



The influence of demographic variables to e-waste management practices in Kuala Lumpur, Malaysia

Tengku Adeline Adura Tengku Hamzah, Amirah Sariyati Mohd Yahya, Aziz Shafie

Department of Geography, Faculty of Arts and Social Sciences, Universiti Malaya, UM,
50603, Kuala Lumpur, Malaysia

Correspondence: Tengku Adeline Adura Tengku Hamzah (email: adelineadura@um.edu.my)

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Abstract

E-waste is defined as electrical and electronic appliances that are no longer functioning, broken, obsolete or unwanted by the present owner and are ready to be discarded. The disposal of e-waste is a challenging task as it contains hazardous substances as well as the precious metals. This study seeks to investigate e-waste management practices among respondents based on their demographic background. A quantitative cross-sectional study was conducted among 936 respondents in Kuala Lumpur, and questionnaires survey forms are used as research instrument. A statistical test was run to examine the relation of ten options of e-waste management practices to five demographic variables. The result has shown that respondents' occupation is the most significantly related demographic variables to e-waste disposal practices compared to other demographic variables. Respondents that work in the private sector were reported to have the highest percentage for each e-waste disposal practices compared to other type of occupations. The factors that have led to this finding may be due to the working environment (which deals a lot with electrical and electronic appliances), as well as the exposure and information from wide range of sources. Overall, the e-waste disposal practices vary based on the demographic background. The output of this study is beneficial for decision makers and relevant agencies in creating an appropriate management actions and approach based on demographic background towards sustainable e-waste management in Malaysia.

Keywords: Environment, e-waste management, human health, Kuala Lumpur, practices, public

Introduction

Electrical and electronic waste (e-waste) is defined as electrical and electronic appliances that are no longer functioning, broken, obsolete or unwanted by the present owner and are ready to be discarded. There is a huge range of electrical and electronic appliances produced from commercial entities, household as well as industries, which can be categories into white goods and brown goods. The examples of white goods are air-conditioners, cooker, microwaves, refrigerators and

washing machine. Meanwhile the examples of brown goods are computer, DVD player, laptops, mobile phones, radio and television (George et al., 2019; Mahat et al., 2019; Balde et al., 2017; Liang & Sharp, 2016; Nagajothi & Felixkala, 2015; Tiep et al., 2015; Suja et al., 2014; Afroz et al., 2013).

E-waste is an alarming global environmental issues due to the rapid increase in its volume of generation throughout years. Tiep et al. (2015) and Shumon et al. (2014) stated that Malaysia is also facing the problem of rising of e-waste generation with an average of 14% increment every year. Negative environmental impacts pertaining to e-waste generation is also due to the transition of economic activity and technology development. Technological advancement became the motivation for the public to upgrade their electrical and electronic appliances to meet the needs and demands of the modern lifestyle. This consumption culture has led to shorter lifespan of the appliances; hence contributing to e-waste generation, which eventually impacting the environment and human health (Abeliotis et al., 2006; Afroz et al., 2013; Haron & Othman, 2016; Mahat et al., 2019). For example, the lifespan of mobile phones had been reduced to approximately 18 months only (Milovanstseva & Saphores, 2013; Umair et al., 2015).

E-waste can lead to negative environmental impact and thus, affecting human health if it is mismanaged. Leachate from e-waste contain dissolved and suspended organic substances, high concentration of heavy metals and inorganic compounds which creates the potential for toxic substances to be in the urine, human milk, hair and blood via the contamination of air, soil and water. To reduce the generation of e-waste, and the related impact on environment as well as the human health, and to maximise the usage of unwanted appliances, a proper e-waste management system for households is urgently needed. Considering public access to data and research on e-waste in Malaysia is limited, this study will be able to provide referential information, particularly for the public in Kuala Lumpur, thereby filling in the current knowledge gap. As highlighted in Yahya et al., (2020) the availability of information sources is a critical factor in raising public awareness.

