0.002 | <0.001 | <0.001 | <0.001 |
| Occupation | Chi-square | 48.667 | 14.032 | 48.659 | 44.778 |
| | df | 5 | 5 | 5 | 5 |
| | P-value | <0.001 | 0.015 | <0.001 | <0.001 |
| Income | Chi-square | 47.605 | 21.790 | 34.307 | 15.526 |
| | df | 4 | 4 | 4 | 4 |
| | P-value | <0.001 | <0.001 | <0.001 | 0.004 |
| Type of houses | Chi-square | 10.082 | 15.509 | 36.801 | 46.504 |
| | df | 5 | 5 | 5 | 5 |
| | P-value | 0.073 | 0.008 | <0.001 | <0.001 |
| Residential location | Chi-square | 37.757 | 37.792 | 96.778 | 127.345 |
| | df | 2 | 2 | 2 | 2 |
| | P-value | <0.001 | <0.001 | <0.001 | <0.001 |

*5.5.6 Overall Outcome between The Demographic Variables and Knowledge Questions*

According to the relationship highlighted in findings 5.5.1 through 5.5.5, age, educational background, occupation, income, and residential location all have p-values less than 0.05 with each of the knowledge questions (K1-K14). This relationship shows that each of these demographic variables can influence respondents' knowledge of E-waste recycling.

*5.5.7 Relationship between Demographic Variables and Attitude Questions*

The chi-square analysis was also used to test the relationship between attitude questions and demographic variables in this study. For questions A1 and A5, all demographic variables showed a significant relationship with both questions, as reported, and the p-value was less than 0.05.

As for question A2, gender and number of households reported p-values greater than 0.05, while the other demographic variables showed a significant relationship with p-values less than 0.05. Then, question A3 showed a significant relationship with all demographic variables except for number of households ($p = 0.065$). For question A4, only gender showed a p-value greater than 0.05 ($p = 0.081$).

Question A6 reported a significant relationship with age, educational background, occupation, income, type of house, and residential location, while gender, marital status, and number of households reported no significant relationship, with p-values greater than 0.05. Question A7 had a significant relationship with age, marital status, occupation, income, type of house, and residential location but not with gender, educational background, and number of households: the latter three variables had a p-value greater than 0.05.

Based on the analysis, it has been highlighted those four demographic variables, namely, age, occupation, income, type of houses, and residential location, consistently reported p-values less than 0.05 for all attitude questions. Table 5.10 tabulated the overall output from the analysis conducted between demographic variables and the attitude questions.

**Table 5.10: Chi-square analysis between demographic variables and attitude questions**

| Demographic variables | | Attitude questions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **A1** | **A2** | **A3** | **A4** | **A5** | **A6** | **A7** |
| Gender | Chi-square | 16.705 | 1.911 | 10.186 | 3.044 | 9.160 | 0.005 | 1.444 |
| | df | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | P-value | <0.001 | 0.167 | 0.001 | 0.081 | 0.002 | 0.945 | 0.230 |
| Age | Chi-square | 29.603 | 36.186 | 42.518 | 50.517 | 67.962 | 31.078 | 33.020 |
| | df | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| | P-value | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Educational background | Chi-square | 49.730 | 113.371 | 121.618 | 158.562 | 77.470 | 29.694 | .194 |
| | df | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| | P-value | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.979 |
| Marital status | Chi-square | 8.368 | 18.644 | 51.265 | 7.058 | 11.531 | .811 | 8.761 |
| | df | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | P-value | 0.015 | <0.001 | <0.001 | 0.029 | 0.003 | 0.667 | 0.013 |
| Number of households | Chi-square | 25.828 | 1.070 | 8.858 | 57.696 | 49.584 | 6.413 | 6.989 |
| | df | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| | P-value | <0.001 | 0.899 | 0.065 | <0.001 | <0.001 | 0.170 | 0.136 |
| Occupation | Chi-square | 25.153 | 46.151 | 102.437 | 80.776 | 79.150 | 12.621 | 12.406 |

| Demographic variables | | Attitude questions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **A1** | **A2** | **A3** | **A4** | **A5** | **A6** | **A7** |
| Occupation | df | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | P-value | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.027 | 0.030 |
| Income | Chi-square | 49.136 | 45.481 | 76.944 | 89.946 | 33.153 | 44.471 | 26.407 |
| | df | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| | P-value | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Type of houses | Chi-square | 16.979 | 27.858 | 57.268 | 64.525 | 47.550 | 15.410 | 36.919 |
| | df | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | P-value | 0.005 | <0.001 | <0.001 | <0.001 | <0.001 | 0.009 | <0.001 |
| Residential location | Chi-square | 25.471 | 56.151 | 203.883 | 134.222 | 54.249 | 22.111 | 6.649 |
| | df | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | P-value | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.036 |

### *5.5.8 Relationship between Demographic Variables with The General Practices Regarding the E-waste*

The first part of the practices section consists of three questions about general E-waste practices. Only gender, marital status, occupation, and income were found to have a significant relationship in question P1. For question P2, only age, educational background, marital status, occupation, and residential location variables reported a significant relationship with p-values of less than 0.05. In contrast, the other four demographic variables indicated p-values greater than 0.05. As for question P3, all demographic variables showed significant relationships except for gender, type of house, and residential location. According to the analysis results, only age, marital status, and occupation consistently have a significant p-value of less than 0.05 for all three general practice questions. This indicates that general practices on E-waste among the respondents could be differentiated based on these three demographic variables. Table 5.11 shows the report for chi-square analysis between demographic variables and general practice questions.

**Table 5.11: Chi-square analysis between demographic variables and general practices questions**

| **Demographic variables** | | **Practices questions** | | |
|---|---|---|---|---|
| | | **P1** | **P2** | **P3** |
| Gender | Chi-square | 13.291 | <0.001 | 0.479 |
| | df | 1 | 1 | 1 |
| | P-value | <0.001 | 0.985 | 0.489 |
| Age | Chi-square | 13.472 | 18.681 | 14.300 |
| | df | 4 | 4 | 4 |
| | P-value | 0.009 | 0.001 | 0.006 |
| Educational background | Chi-square | 7.165 | 51.364 | 42.009 |
| | df | 3 | 3 | 3 |
| | P-value | 0.067 | <0.001 | <0.001 |
| Marital status | Chi-square | 8.391 | 45.476 | 16.564 |

| Demographic variables | | Practices questions | | |
|---|---|---|---|---|
| | | **P1** | **P2** | **P3** |
| Marital status | df | 2 | 2 | 2 |
| | P-value | 0.015 | <0.001 | <0.001 |
| Number of households | Chi-square | 7.112 | 1.432 | 18.014 |
| | df | 4 | 4 | 4 |
| | P-value | 0.130 | 0.836 | 0.001 |
| Occupation | Chi-square | 38.231 | 21.244 | 26.939 |
| | df | 5 | 5 | 5 |
| | P-value | <0.001 | 0.001 | <0.001 |
| Income | Chi-square | 12.963 | 7.182 | 31.592 |
| | df | 4 | 4 | 4 |
| | P-value | 0.011 | 0.127 | <0.001 |
| Type of houses | Chi-square | 3.082 | 7.537 | 10.436 |
| | df | 5 | 5 | 5 |
| | P-value | 0.687 | 0.184 | 0.064 |
| Residential location | Chi-square | 2.179 | 21.511 | .539 |
| | df | 2 | 2 | 2 |
| | P-value | 0.336 | <0.001 | 0.764 |

### *5.5.9 Relationship between Demographic Variables with The Disposal Practices of E-waste*

This section reports the results of the chi-square analysis to seek a relationship between practices and demographic variables. This section focuses on responses to questions P4 to P10, which are related to the disposal channels chosen by the respondents to get rid of their unwanted electrical and electronic appliances. Table 5.12 shows the output of the chi-square analysis.

According to the output of the analysis, the educational background of respondents is the only demographic variable that shows a p-value < 0.05, indicating the relationship of educational background with all the disposal practices of E-waste. This is distinct from

the number of households variable, which does not show a relationship with any of the disposal practices questions. Based on this output, the choices of disposal practices among respondents can be varied according to the respondents' educational background.

**Table 5.12: Chi-square analysis between demographic variables and disposal practices questions**

| Demographic variables | | Practices questions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **P4** | **P5** | **P6** | **P7** | **P8** | **P9** | **P10** |
| Gender | Chi-square | 16.307 | 6.596 | 16.393 | 16.639 | 0.023 | 0.065 | 1.363 |
| | df | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | P-value | <0.001 | 0.010 | <0.001 | <0.001 | 0.880 | 0.799 | 0.243 |
| Age | Chi-square | 4.747 | 73.923 | 37.384 | 10.427 | 4.189 | 33.654 | 20.580 |
| | df | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| | P-value | 0.314 | <0.001 | <0.001 | 0.034 | 0.381 | <0.001 | <0.001 |
| Educational background | Chi-square | 15.849 | 96.851 | 95.650 | 31.287 | 11.723 | 52.541 | 68.742 |
| | df | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| | P-value | 0.001 | <0.001 | <0.001 | <0.001 | 0.008 | <0.001 | <0.001 |
| Marital status | Chi-square | 1.285 | 12.538 | 0.120 | 0.185 | 3.660 | 13.828 | 15.176 |
| | df | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | P-value | 0.526 | 0.002 | 0.942 | 0.912 | 0.160 | 0.001 | 0.001 |
| Number of households | Chi-square | 6.554 | 6.812 | 2.839 | 6.976 | 2.064 | 4.462 | 8.115 |
| | df | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| | P-value | 0.161 | 0.146 | 0.585 | 0.137 | 0.724 | 0.347 | 0.087 |
| Occupation | Chi-square | 19.218 | 51.594 | 15.429 | 13.559 | 1.137 | 55.079 | 23.895 |

| Demographic variables | | Practices questions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **P4** | **P5** | **P6** | **P7** | **P8** | **P9** | **P10** |
| Occupation | df | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | P-value | 0.002 | <0.001 | 0.009 | 0.019 | 0.951 | <0.001 | <0.001 |
| Income | Chi-square | 14.972 | 57.297 | 17.207 | 35.260 | 5.926 | 37.271 | 21.611 |
| | df | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| | P-value | 0.005 | <0.001 | 0.002 | <0.001 | 0.205 | <0.001 | <0.001 |
| Type of houses | Chi-square | 5.262 | 16.998 | 12.677 | 2.957 | 9.308 | 20.999 | 17.053 |
| | df | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | P-value | 0.385 | 0.005 | 0.027 | 0.707 | 0.097 | 0.001 | 0.004 |
| Residential location | Chi-square | 12.431 | 36.667 | 12.935 | 1.574 | 12.793 | 2.568 | 31.835 |
| | df | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | P-value | 0.002 | <0.001 | 0.002 | 0.445 | 0.002 | 0.277 | <0.001 |

*5.5.10 Overall Outcome between The Demographic Variables and Practices Questions*

From a total of ten questions in the practices section, three are highlighted in the first section as one group, and another seven are highlighted in the second section as another group of questions. Based on the relationship tabulated in 5.5.8 and 5.5.9, the findings show respondents' practices cannot be varied by type of houses and number of households, respectively, since the p-value consistently reported more than 0.05 for all listed questions.

For the general practices towards E-waste, there were three demographic variables that consistently reported p-value < 0.05 for all questions, indicating the relationship. The general practices among respondents can be varied according to these three specific variables, namely, age, marital status, and occupation. As for the E-waste disposal practices, only the educational background has a consistent relationship with all listed questions, in which the choices of E-waste disposal practices vary according to the level of education among respondents.

*5.5.11 Chi-square Analysis Output*

According to the analysis, age and occupation are both demographic variables that consistently show a significant p-value with all the questions in the knowledge, attitude, and general practices (P1-P3). Individuals' Knowledge, Attitudes, and General Practices towards E-waste recycling can be influenced and varied based on their age group and occupation, according to these similarities. Besides that, it is also found that educational background shows a consistently significant p-value of less than 0.05 with all questions in the knowledge and disposal practices (P4-P10) section. Aside from the inconsistent results in the practises section, this illustrates how a person's educational background might affect the way of disposal of unwanted electrical and electronic appliances. This

also shows that knowledge of E-waste recycling varies according to the respondents' educational backgrounds.

## *5.6 The Relationship of Knowledge, Attitude and Practices on E-waste Recycling among Respondents*

In this sub-chapter, the relationship between all three elements of KAP will be discovered. First, those who responded YES to the questionnaire survey were given 1 mark, and those who responded NO received 0 marks in order to report on research objective 4. Since there are a total of 14 questions in the knowledge section, the maximum score achievable is 14. Therefore, since there are a total of 7 questions in the attitude section, the highest possible score would be 7. Based on the number of questions in the practices section, a total score of 10 is the highest possible. The minimum overall score for these three specific sections would, therefore, be 0. The level of scoring has been classified based on the total score, and the cross-tabulations of KAP on E-waste Recycling have been determined. Tables 5.13 until 5.15 show the outcome of cross-tabulation analysis, which highlighted that the significant p-value between knowledge-attitude, knowledge-practices, and attitude-practices reported less than 0.05. This indicates all these three elements; KAP is able to influence one another.

### *5.6.1 The Relationship between Knowledge and Attitude on E-waste Recycling among Respondents*

A cross-tabulation of the total scores for knowledge and attitude was conducted, and the results are set out in Table 5.13. The cross-tabulation illustrates the percentages of respondents from the total of 3,015 according to the knowledge and attitude scores in each section.

**Table 5.13: Percentage of Respondents based on The Cross-tabulation Scoring between The Level of Knowledge and Attitude on E-waste Recycling**

| P-value <0.001 | | Attitude (%) | | | Total (%) |
|---|---|---|---|---|---|
| | | Low (0-3) | Moderate (4-5) | High (6-7) | |
| Knowledge (%) | Low (0-4) | **43.4** | 22.5 | 34.1 | 100.0 |
| | Moderate (5-9) | 13.0 | 33.3 | **53.7** | 100.0 |
| | High (10-14) | 3.1 | 21.1 | **75.8** | 100.0 |

Based on Table 5.13, the total of respondents that scored between 0 and 4 marks indicates a low level of knowledge on E-waste recycling, and the majority, about 43.4%, also scored a low level of attitude towards E-waste recycling. However, those who scored moderate and high levels of knowledge reported that the majority scored high levels of attitude, with 53.7% and 75.8%, respectively. This output is supported by a significant p-value of less than 0.05 (< 0.001) between the level of knowledge and attitude. The results also proved that knowledge can influence the individual's attitude, as suggested in the previous studies.

The consistency of the results demonstrates how knowledge can influence an individual's attitude. With adequate information and a solid foundation of knowledge, the general public will develop a positive attitude. Furthermore, the analysis revealed that there is a segment of the public with a positive attitude and a desire to participate in this sustainable movement, even though knowledge about E-waste recycling could be improved.

*5.6.2 The Relationship between Knowledge and Practices on E-waste Recycling among Respondents*

For the following section, the analysis continues by examining the relationship between knowledge and practices towards E-waste recycling among respondents. The same method has been applied in this section, and a significant relationship is reported between knowledge and practices p-value less than 0.05 (<0.001). This relationship is presented in Table 5.14, which shows the percentage of respondents based on the cross-tabulation scoring between the level of knowledge and practices on E-waste recycling.

**Table 5.14: Percentage of Respondents based on The Cross-tabulation Scoring between The Level of Knowledge and Practices on E-waste Recycling**

| P-value <0.001 | | Practices (%) | | | Total (%) |
|---|---|---|---|---|---|
| | | Low (0-5) | Moderate (6-7) | High (8-10) | |
| Knowledge (%) | Low (0-4) | **90.7** | 7.1 | 2.2 | 100.0 |
| | Moderate (5-9) | **38.6** | 31.1 | 30.3 | 100.0 |
| | High (10-14) | 24.1 | **43.7** | 32.2 | 100.0 |

According to the cross-tabulation results, there is a significant p-value < 0.001 between the level of knowledge and level of practice among respondents. It was also discovered that the majority of respondents who scored low on knowledge (between 0 and 4) also scored low on practices (between 0 and 5), with a percentage of 90.7%. Similarly, 38.6% of respondents who scored a moderate level of knowledge eventually had a low level of practice. Then, in the group of respondents who scored a high level of knowledge, the majority of respondents (43.7%) reported only a moderate level of practice.

*5.6.3 The Relationship between Attitude and Practices on E-waste Recycling among Respondents*

This section examines the relationship between the attitude and practice elements, which is significant at a p-value less than 0.05 (< 0.001). As in the previous section, this section also examines the cross-tabulation between the total scores for attitudes and practices of E-waste recycling, as set out in Table 5.15.

**Table 5.15: Percentage of Respondents based on The Cross-tabulation Scoring between The Level of Attitude and Practices on E-waste Recycling**

| P-value <0.001 | | Practices (%) | | | Total (%) |
|---|---|---|---|---|---|
| | | Low (0-5) | Moderate (6-7) | High (8-10) | |
| Attitude (%) | Low (0-3) | **75.9** | 19.9 | 4.1 | 100.0 |
| | Moderate (4-5) | 34.3 | **38.5** | 27.3 | 100.0 |
| | High (6-7) | 26.7 | **39.2** | 34.1 | 100.0 |

Since attitude acts as a driving force when carrying out an activity, it is important to mould consumer attitudes with government support through raising awareness and offering incentives, including making sure that the activity, for example, E-waste recycling, is convenient to carry out.

