



Faculty of Social Sciences and Humanities

**E-Waste Management and Residents' Willingness to Pay for Household
E-Waste Recycling in Kuching Division, Sarawak**

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E-Waste Management and Residents' Willingness to Pay for Household E-
Waste Recycling in Kuching Division, Sarawak

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DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Malaysia Sarawak. Except where due acknowledgments have been made, the work is that of the author alone. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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ABSTRACT

'E-waste' or WEEE (waste electrical and electronic equipment) refers to electronic and electrical appliances that are no longer beneficial to consumers. An increasing amount of e-waste generated due to an increased demand for EEE (electronic and electrical equipment) production from the rapid growth of the global population has become a growing global concern. Furthermore, limitation of the assimilative capacity of the environment and depleting natural resources stock have urged the need to increase the amount of household e-waste recycled. This thesis aims to examine the resident's willingness to pay (WTP) for household e-waste recycling (HEWR) in Kuching, Sarawak. Quota sampling method was employed to select a total number of 397 respondents representing 397 households staying in the Kuching, Bau, and Lundu districts of the Kuching Division, Sarawak. A questionnaire survey was administered among the selected residents living in Kuching, Sarawak. The findings of the study show that majority of the residents in Kuching are not willing to pay for household e-waste recycling of electrical appliances such as fridges (50.6%) and fans (59.4%). However, it also varies based on the distinctive types of household electrical appliances they possess. In this study, 10 types of household electrical appliances were selected and the average amount of WTP is expressed based on a percentage of its purchased values of the respective electrical household items listed. It was found that residents from Kuching are only willing to pay an average of 2.3% till 2.6% of recycling fees based on the purchased values of their respective electrical home appliances. The findings also revealed that there is a significant association between the respondents' age and their willingness to pay for the recycling of e-waste. A rather surprising finding from the study is that no statistically significant association is found between educational level, level of income, and willingness to pay for the recycling of e-

waste. Therefore, the study recommends that more environmental education programs are to be carried out or even to be embedded in the formal education system to sensitize the residents and children to the risks associated with e-waste besides imparting the polluter pays principles among the residents to promote sustainable e-waste management, particularly among the growing population in Kuching, Sarawak.

Keywords: E-waste, e-waste management, Kuching, recycling, willingness to pay.

***Pengurusan E-Sisa di Malaysia dan Kesanggupan Membayar Penghuni untuk Kitar
Semula E-Sisa Isi Rumah di Kuching, Sarawak***

ABSTRAK

'E-sisa' atau WEEE (sisa peralatan elektronik dan elektrik) merujuk kepada peralatan elektronik dan elektrik yang tidak lagi berguna kepada seseorang pengguna. Peningkatan jumlah e-sisa yang dijana yang disebabkan oleh peningkatan pengeluaran peralatan elektronik dan elektrik akibat daripada pertumbuhan pesat populasi global telah menjadi kebimbangan global. Tambahan pula, pengehadan kapasiti asimilasi alam sekitar dan pengurangan stok sumber asli sememangnya mendesak keperluan untuk mengutamakan pengurusan e-sisa yang mampan. Tesis ini bertujuan untuk meneliti kesanggupan membayar penduduk untuk mengitar semula e-sisa isi rumah di Kuching, Sarawak. Kaedah persampelan kuota telah digunakan untuk memilih sejumlah 397 responden yang mewakili 397 isi rumah yang menetap di daerah Kuching, Bau dan Lundu di Bahagian Kuching dalam kajian ini. Tinjauan soal selidik telah dijalankan dalam kalangan penduduk terpilih yang tinggal di Kuching, Sarawak. Dapatan kajian menunjukkan majoriti penduduk di Kuching tidak sanggup untuk membayar kitar semula e-sisa isi rumah bagi peralatan elektrik seperti peti ais (50.6%) dan kipas (59.4%). Walau bagaimanapun, ia juga bergantung kepada jenis peralatan elektrik rumah tersendiri yang mereka miliki. Dalam kajian ini, 10 jenis peralatan elektrik rumah telah dipilih dan jumlah purata kesanggupan membayar dinyatakan berdasarkan peratusan nilai belian bagi barangan elektrik rumah masing-masing yang disenaraikan. Didapati bahawa penduduk dari Kuching hanya sanggup membayar secara purata 2.3% hingga 2.6% daripada kos kitar semula berdasarkan nilai pembelian peralatan rumah elektrik mereka. Dapatan

kajian juga mendedahkan bahawa terdapat perkaitan yang signifikan antara umur responden dan kesanggupan membayar untuk kitar semula e-sisa. Satu penemuan yang agak menakjubkan daripada kajian ini ialah tiada perkaitan yang signifikan secara statistik ditemui antara tahap pendidikan, tahap pendapatan, dan kesanggupan membayar untuk kitar semula e-sisa. Oleh itu, kajian ini mencadangkan agar lebih banyak program tentang pendidikan alam sekitar dijalankan atau diterapkan dalam sistem pendidikan formal mengikut peringkat umur untuk menyedarkan penduduk dan kanak-kanak terhadap risiko yang berkaitan dengan e-sisa selain menyampaikan prinsip pencemar membayar dalam kalangan penduduk untuk mempromosikan pengurusan e-sisa mampan, terutamanya dalam kalangan penduduk yang semakin meningkat di Kuching, Sarawak.

Kata kunci: *E-sisa, pengurusan e-sisa, Kuching, kitar semula, kesanggupan membayar.*

TABLE OF CONTENTS

	Page
DECLARATION	i
ACKNOWLEDGEMENT	ii
ABSTRACT	iii
ABSTRAK	v
TABLE OF CONTENTS	vii
LIST OF TABLES	x
LIST OF FIGURES	xii
LIST OF ABBREVIATIONS	xiii
CHAPTER 1: INTRODUCTION	1
1.1 Background	1
1.2 Problem Statement	3
1.3 Research Questions	6
1.4 Research Objectives	6
1.5 Significance of Study	7
1.6 Conclusion	9
CHAPTER 2: LITERATURE REVIEW	11
2.1 E-Waste Management Policies	11
2.2 E-Waste Management Situation in Malaysia	13
2.3 Willingness to Pay for Household E-Waste Recycling	14
2.4 The E-Waste Recycling Process	15
2.5 The Global E-Waste Management	17

2.6	E-Waste Management in Developed and Developing Countries	18
2.7	E-Waste Management in Malaysia	21
2.8	Residents WTP for E-Waste Recycling and Its Factors	23
2.9	Theoretical Framework	26
2.10	Conclusion	31
	CHAPTER 3: METHODOLOGY	33
3.1	Introduction	33
3.2	Research Design	33
3.3	Study Location	36
3.4	Population Sample Size of the Study Sampling	37
3.5	Survey Instrument	41
3.6	Data Analysis	42
3.7	Research Ethics	42
	CHAPTER 4: FINDINGS AND DISCUSSION	44
4.1	Introduction	44
4.2	Demographic Statistics	44
4.3	E-Waste Management (EWM) Situation	50
4.4	The Willingness to Pay (WTP) for E-Waste Recycling	69
4.5	Factors of WTP for E-Waste Recycling as EWM Solutions	82
	CHAPTER 5: CONCLUSION AND RECOMMENDATIONS	88
5.1	Introduction	88

5.2	Conclusion	88
5.3	Limitations of the Study and Recommendations	91
	REFERENCES	94
	APPENDICES	110
	Appendix 1: The Study Questionnaire	110

LIST OF TABLES

	Page
Table 1. 1: Categories defined as E-Waste based on the EU Directive 2002	3
Table 3. 1: The Population Statistics of Sarawak	37
Table 4. 1: Distribution of Respondents by Age Groups	45
Table 4. 2: Distribution of Respondents by Gender	46
Table 4. 3: Household Location by District	46
Table 4. 4: Distribution of Respondents by Whom They Stay with	47
Table 4. 5: Distribution of Respondents by Number of Household Members.	47
Table 4. 6: Distribution of Respondents by Education Level	48
Table 4. 7: Distribution of Respondents by Monthly Income Level	49
Table 4. 8: Household E-Waste Definition	50
Table 4. 9: Handling of Household Electrical and Electronic Appliances	53
Table 4. 10: Number of Respondents by Age Group Dealing with their Household Electrical and Electronic Appliances	57
Table 4. 11: Crosstab between Gender and Actions taken on Malfunctioned or Functioning Household Electrical Appliances	60
Table 4. 12: Crosstab between Household Location and Handling of Malfunctioned or still Functioning Household Electrical Appliances	63
Table 4. 13: Household E-Waste Management Methods among Respondents	66
Table 4. 14: Parties Accountable for Household E-Waste Recycling	69
Table 4. 15: Household Appliances Taxation	70
Table 4. 16: Crosstab between Age and Willingness to Pay for Household E-Waste Recycling among Respondents	73
Table 4. 17: Crosstab between Gender and Willingness to Pay for Household E-Waste Recycling among Respondents.	74
Table 4. 18: Crosstab between Household Location and Willingness to Pay for Household E-Waste Recycling	75

Table 4. 19:	Crosstab between whom the Respondents are Living With and their Willingness to Pay for Household E-Waste Recycling	78
Table 4. 20:	Crosstab between Number of Household Members and Willingness to Pay for Household E-Waste Recycling	79
Table 4. 21:	Crosstab between Education Level and Willingness to Pay for Household E-Waste Recycling	80
Table 4. 22:	Crosstab between Monthly Household Income Level and Willingness to Pay for Household E-Waste Recycling	81
Table 4. 23:	Types of Household Electrical Appliances against the Percentage on the Purchased Value of Respondents Willingness to Pay for Household E- Waste Recycling	84
Table 4. 24:	Reasons of Household E-Waste Recycling	85
Table 4. 25:	Household E-Waste Recycling Costs on Government	87

LIST OF FIGURES

	Page
Figure 2. 1: The Theory of Planned Behaviour	30
Figure 3. 1: The Map of Kuching, Sarawak (East of Malaysia)	37

LIST OF ABBREVIATIONS

AEHA	Association for Electronic Home Appliances
API	Air Pollution Index
AWM	Agriculture Waste Management
ARF	Advanced Recycling Fee
ASEAN	Association of Southeast Asian Nations
BC89	Basel Convention 1989
BLR	Binary Logistic Regression
CRMs	Critical Raw Materials
CVM	Contingent Valuation Method
DOE	Department of Environment
RDDW	Door to Door Waste Collection
EAR	Electro-Altgeräte Register
EEE	Electronic and Electrical Equipment
ElectroG	Electrical and Electronic Equipment Act
EOL	End of Life
EPR	Extended Producer Responsibility
EQA05	Environmental Quality Act 2005

EQRSW05	Environmental Quality Regulations for Scheduled Waste 2005
EWM	E-Waste Management
EWRC	E-Waste Recycling
EWRS	E-Waste Recycling Subsidy
HE	Household Electrical
HEA	Household Electrical Appliances
HEW	Household E-Waste
HEWM	Household E-Waste Management
HEWR	Household E-Waste Recycling
JEHARL	Japanese Electrical Home Appliance Recycling Law
KCCA	Kampala Capital City Authority
LPEUR	Law for Promotion of Effective Utilization of Resources
MBKS	Kuching South City Council
MCO	Movement Control Order
MSW	Municipal Solid Waste
MNCs	Multi-National Companies
MYR	Malaysian Ringgit
NRDDW	Non Door to Door Waste Collection
NREB	Natural Resources and Environment Board

ORDEA	The Ordinance on ‘The Return, the Taking Back and the Disposal of Electrical and Electronic Appliances’
PBDEs	Polybrominated Diphenyl Ethers
PDF	Pre-Disposal Fee
PROs	Producer Responsibility Organizations
PuWaMA	Public Waste Management Authorities
S.EN.S.	Stiftung für Entsorgung Schweiz
SEWM	Sustainable E-Waste Management
SOPs	Standard Operating Procedures
SPSS	Statistical Package for the Social Sciences
SWISCO	The Swiss Association for Information, Communication and Organizational Technology
WEEE	Waste Electronic and Electrical Equipment
WTA	Willingness to Accept
WTP	Willingness To Pay

CHAPTER 1

INTRODUCTION

1.1 Background

In Malaysia, household e-waste management (EWM) has been known to have much space for improvement. Studies have shown that majority of the residents even in Kuala Lumpur, were unwilling to pay for household e-waste recycling (Afroz et al., 2013). This research was carried out in Kuching in order to explore further the situation and context in another region of Malaysia as it may bring forth a different perspective in terms of EWM and Willingness To Pay (WTP) of residents in Kuching for household e-waste recycling.

In 2022, the world population was estimated approximately at eight billion inhabitants (Pison, 2022). The world population has utilised around 50% more natural resources back in 2009 as compared to the 1970s (FOE Europe, 2009). The natural resources available for electrical and electronic equipment (EEE) production are facing a decline due to the increasing demand for electronic gadgets, appliances, and equipment (George, 2018). The raw materials used in electrical and electronic equipment (EEE) include precious metals such as gold, silver, palladium and platinum (Prince & Izant, 2015). In addition, base metals such as iridium, nickel, rhodium, and copper are also essential materials required in EEE production (Yong et al., 2019). Based on a report provided by the Matric Group (2021), electrical components have been in shortage worldwide especially since the pandemic strike in 2020, with a 30% growth in demand for semiconductors.

In many developing countries such as Malaysia, the recycling process of industrial e-waste is often closely monitored by the relevant authorities such as the Department of Environment (DoE). The Environmental Quality Act 1974 is the laws governing Malaysia's environmental quality including industrial E-Waste Management (EWM) in Malaysia. Thus, there is a legislative control over industrial e-waste management in Malaysia. In fact, it is mandatory for any form of industrial e-waste to be recycled in licensed premises and its disposal should be carried out in formal registered e-waste recycling facilities (Hamzah et al., 2011). However, the management of household e-waste is often taken lightly and not formally managed in a systematic process in Malaysia. Unlike the proper procedures for disposing of household e-wastes in Singapore with the involvement of their local e-waste collectors (Wong, 2015), Malaysia is still lacking in the understanding of households' e-waste management. Therefore, it is important to examine households' e-waste management and the willingness-to-pay for household e-waste management before having relevant institutions to take responsibility to manage household e-wastes more properly and effectively (Hamzah, 2011).

1.2 Problem Statement

Widmer et al. (2005) defined e-waste as "a generic term embracing multiple forms of electronic equipment that have stopped to be of any value to their owners" (p.439). In addition, the EU Directive 2002/96/EC of the European Parliament (EU 2002) has defined e-waste as a list of categories listed in Table 1.1 (Liu et al., 2006).

Table 1. 1: Categories defined as E-Waste based on the EU Directive 2002.

No.	Category	Label
1	Large Household Appliances	Large HH
2	Small Household Appliances	Small HH
3	IT & Telecommunications Equipment	ICT
4	Consumer Equipment	CE
5	Lighting Equipment	Lighting
6	Electrical and electronic tools	E&E tools
7	Toys, Leisure and Sports Equipment	Toys
8	Medical Devices (Exception of implanted & infected products)	Medical equipment
9	Monitoring and Control Instrument	M&C

The steep increase of global e-waste has contributed to a total amount of 53.6 metric tons (MT) in e-waste in 2019, a 21% increase from 2015 (Tiseo, 2021). An ongoing increasing amount of household electronic and electrical waste generated and accumulated in the world has been known as an important socio-environmental issue which needs to be urgently addressed (UNEP, 2007). A total amount of 53.6 million metric tons (MT) of e-waste accumulated in 2019 is expected to increase to 73 million metric tons (MT) by 2030 (Forti et al., 2018). This urged for immediate action to be taken in order to reduce the environmental damages caused by e-waste toxins being exposed to the environment (Forti et al., 2020). In Asia, 24.9 million metric tons of e-waste were accumulated in 2019, while Malaysia is estimated to contribute about one million metric tons of e-waste in the same

year (Lim, 2019). However, the targeted e-waste collection in Malaysia for 2020 was only set at 200 metric tons by the Department of Environment (Chang, 2020). Nevertheless, Europe was discovered to be the leading region of the world that generates the most e-waste (Shahabuddin et. al., 2023).