Research background and literature review

Sustainable E-waste management will reduce the impact of e-waste generation on the environment and human health. This includes effective enforcement of law and legislation, adequate and appropriate facilities, and involvement of various stakeholders. In Malaysia, a specific law on e-waste management has been passed by the Parliament. E-waste is covered under Environmental Quality (Scheduled Wastes) Regulations 2005, and listed in the First Schedule (Regulations 2) under code SW 110. Proper e-waste facilities such as recycling centres, collection centres or specific bins for e-waste disposal can be found in many places. Information about the location of authorised e-waste collectors based on requirements by the DOE is available on DOE's website. Additionally, the Malaysian Communications and Multimedia Commission (MCMC) provides collection boxes for unwanted mobile phones at telco outlets. Along with DOE and MCMC, there are also private entities and organisation that provide e-waste collection services namely, DHES (subsidiary company of Alam Flora Sdn Bhd) E-waste Recycling Through Heroes (ERTH), Pertubuhan Amal Seri Sinar (PASS), Scrap Computer Trading, SOLS Tech, Taiwan Buddhist Tzu-Chi Foundation Malaysia, Thanam Industry Sdn Bhd, T-Pot Electrical & Electronics, UrbanR Recycle+ and Used Computer Malaysia, to name a few.

A proper and sustainable e-waste management is not only helping in reducing the amount of e-waste being sent to the landfills, but also creates business opportunities, assists economic development, reduces mining activity for raw materials, helps create a sustainable production and consumption thus, will increase the lifespan of the electrical and electronic equipment (Miner et al., 2020; Mahat et al., 2019; Haron, 2015; Kaspe et al., 2015; Suja et al., 2014; Shumon et al., 2014; Wang & Xu, 2014; Zhang et al., 2012). E-waste recycling is one of the options of sustainable management. It begins with proper segregation of e-waste from other type of household waste (Stoeva & Alriksson, 2017). According to Lim (2019) only 25% of e-waste in Malaysia is being recycled. According to Miner et al. (2020) the commitment, involvement and awareness from the public in ensuring the e-waste being disposed in a proper method is much needed.

There are a few studies related to the practices of e-waste management among the public in Malaysia and other parts of the world. According to Miner et al. (2020) most respondents in Jos, Plateau State, Nigeria chose to store their e-waste at home, whilst a study in Accra Metropolis, Ghana noted that most respondents chose to resell and recycle their e-waste (Owusu et al., 2017). On the other hand, a study in Kota Kinabalu, Sabah, Malaysia reported that majority of the Chinese in Kota Kinabalu decided to sell their e-waste to generate income (George et al., 2019). A study conducted in Pune City by Bhat & Patil (2014) concluded that 57% of the respondents tend to mix their e-waste with solid waste. One thing that can be inferred from these studies is that e-waste recycling is not the most preferred method in e-waste management practices. Therefore, this study seeks to investigate the other options practiced by residents in Kuala Lumpur, and how are these options related to selected demographic variables.

Method and study area

Study area

Kuala Lumpur with the size of 243 km² (3.0852°N, 101.4143°E) is the capital city of Malaysia with a population of 1,790,000 (Portal Rasmi Jabatan Perangkaan Malaysia, 2019). According to Portal Rasmi Jabatan Perangkaan Malaysia (2019), this capital city of Malaysia is under the supervision and jurisdiction of Dewan Bandaraya Kuala Lumpur (DBKL). Figure 1 shows the map of Kuala Lumpur.

Sampling and conducting survey

This cross-sectional study was conducted among 936 respondents, who are Malaysian citizens living in Kuala Lumpur and are at least 18 years old of age. The data collection was conducted via face-to-face interaction. According to Babaei et al., (2015), Zhuang et al., (2008), Huang et al., (2006) and Vidanaarachchi et al., (2006) the response rate for face-to-face data collection is about 90 to 98 percent.

Research design and instrument

A quantitative research methodology was applied in this study, with surveys being the method of data collection and statistical tests as main data analysis technique. Questionnaire survey forms were adopted as instruments for this study. There are two sections in the forms: 5 questions in the

first section on the demographic variables and 10 questions in the second section regarding e-waste management practices. All the questions were adopted from previous studies by Stoeva & Alriksson (2017); Sivathanu (2016); Tiep et al. (2015); Malik et al. (2015); Akhtar et al., (2014); Bhat & Patil (2014); Ghani et al., (2013); Tarawneh & Saidan (2013); Song et al. (2012); Wang et al. (2011); Kalana (2010); Vicente & Reis (2007); Abeliotis et al. (2006); Darby & Obara (2005). All questions in section two were measured by using nominal scale (Yes/No), which is similar to previous studies on the practices of waste management conducted by Almasi et al. 2019, Babaei et al. (2015). Table 1 illustrates the questions in the second section. Out of ten questions, one question (P9) is a negative question.

