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The Current Status of E-waste Management Practices in DKI Jakarta

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Abstract

Electrical and electronic equipment (EEE) continues to grow exponentially in the recent decades. The sale of electrical devices and electronic (EEE) has increased globally over the last decade. Consequently, the lifespan of these products becomes shorter. Initial investigation of the rate of generation and type of electrical and electronic products in the community of DKI Jakarta is the main objective of this research. Furthermore, the questionnaire was adopted and modified from UNEP were used in this study as a tool to collect data and information. Additionally, the questionnaires were distributed randomly in approximately 400 respondents in five areas in Jakarta. The results inform that generally population in Jakarta have electronic devices such as fans, phones, televisions, refrigerators, irons and air conditioning. The research also indicated that the total generation of ewaste around 6208.141 kg / year, which everyone will generate e-waste approximately 5,173 kg / year. Furthermore, this study also estimates that generate e-waste in DKI Jakarta in 2025 was approximately 124,568,613.3 kg. In addition, the majority of respondents does not dispose of used electronic equipment, however, given or sold to second-hand shops. Thus, e-waste is very hard to find in landfills. Recommendations from this study needed for increased collaboration among stakeholders facilitated by the government in relation to the management of e-waste

Keywords: Electrical equipment, Electronic equipment, E-waste, DKI Jakarta, Management,

INTRODUCTION

DKI Jakarta is the central administration of Indonesia. As the capital city of Indonesia, DKI Jakarta with an area of 661.52 km², and there are around 10 million people make this city as one of Southeast Asia's biggest metropolitan. Furthermore, DKI Jakarta has economic growth rates significantly. This is because around 70% of the money circulation the state occurred in Jakarta. In addition, several sectors also support the economy of Jakarta such as trades, services, property, commercial and creative industries. Moreover, DKI Jakarta is also the largest consumer electronic products in Indonesia. Industrial electronics products become the main driver of economic change in recent periods. Further, the electrical and electronic equipment products also giving effect to human life significantly. Technology has two different sides, on the one hand, to provide comfort and convenience for human life. However, on the other hand, the technology also has the potential to become a serious problem for human life and the environment. Progression in the use and dispose of electrical and electronic equipment is ready to increase and will significantly affect the rate of generation of electronic waste.

The definition of electronic waste is an illustration of several type's electronics and electrical products, which have passed through its lifespan, such as computer, laptop, mobile phone, televisions and refrigerators [1]. The e-waste has valuable material content and harmful substances. Therefore, specific techniques are needed in the recycling process in order to handling and management of electronic waste. For example, lead, mercury, arsenic, chromium, cadmium, and plastic capable of releasing, among other compounds, dioxins and furans [2]. Furthermore, studies conducted by Leung et al., [3] found that persistent organic pollutants (POPs) and heavy metals can easily be found in the electronic waste recycling center.

There are several main aspects that the reason for the cause of the high volume of e-waste, such as increased market infiltration, market substitution and a high level of obsolete. Furthermore, numerous other factors that also give to the increase of electronic waste such as affordability, the new discovery technology of electronics products and convenience in the purchase of the new electronic products compared to repair [4]. Moreover, the occurrence of a global apprehension due to the problem of e-waste handling activities of the fastest growing in the world [5]. Some sources showed as a producer of electronic waste such as government offices, public and private sector, academia and research institutes. Additionally, the contribution of inhabitants to increase the volume of e-waste is also significant. Furthermore, the volume of electronic waste has also increased substantially even though the import of electronic waste is an illegal activity. The landfill is the location of the end of most consumer electronics devices. In addition, electronic waste disposed of to landfill, mostly without through proper recycling. However, in some developing countries do not dispose of electronic waste to the landfill due to waste electronics is considered still has value.

