E-WASTE MANAGEMENT IN COLLECTION CENTRES AT KUANTAN, PAHANG

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ABSTRAK

Kajian ini dijalankan untuk mengkaji pengurusan e-sisa di pusat pengumpulan di Kuantan, Pahang kerana tiada kemudahan pemulihan e-sisa yang terdapat di kawasan ini. Kajian ini hanya memberi tumpuan kepada pusat pengumpulan yang diberi kuasa di bawah Jabatan Alam Sekitar (JAS) yang ditugaskan sebagai pengumpul yang sah bagi menguruskan e-sisa di Kuantan, Pahang. Kajian ini terdiri daripada tiga objektif utama yang perlu dicapai setelah selesai kajian ini. Pertama, objektif kajian ini adalah untuk menentukan jumlah e-sisa yang dikumpul oleh pusat pengumpulan di Kuantan melalui permintaan dari pihak pengurusan pusat pengumpulan. Data yang diminta dari pusat ini hanya tersedia untuk dua tahun operasi iaitu pada tahun 2017 dan 2018. Selain itu, kajian ini juga dijalankan untuk mengenal pasti tahap kesedaran risiko kesihatan di kalangan pekerja e-sisa di pusat pengumpulan melalui perbandingan analisis soal selidik yang melibatkan pengetahuan, sikap dan amalan (KAP) para pekerja dengan skor penggredan dari kajian terdahulu dan hasilnya menunjukkan bahawa pekerja mempunyai tahap kesedaran yang baik terhadap risiko kesihatan. Di samping itu, kajian ini juga bertujuan untuk menentukan pematuhan pengurusan e-sisa dengan peraturan e-sisa terutamanya dengan Akta Kualiti Alam Sekeliling 1974. Untuk mencapai matlamat ini, sesi wawancara berdasarkan item senarai semak telah dilakukan dengan pihak pengurusan pusat pengumpulan dan ia menunjukkan bahawa tiada pelanggaran peraturan telah dilakukan oleh pusat pengumpulan sejak mereka menjalankan perniagaan mereka. Walau bagaimanapun, terdapat beberapa cadangan yang perlu dilakukan jika terdapat kajian masa depan mengenai topik penyelidikan ini berdasarkan hasil penyelidikan ini, iaitu memastikan lebih banyak responden terlibat dalam sesi tinjauan serta memberi tumpuan kepada lebih banyak pusat pengumpulan berbanding hanya satu pusat pengumpulan. Kesimpulannya, kajian ini telah mencapai hasil yang merangkumi tiga objektif utama kajian ini.

ABSTRACT

This research was conducted to study e-waste management in collection centre at Kuantan, Pahang because there is no e-waste recovery facility available in this region. The study only focus on collection centre that authorized under Department of Environment (DOE) which assigned as authorized collector for e-waste in Kuantan, Pahang. This study consists of three main objectives that need to be achieved after completion of this study. Firstly, the objective of this study is to determine the amount of e-waste collected by the collection centre in Kuantan through request from the collection centre's management. The data requested from the centre only available for two years of operation which is in years 2017 and 2018. Besides, the study also conducted to identify the level of health risks awareness among the e-waste workers at the collection centres through comparison of questionnaire analysis method of worker's knowledge, attitude and practice (KAP) with the score grading from the previous study and it shows that the workers have a good level of awareness towards health risks. In addition, the study also aims to determine the compliance of the e-waste management with e-waste regulation especially with Environmental Quality Act 1974. To achieve this goal, interview session based on the checklist items has been done with the collection centre's management and it shows that there is no violation of regulation has been done by the collection centre ever since they start operating the business. However, there are several recommendations for future study based on the research findings, which are ensuring more respondents involved in survey as well as focusing on more collection centres rather than only one centre. In conclusion, this study has come out with an outcome which is all three main objectives of this research were achieved after completion of this study.

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DOE	Department of Environment
EEE	Electrical and Electronic Equipment
EQA 1974	Environmental Quality Act 1974
KAP	Knowledge, Attitude and Practice
WEEE	Waste of Electrical and Electronic Equipment

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter will be focusing on the idea of the study which consists of problem statement, objectives, research question, research hypothesis, significant of study, scope of study, operational definitions and conceptual framework.

1.2 Background of Study

Electronic waste (e-waste) or Waste of Electrical and Electronic Equipment (WEEE) is growing as a global issue because amount of e-waste is rapidly increasing in number every year. According to The balance (2016), this rapid rate of E-waste development which commonly electronic equipment such as cell phones are replaced every 22 months, desktop computer is replaced every 2 years, printer is replaced every 5+ years and televisions are replaced every 10+ years. This scenario happened because of rapid growth of economic has created high demand for new electrical and electronic equipment (EEE) among the user which electronic industry has become one of the world's largest and fastest growing manufacturing industry (Schwarzer et al., 2005).

Besides, EEE is more likely become most common gadget and widely used in any kind of activities and places such as schools, residences, offices and manufacturing industries (Ramachandra and Saira, 2004). This scenario is contributing in increasing of production and consumption of EEE across the world (Schwarzer et al., 2005). Based on the data from Ranking Web of Universities (2018), it stated that there are approximately a total of 11,998 universities in the world which mean there will be high usage and amount of EEE that are needed to meet their requirements. Malaysia is also no exception in generating E-waste because statistic study conducted by John et al.

(2010) shown that approximately 405,590 million tons of E-waste was generated in 2008 and it will keep increasing each year.

The increasing amount of e-waste will cause many impacts towards human health and environment if it is not treated properly. Proper e-waste management are needed to ensure these problems are minimized. E-waste management also include action of reduce, reuse and recycle (Oskamp, 1995; Hamburg et al., 1997) of e-waste which it is important in mitigating the problem from getting worst. According to Kelly et al., (2006), successful recycling programmes not only depend on technology, but also on the people involvement and environmental maintenance of responsible behaviour. In industries management, e-waste management should begin at the point of generation which include inventory management, production-process modification, volume reduction and recovery and reuse (Ramachandra and Saira, 2004).

In Pahang, e-waste is collected and managed in collection centres and there are less data of collection centres that exist in Pahang. These centres are functioning as a point for EEE user to dispose and discard any technology that they no longer used. These centres are actually under Department of Environmental Malaysia (DOE) which focusing on Household E-waste management. These centres were established in order to identify and recommend several concerns that need to be clarified in order to formulate an effective acceptable Extended Producer Responsibility (EPR) model under the Malaysia scenario (Household E-waste, 2018).

1.3 Problem Statement

Electronic waste (e-waste) is the technology that has ended its useful life span such as cell phone, television and computer. According to the e-waste problem (2005), e-waste now makes up to 5% of global municipal solid waste which is nearly the same amount as all plastic packaging, but they are much more hazardous.

Improper managing of e-waste can affect the human health and environment because it contains plethora of toxic components including barium (Ba), beryllium (Be), cadmium (Cd), cobalt (Co), chromium (Cr), iron (Fe), lead (Pb), lithium (Li), lanthanum (La), mercury (Hg), manganese (Mn), molybdenum (Mo), nickel (Ni), silver (Ag), hexavalent chromium (Cr(VI)) and persistent organic pollutants (POPs) (Puckett and Smith, 2002). This scenario not only happened in developed countries such as Australia, Canada and Germany; Asia countries which include Malaysia also contributed in discarding an estimated 12 million tonnes of e-waste each year.

There are some studies which stated that informal sector such as e-waste recycling in developing country provides low cost services and it is classified through unsafe working conditions and lack of health standards (Fasanya and Onakoya, 2012; The Rockfeller Foundation, 2014; Stacy and Anna, 2014). This shows that the workers are lack of awareness about the risk working with e-waste.

Therefore, this study tends to review and discuss the current e-waste management in collection centres at Kuantan, Pahang. Besides, this study was conducted to know in what extent the workers at the collection centres are aware about the health risk impact toward their daily jobs. In addition, the research relate with this topic is still low especially at Kuatan, Pahang.

1.4 Research Objective

The main objectives for this research are:

1.4.1 To determine the amount of e-waste collected in collection centres at Kuantan, Pahang.

1.4.2 To identify the level of health risks awareness among the e-waste workers at collection centres.

1.4.3 To determine the compliance of the e-waste management with e-waste regulations.

1.5 Research Questions

The research questions for this study are:

1.5.1 How much e-waste collected by collection centre at Kuantan, Pahang?

1.5.2 Are the workers at collection centres aware about the health risk when handling e-waste?

1.5.3 Are the collection centres at Kuantan, Pahang complying with e-waste regulations?

1.6 Significance of Study

The study was conducted to discuss and review the e-waste management in collection centres at Kuantan, Pahang. This is because improper e-waste management can affect human health and environment. The discussion in the study also includes the compliance of collection centres with the law and regulation.

This study also conducted to identify whether the workers themselves aware about health risk during handling the e-waste. The results obtained from this study can be used to determine the perception of the workers about their job based on the collected data in this study.

Lastly, this study can be helpful to the people or organization which involve with the e-waste management. This information and the data from the analysis hopefully can give better information to the organization to use it in the future.

1.7 Scope of Study

This study was carried out to determine the amount of e-waste collected by an authorized collection centre in Kuantan, Pahang. This study also focuses on the level of health risks awareness among the e-waste workers who involve in managing the e-waste at the collection centre. Besides, this study also focuses on the compliance of e-waste management toward Environment Quality Act 1974

1.8 Operational Definitions

1.8.1 E-waste

E-waste is any kind of electrical and electronic equipment, products, components and peripherals that has been discarded or disposed due to it ends of usage. For example, cell phones, computers, fax machines, radio sets, televisions and more.

1.8.2 E-waste Management

Any process dealing with e-waste which mainly focus on collecting, recycling and disposal of e-wastes by the collection centres. Other process such as reuse, repair and remanufacturer is not highlighted through this study.

1.8.3 E-waste Recycling

Process of reusing and reprocessing any type of electrical and electronic equipment (EEE) that has been discarded because of the life span of EEE ended or damaged. This process initiated to protect human and environmental health mainly due to the widespread environmental pollution impacts of e-waste.

1.8.4 Compliance

The act of the organization conformed to a rule, policy, regulation and act. It also can be describing as an effort by the organization to ensure them aware to comply with relevant laws, policies and regulations.

1.9 Conceptual Framework

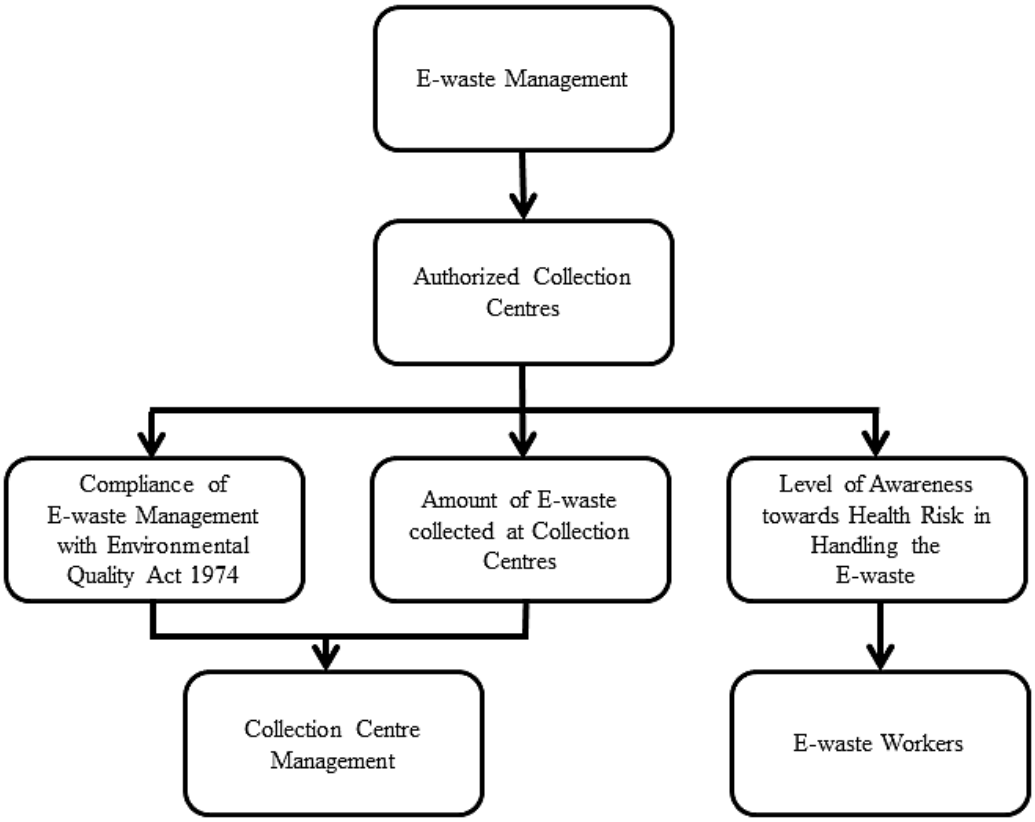

Figure 1.1 Conceptual Framework

1.10 Conclusion

Generally, the idea of this study is focused in this chapter which include problem statement, objectives, research question, research hypothesis, significant of study, scope of study, expected result, operational definitions and conceptual framework. Besides, this chapter is also an introduction for the study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

According to Herat and Agamuthu (2012), electrical and electronic waste or known as e-waste has become one of the fastest growing components of the municipal solid waste stream in the world. This statement supported by Greenpeace (2005) which reported that e-waste in Europe itself is increasing at three to five percent a year. The study conducted by Computer Aid International (2010) has predicted that e-waste generated by European countries will grow up to 12 million tons by 2020. Besides, e-waste has been produced globally approximately about 7.05 million tones and still counting since the start of 2017 (The World Counts, 2017).

2.2 Definition of e-waste

Electrical and electronic waste or e-waste is a term which used to represent various forms of electrical and electronic equipment (EEE) that have been discarded or ceased by the owner because it is no longer useable for them (Balde et al., 2017). According to Mmereki et al. (2015), e-waste also can be categorized as a product which contains printed circuit board (PCB) and use electricity. In some studies, such as Babu et al. (2007), Gladding (2008) and Alavi et al. (2015) called e-waste as waste of electrical and electronic equipment (WEEE). Although there is many research related with e-waste and yet, there is no standard definition towards e-waste or WEEE (Widmer et al., 2005). This statement could arise many questions about the actual definition of e-waste. Is e-waste considering as any electrical or electronic appliances which are obsolete in term of functionality or any products that are discarded operationally or is it both (Wath et al., 2010).

According to European Union Waste Electronic and Electrical Equipment, EU WEE (2002) e-waste is defines as any waste of electrical or electronic equipment which include all components, sub-assemblies and consumables, and those are part of the product at the time of discarding. Basel Action Network also has defined e-waste as a broad and growing range of electronic devices which are ranging from large household devices which have been discarded by their users (Puckett and Smith, 2002). Organization of Economic Cooperation and Development, OECD (2001) has different definition of e-waste which is any appliance that using an electric power supply and has reached its end-of-life. In addition, a study conducted by Sinha (2004) refers e-waste as an electrically powered appliance that no longer satisfies the current owner for its original purpose. Solving the E-waste Problem, StEP (2005) also defined e-waste as the reverse supply chain which collects products no longer desired by a given consumer and refurbishes for other consumers, recycles, or otherwise processes wastes.

Therefore, e-waste can be considered as all end-of-life or disposed electrical and electronic products, components and peripherals which include computers, telephones, cell phones, televisions, fax machines and more (Johri, 2008).

2.3 E-waste Sources

E-waste sources can be numerous (Sushant, 2011). It could be waste generated from the products used for data processing, electronic devices used for entertainment, equipment or devices used for communication, household equipment and also audio and visual components.

A study conducted by Suja et al. (2014) categorizes e-waste into two types of groups which those are from the industrial sector as well as the household and institutional. The source of e-waste from the industrial sector includes electrical and electronic assemblies while household and institution’s e-waste comes from the used and end-of-life electrical and electronic equipment.

2.4 Generation and Quantities of e-waste

E-waste is one of the fastest growing sources of waste in worldwide (Widmer et al., 2005; Lundgren, 2012; Brune et al., 2013). In 2012, UN report predicted that global e-waste will increase above 33% which from 49.7 million to 65.4 million tons per

annum by year 2017 (StEP, 2013). Furthermore, Cucchiella et al. (2015) estimated that the annual growth rate for e-waste stream approximately 3 to 5 percent. This rate is three times faster than other municipal waste streams (Davis and Heart, 2008). The total consumption and production of EEE has increased because of rapid economic growth, urbanization and high demand from the consumers (CPCB, 2007; Bandyopadhyay, 2008; Balabanic et al., 2011). The amount of e-waste produced also increased exponentially because of several factors such as consumers demand and high obsolescence rate of the consumers which lead they to purchase EEE frequently.

2.4.1 Global e-waste quantity

Through the increasing of e-waste generation, Balde et al. (2017) has listed the amount of e-waste by continents and per inhabitants in 2016 which shown in Table 2.1.

Table 2.1 The total amount of e-waste which categorized by continents.