A significant increase in the usage of household electronic goods and an increase in the demand for the latest electronic goods have increased the amount of household e-waste generated in the world. Furthermore, household electrical and electronic appliances have a relatively shorter lifespan over time and it is cheaper and easier to get new household electrical and electronic appliances than repairing the old ones (Akhtar et al., 2014). This has not only brought to a continuous increase in household e-waste, but it has also led to a greater exploitation of natural resources for the production of new household electrical appliances in the market.

The increasing number of the global human population urges more EEE to be supplied because electronic telecommunication gadgets and electrical home appliances have become a necessity among people (Shiroishi, 2018). It has become more prominent since the Covid-19 outbreak in December 2019, when everyone is forced to stay at home to reduce the continuous spread of virus (Anderson et al., 2020; Barnes, 2020). It is during that period of time that there is a drastic surge in the demand of electrical appliances like mobile phones and laptops for members of the society to communicate due to the isolation imposed during the pandemic (Barnes, 2020).

The informal practices of household e-waste recycling in an informal e-waste recycling site is not to be taken lightly for it brings a number of negative impacts to human health and the surrounding environment (Ohajinwa et al., 2019). It is evident when

municipal solid waste (MSW) and household e-waste end up in landfills, producing toxic leachates that leach (concentrated chemical solutions delivered as a result of water passing through multiple sources of waste, including e-waste) into the environment over time (Xiang et al., 2014). Chiam (2013) reported that the residents in Kuching are unfamiliar with managing their household e-waste and are not well informed about the whereabouts of the recycling facilities available in the region.

However, the e-waste management situation in Kuching was said to have improved over time in terms of having more e-waste recycling facilities available for the public to dispose of their e-waste (Louis, 2020). The Kuching Integrated Waste Management Park is a waste management facility available in Sarawak that is designed to cater for municipal solid waste and scheduled waste (including e-waste); it is also claimed to be one of the first integrated waste management parks in South East Asia (Trienkens, n.d.).

There is scanty literature and study on the e-waste management status in Kuching, as most of the studies related to e-waste management in Malaysia only covered bigger cities such as Penang and Kuala Lumpur. Although Suhaili and Abdullah (2023) has carried out a study about the awareness of household e-waste management among Sarawakians in the state, their study is only limited to younger participants who are mostly still pursuing their studies (68.8%). This study thus aims to fill the research gap on the status of EWM by soliciting from the perspectives of citizens beyond the youth group in Kuching of Sarawak. It is important that the e-waste management situation is studied in the division of Kuching in a more holistic manner to ensure that we can have a better and more comprehensive insights about the issue in relation to e-waste management by taking into account perspectives of the residents in Kuching division which include suburb community

in Lundu and Bau. This is considered crucial before proper policy options and strategies are devised to protect the environment to ensure that Kuching remains as a safe and healthy place to live for its citizen.

1.3 Research Questions

This study aims to answer the following research questions:

- a. How is the current status of EWM among residents in Kuching?
- b. How are the residents' WTP for household e-waste recycling (HEWR) in Kuching?
- c. How are the socio-demographic factors affecting WTP among residents in Kuching for HEWR?

1.4 Research Objectives

The objectives of this study are as follows:

- a. To examine the EWM situation among residents in Kuching;
- b. To determine the WTP of residents for household e-waste recycling in Kuching;
- c. To analyse the socio-demographic factors (age, gender, household location, level of income, education level, the number of family members in a single household) of respondents against their WTP for household EWR in Kuching.

1.5 Significance of Study

The study of the WTP of residents for proper e-waste management (EWM) is essential because it facilitates the state-of-art e-waste recycling facilities and technologies that can sustain the amount of e-waste produced yearly in Malaysia (Hamzah et al., 2013). An estimated of one million metric tons (MT) of e-waste produced in 2019 in Malaysia is estimated to be worth around RM3 billion, and this amount of e-waste remains un-recycled (Lim, 2019). On the other hand, Afroz et al. (2013) has carried out a study on the WTP for e-waste recycling by the residents in Malaysia (Kuala Lumpur). However, they have not included the WTP variable against the number of household members in a single household into the equation. Therefore, a study proposed in Kuching for EWM in terms of its current status, WTP of residents for EWM and socio-demographic factors influencing WTP for EWM is essential to be carried out.

The findings could potentially shed light for policymakers to impose an advanced disposal fee (ADF) or an e-waste recycling tax in Sarawak if the research findings show that residents in Kuching are willing to pay for household e-waste recycling. In addition, private companies and multinational corporations (MNCs) may also look into the research findings to work upon e-waste recycling and management businesses by leveraging on the findings obtained in this study particularly on residents' willing to pay for household e-waste recycling. With a potential research result of knowing the willingness of residents to pay for e-waste recycling, a new business model may be viable. Hence, allowing a hypothetical benefit to be brought forth to society. Also, new job opportunities related to the e-waste management (EWM) sector may be able to reduce e-waste and increase society's efforts in moving towards sustainable development, turning waste into a resource (Atinkut et al., 2020).

The current situation of e-waste management in Malaysia is understood to have ample space for improvement for several reasons (Yong et al., 2019; Bashir et al., 2020). Firstly, the residents of Malaysia are still disposing of their waste without strictly separating them into recyclable categories due to the lax in governmental law enforcements in waste management, thereby incurring more costs if wastes were differentiated by third parties (Saeed et al., 2009; Moh et al., 2014; Tiew et al., 2019). Secondly, MNCs' lack of financial support, technological advancements for household e-waste recycling, and a proper household e-waste collection system are still lacking (Kang et al. 2020).

In developed countries such as Europe, household e-waste recycling and collection rates are shown to be higher than developing countries (Soo et al., 2013; Ylä-Mella & Román, 2019). The advancement in e-waste management includes having mobile trucks that recycle e-waste instantly after collecting e-waste from residents in the United States (Ceballos et al., 2020). In Malaysia, one of the biggest issues faced by stakeholders in the execution of having a higher rate in terms of household e-waste being collected and recycled may be the lack of financial resources and technological advancements (Hamzah et al., 2011; Jayaraman et al., 2018).

The discoveries of this study should be able to provide a new perspective of the household e-waste management situation in Kuching, considering that the increasing amount of e-waste in the country justifies the need to make household e-waste recycling more convenient and viable for the public. Hence, a study to understand the consumer's willingness to pay (WTP) to manage household e-waste may provide important inputs for policymakers and stakeholders for better decision making. With a growing population in Kuching, leading to new ideas or innovation or investments in e-waste recycling facilities

or Research and Development might be essential to sustain e-waste recycling at a significant scale.

1.6 Conclusion

This Chapter provides a general introduction about the importance of sustainable e-waste management and the intention behind the study of e-waste management in the context of Malaysia, in which the Kuching division has been chosen as the case study of the research. From a global perspective, managing household e-waste has been a prolonging issue many people face globally. The amount of e-waste has only been increasing yearly and hardly reduced, especially in developing countries (Yong et al., 2019). Therefore, sustainable household e-waste recycling solutions are essential to ensure that the environment no longer suffers from improper household e-waste disposal.

To prioritize sustainable household e-waste management is vital in order to allow more household e-waste to be recycled instead of being treated as worthless waste in landfills. Industrial e-waste has always been formally managed and sent to licensed e-waste recycling facilities (Wong, 2015). However, household e-waste management is still lacking due to an absence of legislative framework to sustain and control household e-waste disposal by the residents residing in Malaysia (Suja et al., 2014).

A study on the willingness to pay (WTP) for household e-waste management or e-waste recycling among the residents of Kuching was carried out to understand the possible solutions to improve sustainable household e-waste management in Malaysia. Most of the studies about e-waste management (EWM) in Malaysia mainly focused on bigger cities

such as Kuala Lumpur and Penang. Hence, this study was carried out based on the perspectives of Sarawak, with Kuching being selected as the study site.

The current household e-waste management status in Kuching is highlighted based on a population sample selected in all the three districts in Kuching division to understand Sarawak's household e-waste recycling process. The research question raised to answer the first objective of the study is how residents in Kuching currently dispose of their household e-waste materials. Next research question tries to find out the relationship between demographic factors such as income and education levels and WTP for household e-waste recycling. These are essential aspects to be studied in this research.

CHAPTER 2

LITERATURE REVIEW

2.1 E-Waste Management Policies

The Basel Convention is an international treaty that manages the transboundary movement of hazardous waste. The existence of this agreement is mainly to curb and reduce the transport of dangerous substances from developed countries to developing nations (Kummer, 1992). Nevertheless, the illegal transportation of e-waste persists throughout developing countries such as China (Liu, 2006). However, these unlawful e-waste transport activities have been reduced since it was banned in China by the Ministry of Ecology and Environment of China in 2018 (Wang et al., 2021).

The Ministry of Environment and Economy, Trade and Industry (METI) in Japan enforced the Japanese Electrical Home Appliance Recycling (JEHAR) law that is based on the Extended Producer Responsibility (EPR) concept (Chaudhary & Vrat, 2018). The EPR concept engaged under the JEHAR law in Japan makes it mandatory for electronic manufacturers to take back their e-waste products (Chung & Murakami, 2008). This procedure is able to minimize the amount of e-waste discarded improperly in Japan, having their citizens worry less about their household electronic and electrical equipment (EEE) at the end of its lifespan (Chung & Murakami, 2008).

However, the recycling services provided by the electronic manufacturers to recycle e-waste in Japan comes with a Pre-Disposal Fee (PDF) that is mandatory for every household EEE to purchase (Song et al., 2012). Since 1998, after the Japanese Home Appliance Recycling Law (JEHAR) was enforced in Japan, household EEE consumers and

producers of EEE shared responsibilities to discard e-waste formally (Song et al., 2012). Whether it would be possible to suggest having PDF (pre-disposal fees) in Kuching is a question to be raised in this study by determining the willingness to pay for household e-waste recycling in the region.

Furthermore, among the ASEAN members, developing countries such as Thailand, Myanmar and Cambodia are known to be managing e-waste in an unsustainable manner (Ibitz, 2012). Unfortunately, ASEAN members of developing nations were unable to compromise and come to a unilateral decision on the policies for e-waste management in their respective countries. The notion that states act accordingly to expected benefits gained is one of the primary reasons behind the failure to comply with a standard policy response due to a stalemate in searching for their common benefits (Ibitz, 2012).

Ismail and Hanafiah (2019) expressed that despite Malaysia being a country where regulations for e-waste management (EQRSW05 - Environmental Quality Regulations for Scheduled Waste 2005) are present for industrial e-waste in the country, proper household e-waste management methods among residents are still not developed. The household e-waste disposed of by Malaysian residents is not only mixed with municipal solid waste (MSW); a majority of the residents also assume that the Malaysian government is supposed to hold full responsibilities for household e-waste recycling in the country (Kamaruddin et al., 2017).

2.2 E-Waste Management Situation in Malaysia

In Malaysia, the majority of its people are still practising informal methods in household e-waste management, such as disposing of their e-waste to scavengers who then sell the household e-waste for a higher price (Wong, 2015). In Malaysia, proper methods of disposing of e-waste are only feasible by sending it to a licensed e-waste recycling facility (Cho, 2018). However, such facilities are outnumbered by the total amount of e-waste accumulated every year (Yong et al., 2019).

Besides, only a handful of e-waste recycling facilities in Malaysia are able to provide convenient e-waste recycling services such as household e-waste doorstep collections for Malaysians (Yong, 2019). Therefore, Yong (2019) states that Malaysian residents are unwilling to pay for EWR (e-waste recycling) as they are still required to transport their household e-wastes to e-waste recycling facilities under their own expense in Penang (Yong et al., 2019). Nonetheless, the current status of e-waste management in Malaysia has only been commonly highlighted in the capital city, Kuala Lumpur (Akhtar et al., 2014).

The significant increase in demand for electronic and electrical equipment (EEE) in Malaysia has not fallen short during the pandemic since March 2020 (Chern, 2020). It is reported that a steep hike in demand for electrical household appliances has been evident, especially between May and June 2020, when the Movement Control Order (MCO) is partially lifted in the country (Chern, 2020). The demand for electrical home appliances such as fans, microwaves, electric ovens, food mixers and printers has spiked since Malaysian residents must work from home (Chern, 2020). Therefore, this shows that it is significant for the public to take household e-waste management seriously as the amount of

e-waste accumulated increases yearly. Without a systematic approach in curbing this issue, a greater amount of household e-waste would only end up in landfills of the country.

2.3 Willingness to Pay for Household E-Waste Recycling

Scholars from China, Bangladesh, Macau and Malaysia have utilized the concept of willingness to pay (WTP) to measure the maximum amount of money respondents in their respective countries are willing to pay for something of no market value (Daud et al., 2012). In other words, researchers utilize the WTP concept to instil value onto something of zero market value (Daud et al., 2012). WTP is a term commonly used in economics. WTP is defined by Daud et al. (2012) as the most significant amount of money that a person will be ready to pay, forgo or trade-off for services or to prevent unwanted events from happening such as avoiding the cultivation of a polluted environment (that brings no benefit to anyone).

In this research, the residents' willingness to pay (WTP) is projected on their answers of being “yes” or “no” in paying for a variety of household electrical appliances in Kuching. If the respondents are to be positive about contributing some money to recycle their household e-waste, they would be asked to choose a percentage ranging from less than 1% until more than 5% based on the purchased amount of household electrical appliances owned. The percentage range mentioned was selected because it is considered the most conservative range in terms of having consumers forgo their monies for the benefit of the environment (for household e-waste recycling in this case). The willingness-to-pay (WTP) of residents in Kuching for household e-waste recycling in this research may

reflect the residents' concern towards a better environment, contributing to reducing environmental pollution caused by improper household e-waste disposal.

The contingent valuation method (CVM) is a crucial tool in this research as it is used to determine every respondent's WTP for household EWM in Kuching. The CVM approach allows the respondents to state their preferred WTP amount in monetary values (MYR) by percentages based on the purchased value of each type of household electrical appliances in this study (Carson, 2020). However, total values of currency (MYR) willing to be paid by residents in this research can only be obtained by multiplying the percentages chosen by respondents based on the respective current market values of each of the 10 types of household electrical items listed in this study.

2.4 The E-Waste Recycling Process

The proper and formal manner of e-waste management in developed countries such as Japan involves separating and dismantling components of e-waste as the first stage of turning waste into a new resource (Cho, 2018). After the separation and dismantling process, the differentiated e-waste components are shredded in state-of-the-art recycling facilities (Cho, 2018). After that, the hydrometallurgy process occurs, where e-waste debris is soaked in an aqueous solution, allowing the leaching process to occur, whereby the metals are separated accordingly by type (Habashi, 2017).

On the other hand, the pyrometallurgy process is also used to differentiate metals from e-waste. It occurs when chunks of crunched e-waste debris are heated under a high temperature, separating the metals through electrolysis under high heat inside a furnace. This method is known to be more efficient because it can extract more metals that are more

refined (Habashi, 2017). However, the hydrometallurgy process to differentiate e-waste is more common in developing countries such as Malaysia due to its lower cost of operation (Yong et al., 2019).

In Malaysia, the recycling rate of e-waste was estimated to be around 25% of the total e-waste discarded (Lim, 2019). In contrast, the remaining e-waste that is not recycled correctly is estimated to be valued at about three billion Ringgit per annum and could possibly be a source of alternative income for the country (Lim, 2019). According to Yong et al. (2019), the pyrometallurgy process gains more metal recovery in e-waste recycling than the hydrometallurgy method. Nevertheless, only one (Johor) out of eight e-waste recycling facilities throughout Malaysia practice the pyrometallurgy method (Yu et al., 2019).

The pyrometallurgy process requires a significantly higher cost estimated by e-waste recyclers due to its heavier production costs, generally utilized in a bigger recycling scale. However, Malaysia is still lacking in terms of the e-waste collection rate due to the relatively lower percentage of e-waste collected back from consumers (Habashi, 2017). In 2020, Malaysia's targeted e-waste collection amount is set at 200 metric tons (200,000 kg) for its whole nation. To achieve this challenge, the Sarawak's Department of Environment (DoE) planned an e-waste recycling campaign in 2020, where 27 metric tons (27,000 kg) of e-waste was collected in Kuching within that time (Chang, 2020). Hence, understanding the various policies related to EWM is momentous in order to allow policy makers to decide on the best EWM policies to be carried out in a given region of a country.