Recycling electronic waste is a profitable business if managed properly and professionally. There are some valuable materials in electronics waste content, for example metal, plastic and glass. The electronic product may combine of approximately 60% metals, 15% plastic, PCB approximately 2%, approximately 2% cables, screens

about 12%, and others around 6% [6]. Furthermore, UNEP and UNU [7] noted that various metal materials used for the manufacture of electrical and electronic tools, such as gold, silver, palladium, copper, tin, cobalt, selenium, antimony, and platinum. Established processes available for the processing of electronic waste in order to extract the precious metals with high yield has been applied in developed countries [8]; [9]. There are significant differences in the electronic waste recycling in developing countries and developed countries. Where, the recycling process is done automatically and using minimal labor. On the other hand, electronic waste recycling activities conducted in a way that is immature and still traditional in developing countries.

Generally, discarded electronic equipment is considered to have exceeded its lifespan. There are approximately 20-25 million tons of electronic waste per year global production [10]. In addition, UNEP [11] also reported that it has been estimated that around 20-50 tons per year of waste produced electronics worldwide. Maculey et al., [12] describes that people can have more than one electronic equipment of the similar variety as an increased capability to buy and the price is affordable. The e-waste is not a relatively new form of waste that has to be addressed when compared to household domestic waste in the developed countries. In contrast, for developing countries, electronic waste is important to consider because of the potential impacts that may arise. This research aims to examine the potential of waste electronic devices or products that may be targeted for Waste Electronic and Electrical Equipment (WEEE) recycling and management in DKI Jakarta. This paper is used for education, government and NGO in DKI Jakarta to measure inventory obsolete electronic devices. Global estimates indicate that WEEE is mainly composed of household electronic equipment such as televisions, personal computers (PCs), refrigerators, cell phone and dispensers [6]; [13]; [[14]. The method of the UNEP is used to measure the generation of e-waste in DKI Jakarta.

LITERATURE REVIEW

Entirely devices that use electricity and has discarded because obsolete and no longer used can be defined as waste electrical and electronic equipment. E-waste is a generic term embracing several forms of electronic equipment. WEEE may be clustered into ten different categories based on the definition of the directive of the European Parliament and the Council on WEEE [15], following:

- Large household appliances (refrigerators/freezers, washing machines, dishwasher)
- Small household appliances (toaster, coffee makers, iron, hair dryers)
- Information technology and communication equipment (personal computers, telephones, mobile phones, laptop, scanners, photocopiers)
- Consumer equipment (televisions, stereo, electric toothbrushes, radio)
- Lighting equipment (fluorescent lamp)
- Electrical and electronic tools (handheld drills, saws, screwdrivers)
- Toys (play station, game boy)

- Medical equipment system (with the exception of all implanted and infected products)
- Monitoring and control instruments)
- Automatic dispenser.

The increased market penetration in developing countries potentially impact to e-waste stream into one of the fastest growing waste [16]; [17]. For example, the average lifespan of a computer is becoming shorter, which in 1997 about six years to less than two years in 2005 [11]. Therefore, there is around 75% of the shipping trade of computers from developed countries to developing countries cannot be used. Additionally, the cellular phone users in China was increasing roughly 200 million from 1996 to 2002 [18]. Moreover, the world produces e-waste approximately 20-50 tons every year [19].

E-waste is one of the characteristics of the waste comes from households, commercial and industrial. In addition, e-waste is also one type of hazardous and toxic waste. This is because e-waste contains a variety of components that are formed from heavy metal material [20]. Thus, this waste involves specific methods on handling and recycle process due to potentially harmful to human health and the environment [21]. The process of recycling may recover and reuse some precious metals and base materials from e-waste. In contrast, various factors are the intention not to recycle e-waste. For example, insufficient of facilities, the high skill of labor, environmental regulations. Cobbing point outs the developed countries sent e-waste to many third countries, where the recycling process on developing countries performed in very simple method and less consideration to the safety of workers and the environment [22]. Therefore, municipals appeared oblivious has to build its own toxic footprints [23].