Continents	**Amount (in million tonnes, Mt)**	**Amount (kg/inh.)**	**E-waste collected and recycled (%)**
Africa	2.2	1.9	-
Americas (North & South)	11.3	11.6	17
Asia	18.2	4.2	15
Europe	12.3	16.6	35
Oceania (Australia)	0.7	17.3	6

Source: Balde et al. (2017)

From the statistic shows in Table 2.1, Asia was the region with highest amount of e-waste generated by far which is 18.2 Mt and followed by Europe (12.3 Mt), the Americas (11.3 Mt), Africa (2.2 Mt), and Oceania (0.7 Mt) respectively. Although Oceania is the least in terms of the total amount of e-waste generated, it was the highest e-waste generator per inhabitant which is 17.3 kg/inh and only 6% of e-waste was officially documented to be collected and recycled. Besides, Europe has been the second largest e-waste generator per inhabitant with amount of 16.6 kg/inh. and has the highest rate of e-waste collection which is 35%. In addition, 11.6 kg/inh. is the amount

of e-waste per inhabitant that generated by the Americas and it only collect 17% of e-waste from the countries, which is slightly higher compared to Asia's collection rate (15%). However, Asia only generates 4.2 kg/inh of e-waste per inhabitant. Lastly, Africa generates only 1.9 kg/inh. per inhabitant and less information is available about the collection rate.

2.4.2 Quantity of e-waste in Malaysia

The primary sources of domestic EEE in Malaysia are from industry sector and household institution (Suja et al., 2014). According to Basel Convention Regional Centre for South-East Asia (BCRC-SEA) (2016), a specific data on generation of domestic EEE production and consumption in Malaysia is still unavailable. Besides, there are also no specific data on domestic e-waste generation in Malaysia, especially the data for household institution. This is because the data is still review internally by the expert team of Japan International Cooperation Agency (JICA). The only data obtained is the gross e-waste quantity from industrial sector in Malaysia which shown in Table 2.2.

Table 2.2 The quantity of E-waste generated by industries in Malaysia.

Number	Year	E-waste Quantity (metric tonnes)
1	2009	134,035.70
2	2010	163,339.80
3	2011	152,722.04
4	2012	78,278.05
5	2013	52,978.13
6	2014	57,103.40

Source: Basel Convention Regional Centre for South-East Asia (2016)

2.5 E-waste Categories

Directive 2002/96/EC of European Parliament and Council (2003) has defined that e-waste consist of ten categories which listed in Table 2.3. These categories have been properly regulated and managed by European Union (EU) with their respective contributed percentage in the e-waste generated in EU 27 (Huismann et al., 2007).

Table 2.3 E-waste categories used by the European Union.

Sr. No.	Category	% of total e-waste	Sub-categories		% of total e-waste
1.	Large household appliances (Large HA)	**49**	**1A**	Large household appliances (Exclude **1B** & **1C**)	**27.7**
			1B	Cooling and freezing	**17.7**
			1C	Smaller items	**3.6**
2.	Small household appliances (Small HA)	**7.0**	**-**	**-**	**7.0**
3.	IT and telecommunication equipment (ICT)	**16**	**3A**	IT and telecom equipment (Exclude **3B** & **3C**)	**8.0**
			3B	Cathode Ray Tube (CRT) monitors	**8.3**
			3C	Liquid-Crystal Display (LCD) monitors	**0.0**
4.	Consumer electronic (CE)	**21**	**4A**	Consumers electronics (Exclude **4B** & **4C**)	**7.8**
			4B	CRT TV's	**13.3**
			4C	Flat Panel TV's	**0.0**
5.	Lighting equipment (Lighting)	**2.4**	**5A**	Luminaries	**0.7**
			5B	Lamps	**1.7**
6.	Electrical and electronic tools (E&E tools)	**3.5**	-	-	**3.5**
7.	Toys, leisure and sport equipment (Toys)	**0.1**	-	-	**0.1**
8.	Medical devices (Medical devices)	**0.1**	-	-	**0.1**
9.	Monitoring and control equipment (M&C)	**0.2**	-	-	**0.2**
10.	Automatic dispensers (Dispensers)	**0.2**	-	-	**0.2**

Source : Widmer et al. (2005), Gaidajis et al. (2010)

From Table 2.3, it shows that almost 95% of e-waste generated by EU 27 has been occupied by categories 1 to 4 and almost half of it accounted by category 1. The least number of percentages of e-waste generated by EU 27 contributed by category 7 and 8 which is toys and also medical devices respectively.

There also different scope of categories that defined by "The Global E-waste Monitor 2017" which stated that e-waste categories consist of six waste categories which they have different lifetime of profile. The e-waste categories consist of:

1. Temperature exchange equipment.
2. Screens and monitors.
3. Lamps.
4. Large equipment.
5. Small equipment.
6. Small IT and telecommunication equipment.

Each of the categories has different method in collection and logistic processes as well as recycling technology because there are some different elements that have been considered by them such as waste quantities, economic values and also potential impacts towards environment and health (Balde et al., 2017).

2.6 Composition of e-waste

E-waste is very complex to handle because of its composition (Sankhla et al., 2016). Most of e-waste is composed by the mixture of metals (usually Cu, AI and Fe) that used to attach, covered or mixed with various types of ceramics and plastics (Hoffmann, 1992). Besides, e-waste contains very diverse composition and it is differing in each product across different categories (Suja et al., 2014). Study conducted by Robinson (2009), Ogondo et al. (2011), Lau et al. (2013) and Menad et al. (2013) have consider e-waste as a resource of valuable materials such as ferrous and non-ferrous metals, engineering plastics, precious metals, platinum group metals and rare earths elements. To ensure these valuable resource and rare elements are not wasted, special treatment of e-waste is needed. For example, materials such as gold (Au) and palladium (Pd) can be mined more effectively from the waste compared to mining from the ore (Chancerel et al., 2009).

Although e-waste is diverse in it composition and contains valuable materials, it also contains potential toxic materials (Mmeriki et al., 2015). This statement supported by the Guidelines for Environmentally Sound Management of E-waste (2008) which stated that there are more than 1000 different substances that contain by the e-waste which is hazardous and non-hazardous. For example, there are more than 40 elements in a mobile phone such as copper (Cu), tin (Sn), lithium (Li), cobalt (Co), indium (In), antimony (Sb), silver (Ag), gold (Au) and palladium (Pd). Besides, e-waste also contains hazardous materials such as heavy metals and persistence organic materials (Alavi et al., 2015).

E-waste has been classified broadly in weightage ratios of materials which are 50% of e-waste is steel, 13% of it is aluminium, copper and other metals and other 21% is plastics. Only1% of e-waste is classified as hazardous and toxic metals and precious metals only occupied small percentage of the total weight of e-waste. The precious metals include 0.1% of gold, 0.2% of silver and 0.005% of palladium respectively. However, these precious metals are very crucial as it gives financial support up to 95% to the recycling infrastructure and other metals and materials such as nickel, lead and various plastics are worth after e-waste recovery (Cui and Forssberg, 2003; He et al., 2006).

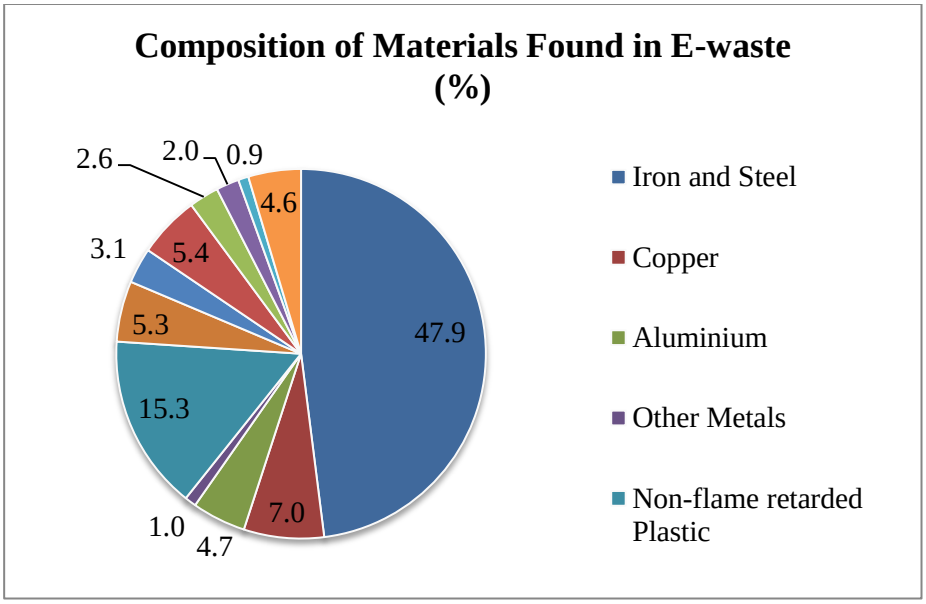

Figure 2.1: Weighted Percentage of Material in E-waste

Source : Widmer et al. (2005)

There also a study conducted by Empa (Swiss Federal Laboratories for materials testing and research) found that e-waste materials consist of several percentage as shown in Figure 2.2.

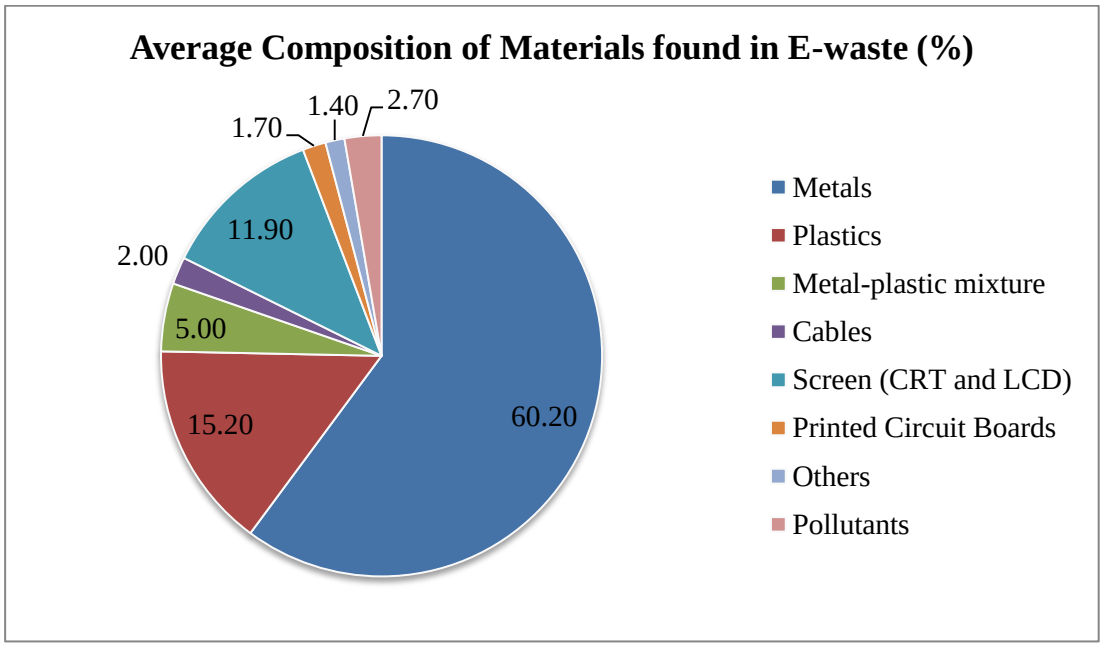

Figure 2.2 Weighted Percentage of Material in E-waste

Source: Widmer et al. (2005)

2.6.1 Hazardous Components and Compounds in e-waste

Generally, e-waste is same as other waste but the presence of heavy metal in e-waste made it different than the other municipal biodegradable waste. This is because they did not involve in bio-degradation process and cause adverse effect towards human health and environment (Vats and Singh, 2014).

However, the compounds only can be classified as hazardous if beyond their threshold limit value (TLV). According to American Conference of Governmental Industrial Hygienists (ACGIH), TLV is a level of chemical substance or compound which worker can be exposed in daily working lifetime without getting any adverse effects. Although e-waste has been classified as hazardous component but not all components in e-waste equipment are hazardous (Vats and Singh, 2014). Table 2.4 will show some hazardous component in EEE which contain hazardous compound and it applications.

Table 2.4 Components of EEE containing hazardous compounds

Sr. No.	Components	Compounds of concern	Applications
1.	Printed circuit boards (PC boards)	Pb, Sb in solder, Cd, Be in contacts and Switches, Hg in switches and relays Ga, As in LEDs, BFR in plastics	Ubiquitous, from beepers to PCs
2.	Batteries	Ni and Cd in Ni-Cd batteries Pb in lead acid batteries, Hg in Hg batteries	In various portable electronic devices
3.	Various Hg containing components	Hg	Thermostats, sensors, relays, switches, gas discharge lamps, medical equipment and telecommunication equipment
4.	Cathode ray tubes (CRTs)	Pb and Sb in CRT glass, Various metal in electron gun getter	Old TV sets, PC monitors, oscilloscopes
5.	Liquid-Crystal displays (LCDs)	Liquid crystals in the screen	Most devices with a screen
6.	Plastics and polymers	PVC and Teflon as polymers BFRs, Cd, Pb, org-Sn and phthalates as additives	Wire insulation, plastic housing, circuit boards
7.	PCB-containing capacitors	PCB	In various electronic circuits
8.	Refrigerating circuits	Freon	Refrigerators, freezers, air-conditioners
9.	Toner cartridges	Toner, including carbon black	Laser printers, copying machines, faxes

Source : Swedish Environmental Protection Agency-Report 6417 (2011)

2.7 E-waste Effects

Improper recycling practices can harm human health and environment through it emissions. This is because, informal recycling practices can enhance health risk of individual (Mcallister, 2013). For example, combustion of e-waste through burning creates fine particulate matter which leads to cardiovascular and pulmonary disease. Besides, the diversity of components in e-waste which contain toxic and hazardous substances could impact on human health and environment if not handle properly through recycling and disposal.

Although, the effect of exposure towards hazardous e-waste substances are still not fully recognized, but there a research which study the relationship between exposure of e-waste with the higher levels of metals and chemicals in humn-derived biological samples (Wen et al., 2008; Chen et al., 2008). There a bundle of toxicity found and documented for each e-waste substances, but there a less information about the toxicity of the mixtures of substance through e-waste recycling. According to Tsydenova and Bengtsson (2011), halogenated compounds and heavy metals is a major contributor to potential health risk of e-waste.

2.7.1 E-waste effect towards Human Health

The potential health effect towards e-waste exposure may include the changes in lung function, thyroid function, expression of hormone, birth weight and outcomes, childhood growth rates, mental health, cognitive development, cytotoxicity and genotoxity (Grant et al., 2013). Besides, exposure towards e-waste hazardous chemical from recycling can cause lifelong changes, abnormal reproductive development, cognitive damaged and concentration difficulties due to carcinogenic effects and disrupting properties (WHO/UNEP, 2013).

Needleman (2009) found that substance such as lead (Pb) consist of neurotoxicant that could lead to cognitive damaged to blood, nervous and also reproductive systems. These findings specify that there is no threshold below which exposure of lead that does not have result in damaging the developing nervous system. Other than lead (Pb), brominated flame retardants could lead to damage to the memory and learning function, change hormone, thyroid and estrogen systems, cause behavioural problems and neurotoxicity (Costa and Giordano, 2007). Cadmium that

usually used as electrode component in alkaline batteries could result in bio-accumulate and it highly toxic for bones, lungs and kidneys (Bernard, 2008). Mercury also is not exception in giving adverse effect to human health. According to Takeuchi (1968) and Takeuchi and Eto (1999) stated that mercury can cause impairment to the brain during early development. Others common toxic substances are shown in Table 2.5 with their impact toward human health.

Table 2.5 Toxic substances associated with e-waste and their health impacts.

