The Effect of Social-economic background on electric and electronic waste
(e-waste) management amongst Residential areas in Kota Kinabalu City, Sabah, Malaysia

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Abstract
Electrical and electronic waste (e-waste) is a very complex waste because it contains harmful and harmless chemicals. The toxic chemical properties and heavy metals are very harmful to humans and the environment. Therefore, e-waste needs to be managed efficiently and systematically. Currently, e-waste management in most countries relies heavily on law and does not take into account the culture and socio-economy of the local community. Therefore, this article will identify e-waste management practices among households and analyse the relationship between selected background and household e-waste management in Kota Kinabalu City. The survey method is used as a method of data collection using the questionnaire as the main instrument. The data is analyzed using descriptive statistics (frequency analysis and cross tabulation) and inference statistics (chi square and logistic regression). The total number of respondents obtained was 395 people. The results of the study found that the practice of storing, disposing of bins and selling used items is a popular management method among the households rather than sending e-waste to recycling centres. The study also found that socioeconomic backgrounds such as gender, age and monthly household income have a significant influence on the way e-waste management is conducted. Therefore, this study proves there is a need to emphasize the socio-economic background in managing e-waste, especially in residential areas.
Keywords: Electrical and electronic waste, e-waste management, hazardous waste, household, management practices, socioeconomic background

Introduction
The increase in solid waste is closely related to the increase in population (Mapa, 2011). electronic waste, or e-waste, is a complex waste as it contains both harmful and harmless chemicals. Therefore, there needs to be a more efficient and systematic management of e-waste because of its toxic chemical properties and heavy metals that harm both the man and the environment. This harmful nature of e-waste to the environment and its inhabitants has resulted in the prohibition of e-waste in disposal sites. In urban areas, waste management component and performance depends on the ability of the system to adjust itself within the context of social and culture in the urban area (Fobil, Armah, Hogarh, & Carboo, 2008).

E-waste production has been identified as the main issue within this era in solid waste management. The rise of wastes and the limited options available for its management has

resulted in e-waste being unsustainable. This therefore has made this waste issue a very serious concern for developing countries (Heeks, Subramanian, & Jones, 2015). This type of waste is said to increase at the growth rate of 3 to 5 percent annually worldwide (Cucchiella, D'Adamo, Lenny Koh, & Rosa, 2015). Computers for example contribute between 20 to 50 million ton of e-waste on an annual basis (Herat, 2007). Therefore, a more systematic method of waste collection needs to be developed to ease e-waste disposal (Kang, Kang, Ilankoon, & Chong, 2020). A systematic collection will increase the rate of recycled electrical and electronic waste or e-waste, and thereby reduce the usage of resources.

Whilst the more developed countries have put in place the technique of waste disposal in the modern households, the legal framework for e-waste disposal or management have not been fully implemented in Malaysia (Kang et al., 2020). This is why many developing countries are faced with informal recycling activities. The presence of these groups in the community are to obtain electronic wastes from households and then sell them back to relevant waste collection centres. The existence of such groups is due to the lack of policies, recycling centres and public awareness (Awasthi, Zeng, & Li, 2016).

Literature
Public E-waste Management
The involvement of residents, especially in residential areas, is important if recycling is to be increased (Mapa et al., 2019). The public's management of e-waste is an important element in the success of a waste management system. This means, a households' management of waste within their homes will determine if e-wastes would end up in landfills or at recycling centres. A study done Owusu *et al*. (2017) found several ways households dispose of their wastes. Amongst them 1) selling wastes to scrap metal collectors known as 'scrap boy', 2) burning, 3) disposing wastes at landfills, and 4) buying new electronic appliances. The abundant electrical waste found in landfills becomes a source of income for scavenger groups (Mapa, 2019). By far, selling to scrap metal collectors or scrap boy is most popular. Households sell their e-waste to these scrap boys because they feel this is the best method of disposal which does the least damage to the environment. Owusu's study also found that households believed burning electronic appliances was safe because according to them, no dangerous gases will be released into the atmosphere. This demonstrates the low level of knowledge and awareness the households in this study had on the negative impacts of burning e-wastes.

In a finding in Mumbai, India revealed, households found it easier to sell e-wastes to the informal sectors (*Kabadiwalas)* (Kwatra *et al.,* 2014). However, the sale of any particular e-waste is dependent on the condition of the product. Only non-functioning and unrepairable appliances are sold to the *Kabadiwalas* (e-waste buyers). Appliances that are in relatively fair working order, will be sold to friends, family members or second-hand shops. This trend of selling e-wastes to non-formal sectors also occur in China. Here, the main reason for selling e-waste is for monetary reasons (Wenhua Wang *et al.*, 2017).

Past studies have also shown disposing of e-waste or keeping e-waste stored in homes are also methods used by households. Though not as dominant an option as the earlier two methods, storing ends up being an option for e-waste management in households. Normally, e-wastes which are stored and ends up being disposed together with other solid wastes in the households and eventually ends up in garbage landfills. Robinson (2009) observed when e-waste and other

household wastes end up in the same landfill, this increases the chances of toxic chemicals being released into the earth and contaminating resources on the ground. On the other hand, households which continue to store their e-wastes at home, do so because they are still deciding on repairing, selling or disposing of the item. In her study, Junaidah (2010) revealed the storing method is popular amongst households in Shah Alam, Malaysia because the respondents believed these items still held some sort of value. However, three to five years later, 70 percent of those who had initially held on to their unwanted electrical appliances will opt to either sell or dispose of it (US Environmental Protection Agency, 2000).