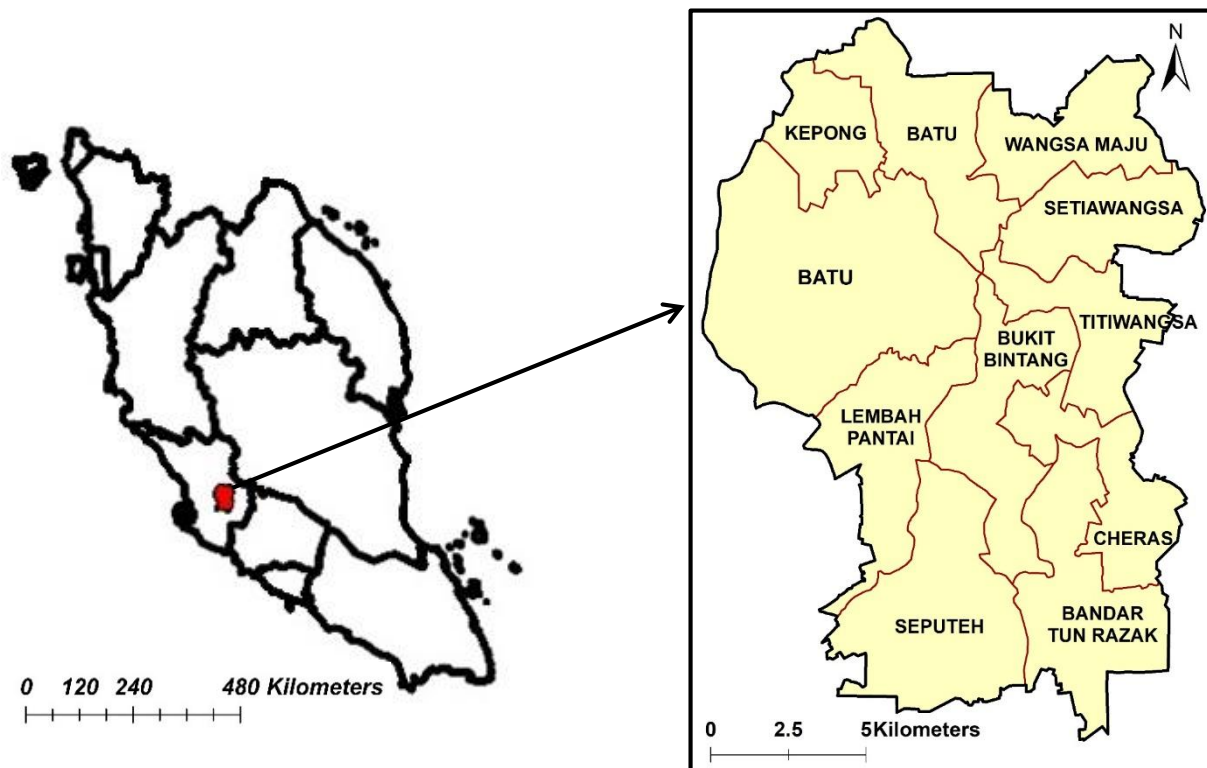


Figure 1. Maps of Kuala Lumpur.

Table 1. List of questions on e-waste practices.

Questions	
P1	I do not simply discard my E-waste
P2	I do not mix my E-waste with other types of waste during the disposal process
P3	I do not keep my E-waste at home
P4	I do trade-in my E-waste for new items
P5	I do sell my E-waste
P6	I do repair my E-waste
P7	I do give out my E-waste for charity purposes
P8	I do send out my E-waste to the formal E-waste collection centers
P9	I do send out my E-waste to the scrap collection dealers
P10	I encourage my family members to practice proper E-waste disposal

Data analysis

Data were analyzed using Statistical Package for Social Science (SPSS), and reported in percentage, based on demographic background. Tables and graphs were produced for every question. The relation between demographic background (in section 1) and each question on e-waste management practices (in section 2) is reported using the p-value. P-value of less than 0.05 indicates that there is a significant association between questions, while a p-value of more than 0.05 denotes otherwise.

Results and discussion

As mentioned in the previous section, the survey questionnaires consist of 5 questions on demographic variables and 10 questions pertaining to e-waste practices among respondents. The findings are described and discussed in the following sections: it begins with description on demographic background of respondents followed by analysis of each question related to e-waste practices.