Similar to the relationship between knowledge and practice, cross-tabulations between attitude and practice revealed a significant p-value of less than 0.05. This result demonstrates that an individual's attitude can influence the individual's practices regarding E-waste recycling. According to Table 5.15, the majority of respondents who scored low on attitude also scored low on practices, with a percentage of 75.9%. Then,

those with a moderate and high level of attitude toward E-waste recycling also had a moderate level of practice, with percentages of 38.5% and 39.2%, respectively.

## 5.7 The Satisfaction Regarding the Available E-waste Management Services

The final part of the questionnaire asked about respondents' satisfaction with the current E-waste services. This sub-chapter highlights the current level of satisfaction with E-waste management services among respondents in general. This data is important because it can be used as a baseline to enable the responsible bodies such as the government and NGOs to continuously enhance E-waste management. Apart from the current status of E-waste recycling activity among respondents as well as the sources of information, the satisfaction of the public is also important for identification. This is to determine whether the present and available E-waste management services are sufficient to satisfy the public's desire to recycle their unwanted electrical and electronic appliances.

Since E-waste is still a new type of waste that is being introduced to the public, a question on the satisfaction of the public towards the current and available E-waste management services is important to highlight. Table 5.16 displays the frequency and percentage of respondents based on their satisfaction with current E-waste management services.

**Table 5.16: The satisfaction of respondents towards the E-waste management services**

| | Frequency | Percentage (%) |
|---|---|---|
| **Yes** | 1515 | 50.2 |
| **No** | 1500 | 49.8 |
| **Total** | 3015 | 100.0 |

From the total of 3015 respondents, the analysis revealed that 50.2% of the total respondents reported that they were satisfied with the E-waste services in their residential

area. In contrast, the remaining 49.8% reported otherwise. Only about 0.4% of the differences were identified between these two groups of respondents.

Of the total of 1500 respondents who were not satisfied with E-waste management, only 475 of them provided comments. Based on the collected comments, respondents were dissatisfied with the E-waste services for a few reasonable reasons. The answers collected were classified into four major groups, namely information and knowledge, facilities and management, opinion and suggestion, and awareness. Figure 5.10 shows the percentage of respondents based on their comments.

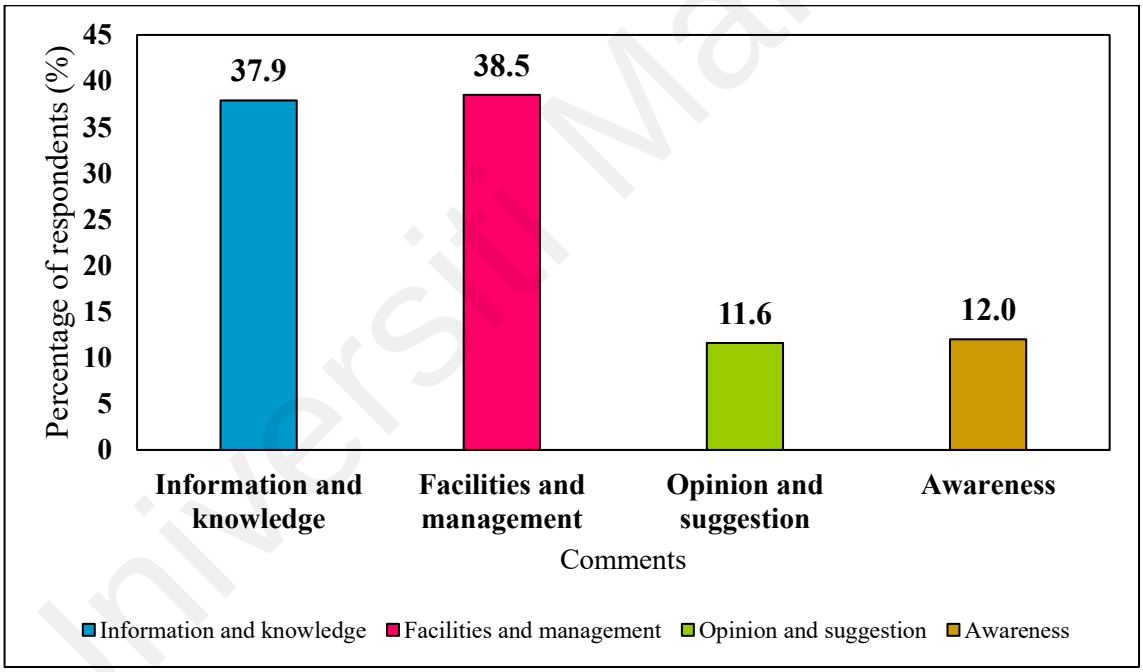


**Figure 5.10: Percentage of respondents based on their comments**

For the first group of comments, 37.9% of respondents said the information and knowledge related to E-waste are not well-informed and adequate to the public as the respondents do not have any knowledge regarding E-waste. Adequate information and knowledge also including the existence of E-waste around them, the general information regarding E-waste, the existence of E-waste management in their housing area, the

advantages of sustainable E-waste management, the location and facilities to dispose of the E-waste, the current related global issue on E-waste.

The second group of comments discovered that 38.5% of respondents labelled the E-waste facilities and management as inconvenient, inconsistent, ineffective, inefficient, not conducive, and not systematic. Respondents also underlined a few issues related to facilities and management, such as the location of E-waste disposal facilities, which are not strategic and very limited in number. There are no facilities near their housing area, and they do not include door-to-door collection. Respondents also underlined that the current E-waste management is not friendly to users and, hence, is not properly handled by the responsible bodies. Respondents also commented on how E-waste management is not extensively and thoroughly provided in their housing area and workplace.

The following group of comments are related to public awareness regarding E-waste. It was discovered that 12.0% of respondents agreed that one of the issues related to e-waste management and services is due to public awareness itself. E-waste awareness is important in order to ensure the public can be responsible for their unwanted electrical and electronic appliances. According to the respondents, there is a lack of awareness among the public also due to a lack of exposure regarding the E-waste from the responsible bodies.

Respondents are not limited to giving out their comments on the available E-waste services. Still, there are also opinions and suggestions on how to improve the E-waste services given by the respondents. 11.6% of the respondents stated that there are some facilities that have not been utilized well by the public, and there is a lack of campaigns related to E-waste and promotion to practice sustainable E-waste disposal among

respondents. It was discovered that respondents stated there is a lack of cooperation among the stakeholders, for example, between the government and the public. Respondents suggest that to have more approaches in providing information on E-waste to the public, this approach should be in a variety of mediums and methods. Besides, the respondents also suggest increasing the number of E-waste facilities and having proper E-waste disposal facilities that are accessible and easy for the public to send their large E-waste appliances. The effectiveness of the recycling process of E-waste has also been suggested by the respondents. Lastly, the respondents highlighted that door-to-door E-waste collection and services should be provided for the public.

## 5.8 Conclusion

This section summarized the output of the analysis that has been reported throughout the entire chapter. In summary, this study found that respondents had good knowledge of the definition and background of E-waste, the effects on E-waste generation, and the advantages of E-waste recycling. As for the law and legislation on E-waste, only a moderate percentage of respondents knew about E-waste, as stated in EQA 1974. Somehow, for the law and regulations on the disposal of E-waste (question K9) as well as the recycling activity conducted at prescribed premises (question K10), the majority knew and had a good percentage. Then, with regard to knowledge of disposal activities, respondents lacked knowledge about the location of collection centres, companies that help the public dispose of their E-waste, and the rewards for properly disposing of E-waste. As for the trade-in services, only a moderate percentage of respondents have knowledge of this matter.

Overall, in the attitude section towards E-waste recycling, most respondents show a good attitude. As for question A1, the percentage of respondents that tend to ensure that their

gadgets are always up to date and follow trends should depend on their necessity and daily lifestyle. This question also related to financial status compared to other questions in Attitude's section that do not relate to financial status. Questions A5 and A6 also revealed that incentives and the convenience of facilities are important to boost the public's attitude and participation in this sustainable movement.

Based on the questions about E-waste recycling practices, most respondents encourage their family members to practice proper E-waste disposal, which reflects a good practice within the small community at home. Then, among all listed disposal practices, most respondents tend to choose the E-waste disposal method with an economic, which these three selected practices will also be able to increase the lifespan of unwanted electrical and electronic appliances.

Additionally, the analysis examined sources of information. Information plays a vital role in educating and creating a sustainable community. This study found that the Internet is the most widely preferred source of information. The output is parallel with the modernization era nowadays. Moreover, television and friends are also the most common choices for sources of information regarding E-waste among the respondents.

According to the chi-square analysis conducted between the demographic variables and each question on E-waste recycling across all KAP sections, age, educational background, occupation, income, and residential location consistently show a significant p-value. Starting with the age variable, all questions in the knowledge, attitude, and general practices (P1-P3) sections have a consistent p-value of less than 0.05. Then, with regard to educational background, it demonstrates a consistent p-value of less than 0.05 with all questions in the knowledge and disposal practices (P4-P10). In the knowledge, attitude,

and general practices (P1-P3) sections, the occupation consistently showed a p-value less than 0.05. With all questions in the knowledge and attitude sections, both income and residential location show a consistently significant p-value of less than 0.05. The results show that respondents' knowledge, attitude, and practises regarding E-waste recycling vary depending on their age, educational background, occupation, income, and residential location.

This study also found that KAP showed a significant p-value less than 0.05 based on the chi-square analysis. This significant p-value reflects that KAP regarding E-waste recycling among respondents can influence one another. It has been identified that respondents with a low level of knowledge of E-waste recycling reported having a low level of attitude as well as practices on E-waste recycling. Then, those respondents with a moderate level of knowledge of E-waste recycling were still able to have a high level of attitude, but somehow, the level of practices is still low and requires room for improvement. As shown in the analysis, respondents with a high level of knowledge of E-waste recycling reported having a high level of attitude. However, for the practices, it was still at a moderate level. According to this, practices on E-waste recycling can still be improved. Apart from the influence of good knowledge and attitude, good practice towards E-waste recycling can be achieved by constantly practicing and becoming an individual's habit.

Finally, this chapter concludes with an analysis of respondents' satisfaction with the current and available E-waste services. Since the difference in percentage between the respondents' satisfaction and dissatisfaction is only 0.4%, it can be seen that since E-waste is still a new type of waste introduced to the public, it might not get full attention from the public. Those who are satisfied with the E-waste services may have only recently

encountered them and rarely disposed of their E-waste. Meanwhile, those who are dissatisfied may be those who are familiar with E-waste management and have typically encountered a problem during E-waste disposal. Hence, respondents' comments on dissatisfaction with the available E-waste management have also been highlighted. It was discovered that the main reason for dissatisfaction is due to the facilities and management. The discussion based on the analysis reported in this chapter will be continued in the following chapter.

# CHAPTER 6: DISCUSSION

## 6.1 Introduction

This chapter provides a discussion about the E-waste recycling activity among the public based on the analysis and findings as illustrated in Chapter 5. This chapter is divided into nine sub-chapters, including the introduction and conclusion sections. The findings of this study highlighted that regarding the knowledge section, respondents had good knowledge about E-waste recycling activity except for knowledge related to the disposal of E-waste and a question regarding E-waste regulations. Overall, respondents showed a good attitude and were willing to change to ensure that E-waste recycling could be managed sustainably. As shown in the analysis, none of the questions reported positive responses of 80% or above, which is the practice for most respondents at a moderate level.

Following the conclusion of the previous discussion, this chapter will discuss the sources of information about E-waste received by respondents since knowledge is the important aspect that will be able to influence an individual. When compared to other sources of information, the internet has been found to be the most preferred source of information. Then, in this chapter, the discussion based on the chi-square analysis among the Knowledge, Attitude, and Practices (KAP) and the demographic variables is also highlighted. The level of satisfaction with the current and available E-waste management services will also be discussed. Lastly, the discussion is summarized, and the conclusion of the study will be presented in the following chapter.

## 6.2 Knowledge of E-waste Recycling among Respondents

Knowledge can be described as awareness, familiarity, and understanding, and it has been agreed that knowledge is one of the keys to ensuring the participation of the community and is also able to create a positive impact on the attitude, as both knowledge and attitude contribute to good practice (Refsgaard & Magnussen, 2009; Mathur et al., 2011; Madhukumar & Ramesh, 2012; Keramitsoglou & Tsagarakis, 2013; Ahmad et al., 2015; Babaei et al., 2015; in El-Gilany et al., 2017; Iyer, 2018).

According to Delcea et al. (2020) and Kumar (2017), E-waste contains a wide range of toxic and hazardous materials, resulting in major environmental concerns today. As a result, E-waste must be properly managed, which should begin with adequate knowledge related to E-waste. Aside from reducing the environmental and human health impacts of E-waste, sustainable E-waste management will enable people to reduce the volume of E-waste in municipal landfill sites. It can also recover valuable materials from E-waste, offering an economic advantage (Delcea et al., 2020; Ravindra & Mor, 2019).

For the discussion on the knowledge of E-waste recycling, there are 14 questions altogether, which are then divided into 12 sections for discussion purposes. The analysis identifies that the respondents lack information in order for them to practice sustainable E-waste management to the E-waste practices. This is in comparison to other knowledge questions. Based on the output, it can be seen that stakeholders play a huge role in providing adequate information to the public not only to understand the context of E-waste but also to make sustainable E-waste practices easier with the available information.

### *6.2.1 Knowledge of the Definition of E-waste*

According to Delcea et al. (2020), Kumar (2017), Bhat and Patil (2014), and Tarawneh and Saidan (2013), E-waste can be defined as any used electrical and electronic appliances that have either a battery, plug, or other electrical power components that are intended to be discarded by the consumer for any reason. Consumers tend to discard their unwanted electrical and electronic appliances if they are broken, no longer serve the purpose for which they were bought, are no longer used, or are old, and any of these might be reasons to dispose of their E-waste.

Based on the analysis, the first question indicates that the majority of the respondents, about 82.4% from the total of 3015 respondents, had knowledge of and familiarity with the term 'E-waste' and its definition. Previous studies have also addressed the same question related to the term 'E-waste' and its definition, with varied output. According to this, the question of definition can be seen as a relevant question up until recent years.

A similar output was highlighted in the study conducted by Bhat and Patil (2014), in which the majority (up to 90.0%) of the respondents in Pune City, India, also displayed good knowledge regarding the term 'E-waste' and its definition. A study conducted by Subhaprada and Kalyani (2017) reported that 89.58% of respondents in Kurnool Medical College, located in Kurnool, Andhra Pradesh, India, had good knowledge of the term 'E-waste' and its definition.

Meanwhile, in the same year, a study conducted by Azodo et al. (2017) reported otherwise, with only 57.1% of respondents at University Wukari in Taraba State, Nigeria, having good knowledge. In 2019, a study conducted by Tukimin et al. for respondents in UNITEN located in Malaysia highlighted that only 31.0% of the total respondents knew

the term ‘E-waste’ and its definition. However, in a study conducted in Jos, Plateau State, Nigeria, only 67.5% of the total respondents had good knowledge of the term ‘E-waste’ and its definition (Miner et al., 2020). Recently, a study conducted among students around Sydney, Australia, found that 79.0% of respondents knew what E-waste was (Islam et al., 2021).

Based on the previous studies, only studies conducted in Pune City and Kurnool Medical College reported that more than 80% of respondents knew the definition of E-waste. This is similar to the present study. Comparatively, this present study involved 3015 respondents with a wide range of demographic variables from three different locations in Malaysia compared to the previous studies.

A good percentage of respondents indicated that the government and other stakeholders had first emphasized the definition or concept of E-waste before pushing strategies for managing it. It is important for the public to acknowledge and understand the definition first. In general, a definition is the starting point before any further discussion can proceed. This definition will provide a better understanding to the public in classifying the different types of waste for them to start to practice sustainable E-waste management, for example, to practice recycling activity, which must begin with segregating waste at the source.

### *6.2.2 Knowledge of the Content of Electrical and Electronic Appliances*

The next question highlighted that 84.7% of the respondents agreed that electrical and electronic equipment contained toxic and hazardous materials. This question has also been highlighted in both local and international studies previously. A previous study conducted in Romania by Delcea et al. (2020) observed that most respondents (76.32%)

knew that electrical and electronic appliances contain toxic and hazardous materials. In the same year, a study in Jos, Plateau State, Nigeria, discovered that about 68.0% of the total respondents had such knowledge (Miner et al., 2020). In addition, a study conducted at the International Islamic University Malaysia, Kuantan campus, Pahang, Malaysia, by Islam et al. (2019) discovered that 77% of respondents knew that the electrical and electronic equipment contained toxic and hazardous materials.