Previous studies have uncovered the best alternative for e-waste management is recycling (Bereketli *et al.,* 2011); Nazatul Faizah *et al.,* 2018). But this practice is not popular amongst households. As found in the study by Rafia *et al.* (2013) in Kuala Lumpur, Malaysia, only two percent of households sent their e-wastes to recycling centres as opposed to 30 percent who simply disposed of these items in the trash, and 27 percent who still kept the items even though they were not using it anymore. As Junaidah (2010) explained, recycling is not a popular option for consumers in Malaysia because the country does not practice the 'take back' policy, or an Extended *Producer Responsibility (EPR)* policy whereby consumers can return to the producers or manufacturers products that are deemed no longer useful for it to be properly disposed. Regardless, Nazatul Faizah *et al.* (2018) emphasises that for any recycling campaign to be effective, requires the commitment of both enforcing agencies as well as consumers. Thus, even as introduces or enforces policies, achieving desired results will not materialise if consumers are not willing to be active participants. Wenhua Wang *et al.* (2017) finds that three factors which prevent households from recycling are households prefer to sell their unusable items to the informal sectors, there is little information about recycling centres within their areas and there is very little awareness on e-waste management within these households.

Past studies have also identified other factors which influence consumer choices for e-waste management. Starr (2014) dan Marinescu, as well as Ciocoiu & Cicea (2016) for example, saw population density, number of occupants in a household, age, income and level of education as factors which can affect the consumer choice for recycling. As Marinescu *et al.* (2016) found in their research, typically respondents within the age range of 41 years, opt to send their e-wastes to recycling centres. It was also found that respondents with tertiary education are more inclined to opt for recycling centres. Unemployed respondents showed little interest in environmental issues, and therefor were less predisposed to visit recycling centres. Respondents with a high income are also prone to utilise recycling facilities. These past researches clearly demonstrate a correlation between a respondent's socio-economic background and e-waste management. Therefore, this research uses respondents socio-economic background to look at consumer preference for e-waste management amongst households in Kota Kinabalu city.

Research Objectives
This research has two objectives:
1. Analyse e-waste management in households
2. Analyse the relation between household background and e-waste management

Research Method

This study uses qualitative approach in data collection, utilizing the survey method. According to Sabitha (2006), the survey method is the best method for data collection particularly for researchers interested in gathering primary data from a large population. This study uses questionnaires as its main instrument for collecting necessary information from respondents. The questions used in this questionnaire are revised from the questions used by Oomman (2014).

Data collected are then transferred to *Statistical Social Sciences Packages* for analysis. This data will be analysed using descriptive and inferential statistics. For Mordkoff (2016) descriptive statistics is used to summarize the data collected. Descriptive statistics analysis is used to describe the basic characteristics of a given data. Inferential statistics on the other had is the conclusions made based on observations done by descriptive statistics (Chua Bee Seok *et al.,* 2016). Descriptive statistics uses frequency analysis which shows the frequency score measured in percentages and cross tabulation analysis. On the other hand, inferential statistics uses Chi-squared test and logistic regression analysis.

The statistical significance used in this research is 0.05. Data analysed using inferential statistics allows for a broader conclusion on a population sample (Filho et al., 2013). If the statistical significance is 0.05, then the corresponding confidence level is 95 percent with only 5 percent error (Morgan *et al.,* 2004). Additionally, if the significance value indicates a significance, this means that there exists a correlation with the variables (Greenwood, 1996; Field, 2005).

Logistic regression analysis is used because this method can indicate relation as well as strength of the association of the variables with the outcome (Menard, 2002). This analysis would eliminate unnecessary variables from the model. In this study, data is recoded to allow for a definition, as well as to run logistic regression analysis while strengthening the constant effect of Exp (B) or *odds ratio* (Morgan *et al.,* 2004).

Sampling is an important step in scientific research. This study uses a stratified random sampling method which the total population is divided into smaller groups or strata to complete a sampling process. These smaller groups should be different and data should not overlap (Fauzi, Jamal & Saifoul, 2014). In this study, households were divided into low- cost residential areas and higher cost residential areas. This is done with the assumption that those living in the low-cost residential areas would be those in the lower income category. Likewise, those living in the high-cost residential areas would be those with the higher income. Thereafter, simple random sampling is used to select respondents in the residential areas. Random sampling is necessary as it ensures every element in the population has equal likelihood of being selected. This would eliminate and potential for bias when selecting one potential respondent over another within the study area (Fauzi *et al.,* 2014).

This study sample is determined using Cohen et. al. (2001) formula. The total population of Kota Kinabalu City is 553 900 people with the reliability of 95 percent, total sample size would be 384. Therefore, the total sample of this study is 395. Therefore, based on the criteria set out by Cohen *et al.* (2001), 395 respondents were sufficient for this study. The main characteristics of the respondents chose must be parents or guardians in that household as they would have full responsibility on the management of the households. In the event there is no parent at home, family members who are above 18 years old are allowed to tag along.