Substance	**Applied in e-waste**	**Health impact**
Antimony (Sb)	Melting agent in CRT glass, plastic computer housings and a solder alloy in cablin.	Antimony has been classified as a carcinogen. It can cause stomach pain, vomiting, diarrhoea and stomach ulcers through inhalation of high antimony levels over a long time period
Arsenic (As)	Gallium arsenide is used in light emitting diodes	It has chronic effects that cause skin disease and lung cancer and impaired nerve signalling
Barium (Ba)	Sparkplugs, fluorescent lamps and CRT gutters in vacuum tubes	Causes brain swelling, muscle weakness, damage to the heart, liver and spleen though short-term exposure
Beryllium (Be)	Power supply boxes, motherboards, relays and finger clips	Exposure to beryllium can lead to beryllicosis, lung cancer and skin disease. Beryllium is a carcinogen
Brominated flame retardants (BFRs): (polybrominated biphenyls (PBBs), polybrominated diphenyl ethers (PBDEs) and tetrabromobisphenol (TBBPA))	BFRs are used to reduce flammability in printed circuit boards and plastic housings, keyboards and cable insulation	During combustion printed circuit boards and plastic housings emit toxic vapours known to cause hormonal disorders
Cadmium (Cd)	Rechargeable NiCd batteries, semiconductor chips, infrared detectors,	Cadmium compounds pose a risk of irreversible impacts on human health, particularly the kidneys

	printer inks and toners	
Chlorofluorocarbons (CFCs)	Cooling units and insulation foam	These substances impact on the ozone layer which can lead to greater incidence of skin cancer.
Hexavalent chromium/chromium VI (Cr VI)	Plastic computer housing, cabling, hard discs and as a colorant in pigments	Is extremely toxic in the environment, causing DNA damage and permanent eye impairment
Lead (Pb)	Solder, lead-acid batteries, cathode ray tubes, cabling, printed circuit boards and fluorescent tubes	Can damage the brain, nervous system, kidney and reproductive system and cause blood disorders. Low concentrations of lead can damage the brain and nervous system in foetuses and young children. The accumulation of lead in the environment results in both acute and chronic effects on human health
Mercury (Hg)	Batteries, backlight bulbs or lamps, flat panel displays, switches and thermostats	Mercury can damage the brain, kidneys and foetuses
Nickel (Ni)	Batteries, computer housing, cathode ray tube and printed circuit boards	Can cause allergic reaction, bronchitis and reduced lung function and lung cancers
Polychlorinated biphenyls (PCBs)	Condensers, transformers and heat transfer fluids.	PCBs cause cancer in animals and can lead to liver damage in humans
Polyvinyl chloride (PVC)	Monitors, keyboards, cabling and plastic computer housing	PVC has the potential for hazardous substances and toxic air contaminants. The incomplete combustion of PVC release huge amounts of hydrogen chloride gas which form hydrochloric acid after

		combination with moisture. Hydrochloric acid can cause respiratory problems
Selenium (Se)	Older photocopy machines	High concentrations cause selenosis

Source: Puckett and Smith (2002).

In addition, there also supplementary aspect of e-waste exposure that may result in adverse effect towards health outcomes. Its mean that, although the individual is less exposed to e-waste daily, the cumulative exposure is frequently high and immensely hard to measure (Chan and Wong, 2012). Study from Chen et al. (2010), stated that the effects of the mixtures of hazardous substance in e-waste are still not identified thoroughly even the level of chemicals effects are studied. This is because some of the substances in e-waste chemical mixture could be have synergistic or modifying effects which are very harmful.

2.7.2 E-waste effect towards Environment

Mostly, large household appliances of e-waste such as washing machines and refrigerators are composed by steel that may consist of less potential environmental contaminants compared to lighter e-waste such as laptops and computers. This is because lighter e-waste tends to have high concentrations of flame retardants and heavy metals (Robinson, 2009). However, improper e-waste disposal could affect the air, soil and water components of the environment (E-Terra Technologies, 2017). This statement supported by Norman et al (2013), which stated that people are exposed to e-waste hazardous substances through air, soil, water, dust and food, which indicate that e-waste hazardous substances can affect the environment.

Beside, several studies conducted by Sepulveda et al. (2010) and Zhang et al. (2011) state that hazardous substances from e-waste can reach beyond processing sites and into ecosystems. This is because, the exposure is vary based on the e-waste type and quantity, length of processing history at sites, processing activities methods and locations and also physiological vulnerability. E-waste (2009) has classified some of the potential environmental contaminants from e-waste disposal or recycling which shows in Table 2.6.

Table 2.6 Potential environmental contaminants which arising from E-waste disposal or recycling.

Contaminant	**Relationship with E-waste**	**Typical E-waste concentration (mg/kg)**	**Annual global emission in E-waste (tons)**
Polybrominated diphenyl ethers (PBDEs) polybrominated biphenyls (PBBs) tetrabromobisphenol-A (TBBPA)	Flame retardants		
Polychlorinated biphenyls (PCB)	Condensers, transformers	14	280
Chlorofluorocarbon (CFC)	Cooling units, insulation foam		
Polycyclic aromatic hydrocarbons (PAHs)	Product of combustion		
Polyhalogenated aromatic hydrocarbons (PHAHs)	Product of low-temperature combustion		
Polychlronated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs)	Product of low-temperature combustion of PVCs and other plastics		
Americium (Am)	Smoke detectors		
Antimony	Flame retardants, plastics (Ernst et al., (2003))	1700	34,000
Arsenic (As)	Doping material for Si		
Barium (Ba)	Getters in cathode ray tubes (CRTs)		
Beryllium (Be)	Silicon-controlled rectifiers		
Cadmium (Cd)	Batteries, toners, plastics	180	3600
Chromium (Cr)	Data tapes and floppy	9900	198,000

	disks		
Copper (Cu)	Wiring	41,000	820,000
Gallium (Ga)	Semiconductors		
Indium (In)	LCD displays		
Lead (Pb)	Solder (Kang and Schoenung, (2005)), CRTs, batteries	2900	58,000
Lithium (Li)	Batteries		
Mercury (Hg)	Fluorescent lamps, batteries, switches	0.68	13.6
Nickel (Ni)	Batteries	10,300	206,000
Selenium (Se)	Rectifiers		
Silver (Ag)	Wiring, switches		
Tin (Sn)	Solder (Kang and Schoenung, (2005)), LCD screens	2400	48,000
Zinc (Zn)		5100	102,000
Rare earth elements	CRT screens		

Source: e-waste (2009)

Based on Table 2.6, polybrominated diphenyl ethers (PBDEs) and polychlorinated biphenyls (PCB) are included in common persistent organic pollutant which found in EEE components. This type of pollutants is very hard to breakdown because it has long half-lives. In addition, these pollutants are released while dismantling process (incineration and smelting) of e-waste. Polycyclic aromatic hydrocarbons (PAHs) are hydrophobic substances that formed during incomplete combustion of gas, oil, coal, wood, incense and tobacco (Agency for Toxic Substances and Disease Registry (ATSDR), 1995). Basically, these hydrocarbons are formed and released into the environment through e-waste burning (Wang et al., 2012). Common elements such as arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni) and zinc (Zn) are also components in EEE that have potential to become hazardous chemical elements.

2.8 E-waste Management

Generally, electrical and electronic equipment (EEE) consumers will not discard or recycle unused electronics immediately because they still think that the products still have some values (Kalana, 2010). According to USEPA (2000), the percentage of retired consumer electronic devices (CEDs) that are kept in the storage for 3-5 years is more than 70%. This shown that the consumers are prefers to choose storage method rather than proper e-waste management which include disposal and recycling of e-waste. It also highlights that the consumer's awareness towards disposal of old technology are low because of psychological factors which is a belief that e-waste has some value.

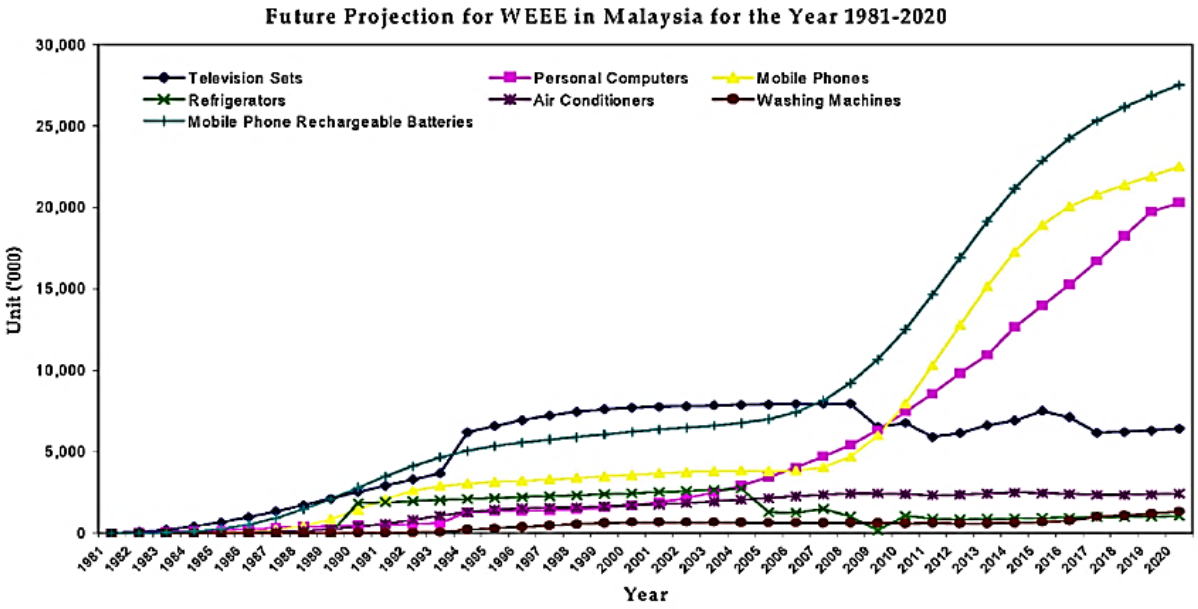

Figure 2.3 Projection of WEEE in Malaysia (Metric Tonnes)

Source: E-waste Inventory Project in Malaysia (2016)

According to Basel Convention Regional Centre for South-East Asia (2016), 57,103.40 tons of e-waste has been generated in Malaysia around 2014. The data obtained through the study reflect that, e-waste collected from the industrial sector is less than expected value in Future Projection of WEEE in Malaysia 1981-2020 (Figure 2.3). Based on Figure 2.3, the total projection of WEEE will be expected to reach approximately 865,384.00 tons of WEEE. Besides, Mundada et al. (2004) state that, most of developing countries which include Malaysia have established neither a good

system for collection, storage, separation, disposal and transportation of waste nor an efficient regulations enforcement related to hazardous waste management.

Figure 2.4 shows the general flow of WEEE from the generation until disposal in Malaysia. It shows a disconnection between the e-waste sources and the DOE licensed e-waste collectors and processors. E-waste is generated from two main sources of categories which are from industrial sector and household area (Suja et al, 2014). Generally, the whole unit of WEEE which consists of whole unit of equipment or sub unit of functional equipment are not collected as e-waste by the DOE licensed e-waste contractors although it has been categorized as e-waste by DOE. Besides, many e-wastes from EEE manufacturer is not a whole unit of WEEE but disassembled components such chipboards, cables, plastic fittings and metal parts.

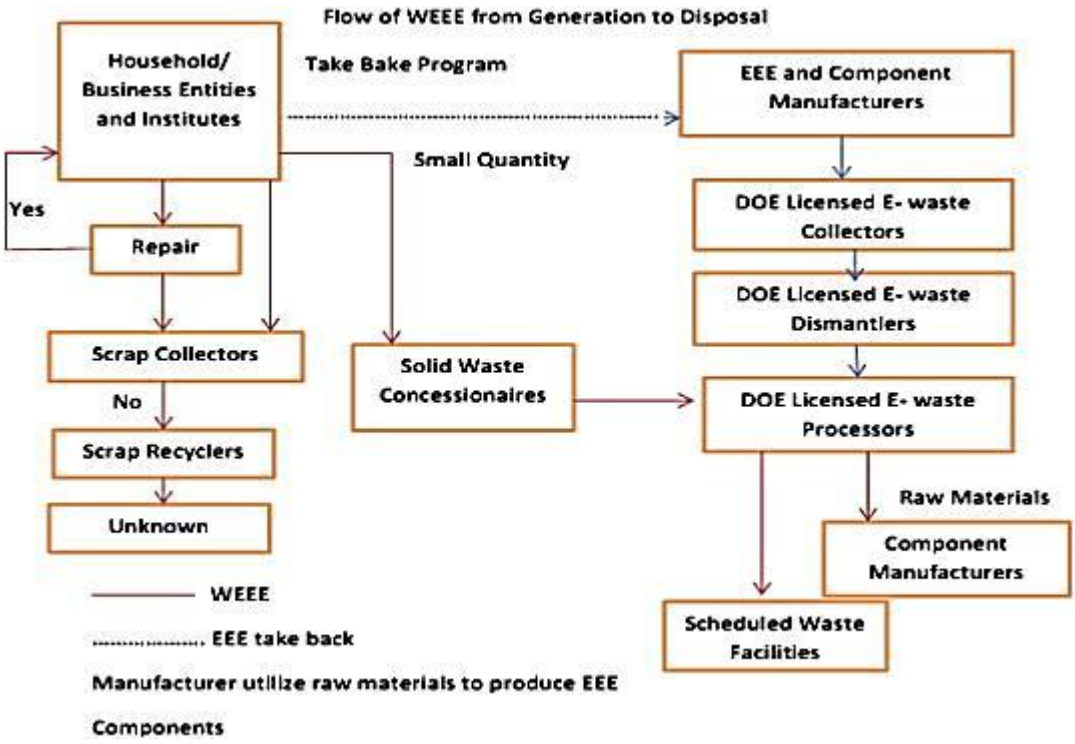

Figure 2.4 General flow of WEEE from the generation until disposal

Source: E-waste Inventory Project in Malaysia (2016)

2.8.1 E-waste Recycling

E-waste recycling is a process of reuse and reprocessing any type of electrical and electronic equipment (EEE) that has been discarded or old (Conserve Energy Future, 2017). The hazardous contents in the e-waste could raise environmental issue during waste management phase if pre-treatment is not performed properly. Therefore, legislation has been drafted by many countries in order to enhance the reuse, recycling and other forms of waste recovery as well as reduce disposal (European Commission, 2002). Besides, e-waste recycling is crucial topic which not only the view of waste treatment but it also crucial from the view of recovery aspect of valuable materials. According to Institute of scrap recycling industries Inc. (ISRI) (2003), there are seven benefits of using scrap iron and steel which identified by US Environmental Protection Agency (EPA) rather than virgin materials (as shown in Table 2.7).

Table 2.7 Benefits of using scrap iron and steel.

Benefits	**Percentage**
Savings in energy	74
Savings in virgin materials use	90
Reduction in air pollution	86
Reduction in water use	40
Reduction in water pollution	76
Reduction in mining wastes	97
Reduction in consumer wastes generated	105

Source: Institute of scrap recycling industries Inc. (2003)

Besides, Cui and Forssberg (2003) stated that e-waste recycling can be classify into three major stages which is disassembly (dismantling), upgrading and refining. There also a study conducted by Kang and Schoenung (2005) which has simplified the recycling method of electric product which shown in Figure 2.5. Generally, Figure 2.5 shows the element in e-waste recycling which consist of collection, sorting, recovery, recycling and disposal.

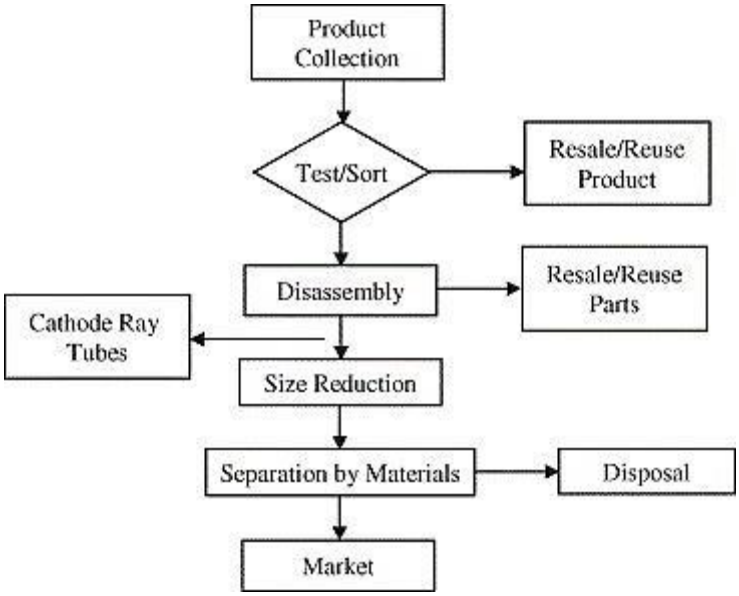

Figure 2.5 Simplified flow diagram for the recycling of an electronic product

Source: Kang and Schoenung (2005)

2.8.2 E-waste Disposal

Generally, e-waste that is not valuable will be disposed by using disposal method of landfill technology (Norazli et al., 2011). This is because electronic plastic wastes have possibility to become energy generation resource (Norazli et al, 2009). This possibility raise because these wastes contained up to 7, 375kcl/kg which very high calorific value compared to Municipal Solid Wastes which is 3, 450 kcl/kg (Environment Impact Assessment, 2004). Besides, study conducted by Othman et al. (2015), predicted that 49% of e-waste will be disposed while 51% will be reused, repaired, remanufactured and recycled in Malaysia. Table 2.8 and Table 2.9 shows the prediction percentage which consist of residents premises with low income (LI), middle income (MI) and high income (HI).

Table 2.8 Prediction percentage of reuse, repair, remanufacturer and recycling for e-waste by the residents

Projection (Years)	LI (%)	MI (%)	HI (%)	Average of Reuse, Repair, Remanufacturer, Recycling
0-3	3.3	0	0	1.1
3-6	58.1	13.0	2.5	24.5
6-9	22.2	13.8	27.2	21.1
9-12	2.2	5.7	5.7	4.5
12-15	0	0.7	0	0.2
TOTAL	86%	100%	35%	51%

Source: Othman et al. (2015)

Table 2.9 Prediction percentage of e-waste generated for disposal by the residents.