However, of respondents from the University of Delhi, India, only 31% acknowledged that E-waste contains toxins (Kumar, 2017). In the study that was also conducted in India by Bhat and Patil (2014), for respondents from Pune City, up to 80% knew that E-waste is hazardous. Thus, it shows that the residential location and demographic background of respondents resulted in a different knowledge regarding the content of electrical and electronic appliances.

In a study conducted in Malaysia, Akhtar et al. (2014) found that 65% of respondents in Kuala Lumpur agreed with the statement that electrical and electronic equipment contains toxic and hazardous materials. Tarawneh and Saidan (2013) found that only 31% of the total respondents in their study in Jordan knew that E-waste contained hazardous materials. Meanwhile, Song et al. (2012) found that only 25.2% of respondents in Macau knew about the toxic and hazardous materials contained in electrical and electronic equipment.

This present study did not focus on selected respondents but used a cross-sectional approach in distributing the questionnaires. Hence, with a large number of respondents and a wide range of demographic variables, it was able to produce a reliable output to represent the current knowledge of E-waste amongst the general public. To handle,

manage, and dispose of E-waste, the public must be well-informed about this issue. It is important for the stakeholders to highlight the content of toxic and hazardous materials in those appliances in order to create awareness of the dangers of E-waste.

### *6.2.3 Knowledge of the E-waste Generation in Malaysia*

E-waste generation is a major environmental concern nowadays. The generation of such waste rises daily across the globe, with an estimated annual growth of about 4% to 5% (Delcea et al., 2020). About 20 to 50 million tons of electrical and electronic appliances have been discarded worldwide, with an expectation that this number will increase to 6.8 kg/inch, with a total of more than 50 million tons in 2021 (Afroz et al., 2020). According to Delcea et al. (2020), the smallest fraction of E-waste comes from Oceania, with only 1.6% of the total global E-waste generation, followed by Africa (5%), America (25.3%), Europe (27.4%) and the largest fraction of E-waste generated is from Asia, at about 40.7%. Malaysia is not excluded from such E-waste generation.

Several factors contribute to the increasing E-waste generation nowadays. According to Arain et al. (2020), the increase in the usage of electrical and electronic appliances amongst the public leads to an increase in the number of new appliances. However, unsustainable consumption among public consumers reduces the lifespan of electrical and electronic appliances.

About 73.6% of the total of 3015 respondents agreed that the quantity of E-waste in Malaysia is rapidly increasing. Similar responses were given by respondents at the International Islamic University Malaysia (Islam et al., 2019) and UNITEN (Tukimin et al., 2019), with 71% and 70% of the total respondents, respectively, agreeing with this

statement. According to this, studies conducted in Malaysia illustrate a similar pattern of percentage even though those studies are conducted in different study areas.

A similar question is highlighted in the previous and present studies. Besides, the percentage of respondents who have knowledge and are aware of the increase in E-waste also reported similarly, which is not more than 80% of respondents. It is also highlighted that, in general, the Malaysian public was aware of the generation of E-waste in Malaysia. When the public is aware of the generation of E-waste, they develop ideas about this issue and the root of the problem. Based on the output, it is suggested that the government and related NGOs should highlight the increasing E-waste generation in Malaysia on every media platform to make the public aware of the current situation.

### *6.2.4 Knowledge of the Effects of E-waste on Environment and Human Health*

As the volume of E-waste continues to rise over time and across locations, this alarming situation will eventually impact the environment and human health. E-waste contains different types of toxic and hazardous materials that pose threats to air, groundwater, soil, and water pollution and affect the human food chain (Kumar, 2017). The findings of this study show that 82.4% of the total respondents agreed that the generation of E-waste would pollute the environment. Meanwhile, 78.4% acknowledged that this alarming situation would also have consequences for human health. The effects of E-waste recycling must be acknowledged as an important issue that the public should know to create awareness and improve motivation to address this issue.

Studies conducted in Nigeria, Romania, India, and Ghana presented these questions separately, similar to the present study. The findings of this study show a higher percentage in both questions. This is compared to Miner et al. (2020), who reported that

72.5% of the total respondents in Jos, Plateau State, Nigeria, knew that E-waste could pollute the environment, and 60.5% of the total respondents acknowledged the effects of E-waste on human health.

A study conducted in Romania by Delcea et al. (2020) reported findings that were broadly similar to those from this study, with 82.7% of the total respondents agreeing that E-waste is able to pollute the environment. At the same time, 75.2% agree that E-waste can impact human health. Additionally, among 342 respondents in Accra Metropolis, Ghana, 53.5% knew about the effects of E-waste on the environment, and 46.5% agreed on the effects of E-waste on human health (Owusu et al., 2017). A study conducted by Azodo et al. (2017) among respondents at the University Wukari, Taraba State, Nigeria, showed that 67.3% acknowledged that E-waste could cause environmental pollution, while 65.6% acknowledged that human health could be put at risk by E-waste.

Similarly, the percentage of respondents who are aware that E-waste can affect the environment is higher than that of respondents who know the impact of E-waste on human health. This is because E-waste is recognized as a global environmental issue, and the public is more likely to understand how it affects the environment. However, 20 to 30 percent of respondents are unaware of how E-waste can also impact human health, potentially reducing lifestyle and national productivity. It is important to highlight this outcome of the analysis as this will provide stakeholders with information on the percentage of respondents who should be provided with related information regarding the effects of E-waste on the environment and human health.

### *6.2.5 Advantages of E-waste Recycling*

In the present study, the advantages of E-waste recycling were addressed in two different questions, K6 and K7. Among the 3,015 respondents, 87.0% agreed that this recycling approach would be able to protect the environment and human health. Also, 78.8% agreed that E-waste recycling would help preserve raw materials. This is a higher percentage than was reported in previous studies. It can be seen that the Malaysian public is most likely familiar with how recycling can protect the environment and human health rather than becoming an aid to preserve raw materials. This could be due to a lack of awareness and understanding about how E-waste recycling can maintain raw resources.

The data also reflects those respondents in the three study areas in Malaysia, illustrating a good level of knowledge regarding the advantages of E-waste recycling. However, a small percentage of respondents still require room for improvement. Hence, the stakeholders should provide information to give exposure and to attract the public to conduct E-waste recycling activities.

When E-waste recycling is implemented in waste management, the generation of E-waste that ends up in landfills will be reduced. This will significantly reduce the impact of environmental degradation due to groundwater contamination, for example. This will also lead to a healthier community. When the E-waste is recycled and the valuable materials are recovered, the mining activity of raw materials can be reduced. This will eventually reduce environmental degradation, such as biodiversity loss due to unsustainable activity.

Previous studies have emphasized the advantages of recycling E-waste. According to Chibunna et al. (2013), proper E-waste management and recycling will provide advantages towards sustainable E-waste management. In this particular study, it was

discovered that only 11.7% of the total respondents in Universiti Kebangsaan Malaysia knew that E-waste recycling would aid in conserving resources. Then, in a similar study, only 17.0% of the total respondents knew that E-waste recycling would be able to recover materials (Chibunna et al., 2013).

Moreover, in a study conducted in Dhaka, Bangladesh, only 3.0% of the total respondents knew that valuable materials could be extracted from E-waste through proper E-waste management and recycling, which can be considered a low level of knowledge regarding this issue (Islam et al., 2016). It was also reported that 61.0% of respondents at the University of Delhi, India, knew that E-waste contains valuable materials that can be extracted (Kumar 2017). Deniz et al. (2019) found that 70.0% of the respondents in Adnan Menderes University, Turkiye, knew how E-waste recycling could contribute to the conservation of raw materials.

Overall, it can be seen that the percentage of respondents who knew the advantages of E-waste recycling activity in the present study is higher than those reported in previous studies. This percentage shows that respondents in Malaysia have better knowledge regarding the advantages of E-waste recycling activity compared to respondents in other study areas. Then, to compare the study that took place in Universiti Kebangsaan Malaysia and the present study, even though the samples were different, it reflects that Malaysian knowledge is improving as it shows there were changes and an increase in the percentage of respondents that have a good knowledge across years.

It is also seen that respondents in Bangladesh have the lowest percentage among all the reported percentages of respondents due to the public not receiving enough exposure

regarding E-waste. Even though that particular study was conducted in Dhaka, the capital city of Bangladesh, only a small percentage of respondents have good knowledge. This reflects that not everyone is aware of this issue despite the residential location. Meanwhile, for the study specifically conducted among respondents at the university by Kumar (2017) and Deniz et al. (2019), it is highlighted that the percentage of respondents who knew the advantages of E-waste recycling activity shows a promising percentage. This reflects that educational background will influence the knowledge of an individual.

### *6.2.6 Knowledge of SW 110 (EQA 1974)*

Based on the literature, rules, laws, and regulations are important in managing E-waste, and the public, as waste generators, should use these guidelines in handling their E-waste. In the present study, respondents were asked about their knowledge of E-waste rules, laws, and regulations. The Environmental Quality Act 1974 Environmental Quality (Scheduled Wastes) Regulations 2005 First Schedule (Regulations 2) states that E-waste is dealt with under code SW 110 by the Department of Environment (DOE). The findings revealed that about 61.4% of the total respondents in this study knew about this regulation. This percentage is higher than the percentages in other study areas. However, the percentage of the Malaysian public that knew about this law is still moderate and requires room for improvement by the stakeholders. For instance, the relevant laws about E-waste must be mentioned in any published reading materials.

Similar questions related to rules, laws, and regulations were also addressed in previous studies. Specifically, in a study conducted by Azodo et al. (2017), respondents at the University of Wukari, Taraba State, Nigeria, were asked about their knowledge of local and international laws on E-waste. However, only 22.8% of the total respondents had any knowledge about such laws. In the same publication year, Subhaprada and Kalyani (2017)

discovered that only 9.3% of respondents in Kurnool Medical College, Kurnool, Andhra Pradesh, India, knew about the government policy on E-waste. Similarly, Kumar (2017) found that none of the respondents from the University of Delhi, India, had any knowledge of the laws related to E-waste. Meanwhile, about 30% of respondents in Adnan Menderes University, Turkiye, had knowledge about E-waste regulations (Deniz et al., 2019). Only 12% of respondents in Chandigarh, India, knew about the E-waste Handling Rules 2011 provided by the Government of India for their community (Ravindra & Mor 2019).

It can be seen that the previous studies focused on selected groups of respondents, specifically the university community. In contrast, the respondents in the present study focused on the public as a whole. Even though the question was only related to local law and did not refer to international law, it is important for the public to have knowledge of the rules, laws, and regulations already in place. In addition, it is useful to compare the output from this with the output from previous studies. In order to manage and participate in E-waste disposal, it is essential to provide rules and regulations.

Those studies were conducted among respondents with tertiary levels of education; even though the sample was different from the present study, the present study also has a group of respondents with similar levels of education. Even though the educational background is able to influence knowledge, in this context, it is not necessarily an individual with a good educational background known regarding the legislation, especially in the context of E-waste since it is a new type of waste in the waste stream. Additionally, laws, rules, and regulations are usually familiar to those directly involved and not the public in general.

### *6.2.7 Segregation of E-waste at Source*

The next question was also related to the rules, laws, and regulations regarding E-waste management. Question K9 highlighted the separation of E-waste from other types of waste. According to this study, 80.5% of the total respondents agreed that E-waste cannot be disposed of with domestic waste. This suggests that the public knows how to manage and dispose of E-waste. This ruling is also underlined in EQA 1974. Similarly, a study conducted in Bengaluru, Karnataka, India, found that the respondents had good knowledge that E-waste must be separated from other types of waste (Iyer 2018). Miner et al. (2020) highlighted that segregation, separation, and sorting activities of E-waste are important in order to improve waste management. Up to 90.8% of their total respondents in Jos, Plateau State, Nigeria, agreed on this.

When the public has knowledge about waste segregation, it is easier for them to practice and participate. This information is important for the stakeholders to acknowledge that most respondents knew that E-waste must undergo a segregation process at the source. The smallest percentage that shows otherwise should be provided with information and exposure that E-waste cannot be disposed of together with domestic waste as well to practice waste segregation at source.

### *6.2.8 Knowledge of the Recycle and Recovery of E-waste at the Prescribed Premises*

According to Kalana (2010), E-waste generators refer to the industrial sector and also to the public, as both categories are considered consumers of electrical and electronic appliances. However, the stated regulations do not directly underline the guidelines for the public in dealing with their households' E-waste but focus on industrial E-waste management. As suggested by Tiep et al. (2015), governments should introduce laws and

regulations specifically for household E-waste to enable consumers to manage such waste in a sustainable manner, such as by recycling their E-waste.

The next analysis output discovered that 82.0% of the 3015 respondents had good knowledge that E-waste can only be recycled and recovered at prescribed premises. This shows that respondents in this study were well informed that E-waste cannot be simply disposed of and managed anywhere but must be dealt with at designated sites.

Meanwhile, 60.4% of respondents in University Wukari, Taraba State, Nigeria, knew that E-waste needs to undergo proper treatment and requires sound management before disposal (Azodo et al., 2017), and 50.9% of respondents in Jos, Plateau State, Nigeria also agreed with this statement (Miner et al., 2020). However, Kumar (2017) found that 46% of respondents at the University of Delhi, India, did not know that E-waste requires special handling and disposal.

Questions K9 (refer 6.2.7) and K10 underlined the ruling of the Environmental Quality (Scheduled Waste) Regulations 2005. To be exact, both referred to industrial E-waste; however, since Malaysia has not enacted any law related to household E-waste, the public can refer to the existing law. Even though the regulations are not specifically for household E-waste, the findings from the present study suggest that the public in Malaysia has good knowledge of this issue.

#### *6.2.9 Knowledge of the Location of the E-waste Collection Centre*

Based on the analysis conducted in this study, only 32.9% of the total respondents knew the nearest E-waste collection centre in their locality. It reflects that the public has a low level of knowledge, indicating that they are not well informed about the locations of their

local collection centres. Even though the percentage reported is higher than those highlighted in previous studies conducted both locally and internationally, it is still considered a low percentage, which is similar to the previous studies.

In the study conducted among staff and students at Midwestern University in the United States, it was reported that only 26.2% of the total respondents knew the location of their nearest collection centre (Arain et al., 2020). The same question was highlighted in previous studies, resulting in a smaller percentage. As highlighted in Ravindra and Mor's (2019) study, only a small percentage of respondents (9%) in Chandigarh, India, knew where to dispose of their E-waste. A study by Subhaprada and Kalyani (2017) illustrates that only 5.2% of the respondents in Kurnool Medical College, India, knew about the nearest recycling centre to their homes.

The same question on the locality of the E-waste collection centre has been highlighted in the previous studies, and it was discovered that the percentage of respondents is low. Even though the study areas were different, the same issue is rising where the public does not know about the E-waste recycling hotspots around them. Information about the E-waste collection centre is important for the public to conduct recycling. This vital information should be provided by the stakeholders in different media platforms in order to ensure that a larger group of the public can receive the information.

### *6.2.10 Knowledge of the Collection Services*

The next question revealed that only 44.5% of the respondents in this study knew that telecommunication network operation companies provide places for the public to dispose of their E-waste. This service by telecommunication network operation companies is important to support proper E-waste management activity in Malaysia. However, the low

percentage of knowledge among respondents is considered to reflect that the public is not well informed regarding the service provided.

Similarly, a study by Subhaprada and Kalyani (2017) found that only 35.4% of the total respondents in Kurnool Medical College, Kurnool, Andhra Pradesh, knew about the E-waste collection services provided around them. When the exposure to this information is low, the awareness to send their E-waste to any recycling bins or locations will also reduce. Since the public is not well aware of this service, stakeholders are required to publish the information widely.

### *6.2.11 Knowledge of the Trade-In Services*

According to Tarawneh and Saidan (2013), sustainable approaches such as the trade-in of E-waste will enhance the quality of appliances, increase the stability of their components, and help reduce production costs. The next analysis discovered that only 66.9% of the respondents knew that manufacturing companies in Malaysia provide trade-in services when their customers buy new appliances. Only a moderate percentage of respondents knew this, possibly because of a lack of information and promotion about these services.

For respondents in Adnan Menderes University, Turkiye, about 65.0% of the respondents did not know about the trade-in services provided by manufacturers (Deniz et al., 2019). This also shows that the percentage of respondents who have knowledge of the trade-in services that the manufacturing company has provided is better compared with respondents in Turkiye. Respondents in Malaysia likely knew about this due to the information received by Malaysians more than in other countries. Another reason is due to the promotion and advertisement related to the trade-in services. In order to provide

such information and to promote their trade-in services, manufacturers should use different types of information sources to ensure that such promotion reaches communities with different demographic backgrounds. The data suggest that trade-in services are well-known among the public compared to the information related to recycling activity. The percentage of respondents acknowledging this trade-in services can be increased through promotion by the stakeholders.

### *6.2.12 Knowledge of the Availability of Rewards*

This study discovered that only 48.0% of respondents knew that distributors or sellers of electrical and electronic appliances give rewards to consumers who dispose of their E-waste through these companies. There are several examples of companies in Malaysia that offer such rewards for consumers, namely Maxis, U-mobile, and Senheng. According to Sakholthaman and Sharp (2016), conveying valuable knowledge, such as advantages, to the public when practicing sustainable waste management is important. Besides, the availability of rewards will change the public attitude, while giving out cash, discount coupons, goods, and vouchers will encourage consumers to change their perceptions.