2.5 The Global E-Waste Management

The increasing amount of e-waste accumulated worldwide is an issue to be addressed (Shahabuddin, et. al., 2023). Furthermore, the rapid increase in household e-waste generated is recognized as a socio-environmental and technological advancement issue (Tanskanen, 2013; Hossain et al., 2015). Tanskanen (2013) stated that the informal practices of differentiating electronic waste in developing countries has been done without taking into account the safety hazards for the environment and their health. In Finland, electronic and electrical appliance manufacturers practice the extended producer responsibility (EPR), where they take back their respective products for recycling as an effort to reduce e-waste from being managed improperly (Tanskanen, 2013).

Furthermore, Hossain et. al. (2015) has also mentioned about the importance of practicing proper e-waste management in order to be closer to achieving the sustainable development goals and for the better health of its society. According to Hossain et. al. (2015), high income nations such as the United States, Western Europe and Japan are the highest contributors in e-waste production, where e-waste comprised 8% against the total municipal waste in the world. Agusdinata et al. (2018) showed that lithium batteries (e-waste components) had increased almost eight times in the past ten years due to the increasing demand for consumer EEE over time. Therefore, the proper management and recycling of EOL lithium batteries are also important for sustainable e-waste management (Agusdinata et al., 2018). These lithium batteries are commonly found in portable consumer electronics such as hand-held vacuum cleaners, mobile phones and laptops (Lee et al., 2012).

2.6 E-Waste Management in Developed and Developing Countries

The studies carried out under e-waste management (EWM) worldwide have fostered a debate on developed countries disposing of their e-waste to developing countries (Baldé et al., 2017). Nevertheless, Switzerland, Germany, and Japan are exceptions to the general trait of illegal e-waste transportation (Chaudhary & Vrat, 2018). Each of the three countries has banned the exportation of e-waste and has withheld their methods of legalizing a systematic way of recycling e-waste and transporting them back to EEE producers, well known as the EPR (extended producer responsibility) approach in terms of EWM. It has not only preserved their environment from the contamination of improper discarding of WEEE (waste electronic and electrical equipment), it has also contributed to providing a guideline for e-waste management to developing countries such as India (Chaudhary & Vrat, 2018).

In Switzerland, there are two organizations: SWISCO (The Swiss Association for Information, Communication and Organizational Technology) and S.EN.S. (Stiftung für Entsorgung Schweiz). They are assigned roles as PROs (Producer Responsibility Organizations) (Chaudhary & Vrat, 2018). These two organizations are mainly responsible for proper EWM based on the EPR (extended producer responsibility) system, which is voluntarily proposed by EEE producers as an initiative to manage e-waste. The PROs also act as the middle-man to the EEE producers and retailers by assessing roles to all the actors (consumers, e-waste collectors) in their circular economy (Chaudhary & Vrat, 2018). The implementation of an ARF (Advance Recycling Fee) is a principle followed by the EWM authorities to finance and facilitate EWM in Switzerland under the ORDEA (Ordinance on 'The Return, the Taking Back and the Disposal of Electrical and Electronic Appliances') (Hischier et al., 2005).

On the other hand, the PuWaMA (Public Waste Management Authorities), private EEE producers and EAR (Electro-Altgeräte Register) are the three main actors in Germany for e-waste management (Deubzer, 2011). In addition, the rest of the key actors in terms of EWM in Germany include the EEE retailers and consumers of EEE (Chaudhary & Vrat, 2018). The Electrical and Electronic Equipment Act (ElectroG) describes a clear set of laws concerning EWM involving manufacturers, EEE traders, solid waste municipalities, owners of EEE and e-waste collectors. The relative roles of the actors mentioned in the success of e-waste management and recycling are drafted in the ElectroG, regulated by the Federal Environmental Agency. All of the marketed EEE products must be registered with the EAR before being distributed and sold to the consumers (Chaudhary & Vrat, 2018). The PuWaMa (Public Waste Management Authorities) are liable to the EAR to perform e-waste collection based on the EPR system (Chaudhary & Vrat, 2018).

In Japan, sustainable EWM is achieved with the financial contribution from the EEE consumers and the EEE manufacturers (Lee, 2010). The EEE companies partially bound the e-waste recycling costs in Japan as corporate responsibilities for e-waste disposed of in an environmentally friendly manner (Schnoor, 2012). Furthermore, every resident in Japan is required to pay a pre-disposal fee (PDF) before purchasing any type of electrical appliance in the country as the end-of-life (EOL) goods will be taken back by the manufacturers for proper recycling (Song et al., 2012). This infamous take-back procedure in EWM is also well known as the extended producer responsibility (EPR) principle (Chung & Murakami, 2008).

Besides, the Japanese law on EWM includes the Basic Law enacted in 2000 that promotes the importance of prioritizing recycling and reusing to curb the issue of heavy reliance on landfills (Sawhney et al., 2008). It has not only allowed normalizing recycling

habits among the residents in Japan but also intends to prepare people to accept the laws that were enacted in 2001; which is the Japanese Electrical Home Appliance Recycling Law and the Law for Promotion of Effective Utilization of Resources (Sawhney et al., 2008).

To summarise, it is shown that the EWM systems in the countries mentioned above have a common strategy in managing e-waste, that is, the EPR system that depicts the extended responsibilities towards the EEE producers. Moreover, the formation of an organization assigned to coordinate and assign third parties to manage e-waste collection can also be found in the EWM systems in Japan, Germany and Switzerland. However, Japan has not shown a holistic approach in covering more areas in the types of e-waste collected. It is due to the specific categories of e-waste being mandatory to be ordered back under the Japanese Electrical Home Appliance Recycling Law (JEHARL). The Association for Electric Home Appliances appointed by the government is responsible for collecting e-waste categories that are solely fallen under the categories listed under the enactment. On the contrary, German and Swiss e-waste collectors would collect all e-waste discovered regardless of specified types (Chaudhary & Vrat, 2018).

2.7 E-Waste Management in Malaysia

In Malaysia, e-waste management (EWM) has been more commonly labelled an infantry stage (Yong et al., 2019). People's level of awareness about e-waste management (EWM) in Malaysia's capital city, Kuala Lumpur, was relatively lower than in developed countries (Alfroz et al., 2013). However, it was noticed that most of the EWM studies in Malaysia were only consisting of regions in the west peninsular where bigger cities are present. Hence, raising the question of whether the EWM situation is the same in Sarawak? Although Suhaili and Abdullah (2023) has carried out a study about EWM in Sarawak, only 9.4% of their respondents were from Kuching from a total sample size of 32 participants aged between 15 till 30.

In Selangor, Hamzah et al. (2011) managed to capture the residents' improper disposal images of e-waste disposed of on the streets, mainly focusing on how the Malaysian government played a limited role in governing EWM under the Environmental Quality Act 2005 (EQA05). Based on EQA05, it is prohibited for any forms of hazardous waste to be disposed of into the surrounding environment of Malaysia (The Commissioner of Law Revision, 2006). However, the e-waste situation in Selangor, as stated, is still in a state where e-waste is not managed well because e-waste was still simply disposed of in the surrounding areas (Hamzah et al., 2011).

Furthermore, legal loopholes persist in the EQA05 (Wong, 2015). The legal law statement in the EQA05 stated that for exceptional cases, licensed vendors are allowed to eradicate hazardous waste into the environment, allowing e-waste (hazardous waste) to be exposed in designated areas (The Commissioner of Law Revision, 2006). It harms Malaysia's surrounding environment and contradicts the Basel Convention 1989 (BC89), an international treaty commenced by the world's leaders to prohibit the illegal

transboundary transportation and exposure of hazardous waste into the environment (Kummer, 1992). However, limited studies were shown to highlight the EWM status in Sarawak, leaving a study gap under EWM in the east region of Malaysia.

Electronic and electrical manufacturers' availability of natural resources to produce EEE was never boundless and remains limited (George et al., 2018). Nevertheless, the rise in the global population and the increase in the demand for household electrical goods urged the need to engage in sustainable EWM (Heacock et al., 2015). Sustainable e-waste management is enhanced when e-waste is treated in designated recycling facilities in developed countries such as Japan, ensuring their electronic producers hold responsibilities to recycle the products that reached their end-of-life (EOL) (Yong et al., 2019).

The possibilities of executing the EPR principle in Malaysia in terms of sustainable e-waste management (EWM) was analysed by Agamuthu (2011). The results showed that Malaysia intended to implement the EPR principle in the state (Agamuthu, 2011). However, there are still many implications, such as not having the agreement from the relevant stakeholders in the electrical industry to comply with the e-waste take-back system in Malaysia (Agamuthu, 2011). The parties involved were unable to conclude who should bear full responsibilities for the costs of e-waste management, and the discussion remains in a stalemate (Agamuthu, 2011; Hamzah et al., 2011).

2.8 Residents WTP for E-Waste Recycling and Its Factors

Afroz et al. (2013) discussed the resident's WTP for proper e-waste recycling in Malaysia's capital city, Kuala Lumpur. However, Afroz et al. (2013) expressed whether the residents were willing to pay (yes or no answers) for e-waste recycling. From their study, 52.5% of the respondents were willing to pay to recycle e-waste, while 47.5% of the respondents showed a negative response (Afroz et al., 2013). The study in WTP of e-waste in Malaysia is to learn whether imposing an ADF (advanced disposal fee) is feasible in the country, having Japan, Germany and Switzerland as the role model in terms of EWM. The WTP of the respondents in Kuala Lumpur to pay for e-waste recycling were obtained from interviewing 350 households in the city. Among those who prefer not to pay for e-waste recycling management in Kuala Lumpur, the most popular reason is due to them preferring to sell their household e-waste instead of paying for it to be recycled (Afroz et. al., 2013).

In addition, the study carried out by Song et al. (2012) showed that 64.91% of the residents agreed to pay a monthly fee for household e-waste recycling while 35.09% of them refused to do so in Macau. In Song et al. (2012)'s study, socio-demographic factors such as age, education level and monthly income level play a significant role in having its residents to be more inclined to pay for household e-waste recycling. An amount of USD 2.50 was estimated as the monthly mean value of willing to pay by each household unit from Macau, amounting to a total estimated figure of USD 5,023,133 per year in e-waste recycling revenue in the city (Song et al., 2012).

However, a lower percentage of residents were willing to pay for proper e-waste management in Bangladesh (10%), where most of the residents think that it is the responsibility of their government in e-waste management (Islam et al., 2016). From the research carried out by Song et al. (2012) in Macau and Cai et al. (2019) in China, the

willingness to pay (WTP) of residents to recycle e-waste is US\$ 2.50 and US\$ 1.60, respectively. Song et al. (2012) and Cai et al. (2019) both utilised the contingent valuation method in gaining the WTP data required in their studies. The logit equation was used to estimate the WTP of their population sample.

Despite having known the percentages of residents being willing and not willing to pay for e-waste recycling in the respective regions carried out by Song et al. (2012) and Afroz et al. (2013), it is noticed that the results were obtained without taking into account the current market values of the distinctive types of household electrical appliances available. On the other hand, although Moussiopoulos et al. (2012) has applied the CVM in conducting their study through carrying out a survey to test the willingness to pay of their residents to recycle e-waste properly in Greece, a limited variety of household appliances were included in the study. Hence, inspired by studies from different scholars mentioned earlier, this study tries to examine how the willingness to pay among residents for e-waste recycling differs based on demographic characteristics of residents and the different types of HEW by selecting ten types of household electrical appliances commonly used by the residents in Kuching. The 10 types of household electrical appliances were selected because they are most common types of household electrical items owned by household members in Kuching.

According to Wang et al. (2019), the determinants of e-waste recycling among its residents in China are the income and the education level pursued by the respondents, similar to the factors determined by Cai et al. (2019) in Zhuhai and Song et al. (2012) in Macau. A resident that has undergone a master's degree is more likely to contribute financially to e-waste management (Wang et al., 2019). Islam et al. (2016) recorded a similar result based on their research on the willingness to pay (WTP) for e-waste

management in Bangladesh, showing that education levels play a positive influential role in driving tendency for respondents to contribute financially to EWM. However, the studies done by Cai et al. (2019), Islam et al. (2016) and Wang et al. (2019) had not included the number of family members in a household against WTP for household e-waste recycling in their research.

According to Atinkut et al. (2020), WTP for eco-friendly agriculture waste management (AWM) were determined by a few factors such as age, knowledge in AWM, economic conditions, government subsidy, environmental perception and the number of family members in a single household. Afroz et al. (2013) and Islam et al. (2016) included awareness level, education level and income level as their primary factors to affect WTP for EWR without considering variables such as age, the number of family members, environmental perception and government subsidy in their study.

Song et al. (2012) state that age is significant in influencing WTP for e-waste recycling in Macau. Their study also shows that a younger age pool between 19-25 years old has a higher tendency to pay for EWR management due to the higher level of education received by the younger respondents, while the family size is insignificant when WTP for e-waste is measured. The study elaborates on the current status of EWM in Macau; hence, factors of EWM in Kuching are included in relation to Song et al. (2012)'s study to express a new perspective of EWM in the context of Malaysia.

2.9 Theoretical Framework

In this research, e-waste would mainly refer to household e-waste. The household e-waste in this study mentioned includes ten types of household electrical appliances including washing machines, fridges, fans, steam irons/ irons, air conditioners, televisions, computers/ laptops, speakers/ sound systems, rice cookers and blenders. These 10 types of household electrical appliances are selected in this study because they are known to be the more common household electrical items owned by residents in Kuching. The concept of willingness-to-pay is referred to, in this research, as the conceptual framework to explain the respondent's willingness to forgo money in exchange for an outcome that brings benefit to their environment (a surrounding free from e-waste pollution).

Scholars have utilized the concept of willingness to pay (WTP) to estimate the amount of money respondents in China, Bangladesh, Macau, and Malaysia are willing to pay for e-waste management (Cai et al., 2019; Islam et al., 2016; Song et al., 2012). WTP was elaborated by Daud et al. (2012) as the most significant amount of money that a person is ready to pay, forgo, or trade-off for services or to prevent unwanted events from happening such as avoiding the cultivation of a polluted environment (that brings no benefit to the surrounding or society). In this research, the respondents are asked about their WTP to recycle their household e-waste based on the purchased values of the respective household electrical appliances. This would be able to show how much the residents are willing to give in order to preserve the environment from the pollution of household e-waste in Kuching.

Sujauddin et al. (2008) have looked into the features and management of household solid waste in Chittagong, Bangladesh. The random selection technique was used to select 75 households based on different levels of income to be involved in their study. The

number of family members in a single household is said to affect the total amount of solid waste discarded by each household in Bangladesh (Sujauddin et al., 2008). Among the 75 households mentioned, 44% of them were willing to pay the trash collector between \$0.30 and \$0.40 each month for the solid waste management. According to Sujauddin et al. (2008), the price of trash pickup should be determined by how much waste is generated by homes. It was discovered that categorizing household solid waste before it is disposed of can change it from a burden to a secondary resource.

Ezebilo (2013) estimated the WTP of households to improve household garbage handling in Kwara state, Nigeria. For this, 236 houses were sampled and more than 80% of respondents in this survey is in support for domestic waste management. WTP for domestic waste management among the households was averaged out to USD 24 yearly, which means among the 236 households, more than 188 households are willing to pay an estimated total amount of USD 4512 per year for waste management in Ilorin city (Ezebilo, 2013). The average amount of WTP in Ezebio's (2013) study was estimated by using the binary logit model. The researcher suggests that informing people about the benefits of including the business sector in Solid Waste Management (SWM) will help to improve the WTP for better solid refuse management.