Projection (Years)	LI (%)	MI (%)	HI (%)	Average of Reuse, Repair, Remanufacturer, Recycling
0-3	1.9	0	0	0.6
3-6	6.9	1.3	6.2	4.8
6-9	5.5	58.6	58.4	40.8
9-12	0	0	0	0
12-15	0	6.9	0	2.3
TOTAL	14%	67%	65%	4.9%

Source: Othman et al. (2015)

2.9 E-waste related law in the context of Malaysia

In Malaysia, Department of Environment (DOE) is a government agency that authorize and responsible in planning and enforcing the regulation related with e-waste with the cooperation of the Ministry of Natural Resources and the Environment (NRE). The main regulation that used by DOE in planning and enforcing the law is Environmental Quality (Scheduled Waste) Regulations 2005 (SWR 2005) which it is relevant to construction and industrial sector as well as household sector.

Other than SWR 2005, there also several regulations and guidelines that related to e-waste with the authority of DOE. The regulations and guidelines are shown as follow:

Table 2.10 Regulations and guidelines that related to e-waste

	Regulations and Guidelines	**Description**
1	Environmental Quality Act 1974	An Act that applies in Malaysia which relate to the prevention, minimize, control of pollution and environment improvement.
2	Environmental Quality (Licensing) Regulations 1977	A regulation that regulate the application for license, revocation and suspension of license.
3	Environmental Quality (Schedule Waste) Regulations 2005	A regulation that provided for the use of management, storage, treatment, disposal and transport of scheduled wastes.
4	Environmental (Scheduled Waste) Regulations 2005 (Amendment) 2007	A regulation that provided for the use of management, storage, treatment, disposal and transport of scheduled wastes (amended in the First Schedule, SW104).
5	Environmental Quality (Prescribed Premises) (Scheduled Waste Treatment And Disposal Facilities) Order 1989	Orders that regulate premises (off-site storage, treatment and recovery facilities, scheduled waste incinerators, land treatment facilities and secure landfills) are prescribe to be premises the occupation.

6	Environmental Quality (Prescribed Premises) (Scheduled Waste Treatment And Disposal Facilities) Regulations 1989	A regulation that provide prescribed periods, notification and inventory of scheduled wastes.
7	Environmental Quality (Refrigerant Management) Regulations 1999	This regulation is applies to a person who handling a refrigerant environmentally hazardous substance in an existing or new installation.
8	Environmental Quality (Prescribed Conveyance) (Schedule Wastes) Order 2005	This order only applies for prescribe conveyance that used for movement whether in land or water.
9	Guidelines for the Classification of Used Electrical and Electronic Equipment in Malaysia. (Department of Environment, January 2008).	Guideline is used to guide and assist the parties which involved in e-waste management to recognize and categorize the used EEE or components based on the regulatory codes.

2.9.1 Environmental Quality (Scheduled Wastes) Regulations 2005

Environmental Quality (Scheduled Wastes) Regulations 2005 are regulations that provided for the use of management, storage, treatment, disposal and transport of scheduled wastes. These regulations are the regulations that used in Malaysia which replaced the withdrawal of Environmental Quality (Scheduled Wastes) Regulations 1989. This regulation replaced the previous regulations because e-waste has been classified by Department of Environment (DOE) as a scheduled waste under the code of SW110. Other than SW110, there also other codes which refer to specific e-waste such as waste from lead acid batteries (SW102), batteries which containing heavy metals (SW103), fluorescent lamps (SW109) and waste from electrical and electronic assemblies containing components such as accumulators, mercury-switches, glass from cathode-ray tubes and other activated glass or polychlorinated biphenyls-capacitors, or

contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyl (SW110).

Based on the classification by the regulation, any e-waste treatment must be performed at the licensed on-site treatment facility, while e-waste disposal only can be performed by the prescribed premise which is Kualiti Alam Sdn. Bhd. Besides, Malaysia is including among the parties in Basel Convention others than Indonesia, Singapore and Thailand (Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 2011), so it is strictly forbid for Malaysia to import or export any e-waste outside the country. This prohibition is stipulated under Article 4, paragraph 1(a) and 1(b) of Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal which state that:

1(a) Parties (refer to the country) exercising their right to prohibit the import of hazardous waste or other waste for disposal shall inform the other Parties of their decision pursuant to Article 13 (Transmission of Information);

1(b) Parties shall prohibit or shall not permit the export of hazardous waste and other wastes to the Parties that have prohibited the import of such waste, when notified pursuant to subparagraph (a) above.

Furthermore, The Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal lists hazardous waste also indicated in paragraph 1(a) of Article 1 that waste that are from any category included in Annex I (Categories of Wastes to be Controlled), unless they do not possess any of the characteristics included in Annex III (List of Hazardous Characteristics). Wastes listed in Annex VIII are also refers as hazardous pursuant to paragraph 1(a) of Article 1.

2.9.2 Guidelines for Classification of Used Electrical and Electronic Equipment

Department of Environment (DOE) has issued the "Guidelines for the Classification of Used Electrical and Electronic Equipment" in January 2008. This guideline is used to guide and assist the parties which involved in e-waste management to recognize and categorize the used EEE or components based on the regulatory codes. The parties that required referring these guidelines are waste generators, waste transporters, importers and exporters of wastes and other applicable authorities which involved in e-waste management. This guideline also has provided a list of the types of e-waste that have potential to contain hazardous substances or material and EEE that required for recycling, recovery or disposal.

2.10 Conclusion

Good practice of e-waste management is very crucial to ensure the adverse effect from the e-waste towards human health and environment can be minimized properly. Besides, there are some beneficial from managing the e-waste which are it is rich source of raw materials, helps in managing solid waste and minimize potential adverse effect to human health and environment.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will be focusing on the discussion of the research methodology that used through the research which consists of research design, study sample, study area, research process, techniques and instruments as well as data analysis.

3.2 Research Design

Descriptive research design is an overall strategy used for this research. Descriptive Research design is a type of research design that helps to provide answers for the questions and how it associated with specific research problem. The questions that preferable for this research design is the questions of who, what, when and where. Although this study can help in finding the particular answer for the questions but, this study cannot determine accurately for answer to why. This research design also used to find any information that associate with the current status of the current phenomena and to describe the existing method or else with the respect to condition of the situation.

Therefore, this research design is being considered as an overall strategy of this research compared to other research design. This is because, this research design is suit and convenient for this research which mainly this research is focusing on finding the answer related with e-waste management practice in collection centre in Kuantan, Pahang.

3.3 Study Sample

Generally, study sample is a sampling process of the research which used to select a particular number of subjects or sample from a population. Sampling is very important in research because it will lead to low validity and reliability of the research due to unsuits sample selection. Besides, sampling also plays important role in research other than research design because it ensures the quality of the research findings.

The sampling procedure that used in this research is cluster sampling. This sampling is a probability type of sampling technique that used by the researcher because it involves a wide area and list of subjects for the research cannot be obtained easily. The reason of using this sampling method is because the scope of the study only focuses on the collection centres at Kuantan, Pahang. Firstly, the selection of the collection centres will be performed by using simple random sampling procedure and then, sample will be selected randomly based on the selected collection centres to obtain the data for the research.

3.4 Study Area

Based on the research, the study area of this research is at e-waste collection centres which only located in Kuantan, Pahang. The selection of the centres is based on the authorized organization or company that involve in collecting, trading, recycling and disposal activities of e-waste. This selection also necessary to ensure the data obtained from this study is valid and reliable for the research. Besides, the selection of study area is crucial in this research because to ensure the objectives of the research are achieved.

3.5 Research Flowchart

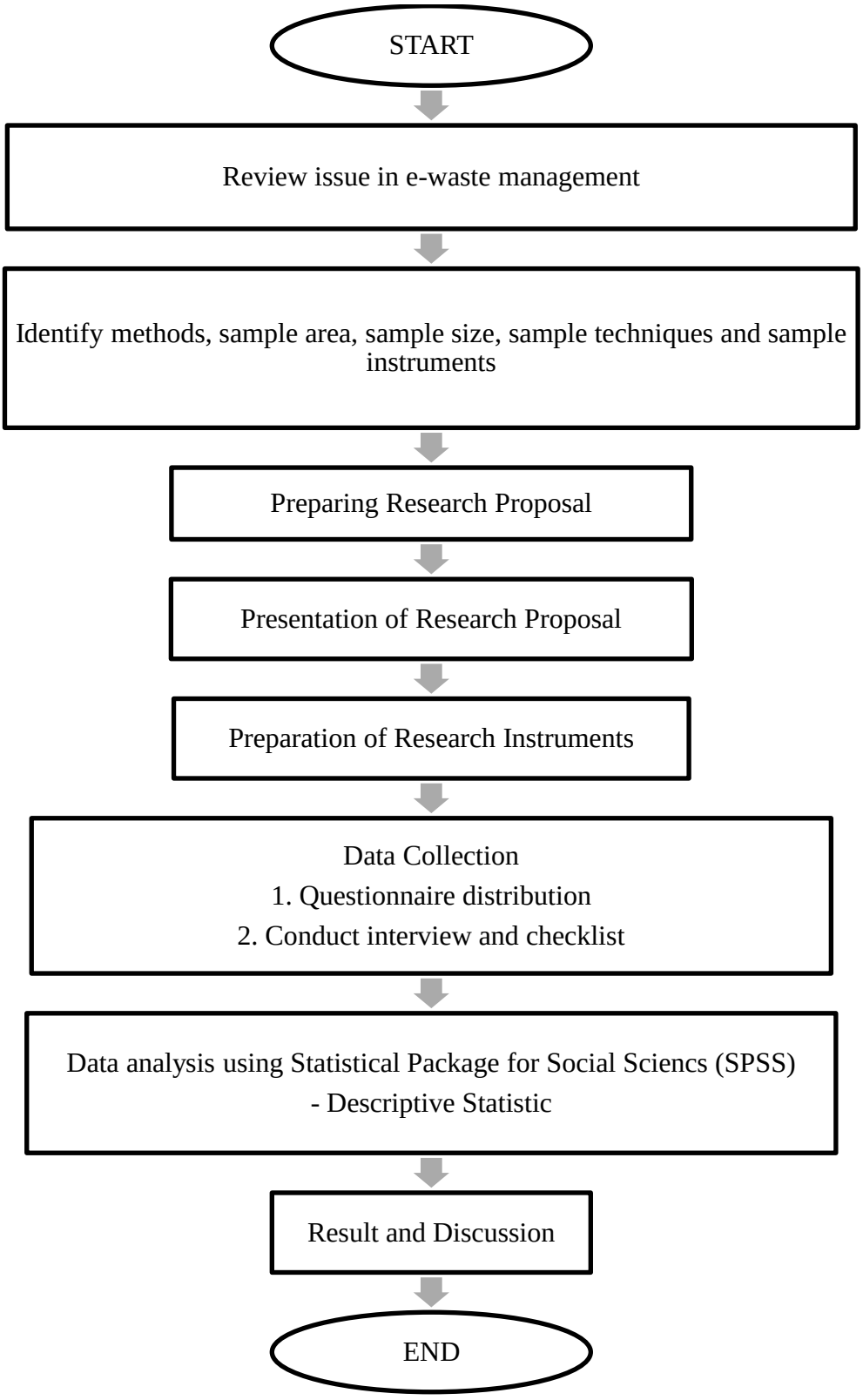

Figure 3.1 Research Flowchart

3.6 Research Techniques

Proper selection of research technique is important in deciding the research methodology. This is because different research needs different techniques in obtaining the data which it linked to particular analysis and process of interpretation. In addition, not every single technique can be implementing to transfer the information and data obtained instantly onto the group of research subjects.

Commonly, each study will used combine multiple techniques to help in reducing the mistakes and variability that present in the research. This is because each data collection techniques have their own strengths and weaknesses. Therefore, this study tends to use several research techniques in obtaining the valid data for the research.

3.6.1 Observation

Observation is a method which helps in accessing the context and meaning of surrounding which it describe what people say and do. There are numerous situations that cannot be visualized that can be seen through this method. It also helps for better in-depth understanding the information obtained to do the analysis for the research.

This research used this technique to analyse and observe the e-waste management practice in that particular collection centre. Besides, any issue related with e-waste management can be obtained directly from this technique. This is because it involves visiting the place or site which e-waste is managed by the collection centres.

3.6.2 Survey

Survey method is commonly method that used to collect information about the population of interest. This is because it quite easy to managed, can be developed faster than the other methods, able to collect the data from a large quantity of respondents, can reduce mistake during gathering the data and more.

The survey technique that used during this research is questionnaire type of method which the respondents were given a questionnaire that consists of closed-ended questions related with the research topic. Generally, the questionnaire is focus on

workers profile, his or her job responsibilities and health risk awareness matter which involve worker's knowledge, attitude and practice (KAP) as in Appendix B.

Survey method is used to determine the level of health risks awareness among the e-waste workers at collection centres. The level of awareness can be identifying through three main aspects which are from worker's knowledge, attitude and practice. These aspects will be evaluated based on the data that have been analysed with the grading score based on Table 3.1.

Table 3.1 Knowledge, attitude and practice (KAP) grading scores

Score %	Knowledge Grade	Attitude Grade	Practice Grade	Total
<50%	Poor	Negative	Inadequate	Poor
50-65%	Fair	Neutral	Adequate	Fair
>65%	Good	Positive	Good	Good

Source: Al-Dharrab et al. (1996)

3.6.3 Desk Research

Desk research or secondary research is a technique that can be used as a stand-alone research method or as initial to primary study. Usually, this method has the readily available data which collected and gathered by other person, organization or agencies. This method is beneficial because it give accurate data as well as time and cost effective.

Based on this technique, any data related with e-waste from the premise will be asked to be given as research purposes. The given data will be useful for the research quality and reliability. Thus, the data that needed for this research is the amount of e-waste collected, recycled and disposed by the collection centres.

3.7 Interview

Interview is one of the common techniques used to obtain the data for the study. This method used because it useful in investigating the issue in-depth which in verbally. Besides, it allows more detailed questions to be asked by the interviewer because it is an open-ended question.

Through this technique, question about e-waste management, compliance of collection centre with e-waste related regulation (environmental Quality Act 1974) and other related topic will be proposed to the top management representative of the collection centres. The question is basically from the checklist in Appendix C.

3.8 Research Instruments

Research instruments are measurement tools which used to collect, measure and analyse the data from the subjects of the research. The instrument of the research can be in term of test, questionnaire, survey or checklist. It also recommended using existing instrument because it may have been developed by professional and tested many times.

3.8.1 Questionnaire

Questionnaire is one of the instruments that used in this research. The design of the questionnaire is based on the existing questionnaire from the previous study. Adoption and modification of questionnaire will be performed based on the interest of the research topic. This is because developing a new questionnaire is quite complicated and need an advice from the expert of this field.

After performing the adoption and modification process, pilot study will be conducted to the 10% of the sample to ensure questionnaire reliability before distribute the actual questionnaire to the workers at the collection centres. Any unnecessary questions also need to be removed based on the Statistical Package for Social Science (SPSS) result. Mainly, the questionnaire is focus on workers profile, his or her job responsibilities and health risk awareness matter which involve worker's knowledge, attitude and practice (KAP) which shown in Table 3.1.

Based on the adopted and modified questionnaire, a total of 18 close-ended questions have been asked to the e-waste workers regarding with three main aspects of awareness which are knowledge, attitude as well as practice. From the questionnaire, each YES answer will be given a score of 1 while NO response was given a score of 0. A maximum score of 2 also will be given for respondents who answered more than one response in their survey for certain questions which total score for each respondent will be 20 if they know all the questions.

3.8.2 Checklist

Besides, checklist also has been used as a research instrument in this study. Based on the third objective which to determine the compliance of the e-waste management with e-waste regulations. Generally, the content of the checklist is based on Environmental Quality Act 1974 and the data will be fill-in the checklist for further analysis as in Appendix C.

The use of checklist in this research also is to verify and check whether the collection centres is complying with the e-waste related regulation or not which it is under third objective. The checklist was designed based on the thorough study related with e-waste regulations and compile it into a form of checklist. Basically the checklist consists of yes and no answers that will be asked to the top management representative to obtained the data. Then, the finding will be extract through data analysis of the study.

3.9 Data Analysis

Data analysis is a process which the raw data is interpreted, discovered and explained based on the research objectives. Based on the study, mainly the data that are needed for this study is the amount of e-waste collected in collection centres, level of health risk awareness among the workers at collection centres and also the compliance of the e-waste management with the regulations. This analysis is important to ensure research objectives are achieved. The analysis of this study is performed by using Statistical Package for Social Science (SPSS).

3.9.1 Statistical Package for Social Science (SPSS)

Statistical Package for Social Science (SPSS) is software which can handle particularly complex data analysis and manipulation with easy instructions. Basically, the data analyses that can be performed through SPSS are frequencies, descriptive, correlation analysis and reliability.