Similarly, Alhassan et al. (2020) found that rewards and financial benefits will be able to increase public engagement with sustainable waste management. Islam et al. (2021) also agreed that giving monetary rewards helps the public as key consumers to manage waste in a sustainable manner. Therefore, it is important for this study to highlight the knowledge related to rewards given by the related parties. As fewer than 50% of respondents knew about these rewards, it appears that people are not well-informed about this matter. The provision of information to the public is also related to the medium or sources of the information, which will be highlighted in the following sub-chapter.

## 6.3 Attitude of E-waste Recycling among Respondents

Attitude refers to the way an individual feels and thinks about practices and is related to his beliefs and emotions, knowledge, and values while deciding and judging whether a scenario is correct or not or whether a person is innocent or not (Launiala, 2009; Babei et al., 2015; Jekria & Daud, 2016; Jayaraman et al., 2019). Moreover, attitude influences consumer participation, making it essential for attaining sustainable development (Mukama et al., 2016; Tangwanichagapong et al., 2017). Since attitude might be helpful in changing individuals' current habits, it is important to determine the attitude of the public in order to acknowledge their behaviour and ways to encourage them (Darby & Obara, 2005; Singhirunnusorn et al., 2017), as in this study, attitude is only used as a tool of general measurement.

For the discussion on the attitude toward E-waste recycling, there are seven questions altogether, which are then divided into seven sections. The analysis identifies that even though the respondents have the desire to upgrade and update their electrical and electronic appliances, they also show a good sign with their willingness to reduce the volume of E-waste. The analysis also found that most respondents are ready to recycle their E-waste if the facilities are convenient and the incentives are given. Besides, most respondents are willing to participate in campaigns and are ready to segregate E-waste at the source and send it out to the collection centre. Stakeholders play a huge role in providing a convenient way for the public to practice the E-waste recycling activity.

### *6.3.1 Attitude on Updating and Upgrading the Appliances*

Electrical and electronic appliances are widely used across the globe due to rapid technological and innovation advancement. The features, design, and multifunctionality of those appliances become the catalysts for consumers to upgrade their appliances. For

example, televisions were upgraded from analogue to digital type, and mobile phones now have a range of different uses, such as audio and visual players and recorders, as well as cameras (Afroz et al., 2012; Azodo et al., 2017; Juyal et al., 2018; Arain et al., 2020).

According to the findings of this study, only 42.4% of all respondents stated that they did not regularly update and replace their electrical and electronic appliances. The remaining 57.6% of respondents responded otherwise. The data indicates that the respondents are divided into two groups with differing views; the percentage of respondents who do not tend to upgrade their appliances is lower than those who do.

Rafia et al. (2013) also discovered that people tend to upgrade their appliances due to the advancements and additional features offered to consumers. This statement is also supported by a study conducted by Miner et al. (2020), who found that respondents in Jos, Plateau State, Nigeria, chose to upgrade their appliances to the newest design. Meanwhile, according to Azodo et al. (2017), consumers in Nigeria, for example, upgrade their electrical and electronic appliances even though their previous appliances can still be used.

A study conducted in Kuala Lumpur revealed that up to 85% of consumers upgrade their mobile phones within four years (Afroz et al., 2012). Meanwhile, Kumar (2017) found that respondents at the University of Delhi, India, specifically replaced their mobile phones after between one and two years of usage. This reflects that as time passes, the public, as consumers, tends to change or upgrade their electrical and electronic appliances within a short period of time.

Advancement and additional features in both technology and design eventually lead the consumer to replace their appliances within a short period of time. Social and economic status can be considered factors influencing this attitude. With the modern digitalization of lifestyle, the public, as key consumers, tends to choose the most convenient appliances to suit their daily usage. However, the most important thing in the context of the present study is how people choose to dispose of their unwanted appliances when they receive new appliances. This will be discussed in the following section.

### *6.3.2 Attitude to Take Part in E-waste Recycling Campaigns*

According to the literature, campaigns can be a stepping-stone to educate the public. Bashir et al. (2018) suggested that given the importance of environmental knowledge nowadays, it should not only be provided in formal education – for example, through educational institutions – but also needs to be highlighted through talks and campaigns. In this study, about 82.8% of the respondents agreed that they would be willing to take part in an E-waste recycling campaign. This indicates a good attitude from respondents in Malaysia. Similarly, a study conducted in Bangalore, India, discovered that the majority of the respondents were willing to take part in E-waste recycling.

Based on this previous study, this good attitude will eventually lead to good disposal practices, which will also lead to an increased recycling rate among the public (Borthakur & Govind 2018). E-waste recycling campaigns need to be conducted for all levels of the public, as different approaches might be needed according to different demographic backgrounds, and the public must take part and implement a good attitude into practices.

E-waste recycling campaigns should begin at school; early education will help produce good future results. Campaigns will also help to enhance the public's knowledge

regarding the importance of sustainable E-waste management. Hence, this will keep reducing the volume of E-waste sent to the landfill. This is also able to reduce environmental pollution, such as groundwater pollution and land pollution due to excessive leachate discharge. According to Mmereki et al. (2015), Fang et al. (2017), and Razali et al. (2020), a successful campaign is able to provide participants with adequate knowledge and will thus increase their awareness, encouraging the participants to improve their practices. Besides, as Shevchenko et al. (2019) stated, E-waste has an economic value and is worth recovering, so economic motivation should be introduced to help increase consumer involvement. In Asia, economic motivations or incentives are highlighted as the major determinants for recycling activity.

### *6.3.3 Attitude in E-waste Segregation*

Segregation is the first step in the recycling of E-waste. As key consumers, the public should segregate their waste at the household level, particularly their E-waste, which requires special handling to reduce its impact. In question A3, 88.5% of the total respondents responded positively that they were ready to segregate household waste and E-waste. A previous study also conducted in Kuala Lumpur discovered that 61% of respondents were willing to segregate their E-waste into a different container from other types of household waste (Afroz et al., 2012). This indicates a moderate attitude toward the segregation of E-waste, which has been increasing over time.

As highlighted in Tarawneh and Saidan (2013), 28.1% of the respondents in Jordan showed readiness and willingness to segregate their E-waste and solid waste at source. A study conducted among respondents in Amirkola, Iran, highlighted that only 10.3% chose to segregate their E-waste (Amouei et al., 2016). Similarly, a moderate level of segregation of E-waste was reported among respondents at the Federal University

Wukari, Nigeria (Azodo et al., 2017). Malaysian respondents show a higher percentage of respondents with regard to the attitude toward segregating E-waste at the source when compared to respondents in Jordan, Iran, and Nigeria. Additionally, Malaysia, an APAC (Asia-Pacific) nation, has greater exposure to E-waste than nations included in EMEA (Europe, the Middle East, and Africa).

Stoeva and Alriksson (2017) discovered that up to 90.0% of respondents from two universities in Kalmar, Sweden, and Plovdiv, Bulgaria, were ready to get involved in separating their household waste. They also acknowledged that this approach is beneficial. However, this study only addressed waste in general and not E-waste specifically. Segregation of E-waste at source is important, especially for E-waste with the composition of toxic and hazardous materials; E-waste requires special handling. After the segregation of E-waste at the source, it will be easier for E-waste to be sent off to the E-waste recycling centre as well to be disposed of in the E-waste recycling bins.

#### *6.3.4 Attitude on Sending E-waste to the Nearest Collection Centre*

The next question revealed that 82.6% of respondents were willing to send their E-waste to the nearest authorized collection centre. This reflects a good attitude amongst the public in Malaysia, which should be implemented into good practice. This question will be further discussed in relation to the disposal methods used amongst the public in the following section. Similarly, Song et al. (2012) revealed that most of the respondents in Macau, China, expressed their willingness to send their E-waste to officially designated collection centres. However, the respondents stated that it also depended on the categories of appliances and the most convenient way to dispose of them.

In a study conducted in Kuala Lumpur by Afroz et al. (2013), only 3% of respondents agreed that they would use this disposal method. When comparing the percentage of Malaysians between previous and present studies, the findings from the present study indicated better attitude, willingness, and readiness to send off E-waste to collection centres. It is also highlighted that the attitude of Malaysians toward sustainable E-waste management has improved over the years. According to Tarawneh and Saidan (2013), 17.6% of the total respondents in Jordan were willing to dispose of their E-waste by sending it off to producers, recyclers, and traders. In comparison to respondents in Jordan, the percentage of respondents in this study illustrates a good attitude towards segregating their unwanted electrical and electronic appliances.

According to the DOE, authorized collection centres and collectors are considered formal collection points in the E-waste management flow. This formal collection included concessionaires' companies, charity organizations, communities, local government recycling centres, NGOs, producers' take-back initiatives, private recyclable buyers, and schools. Since the appliances are of different sizes and weights, the public as consumers will have their own preferences when sending off their E-waste. As an example, unwanted small appliances and mobile phones are easier to handle compared to large appliances. A good attitude should be supported by the efficiency of E-waste recycling. The location of the E-waste collection centre must be within the suitable boundaries in the neighbourhood. Next, the collection centre must be suitable to send off both small and large appliances. The E-waste collection centre also must be monitored and managed by the responsible bodies to ensure the collection centre can be utilized at maximum capacity.

### *6.3.5 Attitude on E-waste Recycling Incentives*

According to Darby and Obara (2005), Juyal et al. (2018), and Yong et al. (2019), electrical and electronic appliances consist of various hazardous materials. Therefore, implementing the waste management principle will help to reduce waste generation, reduce the quantity of E-waste in landfills, reduce the consumption of raw materials, and increase energy efficiency. However, active participation from consumers is much needed to ensure successful waste management (Kumar, 2019). Based on the literature, incentives represent one form of motivational support or catalyst to promote sustainable E-waste management to the public. For example, as suggested by Ravindra and Mor (2019), incentives should be provided by the government to enhance sustainable waste recycling in the community.

In the present study, 78.3% of respondents responded that they would recycle their old, unwanted, broken, and malfunctioning appliances if incentives were available. This indicates that incentives should be given when users recycle E-waste. Stakeholders should consider providing incentives for the public to recycle their E-waste. The study identifies that the attitude of the public toward the practice of E-waste recycling can be improved by giving out incentives.

According to Senawi and Sheau-Ting (2016), Shevchenko et al. (2019), and Thi Thu Nguyen (2019), there are different types of incentives that could be implemented by the government, stakeholders, NGOs and any responsible bodies, such as monetary incentives, including cashback, voucher or discounts; non-monetary incentives. This comprises letters of appreciation, environmental incentives that can be given through tree planting when making any E-waste donation, invitations to environmental-related programmes, motivational talks to encourage the public, and small gifts. As an example,

Bangkok, Thailand, revealed that public attitudes are influenced by the incentives given (Sukholthaman & Sharp 2016). A study conducted in Finland discovered that the majority of respondents agreed that their willingness to recycle waste was influenced by financial incentives (Abila & Kantola 2019). Incentives can be given when the E-waste is sent out to the formal recycling centre as well as when disposing of the E-waste in the designated recycling bins.

### *6.3.6 Attitude on Disposing E-waste at the Collection Facilities*

For this section, it can be seen that 84.5% of respondents in the present study were willing to dispose of their E-waste if there were available collection facilities close to their homes or workplaces. However, only 15.5% indicated that they were willing to dispose of their E-waste properly even if collection facilities were not available, as this group of respondents would choose other options to dispose of their E-waste in a sustainable manner. Based on this result, it would be better if door-to-door E-waste collection services were provided in residential areas and collection facilities at offices provided by the companies.

A similar question about attitude was also asked in previous local studies; as discovered in a study conducted in Shah Alam, Selangor, the majority of the respondents were willing to give away their E-waste without any monetary benefit if the appliances were collected without any service fees (Kalana 2010). Respondents in Kuala Lumpur responded in a similar way (Rafia et al., 2013). It can be seen that convenience is a priority to increase public willingness to engage in sustainable E-waste management with a focus on recycling.

According to Kumar (2017), E-waste recycling is difficult when there is a lack of E-waste collection systems. The availability of collection facilities and services is related to consumers' participation in E-waste recycling activities (Qu et al., 2019; Kumar, 2019). In Malaysia, a few companies provide door-to-door E-waste collection with the aim that consumers can simply book an E-waste collection. For example, ERTH provides free and paid E-waste collection, UrbanR Recycle+ offers to collect large electrical and electronic appliances such as washing machines for a fee, and Used Computer provides the same services for all types of appliances; consumers simply need to fill in an online form to assign a driver for collection purposes.

The attitude of respondents in this present study is good as they are willing to send off their E-waste to the collection facilities. However, this must come with a good reason, which is convenient. This is similar to the previous studies that highlighted convenience as the most important thing to encourage the public to dispose of their unwanted electrical and electronic appliances at the collection facilities.

### *6.3.7 Attitude on Reducing the E-waste*

As suggested by Debnath et al. (2016), in this era of modernization and globalization, every individual must seriously consider waste management principles, reducing the consumption of electrical and electronic appliances to reduce their generation. The final question in the attitude section was about people's readiness to reduce the amount of E-waste they generated. According to Cole et al. (2019), reducing E-waste is the first principle in the waste management hierarchy; thus, it is the most sustainable and least impactful on environmental degradation. Kitila and Woldemikael (2019) suggested some options that can help decrease E-waste generation through purchasing options by the

public as key consumers. The public, as consumers, should consider the quality, originality, and durability of appliances before purchasing.

From the results of the present study, 85.8% of the total respondents reflected a good attitude, indicating that they were ready to reduce the amount of E-waste that they generated. Minelgaitė and Liobikienė (2019) found that reducing the amount of waste generated is related to a habit and can be carried out without any planning. They also underlined that when an individual understands that he is contributing to waste generation, he will eventually make an effort to reduce it at his personal level.

The output of this analysis provides information to the stakeholders that most respondents are willing to reduce their E-waste generation. It reflects a good awareness among the public. However, this movement should have both short and long-term approaches to ensure that the public can properly manage E-waste. This includes providing information, a convenient, designated location to dispose of E-waste, and convincing the public to purchase high-quality appliances to extend their lifespan. Stakeholders must also prepare a proper framework or guideline for the public to manage their electrical and electronic appliances using the cradle-to-grave approach.

## 6.4 Practices of E-waste Recycling among Respondents

The third element after knowledge and attitude is practice. This section will specifically report and discuss respondents' practices regarding E-waste recycling. Practice is a component that helps in determining and evaluating the voluntary action of a study population toward a situation or activity. This might differ based on their personal background and social and psychological factors, namely age, educational background, occupation, and other related aspects (Desa et al., 2011; Babei et al., 2015; Ahmad et al.,

2015; Jereme et al., 2015). There are ten questions highlighted in the practices section. The questions are then discussed in different sections. This part will also illustrate the output from previous studies in order to compare and contrast with the findings of the present study.

### *6.4.1 Practices in E-waste Segregation*

In the present study, 59.5% of respondents agreed that they do not dispose of their E-waste together with other types of waste. This also reflects the percentage of respondents who chose to segregate and not mix E-waste with other types of household waste. This percentage does not indicate that most respondents have good practice, as it is only slightly higher than the percentage of respondents who simply mix E-waste with other waste types. This indicates that only a moderate percentage of respondents practice segregation at source.

This result is similar to the findings reported by Stoeva and Alriksson (2017), who found that among respondents from Plovdiv, Bulgaria, only a moderate percentage of respondents separated their waste at the household level. In the same study, most respondents from Kalmar, Sweden, separated their waste at home. This reflects good practice among the Swedish respondents.

Moreover, a study conducted in Pune City, India, discovered that 87% of respondents did not mix their E-waste with household waste (Bhat & Patil, 2014). This percentage also reflects good practice in Pune City. In another study involving student respondents in Sydney, Australia, about 89.7% did not dispose of their E-waste with other types of household waste (Islam et al., 2021).

Regarding Malaysians, this practice shows room for improvement through suggestions and encouragement for each household to provide different storage or dustbins for each type of waste, especially for E-waste. Segregation at source should be an important approach to kick off the E-waste recycling habit since segregation is the first step before sending off the E-waste to the recycling centre or disposing it in respective recycling bins. While previous studies mostly reported that most respondents show a good level of practice by E-waste segregation, the percentage of Malaysians that segregate their E-waste indicates a moderate level in this study. This can be due to instead of segregating for disposal purposes or being sent off to the recycling centre, those unwanted appliances simply being donated or repaired for re-use purposes or being traded in or sold off.

### *6.4.2 Practices in Storing and Stockpiling the E-waste*

Storing and stockpiling unused, broken, and malfunctioning electrical and electronic appliances might be the easiest way to deal with E-waste. However, how long should this practice be conducted, and do consumers have enough storage for all their broken appliances? Kitila and Woldenmikael (2019) stated that E-waste is not harmful and poses no risk if the chemicals stay inside the appliances. However, it is recommended that E-waste be donated, reused, recycled, or disposed of using any other sustainable options.