Demographic background of respondents

The demographic background of the respondents is tabulated in Table 2. In this study, 936 respondents were involved. Five demographic elements were selected which are gender, age, education level, marital status and occupation. The majority of the respondents were females (57.5%). In term of age group, the highest percentage of respondents are aged between 25 and 34 years old (34.6%). Based on education level, the majority of the respondents had higher or tertiary education qualifications (58.5%). The marital status of most of the respondents is single (52.4%), and the majority of respondent (39.9%) work in private sector. Table 2 shows the detail of demographic background of respondents.

Table 2. Demographic background of respondents in Kuala Lumpur (N=936).

Demographic background		Frequency	Percentage (%)
Gender	Male	398	42.5
	Female	538	57.5
Age (years old)	< 24	316	33.8
	25-34	324	34.6
	35-44	154	16.4
	45-54	97	10.4
	> 55	45	4.8
Educational background	Higher Education	548	58.5
	High School	352	37.6
	Primary School	17	1.8
	No Formal Education	19	2.0
Marital status	Single	490	52.4
	Married	413	44.1
	None above	33	3.5
Occupation	Government Sector	105	11.2
	Private Sector	373	39.9
	Self Employed	118	12.6
	Housewife	99	10.6
	Student	230	24.6
	Pensioner	11	1.2

Relation of e-waste management practices with demographic background

This section highlights the e-waste management practices among public in Kuala Lumpur based on their demographic background. Table 3 shows the percentage of respondents' responses to questions on e-waste disposal practices based on nine questions (P1 to P9) in the survey forms.

Table 3. Percentage of respondents on e-waste disposal practices based on the demographic background.

Demographic background		Percentage of respondents based on demographic background (%)								
		P1	P2	P3	P4	P5	P6	P7	P8	P9
Gender	Male	41.2	43.3	41.5	45.3	46.0	43.0	38.6	43.5	45.4
	Female	58.8	56.7	58.5	54.7	54.0	57.0	61.4	56.5	54.6
Age (Years old)	< 24	39.0	33.8	30.5	34.3	34.7	35.7	33.2	33.5	35.0
	25-34	35.1	36.8	29.8	35.7	33.3	34.8	39.7	32.0	32.5
	35-44	14.6	14.2	19.0	16.5	17.6	15.2	12.5	18.8	17.3
	45-54	8.0	10.1	13.3	9.0	9.5	9.4	9.8	10.4	10.3
Educational background	> 55	3.3	5.0	7.3	4.6	4.9	4.9	4.7	5.4	4.9
	Higher education	71.8	58.2	53.3	59.2	57.9	59.5	54.8	54.4	56.2
	High school	26.5	37.6	40.6	37.2	38.0	36.2	41.3	41.8	39.8
	Primary school	1.1	1.3	3.3	1.3	1.3	1.6	2.1	1.2	1.6
Marital status	No formal education	0.6	2.1	2.8	2.4	2.7	2.7	1.8	2.6	2.5
	Single	62.4	53.7	48.4	52.9	52.3	54.0	56.3	49.6	51.9
	Married	34.3	41.8	46.5	44.6	44.2	43.1	40.7	47.4	44.9
	Others	3.3	4.4	5.2	2.5	3.5	2.9	3.1	3.0	3.2
Occupation	Government sector	9.9	7.7	10.3	11.9	12.4	11.4	10.5	13.0	13.3
	Private sector	40.1	45.9	41.5	42.4	41.1	40.7	41.0	41.5	39.9
	Self-employment	11.9	11.5	13.8	13.5	14.1	13.5	12.5	12.7	14.7
	Housewife	6.1	10.4	14.1	9.0	8.6	8.8	10.2	10.4	9.9
	Student	30.7	23.4	18.5	22.2	22.5	24.2	24.7	20.9	21.2
	Pensioner	1.4	1.2	1.6	1.1	1.3	1.4	1.0	1.5	1.1

There are two interesting interpretations which can be drawn based on the findings. Firstly, the groups of respondents which were reported to have shown better e-waste management practices compared to other groups in the same category (from five different demographic background) are: female (gender), 18 to 24 years old (age group), have higher education qualification (education background), are single (marital status) and working in private sector (occupation). It is important to note that, all the groups mentioned above, are actually having higher frequency than other groups in the same category (Table 2). This may have resulted in a finding which is bias to certain group of respondents.