Furthermore, Banga et al. (2011) studied the willingness to pay of households for improved solid waste disposal services in Kampala, Uganda. The research used 381 houses as its data source. The random sampling method was used to select the respondents in the study (Banga et al., 2011). The double-bounded dichotomous choice method was used to determine the households' mean WTP for improved solid waste pickup service. The study findings revealed that majority (79.8%) of the families (304 households) were found to be willing to pay more at an average of 2,439 Ugandan Shillings (Ush) for improved solid

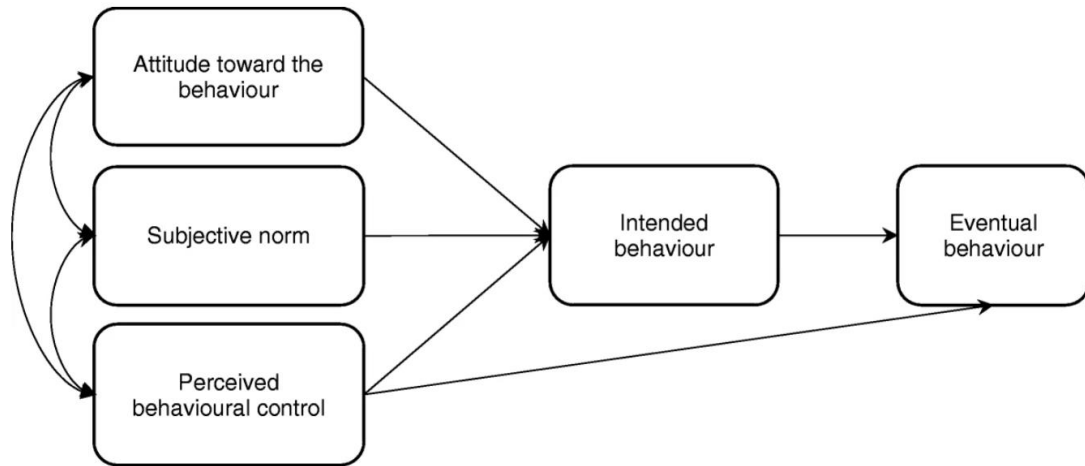
waste removal services. An amount of 2,439 Ush makes USD 0.65, which shows that the household residents from Kampala are only willing to pay USD 7.8 per household a year. For the residents who were unwilling to pay for waste management, comprising of 77 household members from the sample, a majority of them reasoned that they could not afford to pay for the fees mentioned (40.5%). To address the problem of free riders, researchers suggest setting a socially acceptable price that the majority of people are willing to pay.

Based on Banga et al. (2011)'s research findings, the Coase theorem can be used to explain the unwillingness of the residents to pay for their solid waste management, where 29.1% of the respondents among the 77 households has stated that it is not their responsibility but the responsibility of the Kampala Capital City Authority (KCCA) in managing waste in their country. The negative externality of the people paying for solid waste disposal services is when there are free riders who also enjoy the services mentioned when they do not contribute to the access of such services. As the Coase theorem states that "Bargaining between the parties will lead to an efficient outcome if certain conditions are met." (Farrel, 1987). Hence, the study suggested that a more reasonable price to manage waste in Kampala may be the solution to the municipal waste management issue (Banga et al., 2011).

Afroz et al. (2009) used the contingent valuation method (CVM) to determine how much respondents in Dhaka, Bangladesh, were willing to pay to improve the waste collection system. The study determined the variations in WTP between residences that employ a door-to-door trash collection method (RDDW) and residences that do not (NRDDW). Four hundred and eighty houses were picked using the stratified random selection technique and the double-bounded binary choice method was used to calculate

respondents' WTP. It was concluded in the study that Dhaka respondents were willing to pay an average of Taka 13 per household per month. While the mean WTP per family in the NRDDW territory was Taka 12, the mean WTP per home in the RDDW region was Taka 15.8. The main reason for the difference in WTP here is the difference in people's awareness. The research emphasizes the importance of a comprehensive, integrated, and incentive-compatible approach to solid refuse management in Dhaka. Researchers recommend educating households about the planned solid waste management effort and enticing them to join. This will increase the WTP of households.

Bhattarai (2015) examined households' willingness to pay for improved solid waste management in Nepal's Banepa Municipality. This study found that 83% of respondents were willing to spend more for improved solid waste management. For typical households, the mean WTP for improved solid waste management per month was Rupees 166 (USD 1.69). The municipality currently charges each household a daily garbage fee of Re 1 (US \$0.01). This indicates that the present garbage fee collected by their local municipal in Nepal is considerably less than the WTP for a typical household (Bhattarai, 2015). The findings of the study show that bid amount, age of respondent, sex of the respondent, household size, level of education of respondent, present waste collection service, and household income are significant factors to influence household's WTP for improved solid waste management. Larger families may be required to pay higher trash costs based on their WTP (Bhattarai, 2015). When calculating the expense of garbage, the amount of trash generated by homes can also be taken into consideration. However, there should be special exceptions for the poor. They should either not be liable to one at all or pay a relatively small garbage fee.



Ajzen's Theory of Planned Behaviour [4, 26]

Figure 2. 1: The Theory of Planned Behaviour

Figure 2.1 shows the theory of planned behaviour, developed by Ajzen (1991). It is understood that behaviour control is a conscious action in humans, and an external cause that affects one's behaviour directly and indirectly through intentions (Madden et al., 1992). If a person believes that they have less control over a situation or an outcome, it is less likely that they will be inclined to perform such behaviour if they do not think it will benefit them in any way (Orbell, 1997). However, Madden et al. (1992) had also mentioned that the perceived control of behaviour towards a given outcome relies much on the tendency of people to have the ability to achieve something positive that would bring benefits to them.

In this research, the perceived value in paying for household e-waste recycling for the benefit of having a cleaner environment in Kuching and being free from the dangers of toxic leachates affecting human health are the variables affecting the research participants' outcome of their WTP. In accordance to a study carried out in Spain, willingness-to-pay for the conservation of a Spanish urban park was tested in relation to the theory of planned behaviour (López-Mosquera et. al., 2014), where people are willing to pay for the

maintenance of the urban parks because they think it is for the common benefit of its community.

2.10 Conclusion

Chapter two explains the global e-waste situation as a socio-environmental and technological advancement issue. The amount of e-waste produced has increased yearly, and actions to reduce the improper disposal of e-waste are required. The well-established systematic approaches to recycling e-waste in the developed countries like Japan, Switzerland, and Germany regarding sustainable e-waste management were discussed. In addition, the EPR (extended producer responsibility) system as an e-waste management approach implemented by most of the countries was discussed as well.

The EPR system is mainly possible due to the intervention of government bodies in developed countries. For example, environmental law enactments related to the management of e-waste, such as the Japanese Home Appliance Recycling Law (JEHARL) that mandates the taking-back of EOL electrical home appliances by the EEE producers in Japan. However, ARFs must be collected from the consumers of EEE during the purchase of the EEE products. Hence, residents' WTP (willingness-to-pay) for e-waste recycling in countries like Japan would not be compromised as long as the laws on e-waste management are maintained by having ARFs compulsory.

Willingness to pay (WTP) can be influenced by socio-demographic factors such as age, gender, income level, education level and the number of household members in a family. In the same vein, government legislation on passing laws that mandate the public to pay for waste management services are also as vital in determining the outcome of the

amount of WTP by the people of a country. As long as the public are well informed about the benefits they may potentially gain from paying, the higher the chances of them being willing to pay for something that is of zero market value that brings goodness towards their environment.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter discusses the research design and methodological approaches used in this study. It describes the study area, target population, sampling size, sampling procedures and instruments used for data collection as well as data analysis.

3.2 Research Design

This study adopts descriptive analysis. The first objective of this research includes examining the current EWM status among residents in Kuching. In order to provide an answer to the first objective stated, residents are asked to answer what they understand about e-waste management. Besides, their knowledge about the definition of e-waste is also determined by requiring the respondents to take part in a survey questionnaire.

Furthermore, to examine the respondent's WTP for household e-waste recycling in Kuching, they were questioned whether they were willing to pay for EWR by answering 'yes' or 'no' in the survey based on the distinctive types of common household electrical appliances they owned. If the respondents were to answer 'yes' to being willing to pay for EWR, they are then required to answer how many percent they were willing to forgo for the costs of recycling based on the purchase prices of each variety of household electrical appliances stated.

Willingness to pay (WTP) is projected by the use of a contingent valuation method (CVM). A CVM is a questionnaire-based assessment technique that determines respondents' real readiness to pay for or acceptance of a specific product or service. The

procedure is therefore applicable in all circumstances (Akhtar et al., 2014). Hence, in this study the participant's WTP is expressed through a range of percentages namely less than 1% until more than 5% based on the respective purchase values of the household electrical appliances owned by the survey sample.

CVM has mainly been used for unmarketed items, especially those that have to do with resources or goods for the environment. In this context, a fictitious market for an unmarketed good is explained, involving people who are willing to pay for the betterment of their surrounding environment in terms of spending on e-waste recycling to prevent it from polluting the environment. Subject interviews, which can be done by phone, mail, or in person, are a component of the CVM study (Xie & Zhao, 2018).

At the start of a typical CVM study, the participants were usually told about the environmental resource being studied (like air quality), the proposed change to the environmental resource, and the technique to be used to finance the proposed change in the environmental quality (Jones et al., 2017). This information was being given to familiarize the respondents with the change that would be evaluated and increase the probability that they would give truthful and precise answers. The respondents were asked about their willingness to pay in light of this information (Xie & Zhao, 2018). In this research, respondents were told about the issue of household e-waste management in Kuching, where the respondents were asked about their WTP for an un-marketed good (quality of environment free from e-waste pollution).

To confirm the given WTP (or WTA) and to provide socioeconomic background information, it is customary to include some follow-up questions (gender, age, education, employment, income). The willingness-to-pay (WTP) of residents in Kuching for household e-waste recycling in this research may reflect the residents' concern for a better

environment, contributing to reducing environmental pollution caused by improper household e-waste disposal.

The socio-demographic factors mentioned relating to WTP in this research include age, gender, household area, income level, education background and the family household size. The association between each independent variable mentioned was tested against the WTP for household e-waste recycling (dependent variable) through the Pearson's Chi-Squared test and descriptive analysis after integrating the data obtained from the survey questionnaire.

This research used a descriptive research design where quota sampling technique was used in the data collection process. Quota sampling is a non-probability sampling in which the researcher collects data based on initial decided number by districts (Kuching, Bau and Lundu). As the survey was carried out during the implementation of the movement control order (MCO) during the Covid-19 pandemic period, an online survey was carried out to reach out any respondents who were available to answer the survey questions online. This method was deemed appropriate as it assumed that most of the people in Kuching are using electrical and electronic items at their respective households. Therefore, consumers who were accessible online were targeted to obtain the primary data required for the WTP for household e-waste recycling. Every participant in this study was encouraged to partake in the survey through an incentive of MYR5. However, not all respondents accepted the incentive mentioned. There were altogether 397 respondents from different households who participated in this survey.

The survey was planned to be carried out face to face as it is perceived as the most efficient method to receive a valid source of data from the respondents (Daud et al., 2012). However, strict SOPs were mandated by the Malaysian government due to the pandemic

when the research study was carried out. This research is both quantitative and qualitative in nature; hence primary data sources are obtained to express the numerical amount of monies the residents are willing to pay after multiplying the percentages given based on the perceived values of the electrical home appliances in Kuching.

In economics, the willingness to pay (WTP) is a term used to place value onto something of zero market value (Daud et al., 2012). Therefore, a survey involving 397 respondents was carried out to estimate the value that the residents in Kuching would place for e-waste recycling was carried out by utilizing the WTP concept in this study (Mitchell and Carson, 1989). The respondents in this study were from the Kuching, Bau and Lundu districts; they were assessed on how much they would like to contribute financially for EWM in the survey.

3.3 Study Location

This study was conducted in Kuching division, Sarawak. Kuching is the capital city of Sarawak with a total of 2,471,140 inhabitants (The Sarawak Government, 2019). The Kuching division is located in the southwest tip of the state of Sarawak and consists of the highest density in terms of household population (133,687 households) in Sarawak (The Sarawak Government, 2019). Kuching is further divided into three districts, namely, Kuching (133,687 households), Bau (11,166 households) and Lundu (7,900 households), where Lundu and Bau are categorized as the relatively lower populated areas of the division.

The Kuching district falls under the urban category of the region (The Sarawak State Planning Unit, 2012). The population of this study is defined based on household

unit. Only one family member who is an adult would be selected from each household in this research. The rationale of having this pre requirement before allowing respondents to participate in the survey is to ensure that no repetition of raw data was obtained from the same household as each household members usually share their household electrical appliances at home. Figure 3.1 shows the map of Kuching, Sarawak.



Figure 3. 1: The Map of Kuching, Sarawak (East of Malaysia)

3.4 Population Sample Size of the Study Sampling

The final sample size obtained in this study is 397 respondents (one respondent per household) comprising 350 respondents from Kuching, 28 respondents from Bau and 19 respondents from Lundu. Only one member from each household was surveyed to represent the household in the survey considering that the electrical home appliances are mostly shared among family members. Furthermore, to increase the participation rate in the survey for this research, respondents were also offered a token of appreciation of MYR5 for each survey questionnaire answered. The method of answers collected was through the online Google survey platform as the survey was carried out during the Movement Control Order (MCO), where face to face interactions were limited due to the widespread of Covid-19 back in 2020.

Table 3. 1: The Population Statistics of Sarawak

Division/ District	Population 2000	Population 2010	Population 2011e	Number of Households (2010)
Kuching	509,374	617,887	629,936	133,687
Bau	43,190	54,246	55,497	11,166
Lundu	28,070	33,413	34,000	7,900
KUCHING DIVISION	580,634	705,546	719,433	152,753
Samarahan	48,068	87,923	93,396	16,622
Serian	82,042	91,599	92,614	19,505
Simunjan	38,098	39,226	39,341	8,563
Asajaya	29,012	31,874	32,175	6,376
SAMARAHAN DIVISION	197,220	250,622	257,526	51,066
Sri Aman	64,475	66,790	67,026	15,866
Lubok Antu	23,966	27,984	28,421	6,790
SRI AMAN DIVISION	88,441	94,774	95,447	22,656
Betong	51,426	62,131	63,317	12,927
Saratok	43,305	46,094	46,412	10,112
BETONG DIVISION	94,461	108,225	109,729	23,039
Sarikei	59,043	58,021	57,920	13,220
Maradong	29,917	29,441	29,394	6,538
Julau	32,668	15,816	14,709	3,820
Pakan	-	15,480	15,480	3,824
SARIKEI DIVISION	121,628	118,758	117,503	27,402
Sibu	218,106	247,995	251,200	54,146
Kanowit	27,982	28,954	29,053	7,026
Selangau	-	22,819	22,819	5,518
SIBU DIVISION	246,088	299,768	303,073	66,690

Mukah	46,182	42,922	42,609	8,962
Dalat	24,152	19,062	18,616	4,175
Matu	11,498	17,369	18,100	3,808
Daro	15,268	30,671	32,887	6,961
MUKAH DIVISION	97,100	110,024	112,212	23,906
Bintulu	143,429	189,146	194,452	40,226
Tatau	23,943	30,383	31,115	7,063
BINTULU DIVISION	167,372	219,529	225,568	47,289
Kapit	58,430	56,053	55,821	12,862
Song	19,806	20,595	20,676	4,727
Belaga	23,611	36,114	37,682	7,562
KAPIT DIVISION	101,847	112,762	114,178	25,151
Miri	228,231	300,543	308,930	67,598
Marudi	73,922	64,018	63,104	15,046
MIRI DIVISION	302,153	364,561	372,034	82,644
Limbang	40,959	48,186	48,975	10,476
Lawas	33,603	38,385	38,899	7,918
LIMBANG DIVISION	74,562	86,571	87,875	18,394
SARAWAK	2,071,506	2,471,140	2,514,576	540,990

Source: The Sarawak State Planning Unit, 2012.

As shown in Table 3.1, the number of households in Sarawak against the respective divisions are shown. Therefore, bringing forth to the enumerative values below in terms of households against the targeted divisions for this research. In other words, quota sampling method was employed in this study.

1. Kuching - 133,687 households (336 representatives)

2. Bau - 11,166 households (28 representatives)

3. Lundu - 7,900 households (19 representatives)

Hence, the sample size chosen in this study was based on the following equation proposed by Cochran (1963) for unlimited sampling:

$$ss' = [Z^2(p(1 - p))] \div d^2$$

$$ss' = 1.96^2(0.5)(0.5) \div 0.05^2 = 384.16$$

Where (Z = Z value) (1.96 for a 95% confidence level), p = percentage (%) of respondents in the sample size who expressed a choice, depicted in a decimal form (0.5 utilized for the sample size required); d = confidence interval 5% (decimal = 0.05). The above equation shows it is best suited for infinite sampling (Cochran, 1963). However, the total number of households in Kuching is known; the known number of households in a population sample would be expressed as below:

$$ss = ss' \div [1 + (ss' - 1) / F]$$

$ss = 384.16 \div [1 + (384.16 - 1) / 152,753] = 383.20$; Where ss is the sample size and F is the population size of the study (F = 152,753).

