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Disposal of E-Waste: Government Agencies' Perspective

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Abstract. The widespread consumption of electronic products over the years has resulted in the rapid generation of a growing range of e-waste, or electronic waste. The inappropriate treatment of e-waste can cause serious unfavourable impacts on human and environmental sustainability due to the hazardous substances within the e-waste. The focus of this study is on a somewhat under-emphasised group of electronic goods users that contribute significantly to e-waste: government agencies. Even though they create a high rate of e-waste, the disposal methods of e-waste that they deploy are not well understood. Hence, this study is to provide such an understanding. This study draws quantitative data from 112 agencies in Terengganu, Malaysia, obtained by means of a questionnaire-based survey. The findings revealed that most agencies either store their end-of-life electronic items at their office or discard their e-waste together with other general office wastes. This study suggests that more extensive similar descriptive research remains to be performed, covering government agencies in all states of Malaysia to draw a more significant conclusion about the adopted approaches in managing their e-waste.

INTRODUCTION

Electronic waste (e-waste) is disused electrical and electronic equipment (EEE) which have reached the end of its useful life and does not any longer serve its intended design purpose [1]. This includes computers, communication, audio-visual, radio and television, household electrical appliances, instruments, measuring and monitoring, and electric tools and devices. In addition to that, materials and components that are part of these devices such as power cables and wires, consumables, sub-assemblies and discarded parts from the production line are also included in the definition [2].

E-waste is recognised as the largest and fastest-growing waste stream in almost all parts of the world [3], [4]. The tremendous increase of e-waste due to the growing consumption, rapid obsolescence and exponential advancement of information and communication technologies (ICT) has caused global concerns about the environmental and health harmful impacts of e-waste. E-waste consists of a combination of both non-hazardous and hazardous substances [4]. On the toxic and hazardous materials, e-waste is known to contain such as polyvinyl chloride (PVC plastics), nonylphenol, polybrominated diphenyl ethers, polychlorinated biphenyls copper, triphenyl phosphate, chromium VI, barium, beryllium, phosphor, and heavy metals like lead, mercury, nickel and chromium [5], [6]. Thus, e-waste has the possibility of causing human health problems which include cancer, oxidative stress, respiratory issues and DNA damage [7]. As argued by Torres [4], even though EEEs could be recycled, the separation of certain compositions is not possible. In view of all that has been mentioned so far seems to suggest that more attention needs to be given to well-managed e-waste to minimise the environmental and human health burden.

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In view of e-waste generated by Malaysians, Yeoh [8] revealed that in 2019, 364 kilotons (kt) (average of 11.1kg per capita) were produced. Malaysia's pile of e-waste is expected to increase in the coming decades, in line with the growing dependence on EEEs. Apart from household consumers, government agencies are also the ultimate users of EEEs. The high pile of e-waste which has not been disposed of properly has ended up in the office storage space, streets and landfills [7]. Besides taking the storage space, the deposited hazardous e-waste also leads to various negative impacts on human health and the environment due to the discharge of toxic substances into the soil, water and air. The proper management of e-waste is an alarming issue for government agencies [6]. Heeks et al. [9] described that government agencies are group of EEEs' users who currently receives little attention, but contribute significantly to developing country's e-waste. The ways they dispose of their e-waste are not well explored, thus deserve specific attention. The main question of this study then concerns about what methods do Malaysian government agencies use to treat or dispose their end-of-life EEE items.

By performing a questionnaire-based survey, this study offers a small contribution to the literature on e-waste management. First, this study attempts to seek for accurate information on the current e-waste management which practiced by Malaysian government agencies, so that more practical solutions could be established to overcoming the issues in adopting the sustainable e-waste management. Second, it intends to educate the extreme users of EEEs about the risks of improper disposal of e-waste, and the appropriate ways of handling the e-waste to minimize the risks. The first part of this paper presents the definitions and the global e-waste management methods, followed by an explanation on the method of study. The next part discusses the study findings, and the conclusions and future research are provided in the final part.