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Research Area

 The research area, Kota Kinabalu City, is located on the west coast of Sabah. Compared to other towns in Sabah, Kota Kinabalu is relatively small at 351 square kilometres (Zainuddin, 2018). Based on 2010 census, Kota Kinabalu had a population of 462 963 which is made up of Bumiputera (70.4 percent), Chinese (27.4 percent), Indians (0.6 percent) and other ethnic groups (1.6 percent) (Department of Statistics Malaysia, 2010). By 2016, the total population in Kota Kinabalu had increased to 553 900 people (Department of Statistics Malaysia, Sabah, 2017). Kota Kinabalu city has four main sub-districts which are Kota Kinabalu, Inanam, Menggatal and Telipok. Map 1 below shows the four sub-districts in Kota Kinabalu City.
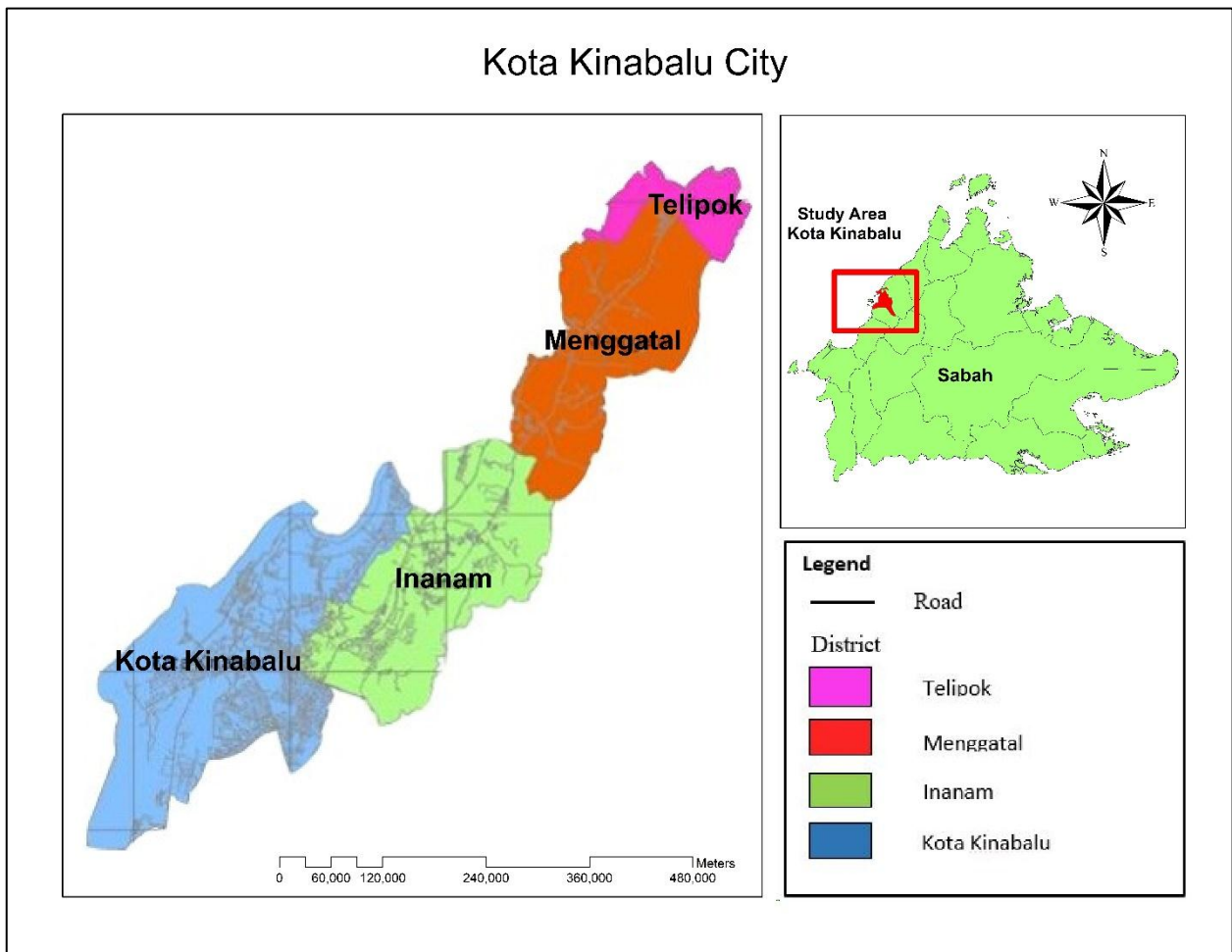
Map 1. Kota Kinabalu City
Source: Adapted from Mapa (2017)

Findings and Discussions

Below is the background of the respondents of the study area (Table 1). A few of the basic characteristics such as gender, age, total number in a household, employment, level of education and monthly income will be examined.

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Table 1. Respondent background (n=395)

| Variable	Frequency (f)	Percentage (%)
Gender		
Male	211	53.3
Female	184	46.6
Age		
18 – 25 years old	71	18
26 – 55 years old	290	73.4
56 years old and above	34	8.6
Total in household		
1	3	0.8
2 – 4 people	130	32.9
5 – 8 people	232	58.7
9 – 12 people	30	7.6
Occupation		
Government	116	29.4
Self-employed	105	26.6
Private (Professional)	26	6.6
Private	61	15.4
Others (Housewife / shop assistant)	87	22.0
Status		
Married	306	77.5
Single	88	22.3
Others	1	0.3
Level of Education		
Pre-tertiary Education	164	41.5
Tertiary Education	231	58.5
Monthly Income		
Low income	197	49.9
High Income	198	50.1

Based on Table 1, of the 395 respondents, 211 people (53 percent) are men while the remainder were female. The respondents' level of education was divided into primary education and tertiary education. Two hundred and thirty-one (58.5) obtained tertiary education whilst 167 people (41.5) respondents had obtained pre-primary education. Tertiary education is categorised as those who had obtained STPM, diploma or higher. On the other hand, those in the pre-tertiary education are those with UPSR, PMR, and SPM. This category also includes those who did not receive formal education.

The monthly income was divided into two categories, respondents of lower income group and respondents in the higher income group. Those in the high-income category are those who earned above RM3 800 a month while those in the lower income category earned between RM950 and RM3799 per month. It was observed that 197 respondents (49.9 percent) received an income of between RM950 to RM3799 a month, as opposed to 198 (50.1 percent) who received an income of more than RM3800 a month. Overall, majority of the respondents in this research

are middle income earners. This can be observed from the chi square analysis which found a significant correlation between income and type of occupation.