Therefore, ss would be more than or equal to a number of 383 respondents in the survey. In this research, the end result of the total number of respondents who showed interest in providing data to the cause of the study is a total number of 397 individuals from different households in Kuching division.

3.5 Survey Instrument

In this study, the survey instrument consists of a list of questions listed in a questionnaire survey online. A total number of 397 respondents from distinctive households participated in the study in Kuching. Google survey was utilised to obtain the data in this research. The online survey platform was chosen because the research results was executed during the movement control order (MCO) in 2020. Before the online survey was carried out, a pilot test survey was first fulfilled in order to ensure that the survey questions were easy to comprehend by the respondents.

The online survey questionnaire was structured into three segments. The first section included the demographic information of the respondents. Their age, gender, household location, education level, monthly household income level and the number of household members were the respective information extracted from the first part of the questionnaire. In the second part of the online questionnaire, the respondents were required to answer three questions to understand what kind of household electrical appliance had malfunctioned before in their household and how they managed their household e-waste. Meanwhile the first question in section B involved asking the respondents what their understanding about the definition of household e-waste was.

Last but not least, the last segment of the online survey questionnaire consists of questions to understand the WTP for household e-waste recycling based on the purchased values of each type of household electrical appliances owned by the respondents. If they were willing or unwilling to pay for household e-waste recycling, they were also asked about the reasons why they did so either way. The respondents were also asked who should hold full responsibilities in terms of managing household e-waste recycling in Kuching.

3.6 Data Analysis

The survey questionnaire data were first cleaned and coded into the statistical packages for social sciences (SPSS) software version 27 for analysis. The contingent valuation method (CVM) was utilized in this research as it is used to determine the participating respondent's WTP for household EWM in Kuching by percentages against the purchased values of the respective types of household e-waste discarded.

The CVM approach allows the research participants to state their preferred WTP in monetary values (MYR) based on a range of percentages against the purchased values of respective household electrical appliances. The data obtained expresses the WTP for environmental benefits or to accept and be willing to pay for the prevention of environmental pollution through HEWR (household e-waste recycling) (Carson, 2000).

However, the exact values of monies willing to be paid by residents in this research could only be obtained by multiplying the percentage chosen by respondents and the current market values of the respective household electrical items listed. The information from the respondents' demographic profile was analyzed using frequencies and percentages. A cross-tabulation analysis was performed on the age of the respondents and their willingness to pay for the recycling of household e-waste and the findings were determined using Chi-Square as well as the significance value.

Furthermore, Pearson's Chi-Squared test was also be utilized in this research in order to test the relationship between the various socio-demographic factors mentioned in the research objective of this study. A contingency table would be required to show the correlation of each socio-demographic factor against its association with each type of

household e-waste in the study belonging to the participants in the research. Besides, the resident's willingness to accept (WTA) recycling costs subsidized by the Sarawak government based on a range of percentage values over the purchased value of distinctive types of household electrical appliances was also tested using the Pearson's Chi-Squared test.

3.7 Research Ethics

Pimple (2002) states that research ethics also refers to responsible conduct in research (RCR). There are various perspectives of the types of research ethics to be followed; however, six ethics are identified to be significant in accordance with this research.

In the process of this study, no risk of harm to all participants in the research had been implied. Furthermore, the outcome of this study should aim in bringing no harm to society and all answers obtained from the survey form should be kept confidential unless provided consent from respondents to reveal the information of the answers given.

Furthermore, while soliciting new insights on the subject matter related to e-waste management in Kuching, Sarawak, every evidence of participation from the respondents in this study was to remain anonymous unless the consent to reveal one's identity in participating in this research was obtained.

In addition, a high stance in prohibiting deception and falsification practices in data collection would also be a principle in conducting this research. Finally, providing the rights for participants to withdraw from this research was also one of the ethics to abide by.

CHAPTER 4

FINDINGS AND DISCUSSION

4.1 Introduction

The chapter discusses analysis of the data, and depiction of the results, and interpretations of the findings obtained as well as policy implications. The results in this study are obtained through the quantitative method. The explanation of the findings was made in response to the study's objectives. Descriptive statistics was used to present the demographic characteristics of the research participants, either in tabulations or figures. It is to note that the response rate of the survey carried out in this research is at 103.66% as the participation of respondents was motivated by incentives given during the movement control order implemented by the Malaysian government.

4.2 Demographic Statistics

This section discusses the demographic findings of the respondents surveyed. The number of respondents by age, gender, household location by district, number of household members, education level and monthly income level are presented in this section. These demographic factors were analysed against their WTP for household e-waste recycling. Their relationship was tested through the Pearson Chi-Squared Test in order to examine whether there was any association between the respective variables.

Table 4. 1: Distribution of Respondents by Age Groups

Age Group	Age Midpoint	Frequency	Percent
18 to 25 years	21.5	164	41.3
26 to 35 years	30.5	127	32.0
36 to 45 years	40.5	61	15.4
46 to 55 years	50.5	26	6.5
56 to 65 years	60.5	18	4.5
66 to 75 years	70.5	1	0.3

A major portion of the respondents surveyed (41.3 percent) was within the age range of 18 and 25, followed by within the ages of 26 and 35 (32 percent), then within the ages of 36 and 45 (15.4 percent), next were within the ages of 46 and 55 (6.5 percent), then within the ages of 56 and 65 (4.5 percent), and 0.3 percent were from 66 till 75 years old. In terms of the distribution of respondents by age, the mode age appears to fall within the age range of 18-25. While the mean of the age groups in this study could be calculated as below:

$$\begin{aligned}\text{Mean Age} &= \frac{21.5(164) + 30.5(127) + 40.5(61) + 50.5(26) + 60.5(18) + 70.5(1)}{397} \\ &= 31.09\end{aligned}$$

Hence, the mean age based on the groupings shown above is 31.09. As the study was mainly conducted during the movement control order period, where an online survey was carried out. The majority of the respondents seemed to be those from the younger age group, who were more technology savvy.

Table 4.2 shows the distribution of the respondents by gender.

Table 4. 2: Distribution of Respondents by Gender

Gender		Frequency	Percent
	Female	235	59.2
	Male	162	40.8
	Total	397	100.0

Females made up 59.2% of the participants in the study, while males made up 40.8 percent. This makes females the majority respondents by gender in this study.

As each respondent represents one household in the respective districts in Kuching, Table 4.3 reported the household location by district of the respondent participants in this study.

Table 4. 3: Household Location by District

District		Frequency	Percent
	Bau	28	7.1
	Kuching	350	88.2
	Lundu	19	4.8
	Total	397	100.0

Majority of the respondents (88.2 percent) were from Kuching, 7.1 percent were from Bau, and 4.8 percent were from Lundu district. This correlates with the number of targeted respondents as Kuching is also the highest populated region among all districts in the Kuching division. Table 4.4 summarizes the types of respondents by whom they stay with.

Table 4. 4: Distribution of Types of Respondents by Whom They Stay with

Type of respondents by whom they stay together		Frequency	Percent
	Stay Alone	29	7.3
	Stay with Family	349	87.9
	Stay with Non-Family Members	19	4.8
	Total	397	100.0

Majority (87.9%) of the respondents surveyed were living with their family, 7.3% were living alone, and 4.8% were living with non-family members such as, their friends. This shows that majority of the respondents surveyed live in houses and are staying together with their family members.

Table 4.5 shows the distribution of respondents by number of household members staying together with them.

Table 4. 5: Distribution of Respondents by Number of Household Members

Number of Household Members (Including the Respondent)		Frequency	Percent
	1	29	7.3
	2	32	8.1
	3	62	15.6
	4	82	20.7
	5	88	22.2
	6	41	10.3
	7	31	7.8
	8	13	3.3

	9	1	0.3
	10	13	3.3
	11	2	0.5
	12	1	0.3
	29	2	0.5
	Total	397	100.0

Majority (22.2%) of the respondents had 5 household members staying together with them. Twenty point seven percent were having 4 household members staying with them in the household, 15.6% were having 3 household members staying with them, 10.3% were having 6 household members staying with them, 8.1% were having 2 household members staying together with them, 7.8% were having 7 household members staying with them, while less than 8% were having more than 7 household members living together with them. The total number of respondents who have someone staying with them makes up a total number of 368 individuals, whereas a total number of 29 individuals (7.3%) are living alone without having any family members or housemates with them.

The education level of the participants is shown in Table 4.6.

Table 4. 6: Distribution of Respondents by Education Level

Education Level		Frequency	Percent
	Primary School	2	.5
	Secondary School	48	12.1
	Pre-University	109	27.5
	Bachelor's Degree	194	48.9
	Master's Degree	39	9.8

	Doctor of Philosophy (PhD)	5	1.3
	Total	397	100.0

About half of the respondents surveyed (48.9 percent) had their Bachelor's Degrees, whereas 27.5 percent of the respondents surveyed only completed Pre-University. Meanwhile 12.1 percent and 0.5 percent of the respondents surveyed only completed their studies up till Secondary School and Primary Schools respectively. On the other hand, 1.3 percent of the respondents surveyed have completed their PhD. This makes the majority of the respondents (60.0%) in this study having completed their tertiary education.

Table 4.7 shows the distribution of the respondents by their monthly household income level.

Table 4. 7: Distribution of Respondents by Monthly Income Level

Monthly Household Income (MYR)		Frequency	Percent
	0-999	112	28.2
	1000-1499	39	9.8
	1500-1999	45	11.3
	2000-2499	28	7.1
	2500-2999	28	7.1
	3000-3499	27	6.8
	3500-3999	14	3.5
	4000-4499	15	3.8
	4500-4999	10	2.5
	5000-5499	16	4.0
	5500-5999	4	1.0
	6000-6499	10	2.5

	6500-6999	4	1.0
	7000-7499	5	1.3
	7500-7999	6	1.5
	8000-8499	10	2.5
	8500-8999	5	1.3
	9000 & above	19	4.8
	Total	397	100.0

Table 4.7 reveals that majority (70.3%) of the respondent's household were earning less than RM3500, with 29.7% households earning more than RM3500 on a monthly basis.

4.3 E-Waste Management Situation

The surveyed respondents had been asked to choose their definition of household e-waste in order to show their respective knowledge in terms of the definition of household e-waste. Table 4.8 depicts the respondents' answers of the latter mentioned. The respondents include residents residing in the Kuching division.

Table 4. 8: Household E-Waste Definition

Definitions of Household E-Waste by Respondents	Frequency	Percentage
E-waste are functional household electrical appliances that I keep at home.	27	6.8
E-waste is electrical household appliances that are no longer useful to me.	183	46.1
Electrical appliances that have reached their end-of-life (EOL).	138	34.8

Household e-waste are electronic appliances that I throw away to garbage collectors.	37	9.3
None of the above.	12	3.0
Total	397	100.0

The findings show that the most prevalent household e-waste definition chosen by the respondents is that household e-waste is electrical household appliances that are no longer useful to them, agreed by 46.1% of respondents. Furthermore, about one third of the respondents (34.8%) agreed that household e-wastes are electrical appliances that have reached their end-of-life (EOL). Less than 10% of the respondents (9.3%) noted that household e-waste is defined as electronic appliances that they throw away to garbage collectors. Hence, this shows that the majority of the sampled population from the Kuching division are inclined to have a reasonable level of understanding in terms of knowing what e-waste is.

Table 4.9 shows different ways of handling household electrical and electronic appliances by respondents. Basically, this study categorizes four different ways on how the respondents handle their electrical and electronic appliances:

(a) Malfunctioned household electrical and electronic appliances that are not replaced.

In other words, respondents never replace the malfunctioned household electrical and electronic appliances.

(b) Malfunctioned household electrical and electronic appliances that are replaced. In this context, respondents replaced the malfunctioned household electrical and electronic appliances.

- (c) Replaced while household electrical and electronic appliances are still functioning well. In this category, respondents buy new household electrical and electronic appliances even though their existing appliances can still be used.
- (d) Respondents do not have any malfunctioned household electrical and electronic appliances. Thus, they never needed to replace any of their household appliances.

Table 4. 9: Handling of Household Electrical and Electronic Appliances (by Percentage)

Types of Household Electrical Appliances	Malfunctioned & Not Replaced	Malfunctioned & Replaced	Replaced while still Functioning	Not Malfunctioned & Never need to be Replaced
Washing Machine	21.4	14.6	40.1	23.9
Fridge	17.1	9.6	34.3	39
Fan	21.2	15.9	32.7	30.2
Steam Iron/ Iron	18.6	9.1	32	40.3
Air Conditioner	20.4	8.3	26.2	45.1
Television	14.9	11.1	44.8	29.2
Computer/ Laptops	20.9	13.6	37.5	28
Speakers/ Sound Systems	23.9	6.3	23.7	46.1
Rice Cooker	16.6	11.1	38.3	34
Blender	18.4	9.8	27.2	44.6

Findings from Table 4.9 concluded that among all the common household electrical and electronic appliances, televisions (44.8%) and washing machines (40.1%) are the two appliances with the highest replacement percentage among the households though the appliances can still be used by the respondents. Among the electrical and electronic items that have malfunctioned, 14.6% of the respondents indicated that they would replace their washing machines while 15.9% would get their fans replaced when it malfunctioned.

Results of this study also have revealed that about one-fourth (23.9%) of the respondents never replaced their speakers or sound systems even though they are malfunctioned. However, 46.1% of the respondents have never faced malfunctioned speakers or sound systems, 45.1% of the respondents and 44.6% of the respondents have never needed to replace their blenders as they were still working well. In general, it was found that majority of the respondents would replace their washing machines (40.1%), fans (32.7%), televisions (44.8%), computers (37.5%) and rice cooker (38.3%) even though their respective household electrical and electronic appliances are not malfunctioned and can still be used.

The results of the analysis have revealed that the majority (45.1%) of air conditioners have been working well, while 26.2% of the air conditioners are replaced anyway while they are still functioning well. On the other hand, 20.4% have malfunctioned before but never replaced while 8.3% have malfunctioned and got replaced. It was found that most (44.8%) televisions have been replaced even when it is still working fine, 14.9% have malfunctioned but never replaced, 11.1% have malfunctioned and replaced while only 29.2% have been working well hence no need to be replaced. Most (37.5%) computers have been replaced while still functional, 20.9% have malfunctioned and never replaced,

and 13.6% have malfunctioned and got replaced while only 28% have been working well and never required any replacement.

Findings of the study have revealed that the majority (46.1%) of speakers have been working well and do not require any replacement, 23.9% have malfunctioned but not replaced, 23.7% have already been replaced even when their existing speakers or sound systems are still working fine, while 6.3% have malfunctioned and got replaced. The findings show that most (38.3%) rice cookers have been replaced even when the existing rice cookers are still functioning, 16.6% have malfunctioned but never replaced, and 11.1% have been replaced while only 34% have been working well throughout its lifespan. It was found that most (44.6%) blenders owned among the surveyed respondents have been working well without any malfunctioning or replacement, 27.2% have been replaced even when it was in a usable condition, 18.4% have malfunctioned and never replaced while only 9.8% have malfunctioned and got replaced.

A crosstab analysis was performed on the respondents to find out how different group of respondents by demographic age, gender, household location by district treat their electrical appliances at home. Table 4.10 shows a crosstab analysis performed on different age group respondents to find out their willingness to replace various types of malfunctioned household electrical appliances or some still functioning household electrical appliances.

The disposal of household e-waste to scavengers who make their livelihood of e-waste collection and trade as a result of the fact that e-waste owners are paid to deliver their household e-waste to them is one of the few examples of the informal ways of EWM that are still practiced by households in Malaysia (Wong, 2015). However, according to Yong et al. (2019)'s research, there are not many household e-waste recycling centres in

Malaysia that are capable of offering the Malaysian public high quality e-waste recycling services.