Various techniques still using in e-waste recycling processes such as mechanical shredding, open burning of plastic and acid leaching of printed circuit board. As the result, these have potentially contributed to the release of hazardous chemicals, including polycyclic aromatic hydrocarbons (PAHs), polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and heavy metals (e.g. Cr, Cd, Cu and Pb) [24]. A research in China by Deng et al., [25] point out that the current level of PAHs in the Guiyu air was higher than in Guangzhou, one of the most polluted cities in China. This possibly reflects the higher emission of PAHs from E-waste management, especially due to open burning of plastics and smelting. Moreover, the contrary impacts from E-waste recycling not only influence the environment and the people working or living in Guiyu, but may also impact the surrounding environment located downstream or downwind of Guiyu [26]. The obsolescent transformers and other electronic or electrical waste can be a significant source of the emission of persistent organic pollutants into the local environment, such as through leakage, evaporation, runoff, and leaching [2]. A severe risk of human and environmental contamination resulting from recycled sources around the demolition site. Additionally, e-waste recycling sites pose the main hazard to waterways such as pollution to nearby

streams and rivers. The heavy metals and inorganic acids may percolate into the waterways through wastewater or ambient air emissions and have the risk of contaminating natural resources such as soil, crops, drinking water, fish and livestock [27].

The process of recycling e-waste causes approximately 80% of children in Guiyu, China impaired respiratory disease [28]. Furthermore, the highest level of Polybrominated Diphenyl Ethers (PBDE) present in employees and the environment at an e-waste recycling location in China. Moreover, PBDE is a chemical commonly originated in electronic plastics as a flame retardant and is found in E-waste recycling sites in the form of dust. Additionally, a study showed there is a significant relationship between environmental pollution and e-waste recycling process [30]. Study on air pollution has shown that recycling process on the e-waste sites, such as dismantling and burning, produce hazardous emissions that potentially damaging health effects [27]. Employees at these sites are also exposed to dust via breathing, ingestion and dermal contact, which may encompass dangerous levels of heavy metals [31]. The overview of the known health impacts of polychlorinated biphenyls (PCBs) in youngsters living near an e-waste recycling and potential risk of postnatal exposure via breastfeeding [32].

METHODOLOGY

The study was designed to attain a data related to household e-waste generation. The research will be interviewed inhabitants directly to obtain material related to electrical and electronic equipment purchase and discarding preferences. The survey mechanism was implemented from the United Nations Environment Programme E-waste assessment methodologies [33]. Moreover, the questionnaire was used in order to achieve information about the pattern of e-waste disposal from residents. The questions on the questionnaire made to determine several factors such as, the type and number of electronic products, period to use and store electrical and electronic equipment. The research was performed in DKI Jakarta. The household was selected randomly in each region of DKI Jakarta. Furthermore, in order to define the number of households, the study was used methodology from WHO. In addition, to estimate a population proportion with specific absolute precision will require a confidence level of 95%, an anticipated population proportion of 5% [34]. Thus, the table of approximating resident percentage with definite absolute accuracy involves the sample size approximately 80 on each area. Therefore, the total number of residents for this research approximately 400 households. Once knowing of categories and quantities of electrical and electronic equipment owned by residents in DKI Jakarta, then appraisal the possible of e-waste generation in any form of products. Moreover, e-waste generation calculation was performed in order to estimate the potential rate of e-waste generation in DKI Jakarta. The research is also investigated and calculated the characteristic and category of electronic products possessed by inhabitants. The data is a necessity to determine the rate of e-waste generation such as, the amount of the equipment, the weight of product and lifetime.

RESULT AND DISCUSSION

The research performed in five areas at DKI Jakarta to achieve the data on possible the generation of e-waste from inhabitants. The survey was obtained several categories of electronic equipment such as large household equipment, small household equipment, lamp, telecommunication devices, consumer equipment, battery and other electronic equipment. The results of the survey on 400 respondents obtained electronic waste generation rate by type and displayed in table 1.