In this study, the younger generation within the age group of 18 to 25 years old only represented 18 percent of the total respondents. Majority instead, was from the 26 to 55 years old age group (73.4 percent). The remainder of the respondents fell in the above 56 years old age group. Analysis also found a significant relation between age range as well as occupation (X^2=17.543, df=8, p< 0.05), which therefore indicates a strong relation between age and type of employment.

There were eight types of electronic and electrical appliances commonly used within this research area (see Table 2). Aside from the items listed in the table, 77.5 percent of the respondents owned other electrical appliances such as rice cooker, iron, electric kettle, fan, water purifiers, blenders and other common household appliances. However, in this study, only main appliances used in homes are listed. Based on this, the top four appliances owned by majority of households are television, laptops, washing machines, mobile phones, and fridges. Of these four items, 98.7 percent of the respondents owned a mobile phone. The mobile phone and the other three items listed are deemed as essential items in any household today.
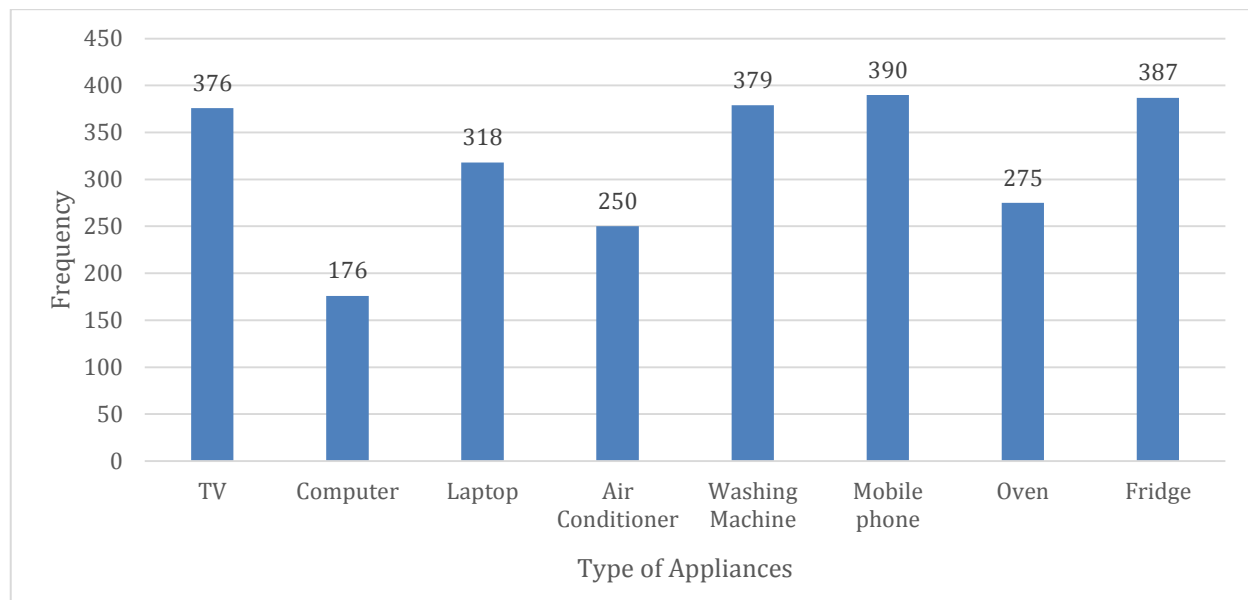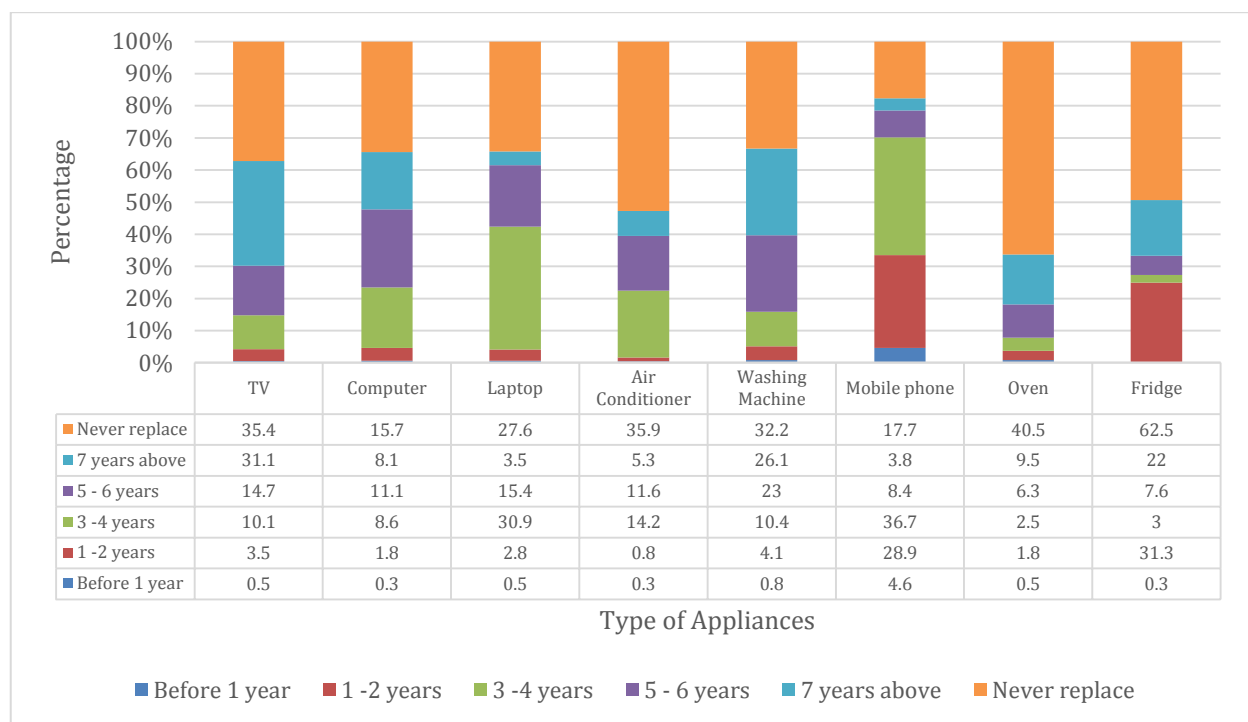