3.9.2 Descriptive Statistic

Descriptive statistics are analysis method used to discuss and describe the elements of the data in the research study. The description of the elements is based on the summaries from the sample and the methods. Besides, it consists of several measures which are measures of central tendency and also measures of variability. Generally, there are three main measure of central tendency which are mode, median and mean. Each of these measures is describing different information of the central value in the distribution. While, measures of variability consist of range, interquartile range, variance as well as standard deviation and it's referring to how spread out a distribution of the data is.

3.10 Validity and Reliability

Based on the instrument that will be used during collecting the data, initial procedure of reviewing the questionnaire are needed to be done properly. This step is crucial to ensure the validity of the questionnaire that will be given to the subject later. This step also will ensure the data obtained from the subject is reliable for the research

3.10.1 Pilot Study

Pilot study is small-scale, preliminary studies which aim to investigate whether crucial components of a main study are reliable or not. It also one of the study that usually used by the researcher to proof reliability of the study based on the data collected. This study is performed by selecting the sample randomly in the particular collection centres to answer the questionnaire. Then, the result from the answered questionnaire will be review and improve to ensure the questionnaire is trusted and good before it spread to the actual group of sample.

3.10.2 Cronbach's Alpha (α) using SPSS

Cronbach's alpha is the most common measure of internal consistency or reliability of the research. Usually, Cronbach's alpha is used to test and see if multiple question surveys are reliable or not. The result from the data will be compared based on the range of Cronbach's alpha which shown in Table 3.1 and reliability result can be seen through it.

Table 3.2 Rule of Thumb for Cronbach's Alpha Results

Cronbach's Alpha	Internal Consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Source: Statistic How To (2018)

3.11 Conclusion

There are many methods that can be used in a research. In order to obtained a good data and result, proper selection of method need to be highlighted based on the suitability of the research conducted. Thus, this chapter has shown the research design, study sample, study area, research process, techniques and instruments as well as data analysis that will be implementing throughout this study.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter will be focusing on the results and the discussion based on the finding obtained through data collection.

4.2 Amount of E-waste Collected by Collection Centres in Kuantan, Pahang

Based on the data obtained from the collection centre, the amount of e-waste received by the collection centre is shown in Figure 4.1. The data only available for two years which are from 2017 and 2018 due to the organisation has just start the operation of collection centre in Kuantan in year 2017. That's why the collection centres only able to collect 9 unit of e-waste during first month of operation. Other factor that contributes in this condition is lack or information by the EEE user on how and where to dispose their used electronic items especially in Kuantan, Pahang. This factor supported by the study conducted by Perunding Good Earth (2009) which they found that about 23.95% of unwanted EEE are still owned by the user. Tiep et al. (2015) has listed some of possible factors why the electronic user still hoarding unwanted EEE through their study which are they do not know how to dispose the waste appropriately and safely, they may think that there are some components in the item still can be used for future part consumption, they hesitate to dispose their e-waste because they had spent much money to purchase that particular items and they are waiting the collector to purchase the waste from them.

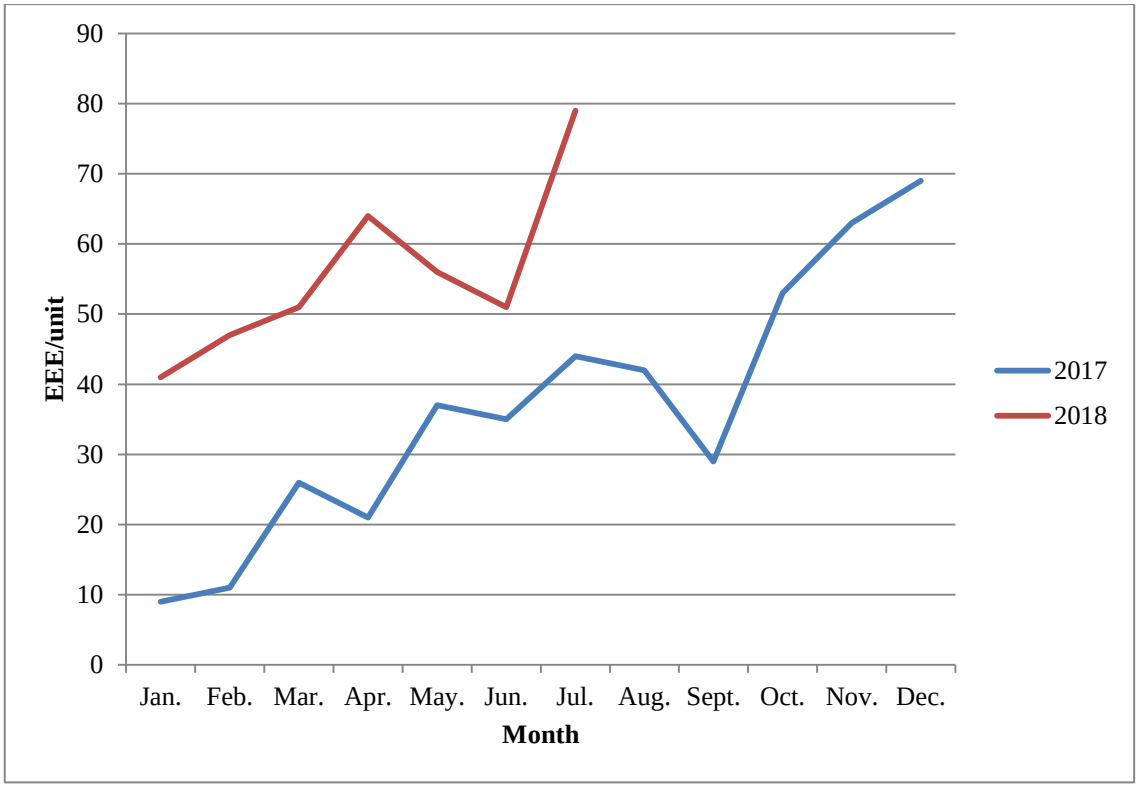

Figure 4.1 Amount of E-waste received by the collection centre

From the data, in 2017 the highest amount of the collected e-waste is in December which is 69 units while in year 2018 is in July which is 79 units. For lowest total amount of e-waste for both 2017 and 2018 are in January which is 9 units and 41 units respectively. Through the analysis, the mean and standard deviation for 2017 is 36.6 and 18.9, while 2018 is 32.4 and 30.1 respectively. Based on the analysis from the previous study (Figure 4.2) on 345 sample of household in Melaka, there is quite number of e-waste disposed by the participant during the past five years such as television, personal computer and mobile phone (Tiep et al., 2015). If the scenario in Kuantan and Melaka is compared, it shows that collection centre in Melaka able to obtained more e-waste than collection centre in Kuantan. The possible factors that may contribute to this outcome could be respondents in Melaka are more aware about e-waste than Kuantan and there is more EEE user available in Melaka than Kuantan. However, this analysis cannot reflect valid comparison of data between these two regions because there is no study has stated that the respondents in Melaka discarded their used EEE into properly in the authorized collection centre.

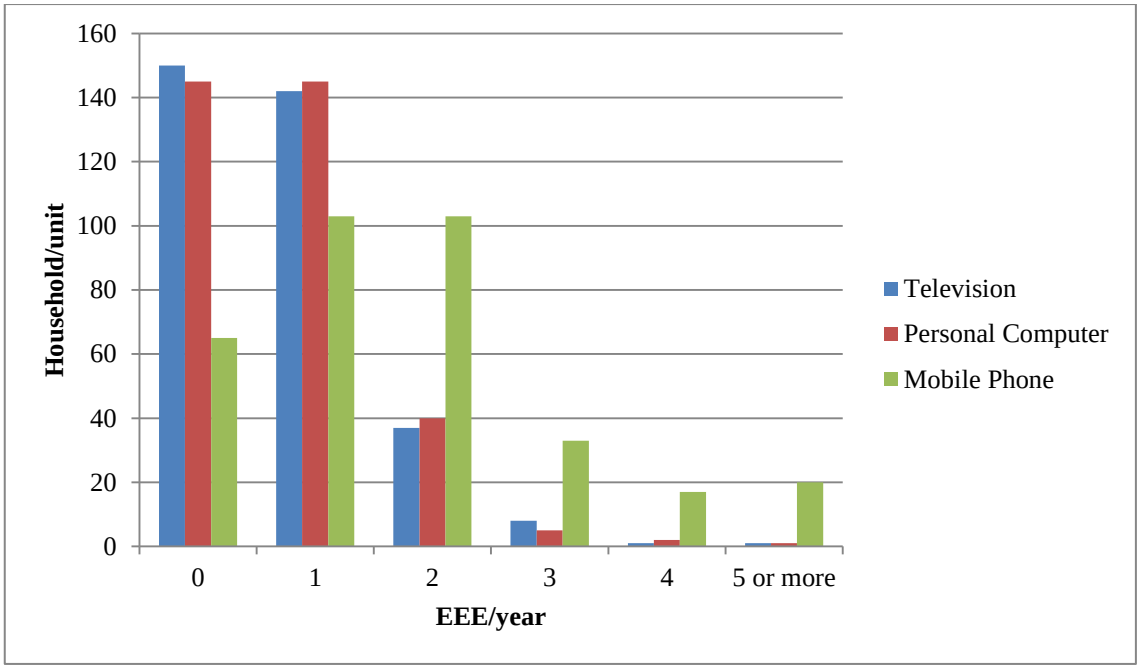

Figure 4.2 Amount of TVs/PCs/MPs disposed during the past five years by the participants in Melaka

Source: (Tiep et al., 2015).

4.3 Health Risk Awareness Level among E-waste Worker

Survey method is used to determine the level of health risks awareness among the e-waste workers at collection centres. The level of awareness can be identifying through three main aspects which are from worker's knowledge, attitude and practice. These aspects will be evaluated based on the data that have been analysed with the grading score based on Table 4.1.

Table 4.1: Knowledge, attitude and practice (KAP) grading scores

Score %	Knowledge Grade	Attitude Grade	Practice Grade	Total
<50%	Poor	Negative	Inadequate	Poor
50-65%	Fair	Neutral	Adequate	Fair
>65%	Good	Positive	Good	Good

Source: Al-Dharrab et al. (1996)

A total of 18 close-ended questions asked to the e-waste workers regarding with three main aspects of awareness which are knowledge, attitude as well as practice. Each YES answer will be given a score of 1 while NO response was given a score of 0. A maximum score of 2 also will be given for respondents who answered more than one response in their survey for certain questions which total score for each respondent will be 20 if they know all the questions.

4.3.1 Personal Data

A total of 32 completed surveys were obtained from the collection centre at Kuantan during the collection data period. Table 4.2 shows the socio-demographic characteristic of the respondents in the collection centre. In general, the socio-demographic consist of general information of the workers that involve with e-waste management activities.

Table 4.2: Socio-demographic characteristic of the respondents in the collection centre

Demographic (N=32)	Sample *n*	Population (%)
Gender		
Male	17	53.1
Female	15	46.9
Ethnicity		
Malay	-	-
Chinese	32	100
Indian	-	-
Others	-	-
Age		
Below 20 years	-	-
20-30 years	-	-
31-40 years	9	28.1
Above 40 years	23	71.9
Marital Status		
Single	6	18.8
Married	26	81.3
Highest Qualification (Education)		
No formal education		
Primary	6	18.8
Secondary	20	62.5
Post-secondary	6	18.8

Receive Job Related Training		
Yes	32	100
No	-	-
Training Type Received		
On-the-job training	32	100
Training by an expert	-	-
Status of Employment		
Permanent	-	-
Temporary/Volunteering	32	100
Years of Work Experience		
1-5 years	20	62.5
6-10 years	12	37.5
More than 10 years	-	-

4.3.2 Knowledge of Work Health Risk

Through the survey as shown in Table 4.3, majority of the workers (65.6%) do not know what e-waste really is, and they unable to mention any chemicals which present in e-waste. Only 11 workers (34.4%) in collection centre can came out with at least one chemical that present in e-waste such as mercury and lead for their answer. A study conducted by Ohajinwa et al. (2017) also gave quite similar result on e-waste worker's knowledge which more than 50% of e-waste worker (88%) who involve in this sector were unable to mention at least one chemical that present in e-waste.

Besides, 90.6% of workers have agreed that chemicals from used electronic equipment could harm their health due to hazardous chemicals or substances which contained in e-waste. Their agreement to this issue is basically in line with the previous study conducted by Grant et al. (2013) which stated that exposure towards e-waste could contribute in affecting human health such as changes in lung function, thyroid function, expression of hormone, birth weight and outcomes, childhood growth rates, mental health, cognitive development, cytotoxicity and genotoxity.

All of the e-waste workers also could mention at least one route of exposure and Personal Protective Equipment (PPE) that necessary for their work while handling the e-waste. Through the survey, most of the answers given for route of exposure were through inhalation and skin, while answer given by the worker for PPE that needed for their job were hand and respiratory protection. Study which also conducted by Grant et

al. (2013) has classified that e-waste could exposed through ingestion, inhalation, dermal contact and absorption as well as trans-placental.

The result from the survey also shows that only 37.5% workers believe that their work environment which involve with e-waste can cause health problem or illnesses. This is because, e-waste contained bundle of toxic components such as barium (Ba), beryllium (Be), cadmium (Cd), cobalt (Co), chromium (Cr), iron (Fe), lead (Pb), lithium (Li), mercury (Hg), manganese (Mn), nickel (Ni) and silver (Ag) that can harm human health and environment (Puckett and Smith, 2002). Chan and Wong (2012) also stated that cumulative exposure of the workers is always high although they are less exposed to e-waste daily which at the same time has proven that their believe that their work environment can cause health problem or illnesses.

Through this survey, overall percentage of knowledge about work health risk is 68.8% which considered as good based on Table 4.1.

Table 4.3: Respondent's knowledge about work health risk

Question	**Response**	
	YES	**NO**
	***n* (%)**	***n* (%)**
1 Do you know what is "e-waste"?	11 (34.4)	21 (65.6)
2 Do you know any type of chemicals comes from used electronic equipment during handling it?	11 (34.4)	21 (65.6)
3 Do you think chemicals from used electronic equipment can affect health?	29 (90.6)	3 (9.4)
4 Which route of exposure do you think chemicals/substances can enter body?	32 (100)	-
5 What type of Personal Protective Equipment (PPE) you think is/are necessary during your work?	32 (100)	-
6 Do you know any health problems/illness which you think can happen due to your work environment?	12 (37.5)	20 (62.5)
Overall percentage of respondent's knowledge	**68.8%**	

4.3.3 Healthy Work Attitude at Work

The survey conducted among the workers at collection centre has reflected their attitudes towards health as a result of their job because all of them (100%) did not perceive any injury at the collection centre weather it is serious, mild or moderate ever since they start working there as shown in Table 4.4. If compared with the e-waste workers in Nigeria, there number of injury prevalence is quite high which 68% in duration of six month and the most common injuries experienced by the workers were cuts (59%) due to sharp object (Ohajinwa, 2018).

Only, 9.4% of workers have experience sickness due to the job such as respiratory problem and allergies, and they (9.4%) believed that the sickness could be as a result from their jobs. Workers who work in the collection centre at Kuantan, Pahang not only work with e-waste but also with other wastes such as paper, plastic items, metal cans and glass bottle. Their symptom of illness supported by Poole and Basu's (2017) study which reviewed occurrence of occupational illness in waste and recycling sector based on the previous studies and they found that illness that could happened are respiratory symptoms, lung function and sensitization to moulds (Coenen et al., 1997) as well as work-related cough and lung function (Heldal et al., 2015).

Based on the data, majority of the workers (81.3%) did not worry about their health while 18.8% of them have mentioned that they were worrying a little about their health. This situation may happen among the workers due to the present of hazardous substances and materials that contained in e-waste such as heavy metals and persistence organic materials (Alavi et al., 2015). Therefore, it is logical for them to have a concerned about their health while working in the collection centre.

Although managing e-waste is quite a concern, the survey shows that 100% of them said that the work environment is considered as their major challenge rather than others option. This outcome is contrast from the study conducted by the Ohajinwa et. al (2017) which majority (51%) of e-waste workers reported that their main concern is finance because they focusing in making more money than worrying about their work environment.

Hence, analysis shown that positive attitude have been reflected by the worker due to overall percentage of respondent's attitude is 96.9%.

Table 4.4 Respondent's healthy work attitude at work

	Question	Response	
		YES	**NO**
		***n* (%)**	***n* (%)**
1	Do you experience any injury due to your jobs?	32 (100)	-
2	If "Yes", how would you perceive the injury	NA	NA
3	Do you experience any sickness due to your jobs?	3 (9.4)	29 (90.6)
4	If "Yes", do you think your sickness due to your jobs?	3 (100)	
5	**Do you worry about your health or your family due to your work environment?**		
	Not worry	26 (81.3)	
	Previously worried, but no longer worried	-	
	Little worried	6 (18.8)	
	Yes, very worried	-	
6	**What do you think the major challenges in your jobs?**		
	Health	-	
	Finance	-	
	Work environment	32 (100)	
	No challenge	-	
Overall percentage of respondent's attitude		**96.9%**	

4.3.4 Healthy Work Practice

The result from the survey shows a good work practice among the workers at the collection centre as shown in Table 4.5. This is because, all of them (100%) used PPE during their working hour (mask, gloves and safety boot), always wash their hands before eating while work and took their work clothing and shoes for laundering. Only 25% of the workers do not change their clothes before going home from work.