Secondly, there is an obvious pattern that respondents who had chosen positive e-waste management practices did also chose to discard their e-waste by sending them to scrap waste collectors (refer question number nine (P9) pertaining to respondents discarding the e-waste via scrap waste collector). This method is not an environmentally friendly way of discarding e-waste as many scrap waste collectors are not registered with Malaysian DOE as e-waste recycler; and as such might opt for an unsustainable method of recovery materials from e-waste, such as acid bath.

However, it seemed that the majority of respondents are not aware of this. A more detail study to investigate the reasons for this action should be conducted in the future. Meanwhile, there is a need for the DOE to increase awareness on this matter among Malaysian citizens to enable them to make the right decision and action regarding sustainable ways of e-waste management practices.

The last question in the survey questionnaire form (P10) is about whether respondents encourage their family members to practice proper e-waste disposal. Most respondents (78.8%) agreed that they encouraged their family members to practice proper e-waste management. The breakdown based on the five demographic background is as shown in Figure 2.

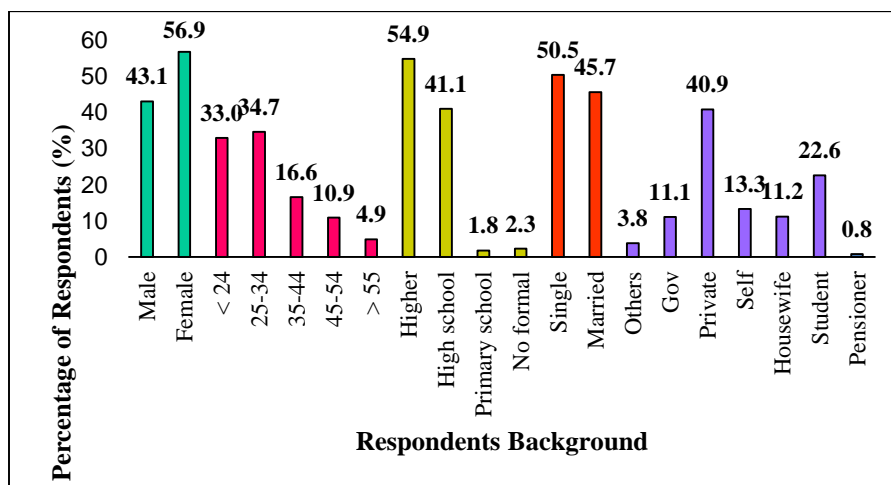


Figure 2. Percentage (%) of respondents that encourage family members for proper e-waste management.

A statistical test was run to investigate the relation of e-waste management practices with demographic value. According to Borthakur & Govind (2017), demographic variables are able to lead a dynamic e-waste disposal practice among respondents. The relation is indicated by a value called the p-value. The results are as tabulated in Table 4.

Table 4. Relation of e-waste disposal practices and demographic background (p-value).

E-waste disposal practices questions	Demographic background (p-value)				
	Gender	Age	Education	Marital status	Occupation
P1: Do not simply throw out	*	.021	<.001	<.001	.001
P2: Do not mix	*	*	*	*	.001
P3: Do not keep	*	.001	.006	.013	<.001
P4: Trade in	.002	*	*	.009	<.001
P5: Sell	<.001	*	.011	*	<.001
P6: Repair	*	*	*	*	.036
P7: Charity	*	*	.003	*	*
P8: Dispose to formal collection centre	*	.001	<.001	.007	.002
P9: Dispose to informal scrap dealer	.018	*	*	*	.002
P10: Encourage	*	*	<.001	*	.018

Note: *Not significant

The analysis of question P1 indicates that 38.7% of respondents chose not to discard their e-waste indiscriminately. This finding is similar to findings by George et al., (2019) based on their study in Kota Kinabalu. This is a positive improvement compared to previous studies in Kuala Lumpur. Akhtar et al. (2014) and Afroz et al. (2013) conducted studies in Kuala Lumpur and found that 30% of respondents simply discard their e-waste into the waste bins. Situations in other areas are similar; for example, a minority of respondents in Melaka (6.8%), Macau (26.0%) and Jordan (28.9%) choose to simply discard their e-waste in the waste bins (Tiep et al., 2015; Song et al., 2012; Tarawneh & Saidan, 2013). The demographic variables which are significantly related to this practice (p-value <0.05) are age, education level, marital status and occupation.