LITERATURE REVIEW

What is E-Waste

In Malaysia context, household and industrial EEEs are the main contributors to the e-waste stream. Environmental Quality (Scheduled Wastes) Regulations 2005 has classified the EEE hazardous waste as a scheduled waste, SW110, which referred as the metal and metal-bearing waste category (SW1) with the scheduled waste code of 10 [10]. The SW110 was defined as "waste from electrical and electronic assemblies (SW110), which includes acid batteries, mercury switches, CRT glass, activated glass and equipment containing PCB capacitors or materials containing cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or PCB [11]. The management of e-waste is administered by the Department of Environment (DOE), according to the Environmental Quality Act 1974 [12]. In a similar vein to [13], this paper refers e-waste as "any appliance using an electric power supply that has reached its end-of-life". The definition does not fulfill the definition of used electrical and electronic equipment (UEEE), hence excluded from the discussions in this paper.

Disposal Method of E-Waste

Recent studies related to the e-waste disposal methods have shown that a variety of arrangements made to tackle the end-of-life electronic products. In contrary to consumers in Thailand, Brazil and Mexico who chose to donate their poor condition EEEs to other users, the obsolete EEEs in India are either sold as second-hand items to other users or handed to the door-to-door scrap collectors for reasonable financial return [14]. In the same country, unlicensed sector recycled 95% of the e-waste [14]. Garlapati [15] reported that approximately 75% of e-waste were stored in users' home, warehouses and offices stores. Hence, to manage the accumulated EEEs junks, he recommended that the extended producer responsibility (EPR), in which the manufacturers are responsible to manage the post-consumer stage products, is replaced with producer responsibility organisation (PRO), whereby the spent products are managed by the third parties assigned by the manufacturers.

Meantime, due to the inexistence of appropriate system to collect and recover the e-waste, the dismantled valuable components are recycled in improper way, whereas the unwanted parts are dumped in landfills in China [16]. Through the informal system, the e-waste unlicensed collectors move from door-to-door to buy the obsolete EEEs from users to resell them to either the refurbishing or recycling centre for further treatment [17].

In Malaysia, the most frequently used method to dispose the end-of-life electrical appliances was selling them as used devices, followed by swapping them with new appliances and sending them to the recycling centre [12]. The e-waste treatment and disposal activities are performed by the licensed premises in an environmentally sound manner (ESM), such as set by the DOE [18]. Thus, there are currently a few licensed e-waste recovery facilities assigned for

handling the e-waste produced by business organisations. Apart from recollected by the EEEs' manufacturers, the industries could opt for repairing the obsolete devices and selling them to the scrap collectors or recyclers [19]. Even though the awareness about the proper e-waste disposal methods is good, but the dispose of e-waste together with other general waste in landfill sites is still high because the e-waste collection facilities in certain area were incomplete [12]. This demonstrates that more measures and improvements need to be formulated to ensure e-waste is managed in environmentally sound approach.

METHODOLOGY

Survey Design

Questionnaire-based survey was carried out to collect quantitative data of methods used to manage e-waste amongst government agencies. The survey instrument consists of two sections:

1. Section A: Demographic Information
   The purpose of this section is to gather the demographic profile of the respondents such as sector, number of employees, year of company existence and types of electronic product disposed by organisation.
2. Section B: E-Waste Disposal Method
   This section contains a list of e-waste disposal methods and respondents were asked to tick which method (s) representing their practice in disposing the end-of-life EEEs.

Population and Sampling

Data were collected from all government agencies in Terengganu, Malaysia. Based on Terengganu i- Directory [20], the total number of government agencies in Terengganu was 150 which composed of all state government agencies, federal government agencies, and local authorities. The agencies come from education and social, finance, health, religious affairs, security, services, and another sectors. Even though the minimum sample size of 108 was determined according to the table of Krejcie and Morgan [21], but the questionnaire was distributed to all 150 government agencies in Terengganu.

Administering the Survey

The agencies were first called to get information of the person-in-charge of the EEEs and having knowledge about how the e-waste is disposed in the organisations. The questionnaire was then emailed to the targeted respondents for their responses. Out of the 150 distributed questionnaire, 112 questionnaires were completed and returned, thus making the response rate of 75% for the survey.

RESULTS AND DISCUSSION

Respondents' Profile

As depicted in TABLE 1, majority agencies (23%) came from the services sector and up to 22 % were from the education and social sector. Among the acquired responses, 43% have 100 to 499 employees, 29% have less than 100 employees and only 5% of the agencies have over 1000 employees. Almost all (91%) surveyed public institutions have operated for more than 10 years. Most respondents (52%) who answered the questionnaire were officers, hence well versed with information regarding the e-waste disposal method in the agencies. Roughly, 57% of them have been working in the organisation for more than 5 years, which indicated that the respondents were familiar with not only the organisation's working environment but also with their respective division in the organisation. In terms of the types of EEEs disposed by the public agencies, items such as printer, pantry equipment, monitor and photocopier contributed about 23%. Whereas cell phones and computer accessories such as cables, cartridges, mouse, and keyboard were 22% and 14% respectively. Furthermore, devices such as a laptop and computer contributed approximately 19% to the disposed e-waste of the agencies.