This situation different from e-waste workers in Nigeria which only 18% of them wear PPE, 68.5% washed their hands before eating while work and approximately 45% of them took their work clothing and shoes for laundering (Ohajinwa et al., 2017). These work practice actually need to be followed by the worker because electronic waste not only can affect the victims through direct exposure but also indirect exposure (Perkins et. al, 2014).

Basically direct exposure can occur when the workers inhaled, ingested or touched the toxic chemicals that contained inside the e-waste while indirect exposure happened because of chemicals found in the electric components are easily to leach out into local water sources, food and also blown away by the wind into the air (Park et al., 2017).

Furthermore, the collection centre is fully using man power in handling the e-waste, the result shows that all the workers (100%) always bend or twist their upper body while working at collection centre. The common activity that involved bend or twist are lifting, carrying and moving the e-waste from one place to another place. This work activity could cause high exposure toward ergonomic risk factor which leads to injury among the workers and although they often bend or twist their upper body, the survey reported that all the workers (100%) comfortable with their work condition during working at the collection centre.

Data obtained from the European Working Condition Surveys (2010) about the work exposure has proven that the workers who involve in this sector are highly exposed to risks due to workload and manual handling. There are more than 50% responses which stated that, about quarter of their working time involves tiring and painful positions. Ohanjinwa et al. (2017) also stated that about 66% of e-waste workers carried heavy loads during work and 55% of them are not comfortable working in that condition (bend or twist).

Through the analysis, the result shown that the workers practicing a good practice while managing the e-waste with overall percentage is 79.2%.

Table 4.5 Respondent's healthy work practice

Question		Response	
		YES	**NO**
		***n* (%)**	***n* (%)**
1	Do you use "PPE" during work?	32 (100)	-
2	Do you always wash your hand before eating anything while at work?	32 (100)	-
3	Do you change your clothes before going home from work?	24 (75)	8 (25)
4	Do you take your work clothes and shoes for laundering?	32 (100)	-
5	**How often do you bend/twist your upper body?**		
	Often	32 (100)	
	Rarely	-	
	Never	-	
6	**What do you think about your work conditions/position during work?**		
	Uncomfortable	-	
	Comfortable	32 (100)	
	I don't know	-	
Overall percentage of respondent's practice		**79.2%**	

4.4 Level of Awareness among E-waste worker in Collection Centre

Based on the analysis of three main components of awareness which are knowledge, attitude and practice (KAP), the summary of overall percentage of respondent's awareness is shown as in Table 4.6.

Table 4.6 Overall percentage score of e-waste workers

	Knowledge Grade	Attitude Grade	Practice Grade	Total
Overall Score (%)	68.8% (Good)	96.9% (Positive)	79.2% (Good)	81.6% (Good)

The score has been compared with grading score of KAP in Table 4.1 and it shows that the awareness level of e-waste worker towards health risk is in good level. This is because, all three grades of KAP shown the workers have a good knowledge, positive attitude and good practice while handling the e-waste in the collection centre.

4.5 Compliance of Collection Centre

Checklist was used in this method to determine the compliance of the e-waste management with e-waste regulations. Hence, an interview session with top management of collection centre was conducted to verify whether they managed to comply with the related regulation or not. Basically, the main reference for the checklist is based on Environmental Quality Act 1974 and the data will be analysed through strong response from the top management in interview session. Through this method, it shown that the collection centre is complying with the regulation (EQA 1974) which focused in the study.

4.5.1 General Compliance Questions

The checklist is adapted and organized as a series of questions on collection centre management based on suitability and priority of the study which is to determine the compliance of the collection centre with the rule and regulation in managing e-waste as shown in Table 4.7.

Table 4.7 Compliance checklist for the collection centre

	Checklist Items	Yes	No
1	Is the collection centre is certified under any authorized organization	√	
2	Can you give a general description of business	√	
3	Does the service at collection centre accept all type of e-waste products	√	
4	Does the service only for this geography area		√
5	Can you identify federal, state and local environment agency contact	√	
6	Is there any regulation/law/guideline that followed by the collection centre	√	
7	Does you have any environmental, health and safety management system and/or plan in place	√	
8	Can you provide a description of services (process)	√	
9	Can you provide a description of what it does with the electronic equipment receives	√	
10	Does the electronics equipment are send for disposal in landfills or for incineration	√	

Through an interview session with top management, the collection centre is working under non-government organization (NGO) which focusing on recycling and environmental protection. The collection centre also considered as an authorized collector which assigned for managing e-waste in Kuantan region.

Besides, the management also managed to provide general description and information about their business which include point of contact, number of volunteer involve in the business, years in business and ownership history as well as summary of operations and services offered.

As an authorized collector, the collection centre accepts all type of used electric and electronic equipment from the customer as long as they able to send it to them directly or through their recycling point. Among the electronic items received, here at the collection centre include computer, cookware (oven, microwave and kettle), fan, washing machine and television.

The services provided by the collection centre are mainly operating in Kuantan but, other people or customers from other region also are no exception in using their services in managing their household e-waste. There are several recycling points available throughout Kuantan such as at Taman Tas, Kg Tengah, Kubang Buaya and Gambang which the customers can send their used electronic items there for recycling purposes.

The management also able to identified local environment agency right after the question has been asked to them which are Department of Environment (DOE) and SWCorp. The collection centre also had mentioned about Majlis Perbandaran Kuantan (MPK) and Alam Flora which they cooperate with in managing the e-waste in Kuantan.

Environmental Quality Act 1974 and Act 672 are among the law that the management mentioned during the interview session. These laws basically are among the regulations followed by the collection centre to ensure they did not contravene with the legal requirement of Malaysia. EQA 1974 is an act that applies in Malaysia which relate to the prevention, minimize, control of pollution and environment improvement while Act 672 is called as The Solid Waste and Public Cleansing Management Act 2007 and it enacted to provide and regulate for every management which controlled solid waste and public cleansing to maintained proper sanitation.

Generally, the collection centre practice a good safety and health management system because they will ensure their volunteer wear proper personal protective equipment (PPE) before start working in the collection centre which mean they able to established a safety environment while working with e-waste. Besides, there also shown an availability of emergency response plan in the collection centre due to there is adequate fire protection device and evacuation procedure in the collection centre. The response from the management also has shown that, they also practicing emergency procedure regularly to ensure the volunteer aware and able to respond with the emergency if happened.

Basically, the collection centre is an authorized collector, and they are compulsory to transfer the collected household E-wastes only either to other authorized collection centres/collectors or retailers or designated Licensed Household E-waste Recovery Facilities by the DOE to meet with their recycling requirements. Figure 4.2 shows an overview on the process that the collection centre going through to ensure proper managing household e-waste. From the management's response through interview session, they answer exactly the same as shown in Figure 4.2 which is they as authorized collector only collect the e-waste through collection point and keep it in proper storage. As authorized collection centre, they also need to ensure there is no mixing of e-waste with other wastes, no dismantling of collected e-waste, transfer of the e-waste to the designated recyclers and reporting of the collection activities (New Mechanism of Household E-waste Management in Malaysia, 2017).

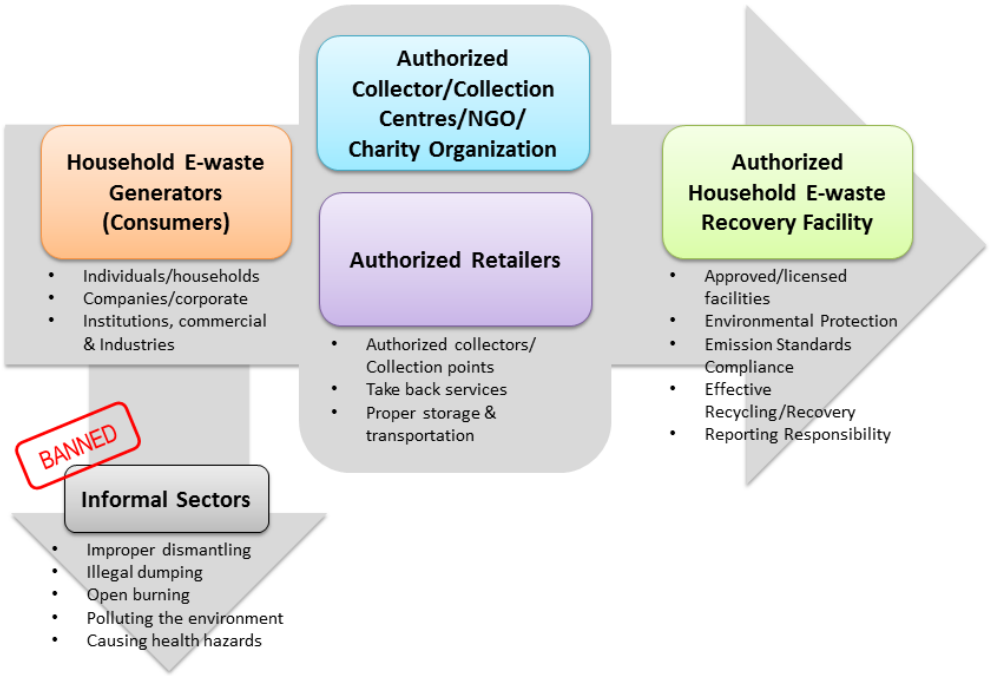

Figure 4.3 Proper Household E-waste Management System

Source: Department of Environment (2015)

The next steps right after e-waste has been collected or received by the collection centre are shows as Figure 4.3. Firstly, e-waste will through sorting and checking phase to identify whether it usable or not by the volunteer. Then, only usable household e-waste will be keep in proper storage in the collection centre or sell to interested organization, while toxic contained e-waste will be send to MPK or authorized factory or facility either for recycling process or disposal. For unusable e-waste, the collection centre will send it to MPK or Alam Flora.

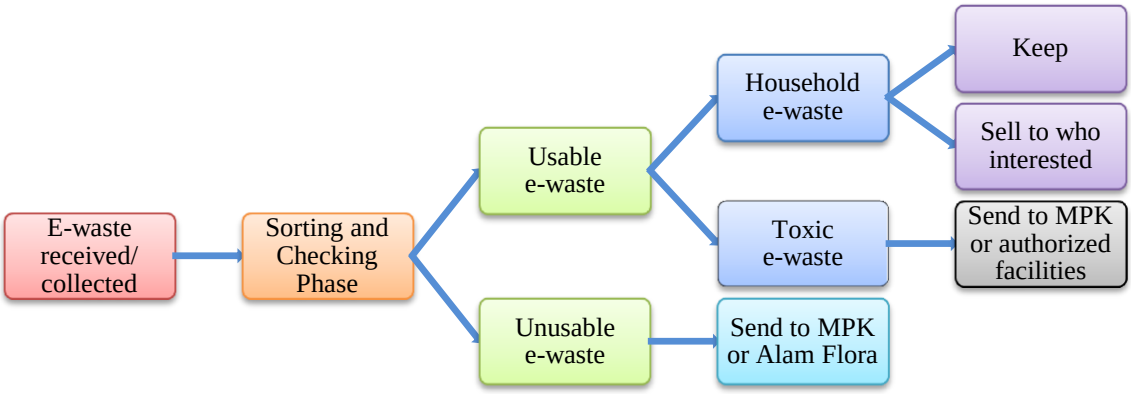

Figure 4.4 Process after e-waste received by the collection centre

Through the management response, the used electronic equipment will not be send for disposal in landfills or for incineration because as recycling centre they want to prolong and reuse the sources that available in e-waste so that it can helps in protecting the environment.

4.5.2 Environmental Quality Act 1974 Checklist

Basically, the checklist (Table 4.8) was referred from the Environmental Quality Act 1974 and contains several items to be verified from the collection centre. The items are based on the sections available in the act and have been chosen according to the suitability for the collection centre.

Table 4.8 Checklist based on Environmental Quality Act 1974

Section	Checklist Items	Yes	No
	PART IV - Prohibition and Control Pollution		
18	Prescribed premises to be licensed	√	
21	Power to specify condition of emission, discharge	√	
22	Restriction on pollution of the atmosphere	√	
23	Restrictions on noise pollution	√	
24	Restriction on pollution of the soil	√	
25	Restriction on pollution of the inland waters	√	
27	Prohibition of discharge of oil into Malaysia waters	√	
29	Prohibition of discharge of wastes into Malaysia waters	√	
29A	Prohibition on open burning	√	
	PART IVA - Control of Scheduled Wastes		
34B	Prohibition against placing, deposit, etc., of scheduled wastes	√	
	PART VI - Miscellaneous		
41	Penalty for offences		√

Section 18 in Environmental Quality Act 1974 (EQA 1974) under Part IV has stipulated that, every prescribed premises should be licensed under this law. As a collection centre, they are necessary to apply a license under this section because they managed hazardous waste that could affect human health and environment. Unlicensed premise is consider illegal and informal waste sector, and it is banned by Department of Environment which shown in Figure 4.2. Cho (2018) has stated that informal sector of recycling are involving with men, woman and children which assigned to recover valuable material inside the e-waste by burning the devices to melt away the non-valuable materials. Usually they will not wear any proper PPE while recycling the items and this condition could give bad consequence to their health.

The collection centre also did not have any power to discharge any pollution or emission from e-waste to the environment because it is not their type of business activity. This condition is very important to be asked to the management due to it available in EQA 1974 under section 21 which it is prohibited to emit, discharge or deposit any environmentally hazardous substance, pollutants, wastes or noise into any area. According to DOE, only authorized household e-waste recovery facility has the power to dispose and recycle e-wastes in an environmentally sound manner (ESM) in

accordance with the legal requirements. Hence, action of complying with section 21 also indicates that the collection centre does not contravene section 22, 23, 24, 25, 27 and 29 of EQA 1974 as shown in Table 4.8.

In addition, the collection centre also did not practicing open burning activity in their premise due to it opposite to their focus on protecting the environment. Besides e-waste, there also other wastes that collected by the premise such as plastic, paper and glass, and they also did not burned it as they want to send it to recycling facilities for recycling. As mention before, only informal sector of waste management will burn the waste to obtain the valuable materials. This statement supported by Ababio (2012), that general informal e-waste recycling are informally conducted in small workshops by using basic methods such as manual disassembly and open burning. Through this practice, it shown that the collection centre is obeys section 29A of EQA 1974.

There also some e-waste consumers that send used lead-acid battery (automotive battery) in collection centre and it is considered as scheduled waste based on Environmental Quality (Scheduled Wastes) Regulations 2005 under code of SW102. Section 29A of EQA 1974 has stipulated that it is prohibited to anyone to place, deposit or dispose any scheduled wastes on land or into Malaysian waters, and the collection centre followed this section. This is because, recycling used lead-acid batteries is one of public health concern according to World Health Organization (WHO), because this sector is associated with a high level of occupational exposure and environmental emissions. Besides, improper method of recycling such as breaking up the batteries manually will releases lead particles and lead oxide dust, which are a source of lead exposure to the worker (Suplido and Ong, 2000; UNEP, 2003). To avoid any unwanted event, proper measure has been taken by the collection centre by sending the scheduled wastes to MPK or authorized facilities for further action as well as the collection centre does not have any facilities that can be used to recycle the used battery.

Basically, section 41 stipulated that any violation and negligent of EQA 1974 provisions will be penalised for ten thousand ringgit or to imprisonment for two years or both. According to the management, there is no history of contravention of law or regulation since the collection centre start to operate. Generally, only informal sector is banned by DOE and this collection centre is not considered as that type of sector. This is because, informal recycling sector of e-waste are widely present in many country such as in China (Chi and Reuter, 2011), Pakistan (Umair, 2015), Nigeria (Ohajinwa et. al, 2017) and Mexico (Tsydenova and Heyken, 2018), and this business activity actually illegal due to this activity can lead to serious threat to both for people and the environment. Hence, as an authorized collection centre, they are followed necessary law and regulation of EQA 1974 while managing the collection centre.

4.6 Study Limitation

All studies have their own limitation and this study also no exceptional to have it. There are several aspects of limitation that can be highlighted based on the research such as sample size and poor research studies on the topic.

Sample size is one of the study limitation due to number of respondents are considered not enough in representing distribution of the population. This is because the conducted study was a quantitative research and it generally less relevant if the sample size is too small. The more number of the respondents who involved in this study, the better and relevant this study was. The less availability and information about the collection centre in Kuantan also contributed in limiting the sample size of the study.

Besides, there was a difficulty in finding the related research topics due to lack of prior research studies on this topic. This aspect is very important in every research, not only for this study because it helps in forming the basis of the literature review as well as the understanding of the research problem that has been or will be investigated. Lack of previous research on this topic indirectly cause significant obstacle in referring reliable data for the study.