Responses to the second question in the practices section, P2, revealed that only 42.7% of the respondents did not store their E-waste at home, while the remaining 57.3% chose to do so. Local and international studies also addressed similar questions. According to a study conducted in Kuala Lumpur by Akhtar et al. (2014), about 27% of respondents agreed that they stored their E-waste at home. Moreover, Tiep et al. (2015) found that only 18.9% of respondents in Melaka chose this approach in dealing with their E-waste.

Another local study conducted in Kota Kinabalu, Sabah, found that 34.0% of the respondents simply kept their E-waste at home (George et al., 2019).

These percentages do not reflect a consistent result for Malaysian respondents across the years. Besides, this study shows that the highest percentage of respondents store their E-waste at home. Keeping E-waste at home is an unsustainable approach to managing E-waste. Instead, E-waste should be recycled by sending off the E-waste to recycling centres or bins. The group of respondents that choose to stockpile their E-waste at home choose to collect or store it at home until one particular time before sending it off to the recycling centre or bins to save time and energy. However, this study did not highlight questions about why the public stockpiles their E-waste and for how long the E-waste is usually being stockpiled, nor did it highlight a question on specifically what type of E-waste is usually being stockpiled at home.

As regards international studies, there have been few studies involving respondents from different demographic backgrounds. A study conducted in the city of Athens, Greece, specifically addressed the percentage of appliances stored at home based on the types of appliances. Only 23.0% of respondents chose to store large white appliances at home, but up to 62.2% of respondents kept unwanted telecommunication or IT appliances at home (Abeliotis et al., 2006). This indicates that respondents are most likely to keep smaller and more mobile appliances rather than larger appliances. This is because less storage space is needed for small appliances.

Dwivedy and Mittal (2012) reported that fewer than 10% of the respondents in their study chose to practice this method. Similarly, in Song et al.'s (2012) study, conducted in Macau, China, only 13% of the total respondents used this approach for their E-waste,

and the same percentage was found by Azodo et al. (2017) in Federal University Wukari, Taraba. A similar percentage (14.5%) of respondents in Jordan kept their E-waste at home (Tarawneh & Saidan 2013). As for respondents in Pune City, about 18% indicated that they usually kept their unwanted appliances at home (Bhat & Patil 2014).

Juyal et al. (2018) conducted a study among respondents in the Madri Industrial Area (MIA), Udaipur, Rajasthan, India, who kept their E-waste at home. It is also reported that 11.4% of respondents stored their E-waste for six months, 31.4% stored it for a month, 37.1% stored unwanted appliances for more than 15 days, and 20.0% did so for fewer than 15 days. These findings indicate that the majority of the respondents keep their E-waste at home for more than 15 days.

Another study conducted in India in the same year reported that 59.3% of respondents in Bangalore kept unwanted electrical and electronic appliances at home (Borthakur & Govind 2018), which indicates the percentage is higher than the present study. Meanwhile, in Jos, Plateau State, Nigeria, 28% of respondents kept their E-waste at home (Miner et al., 2020). Arain et al. (2020) found that 42.8% of respondents in Midwestern University United States kept their E-waste at home. Additionally, on average, about 30% of respondents in Sydney, Australia, reported that they kept their E-waste at home (Islam et al., 2021).

In most international studies, the percentage of respondents who chose to keep their E-waste at home was low compared with the percentage found in the present study, except for respondents in Bangalore. This might be due to the different groups of respondents and the national approach to handling E-waste in each country. However, in the previous studies, Abeliotis et al. (2006) specifically addressed the types of appliances the

respondents stored at home. Meanwhile, Juyal et al. (2018) asked respondents how long they had kept their E-waste. These two specific questions were not addressed in this current study but could be included in future research.

### *6.4.3 Practices in Encouraging the Family Members*

Based on the local studies, Tan et al. (2017) asked respondents in Pulau Pinang, Malaysia, whether they encouraged others to recycle their E-waste. At the same time, respondents in Kuala Lumpur, Malaysia, were asked about their responsibility to encourage their neighbours to recycle their E-waste in the study conducted by Akhtar et al. (2014). The present study focused specifically on whether respondents encouraged their family members.

Al Khateeb et al. (2017) stated that cooperation from family members in waste management at the household level is essential. Amouei et al. (2016) agreed that a lack of cooperation among family members in handling E-waste will lead to a bigger problem. Thus, it is important to educate one's family members. In question P3, 78.0% of respondents from this study indicated that they encouraged their family members to practice proper E-waste disposal.

This finding indicates that Malaysians have the responsibility to ensure that their families contribute to reducing the E-waste issues. All household members should be involved in practicing sustainable E-waste disposal. Contributions in every household will eventually help the whole community. Involvement is needed at different levels of the community. According to Tan et al. (2017), family members are considered internal social influencers; for example, parents are role models to their children. Interaction among family members will eventually lead them to respond and react towards the same practices. Based on this,

the responsibility is not only on the stakeholders, such as government or NGOs. The public, especially family members, requires rules in the household to manage E-waste. Dividing tasks among family members, such as segregation and sending them out to the recycling centre, can also be done at the household level.

### *6.4.4 Practices to Sell the Unwanted Appliances*

From the total of 3015 respondents in this study, the majority (72.6%) chose to sell their E-waste. This option is considered one of the practices that will increase the lifespan of electrical and electronic appliances. Any appliances that are still in good condition can be sold to new users, while even in those that are no longer fully functional, some parts can still be used for different purposes. This percentage indicates a moderate level of practice. Selling unwanted appliances is also considered an economic benefit for the consumer. This question has been addressed in both local and international studies across time, indicating its relevance and importance in determining the current practices of E-waste management amongst the public.

A study conducted in Melaka discovered that only 12.1% of the respondents chose to sell their electrical and electronic appliances (Tiep et al., 2015). For respondents in Kota Kinabalu, Sabah, only 6.9% of the total respondents sold their unwanted appliances (George et al., 2019). According to the literature, selling electrical and electronic appliances has been practised in different study areas by groups of the public with different demographic backgrounds. However, the percentage of practices might be different due to exposure to this selling option as well as the market values. For respondents in this present study who choose to sell off their E-waste in order to dispose of it, consumers must ensure they sell at an authorized collector or registered company. This is in order to ensure that the material flow is sustainable.

The same question was also addressed in international studies. In Beijing, China, respondents chose to sell their E-waste in order to receive an economic benefit (Wang et al., 2011). For the study conducted in Macau, China, only about 19.1% of the total respondents used this disposal method (Song et al., 2012). About 20% of respondents in India also chose to sell their E-waste (Dwivedy & Mittal 2012). According to Tarawneh and Saidan (2013), the percentage of respondents from their study in Jordan who sold their unwanted and used appliances was about 46.1%. However, only 7% of respondents in Pune City reported that they sold their E-waste, suggesting that this is not a favourable approach among consumers in that area (Bhat & Patil 2014).

Similarly, only 11.1% of respondents at Federal University Wukari, Taraba State, chose to sell their E-waste (Azodo et al., 2017). According to Kumar (2017), 61% of respondents at the University of Delhi, India, chose to sell their used large appliances, while 50.0% of respondents sold small appliances to scrap dealers. About 19.8% of respondents in Bangalore, India, chose this method to dispose of their old, unwanted, and malfunctioning appliances (Borthakur & Govind, 2018). According to Miner et al. (2020), about 17.5% of respondents in Jos, Plateau State, Nigeria, disposed of their appliances by selling them, but only 8.7% of respondents in Sydney, Australia, chose to sell their E-waste (Islam et al., 2021).

Overall, it can be seen that the percentage of respondents in the present study is the highest as compared with respondents in the previous studies. This indicates that disposal options have an economic value. This includes selling, have attracted most of the respondents in Malaysia compared to respondents in other study areas. The public will eventually be persuaded to choose selling as the disposal option if the market price is profitable and if numerous companies and businesses offer deals on purchasing E-waste.

### *6.4.5 Practices in Trade-in the Unwanted Appliances*

Another option for extending the lifespan of electrical and electronic appliances is through exchanging old appliances for new ones, also known as trade-ins. Based on the analysis, 69.6% of the respondents chose to trade in their E-waste. When comparing trading in and selling E-waste, respondents preferred to sell rather than trade-in. Although trade-in will benefit the consumer in getting a new item, the trade must be between similar types of appliances, for example, between one mobile phone and another. Sometimes, consumers are required to make an additional payment before getting a new appliance. As stated by Saritha et al. (2015), this trade-in process usually takes place in the case of mobile phones, where consumers tend to exchange their old or used phones for the newest version.

A similar question has been addressed in both local and international studies. As reported by Dwivedy and Mittal (2012), more than 40% of their respondents in India chose to trade in their unwanted appliances. Then, Bhat and Patil (2014) found that 32% of respondents in Pune City, India, chose to trade in their E-waste when they needed to replace it and considered it as the most likely disposal channel compared to other disposal approaches. For respondents in Bangalore, India, only 22.1% of the total respondents chose to trade in their E-waste (Borthakur & Govind 2018). Similar studies were conducted in India despite different sampling and study areas. In general, it can be seen that the percentage of respondents has decreased over the years. Tarawneh and Saidan (2013) illustrated that only 17.6% of the total respondents in Jordan agreed that they manage their E-waste by trading in their used appliances. This percentage is almost the same as the study conducted in Melaka, which discovered that 18.3% of the respondents chose to trade in their E-waste (Tiep et al., 2015). Similar to the selling option, the percentage of respondents who decided on a trade-in is highest in this current study when compared to respondents in

previous studies. The trade-in also has monetary advantages that entice respondents to do so.

There is a demand for this approach; however, enhancing its promotion would be beneficial to increase consumer participation. Even though trade-in will increase the lifespan of the electrical and electronic appliances, the trade-in must be conducted at the registered company as an example to ensure the unwanted appliances are not taken for granted. Besides, trade-in also should be for the whole set, for example, mobile phone, and should be hand-in together with the charger so that nothing will be left behind.

### *6.4.6 Practices in Sending Out E-waste to the Collection Centre*

According to the literature, facilities are one of the catalysts for active public participation in sustainable E-waste management such as recycling. In this practices section, the percentage of respondents who actively sent their E-waste to the nearest authorized collection centre is reported. It was found that this percentage was about 60.7%. A similar question was also presented in a study conducted in Beijing, China, which found that about 12.6% of the total respondents acted by taking their E-waste to the authorized collection centre (Wang et al., 2011). It can be seen that this practice is less popular among respondents in this study compared to selling and trading in E-waste. However, the percentage of respondents who send their E-waste to the collection centre is higher than those in the previous studies.

Tiep et al. (2015) found that 8.2% of their respondents in Melaka sent their E-waste to the collection and recycling centre (Tiep et al., 2015). A similarly low percentage (6.5%) of respondents in Kota Kinabalu disposed of their unwanted appliances at the nearest authorized centre (George et al., 2019). According to Islam et al. (2021), about 25% of

respondents in Sydney, Australia, chose to drop off their E-waste at an authorized collection centre.

It is important for formal collection centres to be located within the neighbourhood boundaries to enhance people's motivation to use these centres for their E-waste. A proper E-waste collection centre that considers the location, distance, convenience, and suitability to send off both small and large appliances will be able to attract more of the public to take part in sending off their unwanted appliances. Good monitoring and financial support also will eventually help to maintain the collection centre.

### *6.4.7 Practices in Sending Out E-waste to the Scrap Collection Centre*

Besides formal and authorized collection centres, E-waste scrap collection centres are also available. The present study discovered that 58.9% of the respondent took their E-waste to scrap collection centres. This was similar to the percentage who used authorized collection centres, and again, it is lower than the percentages of respondents who chose to sell or trade in their E-waste.

A study conducted in Athens, Greece, found that only a small percentage of respondents disposed of E-waste at scrap collection centres (Abeliotis et al., 2006). In Kuala Lumpur, Malaysia, an even smaller percentage (2.0%) of respondents disposed of their old, unwanted, and malfunctioning appliances at recycling and collection centres (Akhtar et al., 2014). Similarly, in Melaka, Malaysia, only 6.7% of respondents used this approach to dispose of their E-waste (Tiep et al., 2015).

In comparison to the current study, the percentage of respondents who send their E-waste to the scrap collection centre is lower, indicating that Malaysians currently consider scrap

collection centres as one of their options for disposing of unwanted appliances without considering whether the centre is operating legally or not. However, the public should be reminded that E-waste can only be sent to formally designated scrap collection centres. Using unauthorised centres might harm the environment if their handling of E-waste does not follow the guidelines and standard operating procedures (SOP). As Nowakowski (2016) stated, scrap collection points are not legal and represent the informal sector unless registered.

### *6.4.8 Practices in Donating Unwanted Appliances*

Donation is also a good option to dispose of unwanted but still functioning electrical and electronic appliances. This will eventually increase the lifespan of the appliances and hence reduce the generation of E-waste in the waste stream. The percentage of respondents who applied this practice to handle their unwanted electrical and electronic appliances was about 61.6%, higher than the percentage who took their E-waste to authorized scrap collection centres. This act of charity not only lightens the burden for any party who cannot afford to buy new appliances but is also a convenient and, hence, approachable practice among consumers. Questions about the donation of electrical and electronic appliances were also addressed in similar studies across the globe. E-waste can be donated to different channels, such as to any charity organizations, schools, and the public in need, as well as family and friends.

For example, in Athens, Greece, 14.0% of the respondents chose to give away their unwanted appliances (Abeliotis et al., 2006). More than 10% of respondents in India chose to donate their E-waste (Dwivedy & Mittal, 2012), as did about 11.3% of respondents in Macau, China (Song et al., 2012). A study conducted in Jordan found that 9.8% of respondents donated their old appliances (Tarawneh & Saidan 2013).

Only 6% of respondents in Pune City did so (Bhat & Patil 2014). Meanwhile, about 32.6% of respondents in Bangalore gave their unwanted and used appliances as gifts to their family members (Borthakur & Govind 2018). According to Miner et al. (2020), only 7.9% of respondents in Jos, Plateau State, Nigeria, donate their E-waste to less fortunate people. Among respondents at Midwestern University, Australia, about 40.8% disposed of their E-waste through donation (Arain et al., 2020).

As for local studies, as highlighted in Tiep et al. (2015), respondents in Melaka, Malaysia, either gave their second-hand appliances to family or friends (21.5%) or donated suitable second-hand appliances to schools or charity organisations (5.0%). Meanwhile, 6.5% of respondents in Kota Kinabalu, Sabah, Malaysia respondents gave appliances to family members, while 1.7% donated them to anyone in need (George et al., 2019).

The percentage of respondents in the present study who choose to donate their unwanted appliances is higher than those in previous studies. Usually, the appliances are still in good condition and have only been utilized for a short period of time, leading the public as consumers to donate them. This approach is convenient since the unwanted appliances can be simply given to anyone needed. The current owner just needs to ensure the appliances are still in good condition before passing them down to the new owner. Hence, it will help to promote the increasing number of consumers practicing this disposal approach.

#### *6.4.9 Practices in Repairing the E-waste*

The next practice to be discussed is repairing. This approach can provide broken appliances a 'second life' and thus increase their lifespan. The lifespan of an appliance is important, as it is significant to the generation of E-waste in the waste stream. As reported

in this study, 72.6% of respondents chose to repair their broken and malfunctioning appliances. This is similar to the percentage who sold their E-waste. Hence, repairing and selling appliances are the most favourable methods among respondents in this study. The main target when repairing broken and malfunctioning appliances is to re-use them.

This output is consistent with previous research conducted in India, where the majority of the respondents were willing to repair their E-waste (Borthakur & Govind, 2018). A study conducted in Onitsha, Nigeria, discovered that only 27.0% of the total respondents chose to repair their used appliances (Nduneseokwu & Appolloni, 2017). In the same year, a study conducted at Federal University Wukari, Taraba, Nigeria, revealed that the percentage of respondents who chose to repair their E-waste was about 16.4% (Azodo et al., 2017). Illustrates that only 1.6% of respondents in Melaka, Malaysia, chose to repair appliances due to the high cost involved (Tiep et al., 2015). In Malaysia, where this option is widely practiced, the percentage of the public as consumers who choose to repair their E-waste has grown over time. There are several different motivations that lead consumers to practice this approach, such as appliances still being within their warranty period, promotional prices to fix the appliances, and the sentimental value of the appliances.

### *6.4.10 Practices in Discarding the Unwanted Appliances*

Among all the methods listed in the previous questions, simply throwing away broken or malfunctioning electrical and electronic appliances is considered the most unsustainable practice for the public to practice. Only 45.7% of the respondents in this study stated that they did not simply throw away their E-waste. However, more than 50% of respondents practiced this unsustainable E-waste disposal method. Analysis revealed that this percentage was the lowest among all the practices. This indicates that respondents in Malaysia do not simply throw away their E-waste but choose other options. A similar

question has been addressed in previous local and international studies over the years with different groups of respondents and varieties of output.