TABLE 1. Respondents' Profile

Demographic Information	Frequency	Percentage
Sector		
Education & social	25	22%
Finance	3	3%
Health	15	13%
Religious affairs	18	16%
Security	18	16%
Services	26	23%
Other	7	6%
No. of Employees		
Less than 100	32	29%
100 to 499	48	43%
500 to 999	26	23%
Over 1,000	6	5%
Year of Company Existence		
Less than 5 years	1	1%
6 to 10 years	9	8%
11 to 15 years	18	16%
16 to 20 years	27	24%
More than 20 years	57	51%
Position		
Administrator	13	12%
Officer	48	43%
Procurement Officer	3	3%
Senior ICT Officer	7	6%
Staff	41	37%
Year of Working		
Less than 1 year	3	3%
2 to 5 years	14	13%
6 to 10 years	31	28%
16 to 20 years	17	15%
More than 20 years	16	14%
Types of Electronic Product Disposed		
Cell phone	108	22%
Laptop	54	11%
Computer	40	8%
Photostat machine	25	5%
Printer	36	7%
Monitor	22	5%
Fax machine	18	4%
Radio	20	4%
Pantry equipment	27	6%
Scanner	32	7%
Fixed–line telephone	21	4%
Computer accessories	66	14%
Modem	15	3%
Medical equipment	4	1%

E-Waste Disposal Method

TABLE 2 illustrates the method used by the government agencies in Terengganu in disposing of their obsolete electronic devices. Overall, it was observed that 21% of the agencies kept the broken EEEs and stored them in the office storage space. This indicates that most agencies do not have a systematic procedure of managing their obsolete EEEs, hence calling for the formulation and implementation of environmentally sound e-waste management procedures. Besides that, 17% of the institutions discarded their e-waste together with other general office waste. This shows that they have poor knowledge of the classification of e-waste as scheduled waste by DOE, which should be treated properly and differently than the other office waste. A similar number of organisations (16%) have been revealed to give out their e-waste to the scrap dealers for free or collected by a qualified manufacturer with financial incentives in return. The data also revealed that 12.5% of government agencies provided their e-waste to be picked up by a recycling centre which would pay for the collected equipment. A similar 12.5% of agencies, which were having skilled technicians and tools to repair the unfunctional EEEs, preferred to repair them to prolong the useful life of the equipment. Besides the advantage of not having to spend money on acquiring new devices, they also managed to delay the e-waste disposal costs. Lastly, only 4% and 1% respectively, of the public agencies which sold their end-of-life EEEs as second-hand items to other users and discarded their e-waste with other solid waste which finally ended up openly burnt in landfill sites.

TABLE 2. E-Waste Disposal Method

Method	Frequency	Percentage
Donation	32	16.0%
Sell to individuals	8	4.0%
Burning	3	1.0%
Store at office	43	21.0%
Sent to recycles	26	12.5%
Repair	26	12.5%
Manufacturer take back	32	16.0%
Discard with general office waste	34	17.0%

CONCLUSION

E-waste is known to have harmful impacts on human health and the environment. The need for adopting sustainable approach of e-waste management is the growing concerns due to its rapid generation around the globe. This study employed survey instruments to collect data on the methods used by government agencies in Terengganu to dispose of their end-of-life electronic appliances. The results showed that most responded agencies hold their e-waste in their office store. Most of them also prefer to donate their no longer in use EEEs or sell the used devices to licensed manufacturers. These findings suggested that systematic e-waste management procedures should be implemented, and more extensive awareness campaign needs to be carried out to the government agencies in Terengganu, to stimulate their intention to divert their existing e-waste disposal practice to the sustainable e-waste management approach. Lastly, two investigations remain to be conducted in other studies: first, more comprehensive of similar descriptive research, covering the government agencies in all states of Malaysia to draw a more significant conclusion of the adopted approaches in managing their e-waste; and second, an examination of the factors influencing the government agencies' intention to participate in sustainable e-waste disposal method.

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