Table 2. Type of Appliances

Research has also revealed that the primary reasons for the increasing volume of e-waste in the country was due to the life expectancy of electrical appliances. Aside from that, the make and model of a particular electrical good will also influence the rate in which an appliance is replaced. This research found that each electrical product has a different useful life span (Table 3). Sixty- three percent of the total respondents who owned fridges, have never had it replaced. This is a high percentage compared to those who owned ovens whereby only 43 percent were still using their first oven. Generally, the average life of a particular electronic appliance is seven

years. These electrical appliances are such as the television, (31 percent), washing machine (26.1 percent), oven (19.5 percent) and fridge (22 percent).

There are other appliances which are replaced in less than seven years. The mobile phone (36.7 percent) and the laptop (31 percent) for example, is replaced between three to four years. In fact, there are other respondents (28.9 percent) who had their mobile phones replaced within just one to two years after purchase. When looked at this closely, the items that are replaced earlier before their life expectancy are due are items that are small and portable. Kwatra *et al.* (2014) found that heavy appliances such as fridges, as well as food processors and musical instruments have a use life of between 10 to 15 years. Whereas smaller portable items like mobile phones have a shorter replacement life of between one to two years. Oomman (2014) adds these items with the shorter replacement life are those gadgets used for IT and telecommunications.

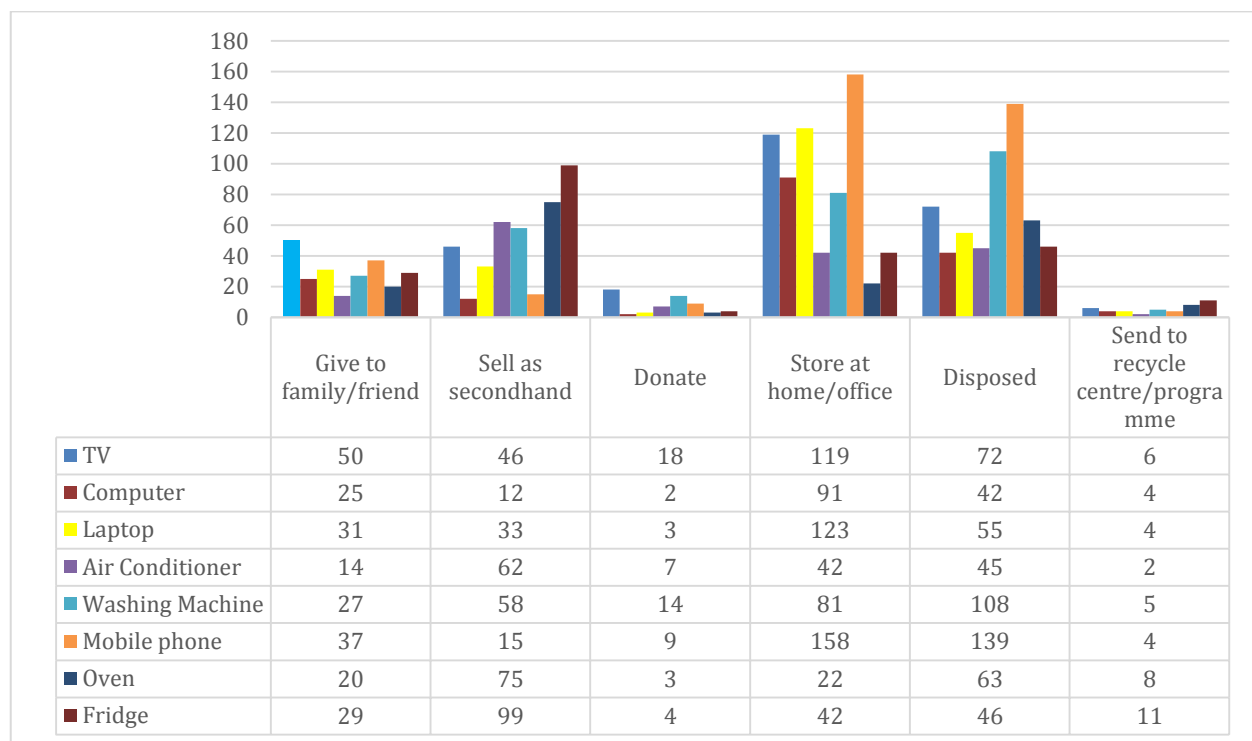|	TV	Computer	Laptop	Air Conditioner	Washing Machine	Mobile phone	Oven	Fridge
Never replace	35.4	15.7	27.6	35.9	32.2	17.7	40.5	62.5
7 years above	31.1	8.1	3.5	5.3	26.1	3.8	9.5	22
5 - 6 years	14.7	11.1	15.4	11.6	23	8.4	6.3	7.6
3 -4 years	10.1	8.6	30.9	14.2	10.4	36.7	2.5	3
1 -2 years	3.5	1.8	2.8	0.8	4.1	28.9	1.8	31.3
Before 1 year	0.5	0.3	0.5	0.3	0.8	4.6	0.5	0.3

Table 3. Elapsed Time and replacement of electrical and electronic appliances

What are the actions or how do households dispose of their unusable appliances is an important question which would lead to better management of e-waste. Typically, consumers in households would give the unwanted items to friends or family members, sell it to second-hand dealers, donate, store it, or send it to recycling centres. Each of the item listed in this study were disposed of differently. This is because not all products can be disposed of the same way. Table 4 shows the different ways in which household electrical appliances are managed after it is no longer useful to the household. This all depends on the size and the initial value of the item as well as its potential resale value. Regardless, the option of disposing unwanted electrical appliances into trash bins should not happen. This shows that the level of awareness on the need for proper disposal of e-waste is still low (Alias, 2015). However, disposal into garbage bins becomes a

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viable option when the e-waste collection services is not available in the particular residential area. It is therefore necessary for the creation of a systematic disposal system within residential areas to ensure e-wastes do not end up in landfills with other wastes (Hasim, 2020).