CHAPTER 5

CONCLUSION

5.1 Introduction

This chapter will be focusing on the conclusion of the research topic as well as it recommendations that are needed for improvement of the study if there a further study about this topic.

5.2 Conclusion

In conclusion, all three objectives have been achieved through this study which is this study able to determine the amount of e-waste collected by the collection centres in Kuantan, Pahang, identify the awareness level of the e-waste workers toward health risk as well as managed to determine the compliance of the e-waste management with e-waste regulation.

This study shown that, the amount of e-waste collected by the collection centres in Kuantan, Pahang is still in low quantity with mean of 36.6 and 18.9 for years 2017 and 2018 respectively. This condition may happened due to the EEE user do not know how to dispose and discard their used household e-waste in this particular region.

Besides, the study also concludes that the e-waste workers have a good level of awareness towards health risk while handling and managing the e-waste in the collection centres. This conclusion is supported by the evidence obtained throughout the analysis of the KAP questionnaire which reflected that the workers have a good level of awareness to those significant issues.

There also no contravention of regulation identified from the study by the collection centre in managing the e-waste. The study shows that the collection centre able to follow specific legal requirement which is Environmental Quality Act 1974 while operating their business in Kuantan, Pahang.

5.3 Recommendations

In order to have a better quality of research, the study has identified several recommendations that are needed to focus with based on the study findings and one of the recommendation that needed for this study is by increasing the number of sample size of the respondent for this study. Larger number of respondent will increase the quality of the study because it will represent the distribution of population among the e-waste workers.

For future study about the related topic, the study should not focus on one collection centre only because there will be more collection centre available throughout Kuantan, Pahang. Due to lack of information available about the collection centre in Kuantan, Pahang, this study only focuses on one collection centre only.

REFERENCES

Ababio, M. O. (2012). Electronic Waste Management in Ghana – Issues and Practices, *Sustainable Development, 7,* 149-166

Agency for Toxic Substances and Disease Registry (ATSDR). (1995). Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs): U.S. Department of Health & Human Services. Agency for Toxic Substances and Disease Registry.

Al-Dharrab, S. A., Mangoud, A. M., Mohsen, M. A. (1996). Knowledge, attitude and practice (KAP) of primary health care physicians and nurses towards hypertension: A study from Dammam, Saudi Arabia. *3*(2), 57-63.

Alavi, N., Shirmardi, M., Babaei, A., Takdastan, A., Bagheri, N. (2015). Waste electrical and electronic equipment (WEEE) estimation: A case study of Ahvaz City, Iran. *Air & Waste Management Association, 65,* 298-305.

Babu, B. R., Parande, A. K., Basha, C. A. (September, 2007). Electrical and electronic waste: A global environmental problem. *Waste Management & Research, 25*(4), 307-18.

Balabanic, D., Rupnik, M., Klemencic, A. K. (2011). Negative impact of endocrinedisrupting compounds on human reproductive health. *Reprod Fertil Dev, 23*(3), 403–416.

Baldé, C. P., Forti, V., Gray, V., Kuehr, R., Stegmann, P. (2017). *The Global E-waste Monitor 2017.* United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA) Bonn/Geneva/Vienna.

Bandyopadhyay, A. (2008). A regulatory approach for E-waste management: a crossnational review of current practice and policy with an assessment and policy recommendation for the Indian perspective. *Environ Waste Manage, 2,* 1–2.

Basel Convention Regional Centre for South-East Asia (BCRC-SEA), United Nations Environment Programme International Environmental Technology Centre. (2016). *Study on E-waste Management in Asean Countries.*

Bernard, A. (2008). Cadmium & its adverse effects on human health. *Indian Journal of Medical Research, 128*(4), 557-64.

Brune, M. N., Goldizen, F. C., Neira, M., Berg, M. V. D, Lewis, N., King, M., Suk, W. A., Carpenter, D. O., Arnold, R. G., Sly, P. D. (2013). Health effects of exposure to e-waste. *Global Health, 1*(2).

Chan, J. K. Y., Wong, M. H. (2012). A review of environmental fate, body burdens, and human health risk assessment of PCDD/Fs at two typical electronic waste recycling sites in China. *Science of the Total Environment, 463-464*, 1111-1123.

Chancerel, P., Meskers, C. E. M., Hagel¨uken, C., Rotter, V. S. (2009). Assessment of Precious Metal Flows During Preprocessing of Waste Electrical and Electronic Equipment. *Industrial Ecology, 13*(5), 791-810.

Chen, A., Dietrich, K. N., Huo, X., Ho, S. (2010). Developmental neurotoxicants in e-waste: an emerging health concern. *Environmental Health Perspective, 119*, 431-438.

Chen, L., Chen, D., Guo, H. (2008). Elevated serum polybrominated diphenyl ethers and thyroid-stimulation hormone associated with lymphocytic micronuclei in Chinese workers from an e-waste dismantling site. *Environmental Science Technology, 42*(14-15), 2195-2200.

Chi, X., Reuter, M. A. (2011). Informal electronic waste recycling: A sector review with special focus on China. *Waste Management, 31*(4), 731-742

Cho. R. (2018). What Can We Do About the Growing E-waste Problem?. Retrieved 20 November, 2018 from State of the Planet: https://blogs.ei.columbia.edu/2018/08/27/growing-e-waste-problem/

Coenen G. J., Dahl S., Ebbehoj N., Ivens U. I., Stenbaek E. I., Wurtz H. (1997). Immunoglobulins and peak expiratory flow measurements in waste collectors in relation to bioaerosols exposure. *Annals of Agriculture and Environmental Medicine, 4*, 75–80.

Computer Aid International. (2010). *Special Report Series ICT and the Environment, Report 2: WEEE Ver. 2.0 - What Europe must do. London: Computer Aid International*.

Conserve Energy Future:What is E-waste Recycling? (2017). Retrieved 20 March, 2018, from Conserve Energy Future: https://www.conserve-energy-future.com/e-waste-recycling-process.php

Costa, L. G., Giordano, G. (2007). Developmental Neurotoxicity of Polybrominated Diphenyl Ether (PBDE) Flame Retardants. *Neurotoxicology, 28*(6), 1047-1067.

CPCB. (2007). *Draft guidelines for environmentally sound management of electronic waste.* Retrieved 28 December, 2017, from http://ewasteguide.info/newsandevents/new-dr

Cucchiella, F., D'Adamo, I., Koh, S. C. L., Rosa, P. (2015). Recycling of WEEEs: An economic assessment of present and future e-waste streams. *Renewable and Sustainable Energy, 51*.

Cui J., Forssberg E. (2003). Mechanical recycling of waste electric and electronic equipment: a review. *Journal of Hazardous Materials*, 243-263.

Davis, G., Heart, S. (2007). Electronic waste: The local government perspective in Queensland, Australia. *Journal of Resources, Conservation and Recycling, 52*(8-9), 1031–1039.

Directive 2002/96/EC of the European Parliament and of the Council. (27 January, 2003). Retrieved from Waste electrical and electronic equipment (WEEE) - Joint declaration of the European Parliament, the Council and the Commission relating to Article 9.

E-Terra Technologies:Impacts of E-Waste on the environment. (25 May, 2017). Retrieved 15 March, 2018, from E-Terra Technologies: http://www.eterra.com.ng/articles/impacts-e-waste-environment/

E-waste. Hazardous Substances in e-Waste. A Knowledge Base for the Sustainable Recycling of E-Waste. E-Waste: A Swiss E-Waste Guide. (2009).

E-waste Inventory Project in Malaysia. (2016). Retrieved from https://www.env.go.jp/en/recycle/asian_net/Project_N_Research/E-wasteProject/06.pdf

Electronic Waste Facts. (2017). Retrieved 28 December, 2017, from The World Counts: http://www.theworldcounts.com/counters/waste_pollution_facts/electronic_waste_facts

Environment Impact Assessment. (November, 2004). *Detailed Environmental Impact Assessment of The Proposed Resource Recovery Centre (Waste to Energy) plant in Mukim Semenyih, Hulu Langat District, Malaysia*.

Environmental Quality (Scheduled Wastes) Regulations. (2005).

European Commission. (2002). Commission Welcomes Agreement on Waste Electrical and Electronic Equipment and the Restriction of Hazardous Substances: European Commission.

European Working Condition Survey. (2010). Retrieved 20 November, 2018. Survey mapping tool and data set on waste management sector: https://www.eurofound.europa.eu/data/european-working-conditions-survey

Fasanya, I.O., Onakoya, A.B. (2012). Informal Sector and Employment Generation in Nigeria: An Error Correction Model. Res. Humanit. Soc. Sci. *2*, 48-55.

Gaidajis, G., Angelakoglou, K., Aktsoglou, D. (2010). E-waste: Environmental Problems and Current Management. *Engineering Science and Technology, 3*(1), 193-199.

Gladding, T. (October, 2008). Waste Electrical and Electronic Equipment: Do New Regulations Promote Sustainability? *Performability Engineering, 4*(4), 319-332.

Grant, K., Goldizen, F. C., Sly P. D. (2013). Health consequences of exposure to e-waste: a systematic review. *Lancet Global Health, 1*(6), 350-361.

Greenpace:The e-waste problem. (23 May, 2005). Retrieved 5 February, 2018, from Greenpace: https://www.greenpeace.org/archive-international/en/campaigns/detox/electronics/the-e-waste-problem/

Guidelines for Environmentally Sound Management of E-waste. (2008).

Guidelines for the Classification of Used Electrical and Electronic Equipment in Malaysia. (2010).

Hamburg, K. E. (1997). Municipal waste recycling in Brandon, Manitoba: determinants of participatory behaviour. *41 (2)*, 149–65.

Haque, T. (3 November, 2016). *Introduction to Electronics (E-waste) Recycling*. Retrieved 5 February, 2018, from The Balance: https://www.thebalancesmb.com/introduction-to-electronics-e-waste-recycling-4049386

Household E-waste. (2018). Retrieved 5 February, 2018, from Department of Environment: http://www.doe.gov.my/hhew/wp-content/plugins/download-attachments/includes/download.php?id=8330

He, W., Li, G., Ma, X., Wang, H., Huang, J., Xu, M., Huang, C. (2006). WEEE recovery strategies and the WEEE treatment status in China. *Hazardous Materials, 136*, 502-512.

Heldal KK , Madsø L, Eduard W. (2015). Airway inflammation among compost workers exposed to actinomycetes spores. *Annals of Agriculture and Environmental Medicine*, *22*(2), 253–258.

Herat, S., Agamuthu, P. (30 July, 2012). E-waste: a problem or an opportunity? Review of issues, challenges and solutions in Asian countries. *Waste Management & Research, 30*(11), 1113-1129.

Hoffmann, J. E. (1992). Recovering precious metals from electronic scrap. *The Minerals, Metals & Materials Society, 44*(7), 43-48.

Huisman, J., Magalini, F., Kuehr, R., Maurer, C., Ogilvie, S., Poll, J. (5 August, 2007). *2008 Review of Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE). Final Report. Tokyo, Japan:United Nations University.* Retrieved 20 January, 2017, from European Comission: http://ec.europa.eu/environment/waste/weee/pdf/final_rep_unu.pdf

Impacts of E-waste on the environment. (25 May, 2017). Retrieved 12 April, 2018, from E-Terra Technologies: http://www.eterra.com.ng/articles/impacts-e-waste-environment/

Institute of Scrap Recycling Industries Inc. (2003). The Scrap Map: An Environmental Publication for Grades K-6.

John, B.C., Chamhuri, S., Ahmad, F.M., Rawshan, A.B. (2010). E-waste Management for Minimum Impact on The Ecosystem. *In: Proceedings of the end International Seminar on Ecology, Human Habitat and Environmental Change.*, 571-581.

Johri, R. (2008). *E-waste: Implications, Regulations, and Management in India and Current Global Best Practices.* Energy and Resources Institute.

Kalana, J. A. (2010). Electrical and Electronic Waste Management Practice by households in Shah Alam, Selangor, Malaysia. *Environmental Sciences, 1*(2), 132-144.

Kang, H. Y., Schoenung, J. M. (December, 2005). Electronic waste recycling: A review of U.S. infrastructure and technology options. *Resources, Conservation and Recycling, 45*(4), 368-400.

Kelly, T.C., Mason, I.G., Leiss, M.W., & Ganesh, S. (2006). *University community responses to on-campus resource recycling.* Retrieved 5 February, 2018, from University of Canterbury: https://ir.canterbury.ac.nz/bitstream/handle/10092/494/12595857_Main.doc?sequence=1&isAllowed=y

Lundgren, K. (2012). *The Global Impact of e-Waste: Addressing the Challenge.* Retrieved 28 December, 2017, from International Labour Office, Programme on Safety and Health at Work and the Environment (SafeWork), Sectoral Activities Department (SECTOR). Geneva:International Labour Office: http://www.ilo.org/wcmsp5/groups/public/—ed_dialogue/—sector/documents/publication/wcms_196105.pdf

Mcallister, L. (4 April, 2013). *The Human and Environmental Effects of E-Waste*. Retrieved 23 February, 2018, from Population Reference Bureau: https://www.prb.org/e-waste/

Menad, N., Guignot, S., Houwelingen, J. A. V. (2013). New characterisation method of electrical and electronic equipment wastes (WEEE). *Waste Management, 33*, 706-713.

Mmereki, D., Li, B., Li'ao, W. (2015). Waste electrical and electronic equipment management in Botswana: Prospects and challenges. *Journal of the Air & Waste Management Association*, *65*(1), 11-26.

Mundada, M. N., Kumar, S., Shekdar, A. V. (2004). E-waste: a new challenge for waste management in India. *Environmental Studies, 61*, 265-279.

Needleman, H. (2009). Low level lead exposure: history and discovery. *Annals of Epidemiology, 19*(4), 235-238.

New Mechanism of Household E-Waste Management in Malaysia (2017)

Norazli, O., Noor Ezlin, A. B., Muhd Noor, M. Y., Lariyah, M. S., Nor Azizi, O. (2009). Potential of Electronic Plastic Waste as a Source of Raw Material and Energy Recovery. *Sains Malaysiana*, 707-715.

Norazli, O., Noor Ezlin, A. B., Muhd Noor, M. Y., Nor'aziz, O. (2011). An Approach Towards the Integrated Electronic Waste (E-waste) Management Technique in Malaysia.

Norman, R. E., Carpenter, D. O., Scott, J., Brune, M. N., Sly, P.D. (2013). Environmental exposures: an underrecognized contribution to noncommunicable diseases. *Review on Environmental Health, 28*(1), 59-65.

OECD. (2001). Extended producer responsibility: a guidance manual for governments. Paris7 OECD.

Ohajinwa, C. M., Bodegom, P. M. V., Vijver, M. G., Peijnenburg, W. J. G. M. (2017). Health Risks Awareness of Electronic Waste Workers in the Informal Sector in Nigeria. *Environmental Research and Public Health*. *14*(8), 911

Ohajinwa, C. M., Bodegom, P. M. V., Vijver, M. G., Peijnenburg, W. J. G. M. (2018). Prevalence and injury patterns among electronic waste workers in the informal sector in Nigeria. *International Society for Child and Adolescent Injury Prevention*. *24*(3), 185-192.

Okoye, A., Odoh, C. (2014). Assessment of the Level of Awareness of E-Waste Management and Concern for the Environmental amongst the Populace in Onitsha, Southeastern Nigeria. *Environmental Protection, 5*, 120-134

Ongondo, F.O., Williams, I. D., Cherrett, T. J. (2011). How are WEEE doing? A global review of the management of electrical and electronic wastes. *Waste Management, 31*, 714-730.

Oskamp, S. (1995). Resource conservation and recycling: behavior and policy. *J Social Issues, 51*(4), 157–177.

Othman, N., Mohammad, R. & Kamaruddin, S. A. (2015). Prediction of Electronic Waste Disposal from Residential Areas in Malaysia. *New Technologies in Mechanical Engineering, 74*(10).

Park, J. K., Hoerning, L., Watry, S., Burgett, T., Matthias, S. (2017). Effects of Electronic Waste on Developing Countries. *Advances in Recycling & Waste Management,* 2, 128.

Perkins, D. N., Drisse, M. N. B., Nxele, T., Sly, P. D. (2014). *Annals of Global Health, 80*(4), 286-295

Perunding Good Earth (PGE), "The e-waste inventory project in Malaysia," Department of Environment, Malaysia & EX- Corporation, Japan. (2009).

Piaw, C. Y. (2016). *Mastering Research Methods.* McGraw-Hill Education (Malaysia) Sdn Bhd.

Poole, C. J. M, Basu, S. (2017). Systematic Review: Occupational illness in the waste and recycling sector. *Occupatio1nal Medicine*. *67*(8), 626-636

Puckett, J., Smith, T. (2002). Exporting harm the high-tech trashing of Asia. In: Coalition, S.V.T. (Ed.).

Ramachandra, T.V., Saira, V. K. (2004). Environmentally sound options for E- waste management. *Journal of Human Settlements*, Energy and Wetlands Group, Center for Ecological Sciences, Indian Institute of Science, Bangalore.