A study conducted in India found that fewer than 10% of respondents simply threw away their E-waste (Dwivedy & Mittal 2012). However, Kumar (2017) found that 67% of respondents at the University of Delhi, India, specifically chose to simply throw away their IT appliances. The percentage of respondents in India who chose to simply dispose of their E-waste has increased over the years despite the differences in the study's samples. This huge disparity of percentages was also found in three different studies that were similarly conducted in Nigeria. Azodo et al. (2017) found that 14.2% of respondents at Federal University Wukari, Taraba, Nigeria, tended to throw away their E-waste when the appliances no longer served their purpose. Further afield, up to 65.7% of respondents in Onitsha, Nigeria, chose this disposal method (Nduneseokwu & Appolloni, 2017). Then, Miner et al. (2020) found that only 6.7% of respondents in Jos, Plateau State, Nigeria, chose to do so. This will reflect the importance of the demographic variables of respondents, as this will lead to variations in output. Next, 25.1% of respondents in Macau, China, chose to dispose of their E-waste in the bin (Song et al., 2012). Similarly, the percentage of respondents in Jordan who simply threw away their E-waste was about 28.4% (Tarawneh & Saidan 2013).

A study conducted by Afroz et al. (2012, 2013) discovered that 29.7% to 30.0% of respondents in Kuala Lumpur simply put their E-waste in the bin. About 30% of respondents in Kuala Lumpur, Malaysia, did the same (Akhtar et al., 2014). A smaller percentage was reported by Tiep et al. (2015), where only 6.8% of respondents in Melaka, Malaysia, chose this practice. Hence, Tiep et al. (2015) specifically reported that those respondents simply disposed of old mobile phones (8.3%), personal computers (6.9%),

and televisions (5.2%) in waste bins. This indicates that small appliances are much easier to dispose of using the waste bin compared to large appliances, which has been highlighted in Abeliotis et al. (2006) that respondents in Athens, Greece, tend to simply throw out their small appliances compared to large white appliances. George et al. (2019) also found that a relatively high percentage, 44.5% of respondents in Kota Kinabalu, Sabah, Malaysia, preferred this method. Based on these, it can be highlighted that the percentage of respondents who simply disposed of their E-waste in this present study is higher than reported in previous studies. Even though those studies were conducted in Malaysia, there were differences in respondents' demographic variables. The relationship between demographic variables and disposal practices will be further discussed in the following sub-chapter.

This practice is simple and easy for anyone in the household to conduct. Electrical and electronic appliances that no longer serve their purposes are simply put in the bin. However, this approach has a higher risk and potential harm to the environment and to human health. This is due to the mixing of different types of waste and the fact that the lifespan of E-waste is reduced in this way, such that it will eventually end up in the waste stream, causing an increment in E-waste generation. The stakeholders should implement appropriate legislation and enforcement to forbid the public from merely disposing of E-waste.

## 6.5 Preferred Sources of Information on E-waste among Respondents

Sources of information represent an important component that will help to increase knowledge and provide adequate information to the public. Previous studies underlined the importance of sources of information in reducing E-waste generation, such as providing information on the advantages of practicing E-waste recycling, how to safely

dispose of used appliances, locations to recycle E-waste, collection systems, and management; hence, sources of information work as an instrument to create a better understanding and increase the public's participation in waste management, such as segregation activity (Darby & Obara, 2005; Mmereki et al., 2015; Rhee, 2016; Martinho et al., 2017; Afroz et al., 2020; Alhassan et al., 2020).

This section will discuss the various sources of information on E-waste. According to Saritha et al. (2015), one of the obstacles in managing E-waste is inadequate information. According to Gurauskienė (2008), the best way to get people involved in effective E-waste management, such as segregating E-waste from solid waste, is to provide them with adequate information and education. Various sources of information can help raise awareness of the effects of E-waste, the importance of E-waste recycling to conserve raw materials, and all related information on E-waste (Iqbal et al., 2015). Azad et al. (2017) emphasized the importance of information whereby a lack of awareness and cautionary information in handling E-waste could lead to harmful exposure to human health.

A similar question was also asked in the study by Islam et al. (2016), who sought to discover whether print and electronic media advertised any information related to environmental issues or E-waste management. Chaudary and Vrat (2019) also highlighted the effectiveness of media, especially the internet, in increasing the level of awareness of E-waste amongst the public. Without information on E-waste recycling, the community may be unable to practice E-waste recycling due to a lack of information (Senawi & Sheau-Ting 2016). This demonstrates that the question is still relevant, and it is essential to identify the sources of information about the related study topic.

Since a large number of respondents (64.3%) agreed that the internet is their primary source of information, this outcome is consistent with the technological and modernization era. The internet provides a completely new hope for conveying messages and information. According to Chaudhary and Vrat (2019), up to 49.0% of respondents in India agreed that this medium can raise public awareness about E-waste. There are several examples of internet sources, such as emails, newsletters, official portals of government agencies, and social media, such as Instagram, Facebook, and Twitter. For example, Delcea et al. (2020) conducted a study on the determinants of E-waste recycling decisions in Romania. They concluded that 40.04% of respondents received information regarding E-waste on their social media newsfeeds, 33.46% from online discussions, 32.33% via commercials, and 24.06% through videos related to E-waste posted on social media. However, the extensive use of the internet among the public today must not devalue other sources of information.

According to the results of this study, television, in addition to the internet, is also a primary source of information, as agreed by another group of respondents, about 59.7%. According to Ahmad et al. (2015), television is an example of traditional media that can effectively provide the public with environmental information. At least one television is normally present in every household. In Malaysia, everyone is able to view free channels such as TV1, TV2, and TV3. As a result, television, as an information medium, is also convenient, easy to use, and user-friendly, regardless of demographic background. Advertisements on television would be sufficient to raise consumer awareness of E-waste and disposal options (Chaudhary & Vrat 2019). Meanwhile, Ongondo and Williams (2011) suggested that television and the internet are both sources of information that will continue to promote sustainable E-waste management, with young people as the target audience because they use both in their everyday routines.

According to Ahmad et al. (2015), family members play a significant role in providing messages and information about environmental issues, leading to positive environmental practices. According to the findings of this study, the majority of respondents who had not had any formal education agreed that family members were their primary sources of information on E-waste. This is consistent with what Ahmad et al. (2015) suggested previously. This output is also related to the question on the practices section (Question P3), in which most respondents agreed that they encouraged their family members to practice sustainable E-waste disposal. Hence, it is proven that family members play a significant role at the household level in this sustainable E-waste management.

Overall, it can be observed that, in addition to the internet and television, which are known as key sources of information on E-waste among the 3,015 respondents in this study. There are also other types of information sources that can provide the public with information and material about E-waste, which were listed in the questionnaire survey. Various sources of information will eventually improve the effectiveness of the media in educating the public about environmental issues. Everyone should have access to the same information through different channels. Stakeholders are essential in providing enough information to raise public awareness and encourage sustainable practices.

According to Amouei et al. (2016), waste management education provided through media such as television and radio can improve knowledge, attitudes, and practices among the public. The availability of E-waste information from various sources allows such information to influence the level of knowledge, attitude, and practices regarding E-waste recycling. For example, information about the effects of E-waste generation and the benefits of E-waste recycling activity will eventually enhance respondents' levels of knowledge. This is similar to the findings of Senawi and Sheau-Ting (2016), who

emphasised the importance of information in increasing E-waste knowledge and awareness, such as how to recycle and the benefits of E-waste recycling. In addition, information such as the monetary value of E-waste and the various programmes to improve sustainable E-waste practices can help to improve respondents' attitudes. The public should be aware of the monetary benefits of carrying out proper E-waste treatment, according to Gunarathne (2015). Furthermore, information regarding where to dispose of E-waste, the availability of facilities, and the rewards for implementing sustainable E-waste management will be able to stimulate the public and thus enhance the level of practices.

Sources of information include billboards, brochures, campaigns, mass media, newsletters, official websites, public hearings, and social media. Besides, the suitability of the information medium will lead to effective communication in order to ensure that the message is conveyed accurately (Vicente & Reis, 2007; Welfens et al., 2016; Moh, 2017). As referred to in the output of this present study, it can be seen that information on E-waste in Malaysia has been promoted on various channels, not only focusing on the popular ones such as the Internet and television. This proves that E-waste is an important environmental issue at the national level and become a concern nowadays. Various sources of information nowadays lead to the effectiveness of information as a medium for the public to increase their knowledge related to E-waste, which eventually will help boost the attitude and practices of an individual.

As this information is highlighted in this study, it will provide insights to the government, NGOs, electrical and electronic companies, and other relevant stakeholders regarding the preferred sources of information on E-waste. As agreed by most respondents in Adnan Menderes University, Turkiye, in the study conducted by Deniz et al. (2019), the local

government is responsible for informing the public regarding E-waste. Islam et al. (2021) also emphasized the importance of local government, especially in educating the public regarding E-waste and encouraging the public to better E-waste management and recycling practices. This also highlights that information should be widely promoted on official social media, such as writing a publication or bulletin, posting posters, and conducting free talks regarding the importance of sustainable E-waste management at various levels. Responsible bodies such as the government or influential individuals such as celebrities and public leaders can also work as mediators in conveying information via awareness campaigns, community programmes, distribution of material from house to house, and educational content on websites and in the educational syllabus (Parizeau et al., 2015; Mamady, 2016; Welfens et al., 2016; Martinho et al., 2017).

## 6.6 The Knowledge, Attitude, and Practices of E-waste Recycling among Respondents Based on the Demographic Variables

Demographic variables are one of the important keys to achieving the objectives of this study, as stated by Thi Thu Nguyen et al. (2019), who found that demographic variables such as family size, educational background, and age could impact the behaviour and attitude of the public towards recycling activity. Similarly, the same idea was highlighted by Nduneseokwu et al. (2017), who found that demographic variables could impact the dependent variables in the case of public intentions to participate in formal E-waste collection. In addition, Delcea et al. (2020) also agreed that demographic variables could determine the public's behaviour regarding recycling activity. According to Sivathanu (2016), age, gender, income, and educational background are those demographic variables commonly found in the literature review to have a significant relationship with recycling behaviour.

However, this opinion contrasts with the findings of Miner et al.'s (2020) study conducted in Jos Plateau State, Nigeria, which concluded that demographic variables do not contribute to the public's knowledge, awareness, and participation related to E-waste. According to Deniz et al. (2019), environmental degradation now affects the public regardless of their demographic background. In this present study, the chi-square analysis is conducted between each of the demographic variables and each of the KAP questions.

The chi-square analysis is used to examine the relationship between demographic variables and knowledge, attitude, as well as practices. This is in line with the suggestion made by Almasi et al. (2019), Barloa et al. (2016), Haron (2015), and Mukama et al. (2016), which highlights how demographic factors can affect a person's knowledge, attitude, and practices. The present study identified five demographic variables consistently reported to have significant impacts (p-value < 0.05) on knowledge of E-waste recycling: age, educational background, income, occupation, and residential location. As significant p-values were consistently discovered for all the knowledge questions in the present study, it can be concluded that knowledge of E-waste recycling amongst the 3,015 respondents differed based on those five demographic variables. This section will also discuss the relationship between the demographic variables and attitude questions. Based on the analysis conducted, five demographic variables, namely, age, income, occupation, type of house, and residential location, consistently showed significant relationships (p-value <0.05) with all questions on the attitude towards E-waste recycling. Hence, the output of this study is aligned with the previous studies that stated demographic variables significantly show association with knowledge, attitude as well as practices.

The practices section differed from the knowledge and attitude sections, as no demographic variables showed consistent significant relationships with all questions in this section. However, some demographic variables had consistent relationships within the questions group on practices. Age, marital status, and occupation showed consistently significant relationships with the questions in the section on the general practices of E-waste recycling. Meanwhile, there was a significant relationship between educational background and disposal practices on E-waste recycling among respondents. This significant p-value reflects a difference in the level of practices according to the listed demographic variables.

It is important to determine the demographic background of the public to show such a relationship, as these factors will aid in promoting E-waste recycling. Based on the information obtained, this present study found that age and occupation variables had consistently significant relationships with all knowledge, attitude, and general practice questions on E-waste recycling. The level of income and residential location were also found to have a significant relationship with knowledge and attitude on E-waste recycling questions. This indicates that the relationship between knowledge and attitude is also supported by these two demographic variables. Educational background also had consistently significant relationships with knowledge and disposal practices, indicating that the relationship between knowledge and E-waste recycling practices is influenced by these two demographic variables. The KAP of the respondents may eventually differ from one another and depending on the particular demographic variables when there is a significant relationship.

### *6.6.1 Relationship of Age with Knowledge, Attitude, and General Practices on E-waste Recycling among Respondents*

In this present study, the age variable shows a consistent result of a significant p-value less than 0.05 with all the questions in knowledge (K1-K14), attitude (A1-A7), and general practices (P1-P3) towards E-waste recycling. According to this, knowledge can be seen as the important key to influencing the attitude of individuals. Then, both knowledge and attitude will be able to influence the general practices on E-waste recycling among the respondents. This is also proven by Saxena et al. (2018), who stated that practices are the consequences of an individual's knowledge and attitude, which are dynamic and evolve over time.

Significant values of p-value < 0.05 were similarly reported in studies conducted among respondents in Onitsha, Nigeria (Nduneseokwu et al., 2017) and in Vietnam (Thi Thu Nguyen et al., 2019), emphasising that age variables had a significant impact on respondents' attitude towards E-waste recycling. Meanwhile, Wang et al. (2016) concluded that E-waste recycling among respondents in China could not be classified based on age since this variable did not yield significant value, and a similar conclusion was found by Miner et al. (2020). According to Saphores et al. (2012), the age variable plays a significant role where there is a generation effect that leads different age groups to practice recycling. In terms of practices, different age groups might be involved in different ways of managing E-waste at the household level. For example, the youngest is the one who segregates the E-waste. At the same time, the oldest is responsible for sending the E-waste to the designated disposal centre, which means everyone in the household has a different role and responsibility towards the E-waste.

Since age can influence the knowledge, attitude, and general practices regarding E-waste, exposure to E-waste should be enhanced at the early stages. This output is similarly found in Davoudi et al. (2018), where the KAP of respondents in Yazd City, Iran, towards E-waste, was influenced by age. It is critical to exchange knowledge and collaborate as a group in order to improve present results. There should be community collaboration without taking age into account. An E-waste recycling initiative involving all community members of all ages should be implemented.

### *6.6.2 Relationship of Occupation with Knowledge, Attitude, and General Practices on E-waste Recycling among Respondents*

Then, next to age, occupation was also found to consistently have a significant p-value of less than 0.05 with all the knowledge, attitude, and general practices questions on E-waste recycling. This indicated that the level of knowledge, attitude, and general practices on E-waste are significantly different amongst people with different occupations. There are several factors that can contribute to this, such as the working environment, colleagues, companies' provision of training or talks related to waste management, and whether the company is related to the environmental management or sustainability field, which will lead to good exposure regarding E-waste. However, this study did not specifically ask respondents about the fields in which their companies operated. This question should be included in future studies to help measure whether working specifically in the environmental field can influence knowledge on E-waste or otherwise.

The finding of the present study is also aligned with the study conducted in Yazd City, Iran, by Davoudi et al. (2018), where occupation is found to be significant (p-value < 0.05). According to Babaei et al. (2015), occupation was an important variable in predicting solid waste recycling activity among respondents in Abadan City, Iran. Despite

the fact that their study was about different types of waste and different respondents' backgrounds, it is important to note that occupation is one of the elements that contribute to disparities in output across respondents. Occupation is usually based on the educational background of an individual. Hence, the occupation variable led to differences due to the working environment, training or talks on-site related to environmental awareness, and information from colleagues.

### *6.6.3 Relationship of Income with Knowledge and Attitude on E-waste Recycling among Respondents*

Apart from age and occupation, the level of income among respondents was also found to have consistently significant relationships (p-value < 0.05) with all knowledge and attitude questions. This significant relationship has shown that the level of income will be able to influence the knowledge of an individual, which then also influences the attitude. The income level is also related to the purchasing power of an individual who can choose a quality appliance with a longer lifespan despite its price. Meanwhile, for the practices section, the level of income was not found to be consistently influenced by the practices. Level of income is one of the demographic variables commonly found in previous studies to influence recycling behaviour (Sivathanu, 2016). Different income levels are usually due to differences in educational background and type of occupation. Income levels can also determine the individual's purchasing power and expenses.

A study conducted in Onitsha, Nigeria, by Nduneseokwu et al. (2017) found that the intention of an individual to participate in a formal E-waste collection system was significantly affected by income. Wang et al. (2016) emphasized that people with higher levels of income were most likely to choose convenience in managing their E-waste but were unconcerned about the benefit that would be received when conducting proper E-

waste management. This is why individuals with higher incomes are more likely to recycle (Saphores et al., 2012).

### *6.6.4 Relationship of Residential Location with Knowledge and Attitude on E-waste Recycling among Respondents*

In addition, the residential location was also consistently and significantly related to all questions in both knowledge and attitude sections at a p-value less than 0.05 in this present study. This reflects that the knowledge and attitude of respondents towards E-waste recycling can be different based on their residential area. This was the geographical aspect that was considered in this study. Even though E-waste is a global environmental issue that could affect everyone regardless of their demographic background, the significant p-values reflect a difference in levels of knowledge and attitude amongst respondents based on their residential location. Several factors lead to the differences: community lifestyle, purchasing power, and exposure to related issues. The residential location will reflect the neighbourhood and community that the public interacts with. The neighbourhood association, also known as "Rukun Tetangga," can also become the medium for publicizing information related to E-waste.