The second question (P2) is on whether respondents practice discarding their e-waste with other type of waste. It is found that, the majority of the respondents (55.7%) did not mix their e-waste with the general waste. Previous studies in Pune City and Nigeria reported similar results where only 13% and 25% from the total respondents mix their e-waste with general or household waste respectively (Miner et al., 2020; Baht & Patil, 2014). To increase e-waste segregation behaviour among the public, it is crucial to impart knowledge and awareness on the importance of sustainable disposal practices. The demographic variable which is significantly related to this disposal practice is respondents' occupation.

Statistical analysis on question P3 has shown that 45.4% of the respondents did not keep their e-waste at home; indicating that the majority of the respondents (54.6%) chose to keep their e-waste at home. According to Afroz et al. (2013) and Akhtar et al. (2014) respondents that kept their e-waste at home were 26.67% and 27% respectively and the percentage has increased over time. Similarly, storing e-waste at home is common among respondents in Kota Kinabalu (George et al., 2019) and Nigeria (Miner et al., 2020). A study in Melaka shows that keeping the e-waste at home as the second ideal disposal method (18.9%) (Tiep et al., 2015). However, in Jordan, storing e-waste at home is not the preferred management method, and only 14.46% of respondents chose this method (Tarawneh & Saidan, 2013). One possible reason that led the public to keep their e-waste at home is due to lack of door-to-door e-waste collection services (Miner et al., 2020; Tiep et al., 2015). Miner et al. (2020) and Tiep et al. (2015) suggested door-to-door e-waste collection in order to reduce the number of e-waste being stored at home by its owners. The demographic variables which are significantly related to this management practice (p-value <0.05) are age, education level, marital status and occupation.

E-waste, though is not wanted by the present owner, may have some values for other people. Exchanging e-waste with brand new items (with minimal payments) or 'trade-in' as it is commonly known in Malaysia, is one of the most preferred e-waste managements dan disposal method. Analysis of question P4 has shown that 76.2% of respondents in Kuala Lumpur chose to trade-in their e-waste. According to Tiep et al. (2015) trade-in of e-waste is able to increase the lifespan of the electrical and electronic equipment and helps in reducing the generation of e-waste, as well as delayed the movement of e-waste to the disposal site. Furthermore, these electrical and electronic appliances have a monetary worth that is comprised of tradable features which can benefit the public as a key consumer (Borthakur & Govind, 2017). In Malaysia, trade-in is one of the disposal options that is being offered to the public. For example, Sen Heng Malaysia and Maxis has a trade-in programme where public may swap in their old appliances for new ones. Demographic variables which are significantly related to this practice are gender, marital status and occupation of respondents.

Question P5 asked whether respondents sell off their e-waste as an option to discard them. Analysis has shown that about 74.1% of the respondents chose to sell off their e-waste. This option

also brought monetary benefit for the public. Owusu et al. (2017) reported that selling off e-waste is a popular option in Ghana, compared to other methods of disposal. Similarly, majority of respondents in Jordan (40.08%) chose to sell their e-waste as reported by Tarawneh & Saidan (2013). However, studies in Pune City, Melaka and Nigeria had a different finding; selling of e-waste is not a popular option among the respondents, reported at 24%, 12.1% and 17.5% respectively (Bhat & Patil, 2014; Tiep et al., 2015; Miner et al., 2020). Similarly, a study conducted in Kota Kinabalu has shown that selling off e-waste is less practiced by the respondents (George et al., 2019). The results indicate that significant differences exist in the preference to sell off the unwanted appliances across the respondents from different study areas. The demographic variables which are significantly related to this management practice are gender, education level and occupation.

For the following question (P6), on whether respondents practice repairing their faulty electronic and electrical items to extend the lifespan of their appliances; 73.8% from the total respondents agreed that they chose to do so. Similarly, respondents in Ghana agreed that by repairing their equipment, they were able to save money compared to purchasing new electrical and electronic equipment (Owusu et al., 2017). In contrast, respondents in Kota Kinabalu chose to buy the new equipment compared to repair their existing equipment due to the expensive cost of repairing (George et al., 2019). Repairing electrical and electronic appliances that are considered old or damaged, as recommended by Jayaraman et al. (2019), is a viable e-waste management approach compared to discarding e-waste as trash. The damaged part can be replaced with a working one, and this procedure will extend the appliance's lifespan and usage, making it a temporary option for reducing e-waste generation. The only demographic variable which is significantly related to this management practice is the occupation of respondents.