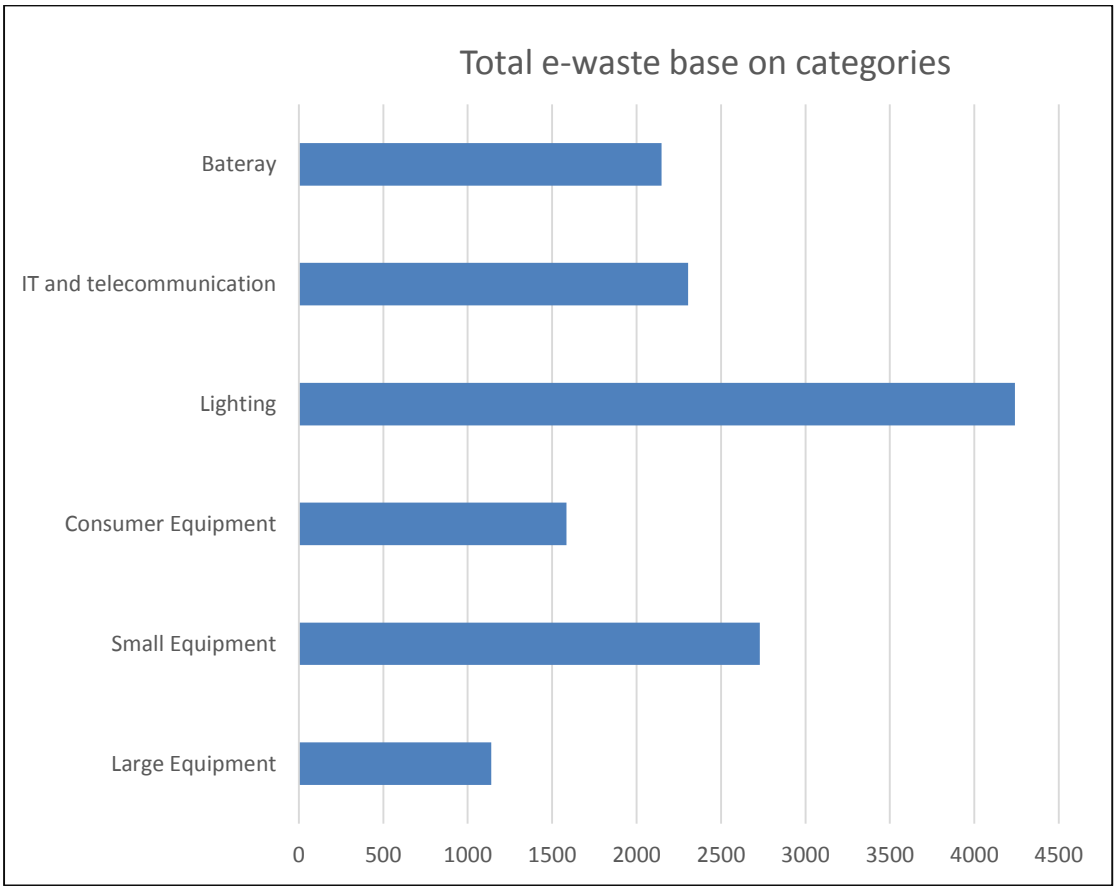

Figure 1: Total e-waste base on categories

The graph showed that the number of e-waste base on the types. Additionally, the picture also provides information that the quantity of lighting was a higher approximately 4241 units. However, the small amount of e-waste category was large equipment around 1139 units. The interest from the graph is the number of IT and telecommunication appliances around 2300 units. It will be able to demonstrate significantly to the total weight of e-waste.

Table 1. The proportion of electrical and electronic equipment owned by the inhabitants

No.	Appliances	Amount	%	No.	Appliances	Amount	%
1	Refrigerator	241	0.017	18	PRINTER	196	0.014
2	AC	572	0.041	19	TV CRT 14"	59	0.004
3	Wash Machine	326	0.023	20	TV CRT 21"	157	0.011
4	Iron	454	0.033	21	TV LCD 17"	54	0.004
5	Kettle	78	0.006	22	TV LCD 19"	34	0.002
6	Blender	379	0.027	23	TV LCD 21"	125	0.009
7	Microwave	125	0.009	24	TV LCD 29"	136	0.010
8	Fan	731	0.052	25	Camera	244	0.017
9	Vacuum Cleaner	126	0.009	26	Radio	205	0.015
10	Rice cooker	421	0.030	27	DVD	343	0.025
11	Dispencer	416	0.030	28	VCD	119	0.009
12	KOMP. DESK	134	0.010	29	MP3	109	0.008
13	CRT 14"	60	0.004	30	Bateray 1.5V	2039	0.146
14	CRT 17'	55	0.004	31	Bateray 9V	135	0.010
15	LAPTOP 10"	132	0.009				
16	LAPTOP 14"	288	0.021				
17	HANDPHONE	1441	0.103				
Total amount		**14148**					