Table 4. 10: Number of Respondents by Age Group Dealing with their Household Electrical and Electronic Appliances

Types of Household Electrical Appliances	Status of Household Electrical Appliances Owned	Age Groups				Chi-Square	Sig
		18 to 25 years	26 to 35 years	36 to 45 years	46 years & above		
Washing Machine	Malfunctioned & Not Replaced	41	27	9	8	25.532	0.043
	Malfunctioned & Replaced	20	13	15	10		
	Replaced while still Functional	73	44	21	21		
Fridge	Malfunctioned & Not Replaced	30	21	11	6	15.933	0.387
	Malfunctioned & Replaced	12	10	9	7		
	Replaced while still Functional	62	39	17	18		
Fan	Malfunctioned & Not Replaced	41	23	10	10	21.477	0.122
	Malfunctioned & Replaced	21	17	17	8		
	Replaced while still Functional	54	42	18	16		
Steam Iron	Malfunctioned & Not Replaced	39	22	7	6	25.499	0.044
	Malfunctioned & Replaced	10	9	11	6		
	Replaced while still Functional	61	34	19	13		
Air Conditioner	Malfunctioned & Not Replaced	38	27	8	8	30.524	0.010
	Malfunctioned & Replaced	12	7	7	7		
	Replaced while still Functional	41	28	17	18		

Types of Household Electrical Appliances	Status of Household Electrical Appliances Owned	Age Groups				Chi-Square	Sig
		18 to 25 years	26 to 35 years	36 to 45 years	46 years & above		
Television	Malfunctioned & Not Replaced	27	18	8	6	22.326	0.100
	Malfunctioned & Replaced	14	10	13	7		
	Replaced while still Functional	81	52	25	20		
Computer/Laptops	Malfunctioned & Not Replaced	34	27	16	6	14.274	0.505
	Malfunctioned & Replaced	19	16	13	6		
	Replaced while still Functional	62	55	14	18		
Speakers	Malfunctioned & Not Replaced	41	31	14	9	13.297	0.579
	Malfunctioned & Replaced	6	9	7	3		
	Replaced while still Functional	47	27	12	8		
Rice Cooker	Malfunctioned & Not Replaced	36	15	7	8	25.413	0.045
	Malfunctioned & Replaced	12	13	10	9		
	Replaced while still Functional	67	51	20	14		
Blender	Malfunctioned & Not Replaced	39	15	11	8	16.094	0.376
	Malfunctioned & Replaced	13	13	8	5		
	Replaced while still Functional	42	39	19	8		

Table 4.10 shows the results of the study between the willingness of respondents to replace a malfunctioned or still functioning household electrical appliance and the age range of respondents which indicated the Pearson Chi-square value between 13.297 and 30.524. Household electrical and electronic appliances including washing machines (0.043), steam irons (0.044), air conditioners (0.010) and rice cookers (0.045) by age groups. The p-values are designated at 0.05 or less signifying that there is a significant association between age and respondent's willingness to replace a malfunctioned or still functioning washing machine, steam iron, air conditioner and rice cooker.

Furthermore, for the remaining household electrical appliances including fridges (0.387), fans (0.122), computers or laptops (0.505), blender (0.376), television (0.100) and speakers (0.579), there was an insignificant association between the age and willingness for the respondents to replace their household electrical appliances that are malfunctioned or still functional as their p-values are more than the significant value of 0.05. Therefore, the age of respondents is not associated with their willingness to replace a malfunctioned or still functioning fridge, fan, computers or laptops, blender, television and speakers in Kuching. This could be due to the reason that respondents from a younger age are still (87.9%) living with their family members, making them think that it is the responsibility of the seniors in the family to be the ones handling their household e-waste in Kuching. This finding matches the findings carried out by Song et al. (2012), where it was stated that the lower the age, the lower the WTP for household e-waste recycling in Macau.

On the other hand, a crosstab analysis was also performed on the gender of the respondents and willingness to replace a malfunctioned or still functioning household electrical appliance. The results are shown in Table 4.11.

Table 4. 11: Crosstab between Gender and Actions taken on Malfunctioned or Functioning Household Electrical Appliances

Types of Household Electrical Appliances	Status of Household Electrical Appliances Owned	Gender		Asymptotic Significance (2-sided)	Chi-Square
		Female	Male		
Washing Machine	Malfunctioned & Not Replaced	55	30	1.379a	0.710
	Malfunctioned & Replaced	33	25		
	Replaced while still Functional	92	67		
Fridge	Malfunctioned & Not Replaced	40	28	0.114a	0.990
	Malfunctioned & Replaced	22	16		
	Replaced while still Functional	82	54		
Fan	Malfunctioned & Not Replaced	56	28	2.551a	0.466
	Malfunctioned & Replaced	35	28		
	Replaced while still Functional	75	55		
Steam Iron	Malfunctioned & Not Replaced	53	21	9.353a	0.025
	Malfunctioned & Replaced	16	20		
	Replaced while still Functional	69	58		
Air Conditioner	Malfunctioned & Not Replaced	54	27	11.372a	0.010
	Malfunctioned & Replaced	12	21		
	Replaced while still Functional	56	48		

Types of Household Electrical Appliances	Status of Household Electrical Appliances Owned	Gender		Asymptotic Significance (2-sided)	Pearson Chi-Square
		Female	Male		
Television	Malfunctioned & Not Replaced	37	22	0.452a	0.929
	Malfunctioned & Replaced	25	19		
	Replaced while still Functional	104	74		
Computer	Malfunctioned & Not Replaced	52	31	4.318a	0.229
	Malfunctioned & Replaced	26	28		
	Replaced while still Functional	86	63		
Speakers	Malfunctioned & Not Replaced	59	36	4.400a	0.221
	Malfunctioned & Replaced	11	14		
	Replaced while still Functional	51	43		
Rice Cooker	Malfunctioned & Not Replaced	43	23	2.848a	0.416
	Malfunctioned & Replaced	24	20		
	Replaced while still Functional	84	68		
Blender	Malfunctioned & Not Replaced	55	18	11.439a	0.010
	Malfunctioned & Replaced	18	21		
	Replaced while still Functional	63	45		

The findings from Table 4.11 reveal that the Pearson Chi-square value was between 0.114 and 11.439 with significant p-values for steam iron (0.025), air conditioner (0.010) and blender (0.010) which is less than the designated value of 0.05. This signifies that there is a significant association between gender and respondent's willingness to replace a household electrical appliances such as steam irons, air conditioners and blenders, which are either still functioning or has malfunctioned.

However, for the other household electrical appliances such as washing machines (0.710), fridges (0.990), fans (0.466), television (0.929), computers or laptops (0.229), speakers (0.221) and rice cookers (0.416), there was an insignificant association between willingness to household electrical appliance and gender. Therefore, gender brings a difference regarding willingness to replace a malfunctioned or still functioning of EEE, for electrical appliances such steam irons, air conditioners and blenders among the respondents.

In addition, a crosstab analysis was also performed on the household location by district and the willingness of respondents to replace a malfunctioned or still functioning EEE.

Table 4. 12: Crosstab between Household Location and Handling of Malfunctioned or still Functioning Household Electrical Appliance

Types of Household Electrical Appliances	Status of Household Electrical Appliances Owned	Household Location by District			Pearson Chi-Square	Sig
		Bau	Kuching	Lundu		
Washing Machine	Malfunctioned & Not Replaced	6	75	4	7.716	0.260
	Malfunctioned & Replaced	2	55	1		
	Replaced while still Functional	14	133	12		
Fridge	Malfunctioned & Not Replaced	6	58	4	4.542	0.604
	Malfunctioned & Replaced	3	35	0		
	Replaced while still Functional	9	118	9		
Fan	Malfunctioned & Not Replaced	8	63	3	5.717	0.456
	Malfunctioned & Replaced	3	33	0		
	Replaced while still Functional	10	110	7		
Steam Iron	Malfunctioned & Not Replaced	8	68	5	5.018	0.542
	Malfunctioned & Replaced	3	30	0		
	Replaced while still Functional	7	90	7		
Air Conditioner	Malfunctioned & Not Replaced	7	49	3	9.286	0.158
	Malfunctioned & Replaced	1	42	1		
	Replaced while still Functional	12	153	13		

Types of Household Electrical Appliances	Status of Household Electrical Appliances Owned	Household Location by District			Pearson Chi-Square	Sig
		Bau	Kuching	Lundu		
Television	Malfunctioned & Not Replaced	12	66	5	13.947	0.030
	Malfunctioned & Replaced	2	52	0		
	Replaced while still Functional	6	136	7		
Computer	Malfunctioned & Not Replaced	10	81	4	7.797	0.253
	Malfunctioned & Replaced	0	25	0		
	Replaced while still Functional	8	79	7		
Speakers	Malfunctioned & Not Replaced	10	81	4	7.797	0.253
	Malfunctioned & Replaced	0	25	0		
	Replaced while still Functional	8	79	7		
Rice Cooker	Malfunctioned & Not Replaced	9	53	4	10.332	0.111
	Malfunctioned & Replaced	2	42	0		
	Replaced while still Functional	6	137	9		
Blender	Malfunctioned & Not Replaced	8	61	4	7.846	0.250
	Malfunctioned & Replaced	4	35	0		
	Replaced while still Functional	4	96	8		

Table 4.12 reveals the result of Pearson Chi-square value of 13.947 indicating that the willingness to replace all types of malfunctioned or still functioning household EEE as significant for television as the p-value of 0.03 is less than the designated value of 0.05. This signifies that there is a significant association between household location and respondent willingness to replace malfunctioned household electrical appliances only for televisions and not for other types of electrical appliances such as washing machines, fridges, fans, steam irons, air conditioners, computers or laptops, speakers, rice cookers and blenders.

The study evaluated the ways that the households have used to manage faulty electrical and electronic items in the household, as illustrated in Table 4.13.

Table 4. 13: Household E-Waste Management Methods among Respondents

Types of Household Electrical & Electronic Appliances	Leave at home	Retail seller collects it	Send for donation	Send to recycling centers	Send to service centers	Taken by garbage collectors	Not applicable (Not managing e-waste)
Washing Machine	15.9%	15.6%	2.8%	21.2%	18.4%	15.1%	11.1%
Fridge	10.1%	17.4%	2.5%	16.9%	20.9%	11.6%	20.7%
Fan	14.4%	7.6%	1.8%	23.2%	10.1%	25.9%	17.1%
Steam Iron/ Iron	13.6%	5.8%	0.5%	20.9%	7.1%	28.2%	23.9%
Air Conditioner	10.8%	18.6%	0.8%	18.1%	17.1%	10.8%	23.7%
Television	18.1%	11.3%	5.8%	19.4%	18.9%	12.3%	14.1%
Computer/ Laptop	27.2%	9.1%	4.5%	17.1%	17.1%	10.6%	14.4%
Speakers/ Sound Systems	17.9%	6.0%	2.0%	17.6%	11.3%	16.1%	29.0%
Rice Cooker	16.4%	6.5%	3.0%	21.9%	8.1%	23.4%	20.7%
Blender	14.4%	6.0%	2.3%	19.1%	6.5%	24.7%	27.0%

The findings in Table 4.13 show that about one fifth (21.2%) of the respondents prefer to send their washing machines to recycling centers on malfunctioning, and 18.4% of the respondents send washing machines to service centers, while 15.9% prefer washing machines to be left at home. The least respondents (2.8%) prefer sending washing machines for donations. Other respondents (15.6%) noted that retail sellers collect them and another 15.1% of the respondent's washing machines are taken by garbage collectors.

Results of the study also reveal that about one fifth (20.9%) of the respondents prefer to send fridges to service centers on malfunctioning, and 17.4% noted that retail sellers collect their fridges, while 16.9% prefer to send fridges to recycling centers. Least respondents (2.5%) prefer sending fridges for donations. Other respondents (10.1%) noted that they leave fridges at home on malfunction and some (11.6%) are taken by garbage collectors.

Findings of the study also show that about one fourth (25.9%) of the respondents prefer fans to be taken by garbage collectors, and 23.2% send fans to recycling centers, while 14.4% prefer fans left at home. The least (1.8%) respondents prefer sending fans for donations. Besides, findings of the study also indicate more than one fourth (28.2%) of the respondents prefer steam irons to be taken by garbage collectors, and 20.9% send steam irons to recycling centers, while 13.6% prefer steam irons to be left at home. Only 0.5% of the respondents prefer sending steam irons for donations.

Results of the study also reveal that about one fifth (18.6%) of the respondents prefer retail sellers collecting air conditioners on malfunctioning, and 18.1% noted that they send air conditioners to recycling centers, while 17.1% prefer sending air conditioners to service centers. Least respondents (0.8%) prefer sending air conditioners for donations.

Other respondents (10.8%) noted that they leave malfunctioned air conditioners at home and some (10.8%) are taken by garbage collectors.

Findings of the study also show that about one fifth (19.4%) of the respondents prefer to send televisions to recycling centers, and 18.9% send televisions to service centers, while 18.1% prefer televisions left at home on being faulty. Only a few respondents (5.8%) prefer sending televisions for donations.

On the other hand, findings of the study also indicate more than one fourth (27.2%) of the respondents prefer faulty computers or laptops to be left home when it malfunctions, and 17.1% send faulty computer or laptops to service centers and another 17.1% of the respondents also discard their old computers or laptops to recycling centers. Least respondents (4.5%) prefer sending computers or laptops for donations. Other respondents (9.1%) noted that retail sellers collect computers or laptops from them while other computers (10.6%) are taken by garbage collectors.

Results of the study also reveal that less than one-fifth (17.9%) of the respondents prefer malfunctioning speakers/ sound systems to be left at home, and 17.6% noted that they send speakers/ sound systems to recycling centers, while 11.3% prefer sending malfunctioned speakers/ sound systems to service centers. The least respondents (2.0%) was found to prefer sending faulty speakers/ sound systems for donations.

Findings of the study show that less than one fourth (23.4%) of the respondents prefer faulty rice cookers to be taken by garbage collectors, and 21.9% send faulty rice cookers to recycling centers, while 16.4% prefer faulty rice cookers to be left home. The least respondents (3.0%) prefer sending faulty rice cookers for donations.

In addition, results of the study also reveal that about one fourth (24.7%) of the respondents prefer malfunctioning blenders to be taken by garbage collectors, and 19.1% noted that they send malfunctioned blenders to recycling centers, while 14.4% of malfunctioning blenders are left at home. The least respondents (2.3%) indicated that they prefer sending faulty blenders for donations.

4.4 The Willingness to Pay (WTP) for E-Waste Recycling

The study evaluated the perceptions of respondents on the parties that should be held accountable to pay for the cost of household e-waste recycling. The findings are as per Table 4.14.

Table 4. 14: Parties Accountable for Household E-Waste Recycling

Parties Accountable for Household E-Waste Recycling		Frequency	Percent
	Respondent's family members and/ or the respondent	140	35.2
	Respondent's housemates/ flatmates	2	0.5
	Respondent's landlord/ house owner	6	1.5
	The electrical household appliance manufacturers	42	10.6
	The electrical household appliance retailers	20	5.0
	The Local Council	84	21.2
	The Malaysian government	61	15.4
	The State Government	42	10.6
	Total	397	100.0

More than one-third of the respondents (35.2%) shown in Table 4.14 noted that their family members and respondents themselves are accountable to pay for household e-waste recycling. About one-fifth (21.2%) of the respondents indicated that the local council should be taking charge of household e-waste recycling costs. A total of 61 respondents

(15.4%) indicated that the Malaysian federal government is responsible for paying the cost of e-waste recycling, and 10.6% stipulated that electrical household appliance manufacturers and the Sarawak State Government respectively should be accountable for household e-waste recycling costs. Only a few respondents (5%) noted that electrical household appliance retailers should cater to costs in household e-waste recycling. It can be seen that though more than one-third of the respondents indicated that they themselves and/ or family members were responsible to pay for the e-waste recycling cost, many residents in Kuching still thought that e-waste management is others' responsibility. As opposed to the findings in the study carried out by Bhattarai (2015), majority (70%) of the households in Nepal's Banepa Municipality themselves were willing to pay for improved solid waste management and only 30% of them are unwilling to pay for the improved solid waste management.

Table 4.15 further reports the Kuching residents' viewpoints on their willingness to pay if the Malaysian government were to impose a fee for e-waste recycling services upon their purchases of new household electrical and electronic appliances.