Table 4 shows five out of eight electronic products which are seldom disposed of by their owners even when these items are no longer used or useful for the owners. Among these items are the television, computers, laptops, air-conditioners and mobile phones. This study has shown that recycling is still not a norm in the study area. This correlates to the earlier findings observed by George, Mapa, & Dinggai (2019) who describe how residents have not been able to embrace sustainable management. This situation is a normal occurrence for countries in Asia even in Singapore whose population are still unsure of the recycling process for e-waste materials (CNA, 2018). This is because e-waste management in Asian countries is still heavily reliant on laws and regulations (Pariatamby & Victor, 2013). The situation is also similar in developing countries due to the lack of basic infrastructures for e-waste management resulting to the items being buried, burned or disposed of into the rivers/ocean (Osibanjo & Nnorom, 2007).

	Give to family/friend	Sell as secondhand	Donate	Store at home/office	Disposed	Send to recycle centre/programme
TV	50	46	18	119	72	6
Computer	25	12	2	91	42	4
Laptop	31	33	3	123	55	4
Air Conditioner	14	62	7	42	45	2
Washing Machine	27	58	14	81	108	5
Mobile phone	37	15	9	158	139	4
Oven	20	75	3	22	63	8
Fridge	29	99	4	42	46	11

Table 4. Respondent management method

Next, this research identifies the relation between the respondents' background and e-waste management behaviour. Using the logistic regression analysis (refer to analysis results in the appendix) there are three main variables, gender, age and income, which show a significant reaction to recycling management (Table 5). However, this study found there to be a statistically significant relationship with type of electronic appliances and the way in which it is disposed.

For larger or more expensive electrical appliances such as refrigerators, laptops, mobile phones, washing machines and fridges, respondents, particularly female respondents, are more likely to pass these items to relatives or friends first. The relation between the way an item is disposed and gender can be seen in Table 5 below.

In this study, there was an observable significance level between the respondent preference for storing and types of electrical appliances particularly television, oven, computer, fridge and laptop. It is interesting to observe female respondents were the least likely to part or sell their electrical appliances, especially their ovens. This is even more so if their oven was one of the more popular branded ones. This tendency of hanging on to electrical appliances which may no longer be functioning at its optimal level stems from the belief that the item can be repaired, though only if it was at a reasonable cost. This is because past study has shown the cost of repairs have been one of the factors which determined if a faulty electrical appliance would be repaired (George *et al.,* 2019).

It has also been observed in this study that appliances such as air-conditioners, ovens and fridges are the most common items which would be sold as used items. Amongst the reasons are these items are bulkier and take up more space in households if owners were to continue to store these unused items. Analysis shows women with a higher income are more inclined to sell electrical items that are no longer being used at home. Hence it would be advantageous if women and adults under the age of 60 were given more information on e-waste management (Milovantseva & Saphores, 2013).

This study looks next into the tendencies of households to dispose of unwanted electrical appliances into their garbage bins. Such inclinations are not encouraged and are harmful to the environment. General wastes that are collected from residential areas will end up in landfills. Acid and sludge that naturally leach from the metals and permeate into landfills. Burning e-waste is also hazardous as it releases pollutants such as hydrocarbons, heavy metals and brominated dioxins into the air, affecting our quality of air (Patil, 2016). In this study, only gender and income has suggested a relation as to tendencies of e-waste ending up in landfills. As shown in Table 5, it appears that women in the higher income range exhibit more tendency for disposing of their electronic appliances together with their general waste.

In plans to share information on e-waste management programs, all three factors need to be taken into consideration. However, the two tendencies which require attention when it comes to e-waste management is disposing into the trash and recycling. The habit of disposing unwanted electronic products into the trash needs to be stopped due to its harmful effects. Therefore, more attention needs to be given to understanding the reasons behind the flippant disposal of harmful wastes into general trash. This study observed very little respondents opt for recycling when it comes to e-waste. Respondents are less likely to send their unwanted appliances to recycling centres mainly because there is no centre yet in Kota Kinabalu that caters specifically for e-wastes. Collection drives done thus far, have been led and carried out by NGOs on an irregular basis (Dinggai, Mapa, & George, 2020).