Ranking Web of Universities. (January, 2018). Retrieved 5 February, 2018, from Ranking Web of Universities: http://www.webometrics.info/en/world

Robinson, B. H. (2009). E-waste: an assessment of global production and environmental impacts. *The Science of Total Environment, 408*(2), 183-91.

Robinson, B. H. (2009). E-waste: An assessment of global production and environmental impacts. *Science Total Environment, 408*, 183-191.

Sankhla, M. S., Kumari, M., Nandan, M., Mohril, S., Singh, G. P., Chaturvedi, B., Kumar, D. R. (2016). Effect of Electronic waste on Environmental & Human health- A Review. *Environmental Science, Toxicology and Food Technology, 1*(9), 98-104.

Schwarzer, S. A. (2005). E-Waste, the Hidden Side of IT Equipment's Manufacturing and Use. *Geneva, Switzerland: United Nations Environment Programme*.

Sepulveda, A., Schluep, M., Renoud, F. G., Streicher, M., Kuehr, R., Hageluken, C., Gerecke, A. C. (2010). A review of the environmental fate and effects of hazardous substances released from electrical and electronic equipments during recycling: Examples from China and India. *Environmental Impact Assessment Review, 30*(1), 28-41.

Sinha, D. (2004). The management of electronic waste: a comparative study on India and Switzerland. St. Gallen, University of St. Gallen. Master Thesis.

Stacy B., Anna Hartley M.P. (2014). A Human Lens on the Lives of Informal Workers. Rockefeller Foundation; New York, NY, USA. 16–132.

StEP. Solving the e-waste problem: a synthetic approach (StEP). (2005). Retrieved 2 January, 2018, from Draft Project Document: http://step.ewaste.ch.

Suja, F., Abdul Rahman, R., Yusof, A., Masdar, M. S. (2014). e-Waste Management Scenarios in Malaysia. *Waste Management, 7*.

Suplido, M. L., Ong, C. N. (2000). Lead exposure among small-scale battery recyclers, automobile radiator mechanics, and their children in Manila, the Philippines. *Environmental Research, 82*(3), 231-8

Sushant. (6 October, 2011). *Source of E Waste*. Retrieved 28 December, 2017, from Waste Management: http://www.wastemanagement.in/sources-of-e-waste.html

Swedish Environmental Protection. (2011). *Recycling and disposal of electronic waste.*

Takeuchi, T. (1968). Pathology of Minamata disease. In: Minamata Disease (Kutsuna M, ed). Kumamoto, Japan:Kumamoto Shunhan. 141–252.

Takeuchi, T., Eto, K. (1999). The Pathology of Minamata Disease. A Tragic Story of Water Pollution. Fukuoka:Kyushu University Press.

Tiep, H. S., Kin, T. D. Y., Ahmed, E. M., Teck, L. C. (2015). E-Waste Management Practices of Households in Melaka. *International Journal of Environmental Science and Development*. *6*(11).

The Rockefeller Foundation. (2014). Insights into Urban Informal Workers and Their Health. Rockefeller Foundation; New York, NY, USA. 1–20.

Tsydenova, N., Heyken, M. (2018). Formal and Informal E-waste Collection in Mexico City. *Cascade Use in Technologies 2018*.

Tsydenova, O., Bengtsson, M. (2011). Chemical hazards associated with treatment of waste electrical and electronic equipment. *Wate Management, 31*, 45-58.

Umair, S. (2015). Informal Electronic Waste Recycling in Pakistan. *The Journal of Solid Waste*

UNEP (2003). Technical guidelines for the environmentally sound management of waste lead-acid batteries. Secretariat of the Basel Convention. Basel Convention series/SBC No. 2003/9. Geneva: Basel convention Secretariat; 2003 Retrieved 20 November, 2018, from http://www. basel.int/Portals/4/Basel%20Convention/docs/pub/techguid/tech-wasteacid.pdf,

United Nations University (UNU), Solve the E-waste Problem (StEP), Massachusetts Institute of Technology (MIT), National Center for Electronics Recycling

(NCER). *World e-waste map reveals national volumes, international flows.* (2013). Retrieved 27 December, 2017, from https://www.vie.unu.edu/file/get/11505.pdf

United States Environmental Protection Agency (USEPA). (2000). Electronic reuse and recycling infrastructure development in Massachusetts. EPA–901-R-00-002.

United States Environmental Protection Agency (USEPA). (2012). Checklist for the Selection of an Electronics Recycler. Retrieved 2 June, 2018, from https://www.epa.gov/fec/checklist-selection-electronics-recycler-722012

Vats, M. C., Singh, S. K. (2014). E-Waste characteristic and its disposal. *Ecological Science and Environmental Engineering*, *1*(2), 49-61.

Wath, S. B., Vaidya, A.N., Dutt, P.S., Chakrabarti, T. (December, 2010). A roadmap for development of sustainable E-waste management system in India. *The Science of Total Environment*, *409*(1), 19-32.

Wen, S., Yang, F. X., Gong, Y. (2008). Elevated leves of urinary 8-hydroxy-2'-deoxyguanosine in male electrical and elctronic equipment dismantling workers exposed to high concentrations of polychlorinated dibenzo-p-dioxins and dibenzofurans, polybrominated diphenyl ethers, and polychlorinated. *Environmental Science & Technology, 42*, 4202-4207.

WHO/UNEP. (2013). *Children's Environmental Health*. Retrieved 12 April, 2017, from World Health Organization: http://www.who.int/ceh/publications/endocrine/en/

Widmer, R., Krap O. O., Khetriwal, D. S., Schnellmann, M., Boni, H. (July, 2005). Global perspectives on e-waste. *Environmental Impact Assessment Review, 25*(5), 436-458.

Zhang, X. L., Luo, X. J., Liu, H. Y., Yu, L. H., Chen, S. J., Mai, B. X. (2011). Bioaccumulation of several brominated flame retardants and dechlorane plus in waterbirds from an e-waste recycling region in South China: associated with trophic level and diet sources. *Environmental Science & Technology, 45*(2), 400-5.

APPENDIX A
GANTT CHART

Research Activities	2018											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Title Selection												
Discussion with supervisor												
Introduction												
Literature Review												
Methodology												
Submit first draft proposal												
Submit second draft proposal												
Submission of proposal												
FYP1 Viva Presentation												
Develop Questionnaire/Checklist												
Collect data												
Thesis writing												
Thesis draft submission												
Thesis presentation												
Thesis submission												

APPENDIX B
QUESTIONNAIRE

No. Responden:

FAKULTI TEKNOLOGI KEJURUTERAAN

RESEARCH QUESTIONS

KAJIAN SOAL SELIDIK

E-WASTE MANAGEMENT IN COLLECTION CENTRES AT KUANTAN, PAHANG

PENGURUSAN E-SISA DALAM PUSAT PENGUMPULAN DI KUANTAN, PAHANG

All the information you provide in this questionnaire is for research purposes only and all information will be kept confidential. Hopefully with the cooperation you provide can facilitate this study and sincerity is greatly appreciated. *Semua maklumat yang anda berikan dalam borang soal selidik ini adalah untuk tujuan kajian sahaja dan segala maklumat akan dirahsiakan. Semoga dengan kerjasama yang anda berikan dapat memudahkan lagi kajian ini dijalankan dan keikhlasan amat dihargai.*

2018/2019

QUESTIONNAIRE

Please place a tick (√) in the box based on your answer for the questions given.
Sila letakkan tanda (√) dalam kotak berdasarkan jawapan anda untuk soalan yang diberikan.

SECTION 1: Personal Data

1. Gender/*Jantina*
   □ Male/*Lelaki* □ Female/*Perempuan*
2. Ethnicity/*Etnik*
   □ Malay/*Melayu* □ Chinese/*Cina* □ Indian/*India* □ Others/*Lain-lain*
3. Age/*Umur*
   □ Below 20 years/*Bawah 20 tahun* □ 20-30 years/*20-30 tahun*
   □ 31-40 years/*31-40 tahun* □ Above 40 years/*Atas 40 tahun*
4. Marital status/*Status perkahwinan*
   □ Single/*Bujang* □ Married/*Berkahwin*
5. Highest qualification (Education)/*Kelayakan tertinggi (Pendidikan)*
   □ No education/*Tiada pendidikan*
   □ Primary/Secondary/*Sekolah rendah/menengah*
   □ Post-secondary (University/College)/*Sekolah pasca menengah (Universiti/Kolej)*
6. Receive job related training (**Skip question 7 if answer "No"**)
   *Menerima latihan berkaitan kerja (**Langkau soalan 7 jika menjawab "Tidak"**)*
   □ Yes/*Ya* □ No/*Tidak*
7. Training type received/*Jenis latihan yang diterima*
   □ On-the-job training/*Latihan di tempat kerja*
   □ Training by an expert (Courses)/*Latihan oleh pakar(Kursus)*
8. Status of employment/*Status bekerja*
   □ Permanent/*Kekal* □ Temporary/Volunteering/*Sementara/Sukarela*
9. Years of work experience/*Tahun pengalaman bekerja*
   □ 1-5 years/*1-5 tahun* □ 6-10 years/*6-10 tahun*
   □ More than 10 years/*Lebih 10 tahun*

SECTION 2: Knowledge of work health risk

Question with sign (**) can be tick with more than 1 answer.
Soalan dengan tanda (**) boleh ditandakan dengan lebih daripada 1 jawapan.

1. Do you know what is "e-waste"?/*Adakah anda tahu apa itu "e-sisa"?*
   □ Yes/*Ya*
   □ No/*Tidak*
2. Do you know any type of chemicals comes from second hand/used electronics during recycling?
   Adakah anda tahu mana-mana jenis bahan kimia datang dari elektronik terpakai semasa kitar semula?
   □ Yes (please specify)/*Ya (sila nyatakan)*: _____
   □ No/*Tidak*
3. Do you think chemicals from second-hand electronics can affect health?
   □ Yes/*Ya* □ No/*Tidak* □ I don't know/*Tidak Tahu*
4. Which route of exposure (entrance to the body) do you think the chemicals/substances can enter your body?**
   *Laluan yang manakah yang anda fikir bahan kimia boleh masuk ke dalam badan anda?***
   □ Inhalation (breathing)/*Penyedutan (pernafasan)*
   □ Skin (or eye) contact/*Sentuhan kulit (atau mata)*
   □ Swallowing (ingestion or eating)/*Menelan (makan)*
   □ Injection/*Suntikan*
   □ Other (please specify)/*Lain-lain (sila nyatakan)*: _____
   □ I don't know/*Tidak tahu*
5. What type of Personal Protective Equipment (PPE) you think is/are needed for your work?**
   *Apakah jenis Peralatan Perlindungan Peribadi (PPP) yang anda rasa diperlukan untuk kerja anda?***
   □ Arm & Hand Protection (gloves)
   Pelindung lengan & tangan (sarung tangan)
   □ Body Protection (apron, clothing protection, coats)
   Perlindung Badan (apron, perlindungan pakaian, kot)

□ Ear & Hearing Protection (earplugs, earmuffs)

Perlindung Telinga & Pendengaran (plug telinga, earmuff)

□ Eye & Face Protection (safety glasses, goggles, face shield)

Perlindung Mata & Muka (cermin mata keselamatan, cermin mata, perisai muka)

□ Eyewash Stations

Stesen Mencuci Mata

□ Foot Protection (safety shoes, boots)

Perlindung Kaki (kasut keselamatan, kasut)

□ Head Protection (safety hats)

Perlindung Kepala (topi keselamatan)

□ Respiratory Protection (masks)

Perlindung Pernafasan (penutup muka)

□ Emergency Showers

Pancuran Kecemasan

□ Other (please specify)*/Lain-lain (sila nyatakan)*: _____

□ I don't know/*Tidak tahu*

6. Do you know any health problems or illnesses which you think can happen due to your work environment?

   Adakah anda tahu apa-apa masalah kesihatan atau penyakit yang anda rasa boleh berlaku kerana persekitaran kerja anda?

   □ Yes (please specify)/*Ya (sila nyatakan)*: _____

   □ No/*Tidak*

   □ I'm not sure/*Saya tidak pasti*

SECTION 3: Healthy work attitude at work

1. Do you have experience any injury due to your jobs? (**Skip question 2 if answer "No"**)

   *Adakah anda pernah mengalami kecederaan akibat pekerjaan anda? (**Langkau soalan 4 jika menjawab "Tidak")***

   □ Yes/*Ya (sila nyatakan)*: _____

   □ No/*Tidak*

2. If “Yes”, how would you perceive the injury you experience on this job most times?

   Jika “Ya”, bagaimanakah anda dapat melihat kecederaan yang anda alami pada pekerjaan ini pada kebanyakan masa?

   □ Serious/*Serius* □ Mild/moderate/*Ringan/sederhana*

3. Do you experience any sickness due to your jobs? (**Skip question 4 if answer “No”**)

   *Adakah anda mengalami sebarang penyakit akibat pekerjaan anda? (**Langkau soalan 4 jika menjawab "Tidak")***

   □ Yes (please specify) /*Ya (sila nyatakan)*: _____

   □ No/*Tidak*

4. Do you think the sicknesses you had due to your jobs?

   Adakah anda menganggap penyakit yang anda miliki kerana pekerjaan anda?

   □ Yes/*Ya* □ No/*Tidak* □ I don’t know/*Tidak tahu*

5. Do you worry about your health or that of your family due to your work environment?

   Adakah anda bimbang tentang kesihatan anda atau keluarga anda kerana persekitaran kerja anda?

   □ Not worry/*Tidak risau*

   □ Previously worried, but no longer worried/*Sebelumnya risau tetapi tidak lagi*

   □ Little worried/*Sedikit risau*

   □ Yes, very worried/*Ya, sangat risau*

6. What do you think the major challenges in your job?

   Apa yang anda rasa cabaran utama dalam pekerjaan anda?

   □ Health/*Kesihatan* □ Work environment/*Persekitaran kerja*

   □ Finance/*Kewangan* □ No challenge/*Tiada cabaran*

SECTION 4: Healthy work practice

1. Do you use “PPE” during work/Adakah anda *menggunakan “PPP” semasa bekerja*

   □Yes/*Ya* □ No/*Tidak*

2. Do you always wash your hand before eating anything while at work?

Adakah anda sentiasa mencuci tangan sebelum makan apa-apa semasa bekerja?

□ Yes/*Ya* □ No/*Tidak*

3. Do you change your clothes before going home from work?
   Adakah anda menukar pakaian anda sebelum pulang daripada kerja?
   □ Yes/*Ya* □ No/*Tidak* □ Sometimes/*Kadang-kadang*
4. How often do you bend and/twist your upper body (uncomfortable work position)?
   Berapa kerapkah anda membengkok dan memutar badan atas badan anda (kedudukan kerja yang tidak selesa)?
   □ Often/*Selalu* □ Rarely/*Jarang sekali* □ Never/*Tidak pernah*
5. Do you take your work clothes or shoes home for laundering?
   Adakah anda mengambil pakaian kerja atau kasut anda di rumah untuk dicuci?
   □ Yes/*Ya* □ No/*Tidak* □ Not applicable/*TIdak berkenaan*
6. What do you think about your work conditions/position during work?
   Apa pendapat anda tentang keadaan/kedudukan kerja anda semasa bekerja?
   □ Uncomfortable work conditions/*Keadaan kerja yang tidak selesa*
   □ Comfortable/*Selesa*
   □ I don't know/*Tidak tahu*

Source: Ohajinwa et al. (2017)

APPENDIX C
CHECKLIST

SECTION 1: General

NO.	QUESTIONS TO BE ASK	YES	NO
1.	Is the collection centre is certified under any authorized organization?		
2.	Can you give a general description of the business		
3.	Does the service at collection centre accept all type of e-waste products		
4.	Does the service only for this geography area		
5.	Can you identify federal, state and local environmental agency contact		
6.	Is there any regulation/law/guideline that followed by the collection centre		
7.	Does you have environmental, health and safety management systems and/or plans in place		
8.	Can you provide a description of services (processes)		
9.	Can you provide a description of what it does with the electronic equipment it receives?		
10.	Does the electronics recycler send materials for disposal in landfills or for incineration		

Source: United States Environmental Protection Agency (2012)

SECTION 2: Environmental Quality Act 1974

NO.	QUESTIONS TO BE ASK	YES	NO
1.	Prescribed premises to be licensed [Sec 18]		
2.	Power to specify condition of emission, discharge [Sec 21]		
3.	Restriction on pollution of the atmosphere [Sec 22]		
4.	Restriction on pollution on noise pollution [Sec 23]		
5.	Restriction on pollution of the soil [Sec 24]		
6.	Restriction on pollution of the inland waters [Sec 25]		
7.	Prohibition of discharge of oil into Malaysia waters [Sec 27]		
8.	Prohibition of discharge of wastes into Malaysia waters [Sec 29]		
9.	Prohibition on open burning [Sec 29A]		
10.	Prohibition against placing, deposit, etc, of scheduled wastes [Sec 34B]		
11.	Penalty for offences [Sec 41]		

Source: Environmental Quality Act 1974