Table 4. 15: Household Appliances Taxation

Taxation by Types of Household Electrical Appliances	No	Yes
New Washing Machine taxation	50.1%	49.9%
New Fridge taxation	50.6%	49.4%
New Fan taxation	59.4%	40.6%
New Steam Iron/ Iron taxation	65.7%	34.3%
New Air Conditioner taxation	55.2%	44.8%
New Television taxation	57.7%	42.3%
New Computer/ Laptop taxation	58.9%	41.1%
New Speakers/ Sound Systems taxation	67.0%	33.0%
New Rice Cooker taxation	66.2%	33.5%
New Blender taxation	68.8%	31.2%

The majority of the respondents (indicated by the percentage of more than 50%) were not willing to pay for any taxation or fee imposed by the government for e-waste recycling services upon their purchases of all electrical and electronic items. Hence, the findings of the current survey suggested that a pre-disposal fee (PDF) may not be viable for more than half of Kuching's population.

The largest percentage of objections to the government's imposition of taxation or fee for recycling services upon respondents' purchase of electrical and electronic goods came from purchasers of new blenders (68.8%). This is followed by those who purchase new speakers/ sound systems (67.0%), new rice cookers (66.2%), new steam iron/ iron (65.7%), new fan (59.4%), new television (57.7%), new air conditioner (55.2%), new fridge (50.6%) and new washing machine (50.1%). The findings show that only 31.2% (new blender) to 49.9% (new washing machine) of the surveyed respondents are willing to pay taxes to the government for recycling fee upon their purchase of those new electrical and electronic goods. This raised concern about the growing amount of electronic and electrical garbage generated without having many willing to pay for the e-waste recycling services.

This problem has to be addressed properly as there is a growing demand for electrical and electronic goods all over the globe which indicates a growing amount of electrical and electronic garbage generated and collected. In addition, the steady rise in the amount of electronic trash produced is acknowledged as a significant socio-environmental issue (Koshta et al., 2022; Nguyen et al., 2021; Zhong et al., 2022).

Furthermore, a crosstab analysis was performed on groups of respondents depending upon the age, gender, household location by district, individuals living with,

number of household members, education level, monthly income level and willingness to pay for the recycling costs of household e-waste based on its purchased value.

Table 4.16 shows a crosstab analysis performed on the age of the respondents and willingness to pay for the recycling costs of household e-waste. Only the respondents who answered yes to being willing to pay for any of the ten types of household electrical and electronic appliances are required to provide answers in this section of study. The results show that only 198 respondents out of 397 respondents (49.8%) were willing to answer how much they are willing to forgo based on the purchased values of household electrical goods they respectively own as residents in the division of Kuching, Sarawak.

Table 4. 16: Crosstab between Age and Willingness to Pay for Household E-Waste Recycling among Respondents

		18 to 25 years	26 to 35 years	36 to 45 years	46 to 55 years	56 to 65 years	Chi-Square	Sig
Percentage on the Purchased Value of Respondents Willingness to Pay for Household E-Waste Recycling	0% (Not Willing to Pay)	69	67	35	20	8	44.657	0.024
	Less than 1%	16	20	11	0	2		
	1.0%	19	14	3	1	5		
	2.0%	21	9	6	0	2		
	3.0%	13	11	1	2	1		
	4.0%	4	1	0	0	0		
	5.0%	17	3	4	1	1		
	More than 5%	5	2	1	2	0		

In Table 4.16, the result of the Pearson Chi-square test of 44.657 with a p-value of 0.024 signifies that there is a significant association between age and respondents' willingness to pay for recycling. Therefore, age differences would affect the willingness to pay for the recycling of household e-waste among the residents in Kuching. From the data obtained in Table 4.16, 199 respondents (50.2%) were not willing to pay for EEE recycling.

Table 4.17 shows a crosstab analysis performed on the gender of the respondents and willingness to pay for the recycling costs of household e-waste.

Table 4. 17: Crosstab between Gender and Willingness to Pay for Household E-Waste Recycling among Respondents

		Female	Male	Chi-Square	Sig.
Percentage on the Purchased Value of Respondents Willingness to Pay for Household E-Waste Recycling	0% (Not Willing to Pay)	110	89	4.115a	0.766
	Less than 1%	33	16		
	1.0%	24	18		
	2.0%	26	12		
	3.0%	17	11		
	4.0%	3	2		
	5.0%	16	10		
	More than 5%	6	4		

From Table 4.17, the Pearson Chi-square value (4.115) and p-value (0.766) signify that there is no significant association between gender and willingness to pay for household e-waste recycling among the residents in Kuching. Therefore, in contradictory to the results shown in the study done by Bhattarai (2015) which indicated that the sex of respondents is one of the factors significantly affecting the willingness to pay among households for improved solid waste management. This study carried out in Kuching shows different

results. This is likely due to both male and female participants having limited knowledge or awareness about household e-waste recycling and its importance.

Besides, a crosstab analysis was performed on the household location by district and willingness to pay for the recycling costs of household e-waste among the residents in Kuching. Results are shown in Table 4.18 below.

Table 4. 18: Crosstab between Household Location and Willingness to Pay for Household E-Waste Recycling

		Household Location by District			Chi-Square	Sig
		Bau	Kuching	Lundu		
Percentage on the Purchased Value of Respondents Willingness to Pay for Household E-Waste Recycling	0% (Not Willing to Pay)	15	169	15	17.004a	0.256
	Less than 1%	2	47	0		
	1.0%	2	38	2		
	2.0%	6	32	0		
	3.0%	1	26	1		
	4.0%	1	4	0		
	5.0%	1	24	1		
	More than 5%	0	10	0		

Table 4.18 reveals that the Pearson Chi-square value is 17.004 and the p-value is 0.256. This signifies that there is an insignificant association between household location by district and respondents' willingness to pay for e-waste recycling in Kuching. Therefore, the household location by the district in Bau, Kuching, and Lundu does not affect significantly the willingness to pay for the recycling of household e-waste. This is an interesting finding as it is antithetical to the findings from Bhattarai (2015), which indicates that household location significantly influenced the willingness to pay for improved solid waste management. This probably could be explained by rather similar

infrastructure facilities developed as well as rather similar low environmental education level among the residents in all districts in Kuching division of Sarawak.

A crosstab analysis was also performed on whom the respondents are living with and their willingness to pay for the recycling costs of household e-waste based on the respective purchased values of EEE. The results are shown in Table 4.19. The result of Pearson Chi-square of 9.162 and p-value (0.821) signifies that there is no significant association between whom the individual respondents are living with and their willingness to pay for e-waste recycling. In other words, whether the resident is staying alone, or staying with family or non-family members, it does not significantly affect the willingness to pay for household e-waste recycling in Kuching.

On the other hand, a crosstab analysis was also performed in Table 4.20 on the number of household members and willingness to pay for the recycling costs of household e-waste in Kuching. The Pearson Chi-square value of 26.52 and p-value (0.187) indicate that there is no significant association between the number of household members and respondents' willingness to pay for e-waste recycling in Kuching. This result does not support the hypothesis that the greater the number of household members the higher the willingness to pay for the recycling of household e-waste. This result is contradictory to the findings from Bhattarai (2015) which indicated that household size is a significant factor influencing respondents' willingness to pay for improved solid waste management.

A crosstab analysis was also performed on the education level and willingness to pay for the recycling costs of household e-waste in Table 4.21. The Pearson Chi-square value (28.34) and p-value (0.780) reveal that there is no significant association between education level and respondents' willingness to pay for e-waste recycling in Kuching. This again contradicts the findings from previous studies (Bhattarai, 2015; Song et al., 2012)

which indicated that educational level does affect willingness to pay for improved solid waste management among households.

A crosstab analysis was also performed in Table 4.22 on the monthly household income level and respondent's willingness to pay for the recycling costs of household e-waste in Kuching. The Pearson Chi-square value of 92.223 and p-value of 0.746 in Table 10 signify that there is no significant association between monthly income level and respondents' willingness to pay for e-waste recycling in Kuching. Therefore, it again rejects the hypothesis that a higher monthly income level of an individual indicates a higher willingness to pay for the recycling of household e-waste. These findings also contradict the findings by Song et al. (2012)'s research in Macau which indicates that income affects respondents' willingness to pay for e-waste management.

Table 4. 19: Crosstab between whom the Respondents are Living With and their Willingness to Pay for Household E-Waste Recycling

		Status with whom the Respondents Stays Together			Chi-Square	Sig
		Stay Alone	With Family	With Non-Family Members		
Percentage on the Purchased Value of Respondents Willingness to Pay for Household E-Waste Recycling	0% (Not Willing to Pay)	16	172	11	9.162a	0.821
	Less than 1%	1	45	3		
	1.0%	4	37	1		
	2.0%	3	33	2		
	3.0%	2	26	0		
	4.0%	0	5	0		
	5.0%	1	24	1		
	More than 5%	2	7	1		

Table 4. 20: Crosstab between Number of Household Members and Willingness to Pay for Household E-Waste Recycling

		Number of Household Members				Chi-Square	Sig
		Less than 3 members	3 to 5 members	6 to 9 members	More than 9 members		
Percentage on	0% (Not Willing to	57	59	32	51	26.520	0.187
the Purchased	Pay)	14	20	7	8		
Value of	Less than 1%	13	14	3	12		
Respondents	0.01	9	8	6	15		
Willingness to	0.02	12	8	3	5		
Pay for	0.03	1	1	0	3		
Household E-	0.04	4	9	9	4		
Waste	0.05	4	2	2	2		
Recycling	More than 5%						

Table 4. 21: Crosstab between Education Level and Willingness to Pay for Household E-Waste Recycling

		Primary School	Secondary School	Pre- University	Bachelor's Degree	Master's Degree	Doctor of Philosophy / PhD	Chi-Square	Sig
Percentage on the Purchased Value of Respondents Willingness to Pay for Household E- Waste Recycling	0% (Not Willing to Pay)	2	24	51	100	19	3	28.340	0.780
	Less than 1%	0	4	10	29	5	1		
	1.0%	0	8	13	17	4	0		
	2.0%	0	5	14	15	4	0		
	3.0%	0	2	9	13	4	0		
	4.0%	0	1	0	4	0	0		
	5.0%	0	2	11	12	1	0		
	More than 5%	0	2	1	4	2	1		

Table 4. 22: Crosstab between Monthly Household Income Level and Willingness to Pay for Household E-Waste Recycling

		Less than 1%	1.0%	2.0%	3.0%	4.0%	5.0%	More than 5%	Chi-Square	Sig.
Monthly Household Income Level	RM0 - RM999	21	20	21	16	6	7	21	92.223	0.746
	RM1,000 - RM1,499	7	6	7	8	0	4	7		
	RM1,500 - RM1,999	6	4	7	8	1	10	9		
	RM2,000 - RM2,499	4	9	7	3	0	2	3		
	RM2,500 - RM2,999	7	8	4	2	0	2	5		
	RM3,000 - RM3,499	3	7	4	5	0	1	7		
	RM3,500 - RM3,999	4	2	1	2	0	3	2		
	RM4,000 - RM4,499	1	2	4	4	0	2	2		
	RM4,500 - RM4,999	1	3	0	4	1	1	0		
	RM5,000 - RM5,499	4	2	3	3	0	1	3		
	RM5,500 - RM5,999	0	1	1	1	0	1	0		
	RM6,000 - RM6,499	3	1	1	1	0	0	4		
	RM6,500 - RM6,999	3	0	0	0	0	1	0		
	RM7,000 - RM7,499	0	2	1	1	0	1	0		
	RM7,500 - RM7,999	1	0	0	2	0	1	2		
	RM8,000 - RM8,499	4	2	2	0	0	1	1		
	RM8,500 - RM8,999	2	1	1	1	0	0	0		
	RM9,000 & above	5	3	2	2	0	2	5		

4.5 Factors of WTP for E-Waste Recycling as EWM Solutions

The study evaluated how the residents in Kuching would be willing to pay for household e-waste recycling based on the purchased value of the appliance. Table 4.23 illustrates the results of the analysis.

The study assessed the extent to which respondents would be willing to pay for household e-waste recycling based on the purchased value of the electronic appliances. Most respondents noted that they are not willing to pay for e-waste recycling, where residents disagree to pay for blenders (68.8%) and speakers (67.0%) the most.

Among the 397 respondents in this study, 12.3% of the respondents noted that they were willing to pay less than 1% for the purchased values of washing machines, while 12.1% of the respondents were also willing to pay less than 1% for the recycling costs for fridges. Likewise, 9.8%, 11.8% and 9.8% of the respondents also selected to pay less than 1% for the recycling fees for fans, air conditioners and computers or laptops.

On the other hand, 10.6% of the respondents were only willing to pay 1% of recycling fees based on the price they pay for televisions in the market. Meanwhile 8.8% of the respondents in this study were willing to pay 1% for the recycling costs for their steam irons. In addition, 9.8% of the respondents has also chosen to pay 1% of recycling fees for the values of speakers or sound systems. As for rice cookers and blenders, a similar percentage of 9.3 among the respondents have as well selected the 1% payment based on purchased value as their allocated cost for the recycling fees for their respective household electrical items.

The results show that for all the household electrical and electronic appliances which include washing machine, fridge, fan, steam iron/ iron, air conditioner, television, computer/ laptop, speakers/ sound systems, rice cooker and blender; majority of the respondents surveyed in Kuching were not willing to pay for recycling on these electrical items (0% costs).

Rawat et al. (2020) noted that even those who are prepared to pay or willing to pay are those who believe that their money would guarantee safe and ecologically friendly recycling of e-waste. Reusing electronic components and precious metals can help lessen our dependence on mining fresh resources for new electronic components and appliances. However, it is rather disheartening to discover that most residents in Kuching are likely unaware about the importance of household e-waste recycling, which resulted in a significant number of them unwilling to pay for the cost of household e-waste recycling.

Table 4. 23: Types of Household Electrical Appliances against the Percentage on the Purchased Value of Respondents Willingness to Pay for Household E-Waste Recycling

Percentage of Purchased Value of Respondents WTP for Household Electrical Appliances and the Types of Electrical Appliance	0%	Less than 1%	1.0%	2.0%	3.0%	4.0%	5.0%	More than 5%
Washing Machine	50.1%	12.3%	10.6%	9.6%	7.1%	1.3%	6.5%	2.5%
Fridge	50.6%	12.1%	11.3%	8.1%	8.1%	1.8%	5.5%	2.5%
Fan	59.4%	9.8%	9.1%	8.1%	8.1%	1.3%	3.3%	1.0%
Steam Iron/ Iron	65.7%	8.3%	8.8%	7.8%	5.3%	0.5%	3.0%	0.5%
Air Conditioner	55.2%	11.8%	10.8%	8.1%	7.1%	1.8%	3.0%	2.3%
Television	57.7%	9.8%	10.6%	8.1%	8.1%	1.0%	3.5%	1.3%
Computer/ Laptop	58.9%	9.8%	9.1%	8.3%	6.0%	1.3%	4.3%	2.3%
Speakers/ Sound Systems	67.0%	8.3%	9.8%	6.5%	3.3%	0.8%	3.8%	0.5%
Rice Cooker	66.2%	8.8%	9.3%	7.1%	4.5%	1.3%	2.5%	0.3%
Blender	68.8%	8.8%	9.3%	5.0%	4.8%	1.0%	2.3%	0.0%

The study assessed the reasons as to why respondents are willing to pay for household e-waste recycling services, as illustrated in Table 4.24.

Table 4. 24: Reasons of Household E-Waste Recycling

Reasons to Recycle Personal Household E-Waste	Frequency	Percentage
For my own environmental awareness of the toxic pollution caused by e-waste being in landfills.	23	5.8
I am aware of the consequences of e-waste pollution towards human health.	20	5.0
I am aware that it is harmful to the future generation if e-waste is not managed properly.	48	12.1
I am concerned about my household e-waste being exposed to the environment, causing pollution.	71	17.9
I have no choice.	3	0.8
I think that recycling e-waste is the best option to manage it.	44	11.0
It is irrelevant.	188	47.4
Total	397	100.0

In Table 4.24, slightly below 20% of the respondents (17.9%) noted that they are concerned about their household e-waste being exposed to the environment, causing pollution. Furthermore, 12.1% of the respondents noted that they are aware that it is harmful to the future generation if e-waste is not managed properly. About 11% of the respondents think that recycling e-waste is the best option to manage e-waste and the environment. A total of 5.8% noted that they are willing to pay for household e-waste recycling due to their own environmental awareness of the toxic pollution caused by e-waste being in landfills. Some respondents (5%) noted that they are aware of the consequences of e-waste pollution towards human health, while a minority of the respondents (0.8%) has stated that they have no other choice but to recycle their e-waste in Kuching.