Table 2. The calculation of e-waste generated by type of electronic equipment

No.	Appliances	Weight	Amount (B)	Lifespan	Potential Generation
		(A)		(C)	(A) x (B) / (C)
1	Refrigerator	31.82	241	11.8	649.883
2	AC	31.16	572	12.7	836.658
3	Wash Machine	27.25	326	10.1	879.554
4	Iron	0.5	454	10	22.700
5	Kettle	1.032	78	3	26.832
6	Blender	2.57	379	5	194.806
7	Microwave	15	125	13.2	142.045
8	Fan	9.6	731	8.3	845.494
9	Vacuum Cleaner	8	126	7	76.364
10	Rice cooker	4	421	8.3	202.892
11	Dispencer	2.43	416	10	101.088
12	KOMP. DESK	4.2	134	6.6	85.273
13	CRT 14"	7.9	60	6.6	71.818

14	CRT 17'	16	55	6.6	133.333
15	LAPTOP 10"	1.38	132	7.4	24.616
16	LAPTOP 14"	2.5	288	7.4	97.297
17	HANDPHONE	0.115	1441	4.3	38.538
18	PRINTER	4.8	196	7.1	132.507
19	TV CRT 14"	9.34	59	10	55.106
20	TV CRT 21"	20.47	157	10	321.379
21	TV LCD 17"	7	54	10	37.800
22	TV LCD 19"	7	34	10	23.800
23	TV LCD 21"	7	125	10	87.500
24	TV LCD 29"	16	136	10	217.600
25	Camera	0.17	244	10	4.148
26	Radio	4.5	205	9.5	97.105
27	DVD	1.8	343	7	88.200
28	VCD	1.8	119	7	30.600
29	MP3	0.2	109	5	4.360
30	Bateray 1.5V	0.01	2039	0.2	101.950
31	Bateray 9V	0.015	135	0.2	10.125
TOTAL					**6208.141**

The above table indicates the amount of e-waste generation by households in Jakarta. Moreover, there are various categories of equipment's are used as research, such as television, refrigerator, rice cooker, laptops, monitors and mobile phones. Additionally, the investigation shows that the washing machine is a type of products that generates the highest generation rate is roughly 1597.24 Kg.n/year. Moreover, Battery 1.5V is one type of electronic products most widely held by the respondent. In addition, the result indicates that the inhabitant has a television in a variety of types of. This product contributes waste generation approximately 743.185 Kg.n/year. Research conducted by Peralta and Fontanos [37] regarding e-waste generation in the Philippines in 2010, found that there are about 445.300 units of refrigerators, televisions around 943,000 and approximately 576.700 units of washing machines become obsolete. Furthermore, research conducted by Qingbin Song et al., (2012) in 2010 on the respondents a number of 100 households in Macau was discovered around 264 air conditioning units, 154 units of desktop computers and 56 units of laptops [38].

DKI Jakarta population statistics in 2015 used to calculate future population projections. It also used Geometric methods in order to estimate the inhabitants [39]. The survey was performed on 400 residents with an average family of four people, so there are 1200 people who will be the basis for estimating e-waste generation. The total e-waste generation is 6208.141. Thus, the e-waste generation for inhabitants in DKI Jakarta around 5.173 kg/year.

Additionally, based on data from BPS DKI Jakarta, reported that the population in 2014 is approximately 10,075,310. Thus, the estimated rate of generation of e-waste can be seen in the table below.