### *6.6.5 Relationship of Educational Background with Knowledge and Disposal Practices on E-waste Recycling among Respondents*

Chibunna et al. (2013) stated that education has a significant impact on individuals, which means that it is important to measure the educational background and level of knowledge. Different levels of educational background will eventually lead to differences in receiving information. In Malaysia, environmental awareness has been discussed at different levels of education and in different subjects, such as sustainability, waste management, and

environmental degradation. However, the acceptance and understanding of these issues vary based on the level of education.

According to the Ministry of Education (MOE), the national education system in Malaysia is categorized into several stages. It starts with preschool education for children aged between four and six, followed by primary school for six years in total. Then, it is followed by lower and upper secondary school, and following that is the post-secondary education, also known as the pre-university stage. For this post-secondary education, an individual can choose from different options, such as Sijil Tinggi Persekolahan Malaysia (STPM), matriculation, and Sijil Tinggi Agama Malaysia (STAM). This is then followed by higher education, comprising either a Certificate or Diploma education, teacher education at Teacher Training Institutes, or a bachelor's degree. There is also postgraduate study for either a master's degree or a PhD after acquiring a bachelor's degree (StudyMalaysia, 2015; Ministry of Education, 2019). The educational background might differ between individuals, resulting in different levels of knowledge about environmental issues.

Based on this present study, it is found that educational background shows a consistently significant p-value of less than 0.05 on all questions in the knowledge and disposal practices questions of E-waste recycling. For respondents in Yazd City, Iran, a significant relationship was also found (p-value $< 0.05$) between knowledge and attitude (Davoudi et al., 2018). According to this, it can be seen that knowledge is similarly found to have a significant relationship in the previous study. Davoudi et al. (2018) highlighted that the higher an individual's educational background, the more knowledgeable he would be. This also highlighted the importance of training and increasing knowledge through education. The continuation of educating people should be conducted from time to time.

Since all questions in both the knowledge and disposal practices sections were reported to have a significant p-value with the educational background, it can be seen that knowledge plays an important role in enhancing the sustainable disposal practices of unwanted appliances at the public level. Hence, it is important to ensure that all stakeholders take part in educating the community as well as utilizing all mediums in delivering the information. Based on the output of this present study, the internet has been seen as the most preferable source of information regarding E-waste. However, the other sources of information should not be left out since a small percentage of respondents still choose other sources of information apart from the Internet.

As Chibunna et al. (2013) emphasised, education significantly impacts public participation in E-waste recycling. Knowledge ultimately influences practices. Education helps individuals gain knowledge, input, and information, leading to good practice. The difference in levels of practices amongst respondents with different levels of education is due to exposure to environmental issues. The syllabus taught acceptance and understanding of how to manage E-waste. This output has similarly discussed in Sivathanu (2016) that educational background is commonly found in the literature review to have a linkage with the recycling behaviour of an individual. For example, Saphores et al. (2012) agreed that the higher the level of education, it will be able to foster a person to recycle. Then, Amulhim (2022) stated that education is the key to measuring the sustainability of E-waste.

### *6.7 Relationship of Knowledge, Attitude, and Practices (KAP) of E-waste Recycling among Respondents*

Knowledge works as a catalyst in influencing the shift from a negative to a positive attitude. However, this attitude still depends on how the knowledge is presented and how

the individual receives the information (Darby & Obara, 2005; Vicente & Reis, 2007; Launiala, 2009; Desa et al., 2011; Sanjeev et al., 2014; Akhtar et al., 2014; Babaei et al., 2015; Jekria & Daud, 2016). Based on this, the knowledge and attitude elements have a relationship and are hence able to influence one another. Knowledge regarding waste disposal can affect the public's attitude.

According to Chibunna et al. (2013), Haron (2015), and Shahzadi et al. (2018), in order to achieve a successful recycling practice, it depends on the individual's attitude toward waste recycling. In addition, according to Ali et al. (2016), knowledge and practices show a positive relationship, such that when knowledge increases, practices also increase. It is thus suggested that a good approach to promoting knowledge will be able to help in enhancing practices. This linkage shows the importance of each element of KAP towards one another.

Based on the analysis conducted for this present study, it can be seen that the relationship between knowledge and attitude, knowledge and practices. Attitudes and practices all reported a significant p-value of less than 0.001, which shows that KAP is able to influence one another in the context of E-waste recycling. The cross-tabulations on KAP of E-waste recycling among respondents can be explained as follows: the majority of respondents with low levels of knowledge and attitude also scored low levels of practices. Then, for respondents whose scores indicated moderate and high levels of knowledge, the majority had high levels of attitude. However, the majority of those with high levels of knowledge as well as attitude reported having a moderate level of practice. As for the attitude section, most respondents who scored moderate and high levels of attitude reported moderate levels of practice.

Tarawneh and Saidan (2013) highlighted the importance of knowledge as the key factor in achieving better and more sustainable E-waste management. In addition, according to Iyer (2018), when there is an increase in knowledge on E-waste, the public's attitude towards E-waste will eventually increase. This can be proven if an individual does not have the knowledge. This would not help to boost his attitude as in this present study, where the majority of respondents who were discovered to have a low level of knowledge also have a low level of attitude. Knowledge can be seen as a push factor. Even a moderate level of knowledge is able to lead to a high level of attitude, which reflects how significant and important the knowledge is.

In order to illustrate how important the role of knowledge is to develop a sustainable community, it can be seen that the majority of respondents with low levels of knowledge were eventually also discovered to have low levels of attitude and practices. This shows a huge impact on knowledge. Hence, in order to promote sustainable E-waste recycling in the community, it is important to ensure adequate knowledge is provided throughout. Even though in this present study generally, the knowledge of respondents towards E-waste recycling shows a good outcome, the continuation of educating the community should be sustained. It also can be seen that in this present study, the majority of the respondents with moderate levels of knowledge were discovered to have low levels of practice. Meanwhile, in the study conducted by Azodo et al. (2017), both knowledge and practices on E-waste were reported to be moderate in level. Then, those respondents who scored a high level of knowledge had a moderate level of practice. This indicates that apart from knowledge, conducting sustainable practices in E-waste recycling requires external factors such as convenience, distance, location, and economic values that should be taken into consideration. In this study, the majority of respondents agreed that they are ready to recycle their unwanted electrical and electronic appliances if only incentives are

provided. Additionally, most respondents concurred that they would be willing to dispose of their E-waste properly if a collection facility were near their homes and workplaces.

Then, as the results of the relationship between attitude and practices on E-waste recycling, the majority of respondents with a low level of attitude reported having a low level of practices. Those who reported having a high level of attitude eventually had a moderate level of practice. Both outcomes were similar, as reported in the knowledge section. Meanwhile, the majority of respondents with moderate levels of attitude also have moderate levels of practice. According to these outcomes, in this present study, it can be seen that a good attitude will help boost an individual to do what they intend and believe in. This can be viewed in the light of the definition of attitude defined by Akhtar et al. (2014), Babaei et al. (2015), Darby and Obara (2005), Desa et al. (2011), Jekria and Daud (2016), Launiala (2009); Pelto (1994) in Launiala (2009); Petty and Cacioppo (1981), Sanjeev et al. (2014), Sivathanu (2016), and Vicente and Reis (2007), who characterised attitude as beliefs, emotions, feelings, thinking, and values of an individual that can affect a person's actions and the development of new habits.

The present study has shown that knowledge plays an important role in enhancing attitudes and practices. Jayaraman et al. (2019) illustrated that the public, as key consumers, must have the knowledge to manage their E-waste sustainably. Even though in this present study, only knowledge and attitude showed high scores, while practices reported a moderate level in general, improvement is required for groups of respondents whose scores indicate low levels of KAP. Amouei et al. (2016) also reported a high level of knowledge of E-waste; however, the study reported moderate and low levels of attitude and practices, respectively. As highlighted in the study conducted by Akhtar et al. (2014), the environmental knowledge and attitude of individuals are influenced by factors such

as age, education, gender, and social influence. In this study, we have found that both age and educational background significantly influence KAP regarding E-waste recycling.

## 6.8 Satisfaction Level of E-waste Services among Respondents

According to Saritha et al. (2015), in order to manage E-waste, a long-term, systematic, and formal approach is required. E-waste management involves collaboration and accountability from all stakeholders, for example, the public. As Senawi and Sheau-Ting (2016) suggested, public feedback on E-waste recycling is vital in supporting E-waste management. The feedback of respondents is important in order to achieve significant improvements in the E-waste management system. Hence, this present study highlighted a question related to the public's satisfaction with the current E-waste management in Malaysia. This question is highlighted in order to achieve the final objective of this study. Almasi et al. (2019) posed a similar question to respondents in Kermanshah, Iran, in order to investigate public satisfaction with the waste collection system. Similarly, Seng et al. (2018) and Babaei et al. (2015) sought to find out how satisfied people were with waste management in Phnom Penh, Cambodia, and Abadan, Iran, respectively. However, previous studies focused on the management of solid waste rather than E-waste.

Since the percentage differences between the satisfied and dissatisfied respondents are so small, they are presented as two separate major groupings. Respondents who selected "No," indicating that they were dissatisfied with the way E-waste is currently managed, may submit comments in the section dedicated to that purpose. Based on the analysis, the comments were then classified into four major categories: facilities and management, opinion and suggestions, information and knowledge, and awareness. The percentage of respondents who are satisfied with the current E-waste management is satisfactory, according to the analysis's output, although it occasionally needs to be improved. Those

comments should be taken into account in order to increase the percentage of the public who are satisfied.

Among all four major groups of comments from the respondents who were unsatisfied with the current and available E-waste management, most agreed that it is due to facilities and management. Respondents emphasised the need for facilities and management approaches that make it easier for the public to participate in E-waste recycling. They referred to E-waste disposal bins, disposal centres, and door-to-door collection as facilities. Respondents wanted a convenient location to dispose of their E-waste. Convenience can be identified as the location of the disposal bin and the centre near the housing area. The door-to-door collection is convenient for them because it excludes the need to travel around to dispose of their E-waste. As Sivathanu (2016) suggested, recycling activities require an individual's time, effort, money, and space. Since recycling facilities must be easily accessible, it is crucial that they be in a convenient location for the public (Senawi & Sheau-Ting 2016; Nduneseokwu et al. 2017). The responsible bodies must ensure that the facilities are in good condition so the public can use them to dispose of their E-waste. Inventory and inspection of disposal facilities are required to ensure that the facilities are fit for purpose. This is similar to Nduneseokwu et al.'s (2017) proposal that the facilities provided must be functional for recycling activity to occur.

Then, another major response is regarding the information and knowledge. The process starts with information and knowledge, which can be delivered in various ways, including through media, campaigns, and promotions. In order to promote and motivate the public, monetary and reward incentives are needed to attract people's attention. Iqbal et al. (2015) proposed that product manufacturers should provide information on the product's component and substance content and the correct disposal method. According to the

comments in the present study, respondents primarily looked for general information on E-waste. Even though the information has been provided, thus far, it has not been able to achieve its objective since a group of respondents are dissatisfied with the available management and services due to a lack of information. The relationship between knowledge and attitude is represented by linking information and knowledge with awareness. It is possible to raise public awareness with adequate information. In addition, good practice will result from increased awareness. According to Senawi and Sheau-Ting (2016), reminders are required because people forget easily. These reminders can be both verbal and written, as they can be posted in common areas. This important feature will also help raise public awareness about E-waste. According to respondents' comments, a lack of exposure to E-waste causes a lack of awareness, resulting in dissatisfaction with E-waste management and services.

Apart from the two groups of comments, some respondents were unsatisfied with the current and available E-waste management due to their awareness of E-waste. In order to increase the awareness of this group of the public, the stakeholders, such as the government and NGOs, should take responsibility for providing adequate information. Adequate information would be a great help for the public to boost their awareness. The usage of various sources of information would make it convenient for the information to be conveyed to the public of different demographic backgrounds. Based on the analysis, it was discovered that respondents also filled in the comment section with some opinions and suggestions. All of the respondents' opinions and suggestions are valuable and should be considered. They will then play a role in increasing public participation in managing their E-waste. In this study context, public participation also represents the practices of E-waste recycling among respondents.

The output from this question discovered that the services provided on E-waste are a concern among respondents. It is important to receive output from respondents as the public is the primary key in electrical and electronic usage flow. Government agencies, private companies, NGOs, E-waste collectors, policymakers, and all relatable linkages in managing E-waste should consider all related comments in order to improve E-waste services. Involving all the stakeholders with active participation will eventually help achieve sustainable E-waste management. Information and knowledge work as important keys before an individual starts to take any action or conduct any practices, as with the information and knowledge, awareness will also bloom from time to time. The improvement of the management and facilities in handling the E-waste also works as they are key in ensuring the public practices sustainable E-waste disposal.

## 6.9 Conclusion

This sub-chapter summarised the discussion that has been illustrated throughout this chapter in relation to the research objectives. Overall, the respondents' knowledge of E-waste recycling was good. While the other questions on the knowledge of E-waste recycling illustrated a percentage of more than 70.0%, there were five questions to which the output required attention. There were four questions related to the disposal activity of E-waste, one question regarding the regulation, and another. Apart from information related to the ways of handling E-waste as well as the background of E-waste, important information, such as the related regulations, should not be left out. This is due to the existence of laws and regulations; the public will be more aware and feel responsible, thus taking this issue seriously. Then, as for questions related to the disposal of E-waste, the majority shows a moderate to low level of percentage of respondents who knew and were aware. All the related information should be adequate for the public to conduct sustainable management in handling E-waste.

Then, respondents' attitude toward E-waste recycling shows a good percentage. Based on the output in this attitude section, it can be foreseen that this group of the public has the potential to ensure that E-waste is managed sustainably, especially by practicing E-waste recycling. Based on the output, it was also discovered that convenience and economic benefits are catalysts in attracting the public towards E-waste recycling activity. Hence, it is important to ensure that besides the available information related to the location of the disposal facilities, those facilities must be convenient and conducive for the public and available in many areas. Thus, the economic benefit also must be promoted and made available to those who support this sustainable movement.

As for the practices towards E-waste recycling among respondents, it was discovered that the practices of encouraging the family member, as well as selling and repairing as the disposal practices illustrated 70.0% and above. Other questions show moderate and low levels of practice. According to this, practices towards E-waste recycling need to be enhanced among the community, especially stockpiling and simply disposing practices. The public as a whole must be educated on the importance of extending the life of E-waste and on how to properly dispose of it while ensuring an increase in its lifespan.

The current KAP on E-waste recycling has been highlighted in relation to the first research objective of this study. With the availability of this information, stakeholders such as the government eventually acknowledged the current status of KAP of E-waste recycling among Malaysian respondents. Additionally, to be able to identify which components of the KAP should be enhanced and require special attention in order to achieve sustainable E-waste management.

Apart from discovering the KAP of respondents towards E-waste recycling, sources of information are also being discussed. The internet was the most frequently preferred source of information on E-waste recycling amongst respondents in the present study. This reflects the fact that most E-waste recycling information is now delivered via the internet, which reflects the modernization nowadays. The internet has also been highlighted in previous studies, such as in India and Romania, and chosen as the most preferred medium for receiving information related to E-waste. Even though the internet is the most preferable, this study also highlights the importance of utilizing other sources of information as a medium to deliver information related to E-waste.

Stakeholders such as the government and non-governmental organizations (NGOs) ought to convey all E-waste-related information to the public. To expand their understanding of E-waste, the public should be well-informed and have enough information. With the results of this study present, those stakeholders can continue to use the internet as well as television as the primary medium to convey messages about E-waste to the general public through news and advertisements. Information is the key to raising public awareness and consequently assisting in the achievement of sustainable E-waste management.

Following the research objective, it was also discovered that demographic variables can influence respondents' knowledge, attitudes, and practices regarding E-waste recycling. Overall, five demographic variables, namely, age, educational background, income, occupation, and residential location, showed a consistent significant p-value with KAP questions. Both age and occupation show significant p-values with all questions in the knowledge, attitude, and general practices sections. As for the income and residential location level, both variables show significant p-values with all questions in the knowledge and attitude sections. Meanwhile, educational background was related to

knowledge and disposal practices. These demographic variables were important to reflect how their demographic variables influenced the KAP of respondents. Except for residential location, four other demographic variables were also significantly associated with at least one of the KAP components.

Policymakers will be able to project how specific demographic variables influence the KAP towards E-waste recycling based on the availability of data and information obtained in parallel with research objective 3. An action plan for achieving sustainable E-waste management can be suggested by determining which groups of people need special attention in order to improve E-waste management at the public level.