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Table 5. Summary of Logistic Regression analysis between respondent background and respondent behavior towards e-waste

Background	Age			Sex			Income		
Management Behavior	**Type of Appliance**	**Exp (B)**	**Variable**	**Type of Appliance**	**Exp (B)**	**Variable**	**Type of Appliance**	**Exp (B)**	**Variable**
Keep	Television	2.340	26 years old and above	Oven	2.612	Female	Laptop	3.308	High Income
							Fridge	0.297	High Income
							Computer	2.874	High Income
Give to family member/friend	Laptop	0.223	26 years old and above	Laptop	5.368	Female	Computer	4.675	High Income
	Mobile phones	0.429	26 years old and above	Mobile phones	3.850	Female	Television	2.787	High Income
				Washing Machine	2.452	Female	Laptop	4.516	High Income
				Fridge	4.695	Female			
				Computer	9.464	Female			
Sell to used shops				Air conditioner	0.371	Female	Air Conditioner	5.520	High Income
				Computer	0.375	Female	Oven	8.656	High Income
				Oven	0.549	Female	Fridge	2.578	High Income
Dispose				Television	0.571	Female	Mobile Phone	0.559	High Income
				Washing Machine	0.360	Female			
				Mobile Phone	0.478	Female			
				Oven	0.455	Female			
				Fridge	0.514	Female			

Conclusion

This study has proven that respondent's background such as age, gender and income exhibit a statistical significance which influences household behaviour in waste management. The most obvious observation would be between gender and waste management. This may not be surprising because women had more tendency to do housework or chores around the house. Income was also a determinant in influencing waste management behaviours in households. Based on the discussions above, while age shows some relation with management behaviour, the relation was not as significant as compared to gender or income.

It can be concluded though, that waste management tendencies in Kota Kinabalu City is still low. This is because consumers here still prefer to store or throw their unwanted electrical

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appliances rather than drop it off at a recycling centre. A more sustainable e-waste management system is still lacking in Kota Kinabalu. This is a worrying situation seeing as the volume of disposed e-waste keeps increasing annually. Therefore, in planning for an effective solution, social cultural and socio-economic situations of the community need to be factored in.

Acknowledgement

References

Afroz, R., Masud, M. M., Akhtar, R., & Duasa, J. B. (2013). Survey and analysis of public knowledge, awareness and willingness to pay in Kuala Lumpur, Malaysia – a case study on household WEEE management. *Journal of Cleaner Production*, *52*, 185–193.

Alias, A. (2015, September 28). Kesedaran, pengurusan sisa elektronik masih lemah. Berita Harian Online. Retrieved from https://www.bharian.com.my.

Awasthi, A. K., Zeng, X., & Li, J. (2016). Comparative Examining and Analysis of E-waste Recycling in Typical Developing and Developed Countries. *Procedia Environmental Sciences*. https://doi.org/10.1016/j.proenv.2016.07.065

Bereketli, I., Erol Genevois, M., Esra Albayrak, Y., & Ozyol, M. (2011). WEEE treatment strategies' evaluation using fuzzy LINMAP method. *Expert Systems with Applications*, *38*(1), 71–79. https://doi.org/10.1016/j.eswa.2010.06.015

CNA. (2018). Ramai tidak tahu apa yang harus dilakukan dengan sisa elektronik; hanya segelintar kitar semula Sila baca https://berita.mediacorp.sg/mobilem/singapura/ramai-tidak-tahu-apa-yang-harus-dilakukan-dengan-sisa-elektronik/3939382.html. *Berita Mediacorp*. Retrieved from https://berita.mediacorp.sg/mobilem/singapura/ramai-tidak-tahu-apa-yang-harus-dilakukan-dengan-sisa-elektronik/3939382.html

Cucchiella, F., D'Adamo, I., Lenny Koh, S. C., & Rosa, P. (2015). Recycling of WEEEs: An economic assessment of present and future e-waste streams. *Renewable and Sustainable Energy Reviews*, *51*, 263–272. https://doi.org/10.1016/j.rser.2015.06.010

Chua Bee Seok, Ferlis Bullare & Jasmine Adela Mutang. 2018. SPSS: Prinsip dan Analisis Data dalam Sains Tingkah Laku. Penerbit Universiti Malaysia Sabah: Sabah.

Department of Statistics, M. (2010). Population Distribution by Local Authority Areas and Mukims. *Population and Housing Census of Malaysia*.

Dinggai, M. S., Mapa, M. T., & George, F. (2020). Persepsi Masyarakat Tempatan Terhadap Pengurusan E-sisa oleh Syarikat Swasta di Bandaraya Kota Kinabalu, Sabah. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*.

Filho F., Dalson Britto *et al.* 2013. When Is Statistical Significance Not Significant?. Bras. *Political Sci. Rev* Vol.**7**:1.

Fauzi Hussin, Jamal Ali & Mohd Saifoul Zamzuri Noor. 2014. Kaedah Penyelidikan dan Analisis Data SPSS. Penerbit Universiti Utara Malaysia.

Field, A. (2005). *Discovering statistics using SPSS*. London, Sage.

Fobil, J. N., Armah, N. A., Hogarh, J. N., & Carboo, D. (2008). The influence of institutions and organizations on urban waste collection systems: an analysis of waste collection system in

:

Accra, Ghana (1985-2000). *J Environ Manage.*

George, F., Mapa, M. T., & Dinggai, M. S. A. (2019). Preliminary Study on Waste Electrical and Electronic Equipment ({WEEE}) Management by Households in the Kota Kinabalu City. *{IOP} Conference Series: Earth and Environmental Science*, *286*, 12023. https://doi.org/10.1088/1755-1315/286/1/012023

Greenwood, P.E. 1996. *A guide to chi-squared testing*. Chichester New York, John   Wiley.

Haron, N. F., Sidique, S. F., & Radam, A. (2018). (E-Waste) Recycling Participation. *Journal of Design, Art and Communication*, *Special Ed*(September), 1552–1557.

Hasim, M. F. (2020). Pembuangan barangan elektrik tidak terurus beri kesan buruk. *Utusan Malaysia*. Retrieved from https://www.utusan.com.my/nasional/2020/10/pembuangan-barangan-elektrik-tidak-terurus-beri-kesan-buruk/

Heeks, R., Subramanian, L., & Jones, C. (2015). Understanding e-Waste Management in Developing Countries: Strategies, Determinants, and Policy Implications in the Indian ICT Sector. *Information Technology for Development*, *21*(4), 653–667.