From Table 4.23, 49.9% of the respondents were willing to pay for washing machines, 49.4% of the respondents are willing to pay for fridges while 40.6% of the total

respondents are willing to pay for fans in Kuching. Likewise, for steam irons (34.3%), air conditioners (44.8%), televisions (42.3%), computers or laptops (41.1%), speakers or sound systems (33.0%), rice cookers (33.8%) and blenders (31.2%) are also the list of electrical home appliances that the respondents from Kuching are willing to pay for recycling. The percentages of WTP among the 397 respondents are obtained by deducting the respective respondents who are not willing to pay for household e-waste recycling (0%) from 100% in Table 4.23.

The reason why there are respondents who are willing to pay for household e-waste recycling in this research is because the respondents expects their payment for e-waste recycling would enable the e-waste to be recycled and managed in the right manner that is safe and environmentally friendly. Other individuals noted that recycling electronic components and the valuable metals will reduce the dependency on mining new additional materials needed to make more electronic components and appliances. E-waste recycling and collection rates are higher in wealthy nations like Europe than they are in underdeveloped nations (Soo et al., 2013). The improvement in e-waste management is significant enough to warrant the use of mobile vehicles that immediately recycle e-waste after collecting it from Americans (Ceballos et al., 2020).

From the survey conducted among residents in Kuching to assess the reasons why respondents are willing to pay for household e-waste recycling, it was rather shocking to find out that the most prevalent reasons include law enforcement by the Sarawak government and income tax exemption for the expenses on household e-waste recycling services. This shows that the command and control system as well as economic incentives play a significant role in remoulding people's attitude and behaviour in Kuching. The findings of the study also indicate that more frequent awareness campaigns on the importance of household e-waste

recycling besides peer influence/ family influence/ social media influence is crucial if Kuching is to be bring forth towards a more sustainable and livable city.

Table 4. 25: Household E-Waste Recycling costs on government

	N	Minimum	Maximum	Mean	Std. Deviation
Respondent's Opinions if the Sarawak Government should Pay for Household E-Waste Recycling	397	1	10	8.00	2.236

The findings reveal that respondent's opinions if the Sarawak government should pay for household e-waste recycling was a high agreement as shown by the mean value of 8.0. A likert scale was used to extract the opinions of the respondents on whether they strongly disagree or agree that the Sarawak government should bear the costs for e-waste recycling in Kuching. The scale ranged from 1 to 10, with the scale of 1 being strongly disagreeing to the statement mentioned while the scale of 10 being strongly agree. This implies that the residents mostly agree at a mean scale of 8 that the Sarawak government should cover the recycling costs for household e-waste recycling in Kuching.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

Household e-waste management ensures that the environment is free from the hazardous substances that can pollute the environment and make it unfit for human health (Ahirwar & Tripathi, 2021). The chapter contains the research findings, conclusions, implications, limitations, and recommendations for future research. In Malaysia, e-waste management (EWM) is more on its infancy as compared to most developed countries like Japan. People's level of awareness about e-waste management (EWM) in Malaysia's capital city, Kuala Lumpur, was relatively lower than in developed countries. The chapter offers an opportunity to reflect on the essential research and elaborate on the study's findings, highlighting the e-waste management situation in Kuching. Furthermore, testing willingness-to-pay for household e-waste recycling and its association with their socio-demographic characteristics. It also provides an opportunity for the researcher to look at the limitation of this study which could be potential area of the study for future scholars to work on.

5.2 Conclusion

In general, this study only focused on households' e-waste management particularly on WTP for household e-waste recycling among residents in Kuching, Sarawak in the sampled population. In this study, only ten types of common household electrical and electronic appliances were chosen to determine the respondents' willingness to pay for household e-waste recycling when their electrical appliances reached their EOL. These ten electrical household appliances are the more common electrical appliances used in most

homes by Malaysian residents. They include washing machines, fridges, fans, steam irons, air conditioners, televisions, computers, speakers, rice cookers, and blenders. As the sampled population might not be representative enough to represent the whole population in the Kuching division in Sarawak, no generalization should be made from the findings of this study. However, the findings of this study may shed light for policymakers and relevant authorities regarding the condition of e-waste management and the willingness to pay for household e-waste recycling among the surveyed population in Kuching. The policy implication from this study is crucial to be taken into serious consideration for devising a more efficient and sustainable e-waste management in Kuching, Sarawak.

The findings of this study revealed that most households just threw away their e-waste to the garbage collectors. From the findings of the study, it is evident that most respondents have a low willingness to pay for the recycling of household e-waste. Instead, most agreed that the Sarawak government, municipal councils, and the manufacturers of EEE should cover the recycling costs of their household e-waste. In addition, it is important to note that among all the demographic factors associated with the resident's willingness to pay for household e-waste recycling in Kuching, only age plays a significant role in affecting WTP for household e-waste recycling.

On the other hand, there was no statistically significant association between the level of household income or education and their WTP for household e-waste recycling, which contradicts studies carried out in Macau and Zhuhai, China, where Song et al. (2012) and Chai et al. (2019) had mentioned that their population sample were more inclined to be willing to pay for e-waste management when they had higher levels of income and education. Other variables such as gender, household location, with whom the residents are living and

their number of household members are also insignificant in affecting their willingness to pay for household e-waste recycling based on the survey carried out in Kuching, Sarawak.

Age is a factor found to have a significant relationship with WTP for household e-waste recycling in Kuching, Sarawak. This result may have indirectly reflected the hypothesis of presuming that the older the age the higher willingness to pay among the residents or vice versa for household e-waste recycling in Kuching. It might be explained by the fact that the people who fall under the older age range are aware that it is not good to allow their household e-waste not to be recycled (Afroz et al., 2009). The estimation in WTP for household e-waste recycling in this research was determined based on the contingent valuation method, where the WTP for household e-waste recycling based on the purchased value of new household electrical appliances ranged between 1% and 5%. Other than the age factor, environmental awareness is also a factor that affects WTP for household e-waste recycling in this study. This supports claims carried out in past studies done where environmental awareness plays a pivotal role in determining residents WTP for an enhanced surrounding environment (Mahmoud et al., 2022).

Another surprising result in this study encompasses the association between education level and the respondent's willingness to pay for household e-waste recycling. It was indicated by Song et al. (2012) that the higher the education level, the higher their residents in Macau would be willing to pay for e-waste recycling. However, the findings derived from this study show that education level plays an insignificant role in terms of having respondents being willing to pay for household e-waste recycling. This result compliments the study done by Cai et al. (2015) in Zhuhai, China, where education level was not taken into account as an important factor in determining WTP for e-waste recycling. This common trait may be

caused by the lack of public awareness in Kuching and Zhuhai about the importance of managing household e-waste in an environmentally friendly manner.

5.3 Limitations of the Study and Recommendations

The e-waste discussed above is mainly household e-waste, disposed of by Malaysian residents irrespective of municipal solid waste (MSW). The study does not explain how the Malaysian government can assist in the eradication of environmental pollution by reducing e-waste generation as the government holds a higher responsibility in ecological conservation.

A total of 383 respondents were initially targeted to contribute to this research. Nevertheless, there were a total number of 397 respondents surveyed in this study based on the quota sampling method. The sample chosen was small and centralized in one area in Malaysia. This makes the researcher unable to generalize the findings based on the results obtained. Respondents could have been sampled from all states in the country as environmental pollution affects all public members in all regions of the world (Gupta & Bedi, 2018).

The Pearson Chi-Squared Test performed in this study require a higher count of respondents being involved. However, due to time and financial constraints, only 383 respondents were able to be included in this research. This number is inefficient as it has led to having age range counts of less than 5, especially under the outlier categories of ages 70 and above. This research should be targeted to a more even age group for future studies, consisting more even frequencies throughout to provide a more holistic representation of the population of study.

Future studies are recommended to compare Malaysia with other developed countries like the United States and Japan on their organization of e-waste management. In addition, future studies may also use other sampling methods apart from the quota sampling method used in this study due to the restrictions faced during this research was performed. Besides that, other ways of estimating WTP should also be explored in future studies instead of concentrating on one evaluation method on contingent valuation method used in this study.

Finally, the limitation of this study also includes the possibility of having an additional question in the type of education possessed by the sample. The type of studies taken up by undergraduate or postgraduate students should also be taken into account to estimate whether students from the environmental studies background would have any association towards the WTP for household e-waste recycling in a specific location of study. This is because there has not been a correlation found in this study between WTP for household e-waste recycling and education level in Kuching.

Malaysians should learn from the developed countries like the United States and Japan about their organization of household e-waste management. Various techniques and technologies should be adapted to recover the prevailing e-waste organization in Malaysia. If Malaysia can devise the current technology in e-waste, then environmental pollution can be controlled at a higher rate. Recycling can enhance the country's rapid development and enable the provision of employment opportunities for Malaysians. Therefore, more research and studies on e-waste reprocessing and supervision are obligatory in overcoming this problem.

Therefore, the government must play a role in recycling e-waste instead of placing the expectation on its residents to manage their household e-wastes properly. This will reduce environmental pollution as more advanced methods will be used to dispose of solid wastes.

There should be an e-waste management and awareness program to eradicate improper disposal of e-waste in the entire country. A centralized system should be put in place in the country to collect mobile phones, and any other electronic accessories meant for disposal, (Gupta & Bedi, 2018). This may involve setting up collection bins in busy areas like government offices, universities halls, shopping, and telecommunications companies. Once the bins are full of e-waste, they can be taken to a common collecting point, after which they will be recycled for future use to prevent pollution.

Lastly, the public should be taken through vigorous training and awareness of the dangers of e-waste disposal in their households. The ministry of the environment should work together with the ministry of health to educate the public on the risks of e-waste and develop a program for public awareness and participation on the dangers of e-waste in the country. There should be general knowledge availed on the leading media platforms, either social media or the mainstream media, concerning environmental pollution locally.

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APPENDICES

Appendix 1: The Study Questionnaire

This survey is to study the willingness-to-pay for household e-waste recycling among Kuching residents. (For residents currently residing in Kuching/ Bau/ Lundu).

For this survey, you are to select only one answer unless indicated otherwise.

By participating in this study, it is understood that you have given your consent to provide your information for academic purposes only.

You shall only answer this survey if you are 18 years and above as this study is more applicable for adults who are responsible for the management of e-waste from home.

Thank you very much for your participation.

Section A: Demographic Information

1. Age

Please specify: _____.

2. Gender

() Male

() Female

3. House Location by District

() Kuching

() Lundu

() Bau

4. House Location by Area

() Tabuan Jaya

() Tabuan Tranquility

() Tabuan Heights

() Green Heights

() Petra Jaya

() Hui Seng Garden

() Hakka Avenue

() Taman BDC

() Taman MJC

() Batu Kawa

() Jalan Penrissen

() Palm Road

() Stapok

() Richmond Hill

() Taman Moyan

() Jalan Song

() Kenny Hills

() Taman Paradise

() Steven Yong

☐ Others, please specify: _____.

5. Who do you live with?

☐ Family

☐ Non-Family members

☐ Alone

6. Number of Household Members (Including you)?

Please specify: _____.

7. Education Level

☐ Primary School

☐ Secondary School

☐ Pre-University

☐ Bachelor's Degree

☐ Master's Degree

☐ Doctor of Philosophy/ PhD

8. Monthly Household Income Level

☐ RM0 – RM999

☐ RM1,000 - RM1,499

☐ RM1,500 - RM1,999

☐ RM2,000 - RM2,499

☐ RM2,500 - RM2,999

☐ RM3,000 - RM3,499

☐ RM3,500 - RM3,999

☐ RM4,000 - RM4,499

☐ RM4,500 - RM4,999

☐ RM5,000 - RM5,499

☐ RM5,500 - RM5,999

☐ RM6,000 - RM6,499

☐ RM6,500 - RM6,999

☐ RM7,000 - RM7,499

☐ RM7,500 - RM7,999

- () RM8,000 - RM8,499
- () RM8,500 - RM8,999
- () RM9,000 and above.

Section B: E-Waste Management Methods & Level of Awareness about EWM

1. How do you define household e-waste?
 - () E-waste is electrical household appliances that are no longer useful to me.
 - () Electrical appliances that have reached their end-of-life (EOL).
 - () E-waste are functional household electrical appliances that I keep at home.
 - () Household e-waste are electronic appliances that I do not use at home.
 - () None of the above.

2. What are the household electrical appliances in your home that have malfunctioned/ been replaced? **You may tick more than one answer, choose either malfunctioned and/ or replaced.*

Household Electrical Appliances	Malfunctioned	Replaced
Washing Machine		
Fridge		
Fan		
Steam Iron/ Iron		
Air Conditioner		
Television		
Computer/ Laptop		
Speakers/ Sound Systems		
Rice Cooker		

Blender		
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3. How do you manage your malfunctioned/ replaced washing machine/ fridge/ fan/ steam iron or iron/ air conditioner/ television/ computer or laptop/ speakers or sound system/ rice cooker/ blender?
- () Retail seller collects it.
 - () Send to service centers.
 - () Send to recycling centers.
 - () Taken by garbage collectors.
 - () Send for donation.
 - () Leave at home.
 - () Not applicable.

Section C: Resident Willingness-to-Pay for Household E-Waste Recycling

1. Who do you think should be held accountable to pay for the cost of household e-waste recycling?
☐ () My family members and/ or I
☐ () My housemates/ flatmates
☐ () My landlord/ house owner
☐ () The electrical household appliance retailers
☐ () The electrical household appliance manufacturers
☐ () The Malaysian government
☐ () The State Government
☐ () The Local Council

2. If the government imposes a fee for e-waste recycling services on the purchases of new household electrical appliances, would you be willing to pay?

Household Electrical Appliances	Yes	No
Washing Machine		
Fridge		
Fan		
Steam Iron/ Iron		
Air Conditioner		
Television		
Computer/ Laptop		
Speakers/ Sound Systems		
Rice Cooker		
Blender		

3. If your answer was yes to being willing to pay for household e-waste recycling services, how much would you be willing to pay based on the purchased price of the respective household electrical appliances?

Household Electrical Appliances	<1%/1%/2%/3%/4%/5%/> 5%
Washing Machine	
Fridge	
Fan	
Steam Iron/ Iron	
Air Conditioner	
Television	
Computer/ Laptop	
Speakers/ Sound Systems	
Rice Cooker	
Blender	

4. Did you answer “Yes” to being willing to pay for any types of household e-waste recycling mentioned above?
- ☐ Yes
- ☐ No
5. Why are you willing to pay for household e-waste recycling services?
- *Only for respondents who are willing to pay for their household e-waste.*
- ☐ You are concerned about your household e-waste being exposed to the environment, causing pollution.
- ☐ You are aware of the consequences of e-waste pollution towards human health.
- ☐ You are aware that it is harmful to the future generation if e-waste is not managed properly.
- ☐ You think that recycling e-waste is the best option to manage it.
- ☐ For your own environmental awareness of the toxic pollution caused by e-waste being in landfills.
- ☐ You have no choice.
- ☐ Others opinions, please specify:
-
6. What are the factors that would encourage you to pay for household e-waste recycling services? **You may tick more than one answer.*
- ☐ Law enforcement by the Sarawak government.
- ☐ Your own concern and care for the environment.
- ☐ Income tax exemption for the expenses on household e-waste recycling services.
- ☐ More frequent awareness campaigns on the importance of household e-waste recycling.
- ☐ Peer influence/ Family influence/ Social media influence.
- ☐ Others opinions, please specify:
-
7. You are not willing to pay for household e-waste recycling services, because? **You may tick more than one answer, skip this question if your answer was ‘YES’ in Section C, question 2.*

- () The cost of recycling e-waste is the government's responsibility.
- () You are not wealthy enough to afford such expenses.
- () It would be a burden for your family and yourself.
- () The cost of recycling e-waste is the electrical home appliance manufacturer's responsibility.
- () The cost of recycling e-waste is the electrical home appliance retailer's responsibility.
- () The cost of recycling e-waste is the e-waste recycler's responsibility.
- () You do not care about e-waste management.
- () Others opinions, please specify:
-

8. Do you agree that the Sarawak government should pay for its residents' household e-waste recycling services in Kuching? **Please tick one box only.*

	1	2	3	4	5	6	7	8	9	10	
Strongly Disagree											Strongly Agree