Next to the relationship between the demographic variables with each of the questions in all the KAP sections, based on the chi-square analysis, it is also discovered that KAP shows a significant p-value less than 0.001. A low level of knowledge resulted in a low level of attitude as well as practices for the majority of the respondents. Then, those respondents with a moderate or high level of knowledge also have a good level of attitude. However, most respondents, with both high levels of knowledge and attitude, only have a moderate level of practice. Based on the output, it shows that knowledge is an important aspect in influencing attitudes and practices. Thus, enhancing the practices towards E-waste recycling requires external factors such as the disposal location, convenience, collection services, and economic benefits.

Apart from highlighting the influence of demographic variables on KAP, the study's findings also revealed that KAPs can influence one another. This information is also important for stakeholders to recognise that the level of knowledge and attitude among respondents is good and should be maintained as well as improved on an ongoing basis.

It is suggested that E-waste recycling practises are still at a moderate level and should be improved to a satisfactory level in order to achieve sustainable E-waste management. As a result, stakeholders can refer to the output based on the first research objective to determine which components should be improved.

The satisfaction level is an important value added in this study because it required respondents to provide feedback on current E-waste management. Based on this feedback, data was then divided into four major groups. Based on the listed comments, the majority of the respondents stated that facilities and management were the reason behind the dissatisfaction with the current and available E-waste management. Facilities have also been highlighted in the previous sections where related information regarding the availability and location of the E-waste disposal and collection centre must be made available to the public. Furthermore, a good facility for disposing of electronic waste is one of the aspects that the community emphasises. With the help of this feedback, this study will be able to make recommendations on improving E-waste management at the individual and household levels. Previous studies also highlighted the importance of satisfaction level feedback to improve current E-waste management. This specific output will be discussed in the following chapter, the conclusion.

Since most respondents' practices on E-waste recycling are moderate, the final research objective regarding satisfaction with current E-waste management may also assist stakeholders in discovering what basis and how to improve the current E-waste management. The comments made by those dissatisfied with the current E-waste management can be used by stakeholders in developing an action plan to achieve sustainable E-waste management.

# CHAPTER 7: CONCLUSION

## 7.1 Introduction

Electrical and electronic waste, also known as E-waste, is a hazardous resource whose mismanagement can pose major threats to the environment and human health. E-waste is also a global environmental issue that requires attention from all stakeholders, and Malaysia is not excluded from facing this issue. This study managed to collect information on the public's current Knowledge, Attitude, and Practices (KAP) concerning E-waste recycling, their current sources of information regarding E-waste, and the satisfaction level towards E-waste services. Following the completion of this research, it was useful to generate a database to address the demands and discover solutions for an environmentally sound approach to enable the public to manage their E-waste.

The study comprised seven chapters, beginning with chapter one, which introduced the topic in general. This was followed by Chapter Two, focusing on the understanding of E-waste. Then, the literature review on KAP in chapter three highlighted the findings of prior studies on the study topic. Chapter Four sets out the methodology for the entire study. The findings and discussion were presented in Chapters Five and Six, respectively. The final chapter of this entire study is chapter seven, which focuses on the study's conclusion.

This chapter is divided into six sub-chapters to bring the entire study to closure, including the introduction and conclusion. It is based on the findings and discussions from the preceding chapters. Following the introduction, the next sub-chapter provides an overview of major scientific findings, followed by the study's contributions. The study's

limitations are then discussed, followed by recommendations for future research, and finally, a summary of the entire chapter.

## 7.2 Summary of Major Scientific Findings

In summary, this study examined the public's current E-waste recycling activity in three study areas in Malaysia: Port Dickson, Selangor, and Kuala Lumpur, with the respondents grouped together as one public unit. The findings of this study provide an understanding of the current state of E-waste recycling in households, specifically at the individual level. This is due to the general public being the primary users of electrical and electronic appliances, and they share responsibility for disposing of their unwanted appliances in a sustainable manner.

Firstly, regarding knowledge of E-waste recycling, more than 70.0% of respondents had good knowledge overall. However, there were five questions that illustrated that less than 70.0% of respondents knew about them, especially regarding the knowledge of disposal activity. Majority of respondents did not have information on the locations, services, and rewards available for E-waste disposal. As knowledge reflects familiarity, it can be observed that respondents were not familiar with the Environmental Quality Act 1974 (EQA 1974) since numerous respondents did not know that E-waste is stipulated in this EQA 1974. Similarly, regarding disposal activity, more respondents acknowledged the trade-in approach compared to the other listed options, indicating that those respondents were familiar with the ability to trade in used electrical and electronic appliances.

Next, as for attitude, it can be seen that respondents agree that they have the tendency to constantly change their appliances due to the new technologies, designs, and features offered nowadays. The majority of respondents indicated they were willing to join an E-

waste campaign, segregate their E-waste from other types of waste, send their E-waste to recycling centres, and reduce the volume of E-waste they generated. To boost this attitude, incentives and facilities work as motivational aspects, as agreed by most respondents in this study.

The practices variable was the next to be addressed. Segregating, stockpiling and simply throwing away E-waste does not reflect good practice among the respondents. In addition, these approaches cannot contribute to the circular economy. Even though simply throwing away E-waste is the easiest method for the public, such E-waste will end up in the waste stream and will thus cause harm. Selling and repairing used appliances were the most frequently chosen ways to manage and dispose of these unwanted appliances. Both approaches will increase the lifespan of E-waste, provide a monetary advantage if selling is opted for, and provide the ability to secure data if the item is repaired.

Next, most respondents agreed that the internet was the major source of information regarding E-waste. This is parallel to the modern era, where information is easy and convenient to deliver. Based on the output, it can also be illustrated that those with a good knowledge level received information from the internet via various platforms. However, adequate information is still required. Thus, it is important to strengthen the available information and utilize various sources to deliver information related to E-waste.

The findings revealed that occupation and age were both demographic variables that demonstrated significant relations with all questions in the knowledge, attitude, and general practices on E-waste recycling sections. Then, based on these findings, it also appeared that both knowledge and attitude are consistently associated with income and

residential location. All questions in the knowledge and disposal practices sections consistently show a significant relation with the educational background.

The findings from this study also revealed that the KAP variables influenced each other, with p-values of less than 0.001. From the analysis, it was discovered that respondents with low levels of knowledge and attitude also had low levels of practice. Meanwhile, respondents with moderate and high levels of knowledge and attitude reported moderate levels of practice. However, despite a good level of knowledge and attitude, most respondents only have moderate practice. This is considering that E-waste is still a new type of waste in the waste stream. Hence, the public, in general, requires time to get involved in sustainable movements such as E-waste recycling. Besides, other factors such as convenient facilities and incentives would also greatly help boost the public.

In addition, this study also discussed respondents' levels of satisfaction with the currently available E-waste services. It was discovered that the percentage of respondents who are satisfied with the current and available E-waste management, as well as services, is only slightly higher by 0.4% than those who are unsatisfied. Those who are unsatisfied also fill out the designated comment section with their thoughts on why they are dissatisfied. Following the completion of the analysis, various comments were discovered, which were then classified into four major groups. It is likely to conclude that facilities and management were the most written comments from respondents.

## 7.3 Contributions of this Study

Throughout the completion of this study, it can be observed that information related to the EQA 1974 should be promoted and received more attention, for example, to educate the public that E-waste is generally highlighted in this act. Even though EQA 1974

involves mainly industrial E-waste, this act can still be highlighted as a guide for the public in the interim period until the specific act for household E-waste is approved and implemented. It is critical to have a specific act to emphasize the significance of this environmental issue. With the availability of guidelines, the general public will better understand how to manage E-waste. It is also beneficial for the responsible bodies to manage the collection of household E-waste. Furthermore, fines and warnings can be imposed based on the rules that have been established.

Then, in addition to information on the law and regulations, this study determined that specific information should be made available to the public, such as where to dispose of E-waste. That information must be complete, and an inventory of current and available facilities must be performed to ensure they are in excellent condition for operation. Each of the stakeholders plays an essential role in ensuring that the community as a whole receives the information when it is provided. The information must be broadly conveyed. For example, campaigns can be done by the government sector with the help of the private sector and NGOs through the utilization of different kinds of sources of information.

Next, it is challenging to disregard the public's desire to replace and upgrade their current appliances to the newest models. However, reliable details should be disseminated to the general population in order to develop awareness of the flow and cycle of appliances. Encouraging the public to participate in sustainable E-waste management, which includes E-waste recycling, convenient facilities, and financial incentives, is significant. For instance, both the government and the private sector can collaborate to provide the infrastructure needed to conduct door-to-door E-waste collection. NGOs can also play a part in managing the neighbourhood's existing and available collection, disposal, and recycling infrastructure. The framework and standards for incentives provided by the

government, the private sector, or NGOs must then be made accessible to the general public.

Consequently, it can be observed that ensuring a successful rate of sustainable E-waste management, particularly in terms of recycling activity, necessitates coordination from all stakeholders. On a smaller scale, in order to establish a recycling community in a residential area, the community leader or village head must be familiar with E-waste. The government and NGOs should provide adequate training. The community leader or village head should be a source of information for their community – for example, by providing training and adequate information to all household heads. In exchange, the head of the household will act as a medium for the information and will contribute by raising awareness among households.

Aside from information, the public needs efficient options to dispose of their E-waste since the location and distance of recycling centres are key factors. A school, mosque, or public hall in the housing area could be a good spot to drop off and dispose of unwanted appliances. A proper recovery channel for E-waste will eventually lead to a circular economy and help reduce mining activity to extract virgin materials. Besides, sending off the E-waste to respective centre and bins will be a good movement among the public that eventually will help in creating a sustainable community. However, the exact distance of the collection centre from the housing area and the number of bins required should be specified to ensure that all families experience the same benefits and can properly use the facilities. According to the findings of this study, the public as a whole plays an important role in ensuring sustainable E-waste management. All government-initiated movements, as well as campaigns run by the public sector and NGOs, should be supported by the public as a whole. With the public's help, the volume of E-waste that ends up in landfills

will be reduced. Additionally, the lifespan of E-waste can be extended, and the use of E-waste as a raw material replacement can be expanded.

Throughout this study, academic and management contributions have been made. In terms of academic contribution, the output of the analysis conducted will contribute to the existing literature, especially in Malaysia. As this study establishes the current situation of E-waste recycling activity, it increases the information available and provides empirical data, hence filling the gap and representing more Malaysian households. This data can also be used by future researchers to study the role of various stakeholders in E-waste management. The scenario of E-waste recycling was extensively reviewed in the present study, focusing on knowledge, attitudes, and practices among the public. Thus, regarding management contributions, key stakeholders can draw meaningful insights to understand the factors influencing consumer preferences toward the management and disposal of E-waste.

The output of the current situation, including feedback regarding E-waste recycling, is important, as the findings can help when dealing with this environmental issue. The results regarding respondents' E-waste recycling knowledge, attitudes, and practices in those study areas can provide policymakers with significant information and vital inputs that will help them in orienting their efforts for sustainable E-waste management, particularly in the formation of Environment Quality Household Scheduled Waste Regulation 202x.

In addition to the above-mentioned contributions, the findings of this study will help to achieve the national goal of sustainable waste management. This is in accordance with the Twelfth Malaysia Plan (2021-2025), the Sustainable Development Goals (SDG) 2030,

and Net Zero by 2050. This Twelfth Malaysia Plan (2021-2025) is a national development plan that focuses on reforming the country by addressing socioeconomic issues and challenges to achieve sustainable long-term economic growth. This national plan also focuses on achieving a greener and more sustainable environment. When the environment is safe and well-managed, this leads to an increase in the country's productivity, which is related to the economic establishment.

The Twelfth Malaysia Plan (2021-2025) emphasizes in chapter eight: Advancing Green Growth for Sustainability and Resilience. Where the extended producer responsibility for E-waste has been targeted to be accomplished under the Twelfth Malaysia Plan, it is also stated that a new household E-waste regulation will be implemented. When developing a national plan, it must be done in tandem with global planning. This Twelfth Malaysia Plan is being developed in accordance with SDG 2030. For example, in the case of waste management planning, this is parallel to SDG-11: Sustainable Cities and Communities and SDG-12: Responsible Consumption and Production.

Sustainable waste management at the national level necessitates the participation of all stakeholders, including NGOs, the private sector, and the general public. This will not only support the national target but also help accomplish one of SDG-11's goals, which is to focus on municipal and other waste management to reduce the environmental effect on cities by 2030. Furthermore, to achieve two of SDG-12 goals: (i) to be able to reduce waste generation through reuse, recycling, reduction, and prevention, and (ii) to ensure that the public has adequate information and awareness about sustainable development, as well as to be able to live in harmony with nature. When a country achieves this, it will eventually contribute to improving the worldwide environmental situation by 2030.

Based on the findings of this study, it will be a massive help in achieving all of these goals by providing information and knowledge contributions. All relevant information can be compared and contrasted with the current and available action plan. Furthermore, it can contribute to describing how current E-waste recycling works, particularly at the public level. For example, consider the role of the general public as a consumer in using and managing electrical and electronic appliances on a daily basis until they become E-waste.

Furthermore, public encouragement to recycle E-waste requires immediate attention. This is due to the fact that the public is the consumers who use electrical and electronic appliances until they become E-waste. Those unwanted appliances cannot be simply discarded due to their toxic and hazardous characteristics. They must be discarded to ensure that valuable materials from E-waste can be recovered through recycling activity. E-waste should be separated at the source, such as the home. The public should then be responsible for sending E-waste to a formal recycling centre or any designated mobile E-waste bins.

This public role would be significantly helpful in achieving Net Zero 2050. Sustainable E-waste management, for example, through recycling, would greatly help reduce greenhouse gas emissions by lowering energy consumption. The utilization of recycled materials in the manufacture of new products reduces the demand for virgin materials. This reduces greenhouse gas emissions caused by the extraction or mining of virgin materials. Furthermore, manufacturing products from recycled materials uses less energy than manufacturing products from virgin materials.

As the end consumer, the public should know that by practicing E-waste recycling, they have done their part to prevent E-waste from ending up in landfills. Materials that can be

utilized and reused can be recovered by conducting the E-waste recycling activity, reducing the need to mine the virgin materials. Besides, E-waste recycling can also help promote a circular economy, and everyone has responsibility from the beginning until the end of the lifespan of appliances. By conducting E-waste recycling, the volume of E-waste in landfills can be reduced, reducing the impact on the environment and human health, as well.

## 7.4 Limitations of Study

Several limitations that arose while conducting the study are addressed in this section. In order to overcome these limitations, the following measures were undertaken:

1. There was limited information and data related to E-waste in Malaysia, for example, the generation of E-waste in Malaysia. The required information was thus collected from previous studies.
2. There was limited literature focusing on KAP regarding E-waste; hence, any local and international literature discussing the study topic was also included and referred to in this study.

## 7.5 Recommendations for Future Studies

The management of E-waste has become a serious concern in many developing countries as urbanization continues to spread, resulting in an ever-increasing volume of E-waste. This will influence the environment as well as human health. The scenario of E-waste recycling activity was thoroughly examined in this study, with a particular focus on the household level. Aside from what has been presented throughout the study, the following are a few recommendations for future research that should be considered:

1. A public interval study could be conducted to examine the effectiveness of information, facilities, and rewards provided to encourage public

participation as well as E-waste recycling behaviours. The time period could be anywhere from three to twenty-four months.

2. A technical study could be conducted to determine the location and radius of suitable collection centres in residential areas. This will be used to determine the distance and rate of accessibility for the general public to conduct or participate in E-waste recycling.
3. A combination of both qualitative and quantitative techniques could be used to determine the public's perspective and awareness of E-waste recycling.
4. To ensure the effectiveness of the available recycling centres, an inventory analysis should be conducted. Furthermore, in order to maximize data availability, it is necessary to establish the number of appliances used and disposed of by consumers.
5. To increase data availability, a study should be conducted in several study areas across Malaysia using a similar methodology and approach.

## 7.6 Conclusion

E-waste is a global environmental issue that has become a major concern in recent years as the generation of E-waste has increased. It is vital to appropriately manage E-waste, particularly at the household level, given that this waste necessitates special handling. E-waste recycling provides numerous benefits to the community in terms of socioeconomics and sustainable lifestyles. As a result, from this study, it is evident that the public, as the primary consumers, must participate in E-waste management. Overall, the results of this study demonstrate that the majority of respondents had high levels of knowledge and attitude, as well as moderate levels of practice, with regard to E-waste disposal.

This study reveals that to manage E-waste effectively, information about E-waste must be available in various formats to ensure that the public is educated and informed, regardless of their demographic background. Besides that, the respondents' satisfaction with the existing E-waste services demonstrates the importance of convenient and accessible facilities to encourage the public to engage in E-waste recycling. It should also be noted that monetary value is an important factor for the public when deciding whether to engage in sustainable E-waste management. With adequate information, convenient facilities, cooperation from all stakeholders, and the provision of incentives, a recyclable community will be able to develop, leading to improved E-waste recycling activities, with local groups not only understanding but also practicing it. This study contributes to the field of E-waste recycling by offering enhanced suggestions and solutions to boost recycling activity. It will serve as a useful source of information for planning purposes and for strengthening collaboration among stakeholders to resolve the national E-waste issue.

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