Table 3. The estimation of e-waste generation in DKI Jakarta

No	Year	Estimation of population	E-waste Generation	Estimation of E-Waste Generation
1	2014	10075310	**5.173**	52119578.63
2	2015	10905839.97		56415910.16
3	2016	11804832.35		61066397.75
4	2017	12777930.65		66100235.26
5	2018	13831243.59		71549023.07
6	2019	14971383.42		77446966.45
7	2020	16205507.5		83831090.28
8	2021	17541363.13		90741471.48
9	2022	18987336.29		98221490.61
10	2023	20552504.19		106318104.2
11	2024	22246692.32		115082139.4
12	2025	24080536.12		124568613.3

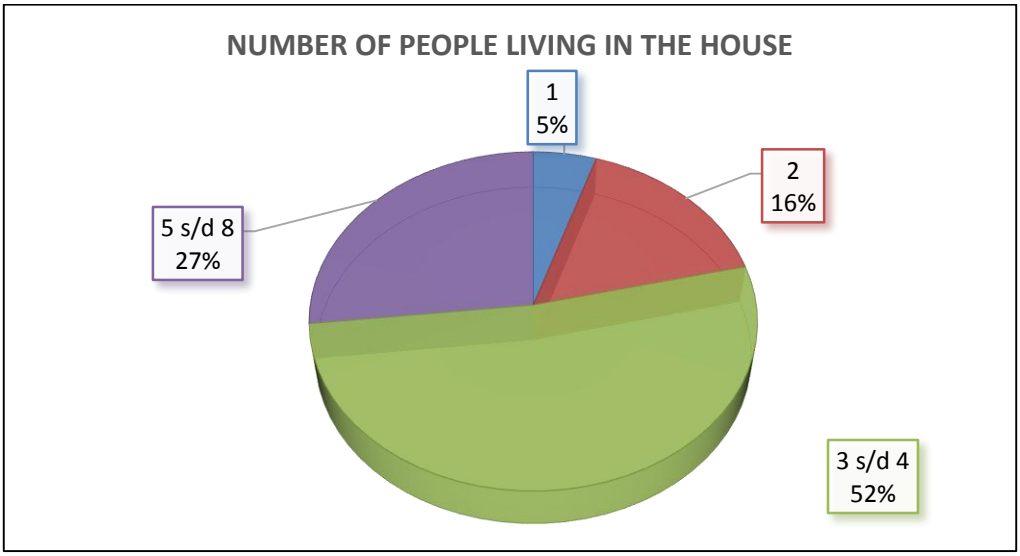

Figure 2: Number of people living in the house

Figure 2 above provides information related to the number of people who live in households in DKI Jakarta. Furthermore, the graph also indicates that around 52% of respondents declares that there were about 3-4 people in the household. In addition,

there are only approximately 5% of respondents stated that the number of people who live in households only one person. Furthermore, the above image also expressed that approximately 27% of respondents stated that there were about 5-8 people in their household.