This study also examines whether giving out e-waste to charity is a likely option for public in Kuala Lumpur (P7). Analysis of data has shown that 65.9% of respondents practice giving out e-waste to charity as option to manage their e-waste. Charity was the least chosen method and unpopular option in disposing the e-waste in previous studies. For example, previous study in Kuala Lumpur conducted by Afroz et al. (2013) has found that only 34.5% respondents chose charity as the disposal method. Whilst previous study conducted in Macau has reported that 11.25% of respondents did so (Song et al., 2012). Similar studies in Jordan and Pune reported a lower percentage of respondents giving out e-waste to charity with 9.8% recorded in Jordan (Tarawneh & Saidan, 2013), and only 6% recorded in Pune (Bhat & Patil, 2014). The lowest percentage is reported in Melaka (Tiep et al., 2015) where only 5% of respondents chose to donate their e-waste. The only demographic variable which is significantly related to this option is education level.

It is an environmentally sustainable option if e-waste is disposed through a proper channel such as formal recycling facilities (P8) and can be otherwise if e-waste is discarded by sending it to informal scrap dealer (P9). There are many listed and legally registered e-waste recycling facilities provided by various responsible bodies in Malaysia such as Government departments and agencies, private companies and NGOs. According to Echegaray & Hansstein (2017), recycling activity benefit the economics and social elements, as recycling work as aid to expand the green technologies and also helps in creating jobs via recycling industry. Afroz et al. (2013) and Akhtar et al. (2014) concluded that about 2% of respondents in Kuala Lumpur choose to send out their e-waste to the formal recycling centre. Similarly, respondents in Melaka and Kota Kinabalu also did not practice this method of disposal widely (Tiep et al., 2015; George et al., 2019). In contrast, in Ghana, sending e-waste to the scrap collector is a popular method of disposal among the public as

they will receive money from the scrap collectors, and the scrap collectors provide house-to-house e-waste collection which proved to be very convenient to the respondents (Owusu et al., 2017). Demographic variables which are significantly related to disposing e-waste to legally registered e-waste recycler are age, education level, marital status and occupation; whilst demographic variables which are significantly related to the practice of discarding-waste to informal scrap dealers are gender and occupation of respondents.

Public as consumer and waste generator work as the key to reduce its generation by redirecting the route for e-waste to the safest flow (Miner et al., 2020). As such, respondents in this study were also asked about whether they encouraged their family members to practice proper e-waste disposal and management methods. The finding shows that most respondents in Kuala Lumpur (78.9%) encouraged their family to dispose the e-waste in the correct manner. When public acknowledge that e-waste can impact the environment and human health, this situation will encourage an individual to manage and dispose e-waste properly in a sustainable manner (Jayaraman et al., 2019). Practices by an individual will help to encourage others to work towards achieving certain goals or values. In the same vein, actions of the family members are able to influence more effectively on recycling activities compared to neighbours (Echegaray & Hansstein, 2017; Xiao et al., 2017). Two demographic variables, educational background and occupation reported p-value of less than 0.05 (<0.001 and 0.018 respectively).

Conclusion

In conclusion, occupation is the most significant demographic variables related to e-waste management practices (has shown p-value of less than 0.05 for all options except for question P7 - on giving or donating their e-waste to others). Respondents working in private sector is reported to have the highest percentage of respondents among the occupation variable. Despite the fact that public awareness of sustainable e-waste management practices is still in its infancy, there is a group of respondents who have good practices. Based on the findings, the public and other stakeholders should shoulder equal responsibility in ensuring that e-waste in Malaysia is appropriately managed. As such, cooperation from the public is necessary and acts as the key success factor. To ensure that the public is conducting sustainable practices on e-waste management and disposal, related information regarding the impact of the hazardous materials on e-waste need to be conveyed effectively. For example, related campaigns or educational program on e-waste management can be conducted by responsible bodies to provide information to the public. Besides that, providing proper facilities and sufficient incentives to the public that participate in sustainable e-waste disposal should be widely encouraged. Law and enforcement will control that proper household e-waste disposal is in order. A proper and sustainable e-waste management will reduce the generation of e-waste and thus, reducing the impact of e-waste on the environment and human health. More importantly, proper e-waste recycling will enable precious materials be recovered from the unwanted appliances as well to create economy advantages through circular economy.

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