Herat, S. (2007). Sustainable management of electronic waste (e-waste). *Clean - Soil, Air, Water*. https://doi.org/10.1002/clen.200700022

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

Kang, K. D., Kang, H., Ilankoon, I. M. S. K., & Chong, C. Y. (2020). Electronic waste collection systems using Internet of Things (IoT): Household electronic waste management in Malaysia. *Journal of Cleaner Production*. https://doi.org/10.1016/j.jclepro.2019.119801

Kwatra, S., Pandey, S., & Sharma, S. (2014). Understanding public knowledge and awareness on e-waste in an urban setting in India. *Management of Environmental Quality: An International Journal*, *25*(6), 752–765. https://doi.org/10.1108/MEQ-12-2013-0139

Mapa, M. T. (2011). Waste management and society: A case study of public participation in waste management Kota Kinabalu city. *Health and the Environment Journal*, *2*(2), 57–63. Retrieved from http://www.hej.kk.usm.my/pdf/HEJVol.2No.2/Article10.pdf

Mapa. (2017). Pengurusan Sisa Pepejal Mampan : Penelitian Ke Atas Dewan Bandar Raya Kota Kinabalu. In Mohammad Tahir Bin Mapa, Ubong Imang, & Mustapa Abd. Talip (Eds.), *Isu-Isu Alam Sekitar & Manusia Di Sabah* (pp. 183–200). Tanjong Malim: Penerbit Universiti Pendidikan Sultan Idris.

Mapa, T., George, F., Potirik, E. S., E., & Dinggai, M. S. (2018). Pengurusan Sisa Elektrik dan Elektronik dalam Kalangan Isi Rumah Kajian Kes Wilayah Persekutuan Labuan. (WEEE Management Among Household: A Study Case in Labuan Federal Teritory).

Mapa, M. T., Haris, L. M., Geogre, F., Dinggai, M. S., Japar, A., & Gulasan, A. (2019). Kajian komposisi dan pengasingan sisa pepejal di kawasan perumahan. *GEOGRAFIA Journal of Society and Space*, *15*(2), 117–128. https://doi.org/https://doi.org/10.17576/geo-2019-1502-09

Mapa, M. T. (2019). Waste Scavenging and Its Contribution for Survival and Urban Recycling in Kota Kinabalu City, Sabah, Malaysia. *Indonesian Journal of Geography*, *51*(2), 183. https://doi.org/10.22146/ijg.42301

Marinescu, C., Ciocoiu, C. N. & Cicea, C. 2016. Socioenomic Factors Affecting E-Waste Collection Rate in Countries from European Union. Proceedings of the 10TH International Management Conference. Challenge of Modern Management, November 3rd - 4th, 2016,

:

Bucharest, Romania.

Menard, S. 2002. *Applied logistic regression analysis, 2nd Edition*. Thousand Oaks,   CA, Sage Publications.

Milovantseva, N., & Saphores, J. D. (2013). E-waste bans and U.S. households' preferences for disposing of their e-waste. *Journal of Environmental Management*, *124*, 8–16. https://doi.org/10.1016/j.jenvman.2013.03.019

Mordkoff, J. T. 2016. Descriptive Statistics.

Morgan, G. A., Leech, N. L., Gloeckner, G. W. & Barret, K. C. 2004. SPSS for   Introductory Statictics. London: Lawrence Erlbaum Associates Publishers.

Oomman, U. P. 2014. A Survey of Consumer Behaviour towards E- Waste Management in the City Of Mumbai. *International Journal of Research in Applied, Natural and Social Sciences*, **2**(8), 1–10.

Osibanjo, O., & Nnorom, I. C. (2007). The challenge of electronic waste (e-waste) management in developing countries. *Waste Management & Research : The Journal of the International Solid Wastes and Public Cleansing Association, ISWA*, *25*(6), 489–501. https://doi.org/10.1177/0734242X07082028

Owusu, G., Donkor, A., Ziwu, C., Nyarko, S., Tawiah, R., Bonzongo, J.-C., … Nyame, F. (2017). Public Perception of E-Waste Management and Disposal Practices in Accra Metropolis, Ghana. *College of Basic and Applied Science*, *1*(1).

Pariatamby, A., & Victor, D. (2013). Policy trends of e-waste management in Asia. *Journal of Material Cycles and Waste Management*. https://doi.org/10.1007/s10163-013-0136-7

Patil, K. (2016). Macro perspective: E-waste environmental impacts. *International Journal of Applied Engineering Research*.

Robinson, B. H. (2009). E-waste: An assessment of global production and environmental impacts. *Science of the Total Environment*, *408*(2), 183–191.

Starr, J. 2014. Patterns in Trash: Factors that Drive Municipal Solid Waste Recycling. Masters Theses   1986.   Retrieved   from   http://scholarworks.umass.edu/cgi/ viewcontent.cgi?article=2302&context=theses

Tarawneh, A., & Saidan, M. (2013). Households Awareness , Behaviors , and Willingness to Participate in E-waste Management in Jordan. *International Journal of Ecosystem*, *3*(5), 124–131. https://doi.org/10.5923/j.ije.20130305.04

US Environmental Protection Agency. (2000). EPA Waste Wise Update. *Environmental Protection*.

Wang, W., Tian, Y., Zhu, Q., & Zhong, Y. (2017). Barriers for household e-waste collection in China : Perspectives from formal collecting enterprises in Liaoning Province. *Journal of Cleaner Production*, *153*, 299–308. https://doi.org/10.1016/j.jclepro.2017.03.202

Zainuddin Baco. (2018). Cabaran Pengurusan Warisan Bina Bandar di Bandaraya Kota Kinabalu (1881-2012). *Jurnal Borneo Arkhailogia*, *2*(1), 115–134.