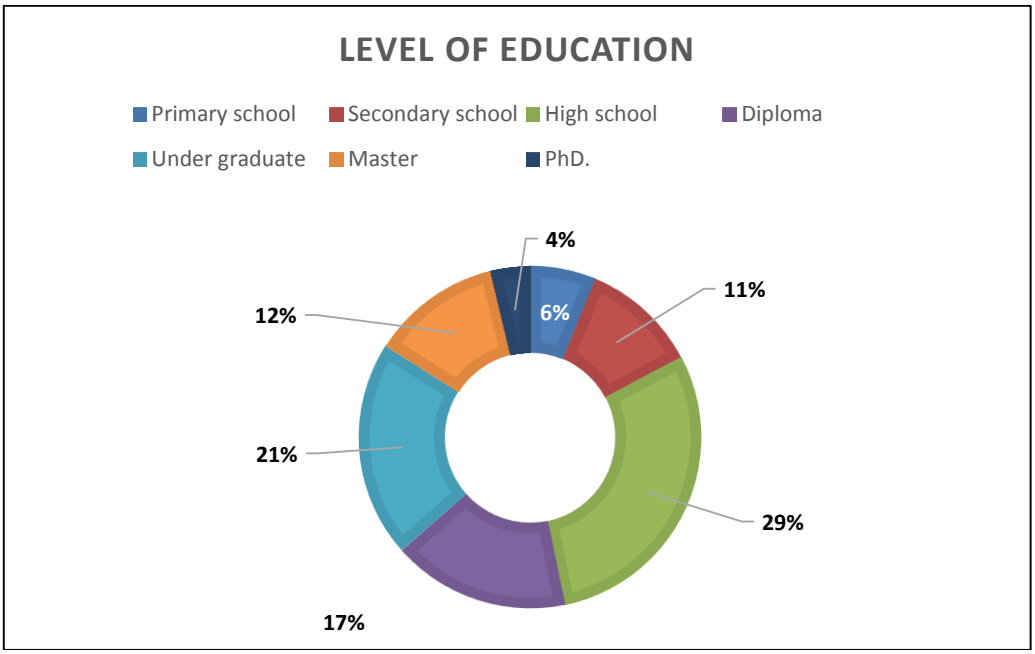

Figure 3: Level of Education

Figure 3 above provides information related the level of education of the respondents in DKI Jakarta, where about 29% of inhabitants expressed the level of education is high school. Meanwhile, there are only about 4% of respondents stated that their education level is primary school. Furthermore, citizens who stated Undergraduate education level is approximately 21%. While respondents expressed their level of education and a secondary school diploma is around 12% and 11% respectively.

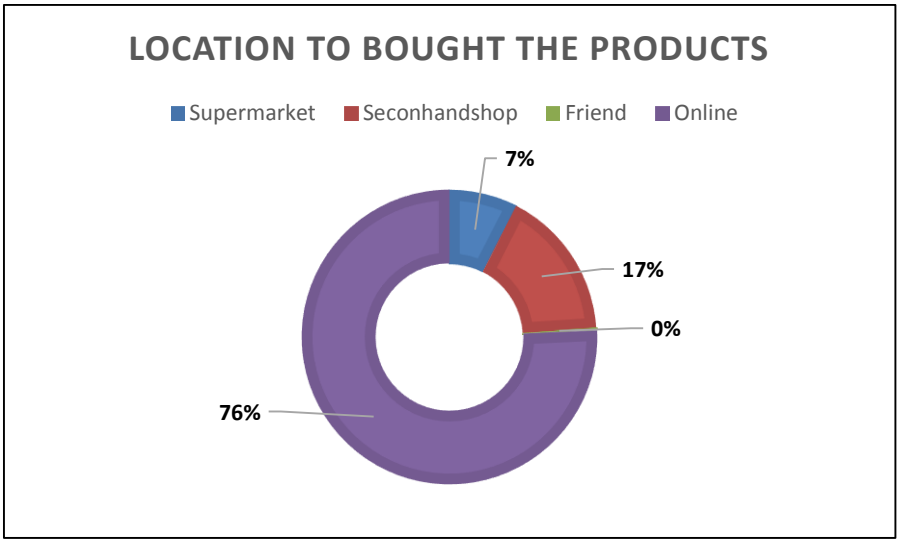

Figure 4: Location to bought the products

Figure 4 above provides an illustration relating to the location when it was first purchased. Additionally, the graph illustrates that the majority of respondents, approximately 7% bought the products from the supermarket. Interestingly, of the picture stated that approximately 76% of respondents who buy products through online. Furthermore, there are approximately 17% of respondents bought the equipment from the second-hand market. There are similarities with Malaysia in a way to achieve the electronic product is currently owned. A study conducted by the Ministry of the Environment of Japan in collaboration with the government of Malaysia [40] stated that around 93% - 97.2% of people who buy electronic equipment in stores or supermarkets. Furthermore, there were no detailed statistical data about the source location of purchase electronic products [41].

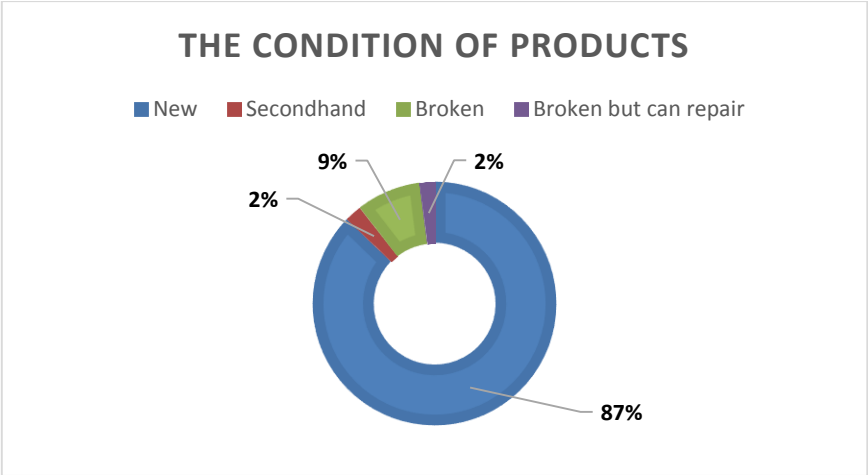

Figure 5: The condition of products

Figure 2 above shows information related the condition of electronic equipment when purchased. The diagram expressed that around 87% of the population obtain equipment that is new and has never been used before. In addition, approximately 2% of households bought the products in a condition that has been used. In addition, a small portion of respondents that bought the electronic devices in a damaged condition only around 9%. There is a detailed description of the reasons for purchase in the damaged circumstance. Generally, there is a similar condition to purchase electrical products and electronics in Malaysia and Cambodia [40]; [41].

Information on the lifetime of the electronic equipment based on the figure 3 below can be explained as follows. There are around 25% of people in DKI Jakarta who uses electronic equipment for five years. Furthermore, households that use the equipment for 1-2 years is approximately 49%. In addition, there are about 20 % of the respondents who use electronic devices for <1years. A study conducted by the Ministry of Environment in collaboration with MONRE Vietnam and EX Company [42] stated that the average lifespan of electronic devices in Vietnam is approximately 5-10 years. Moreover, Peralta and Fontanos [37] found that the lifetime of electronic equipment in the Philippines is around 8-10 years.

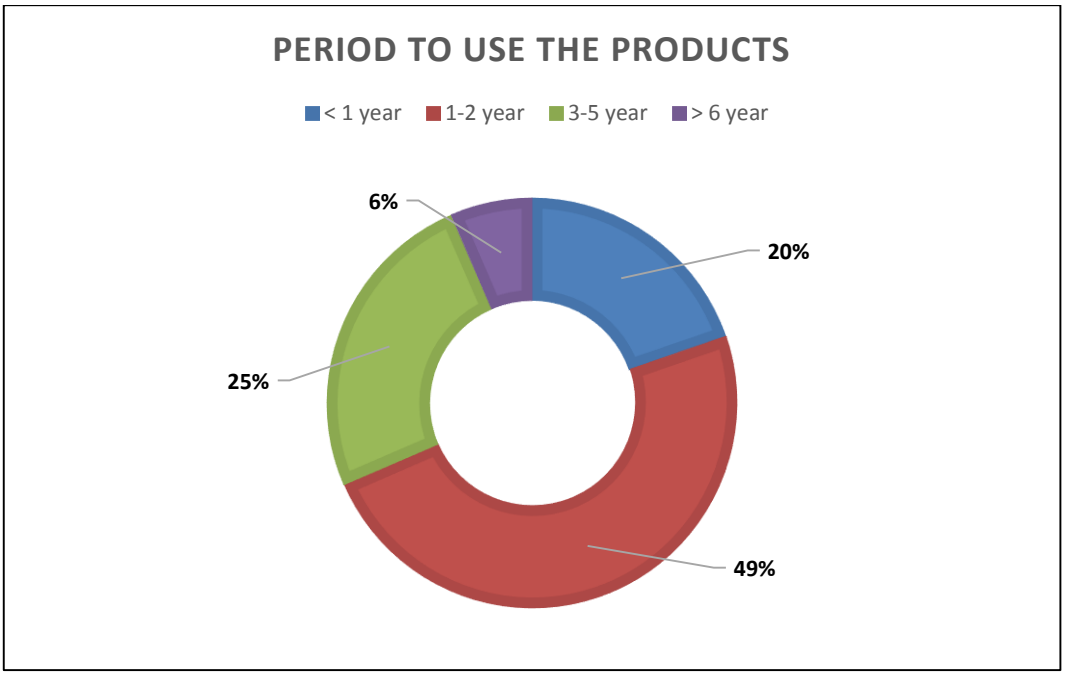

Figure 6: Period to use the equipments

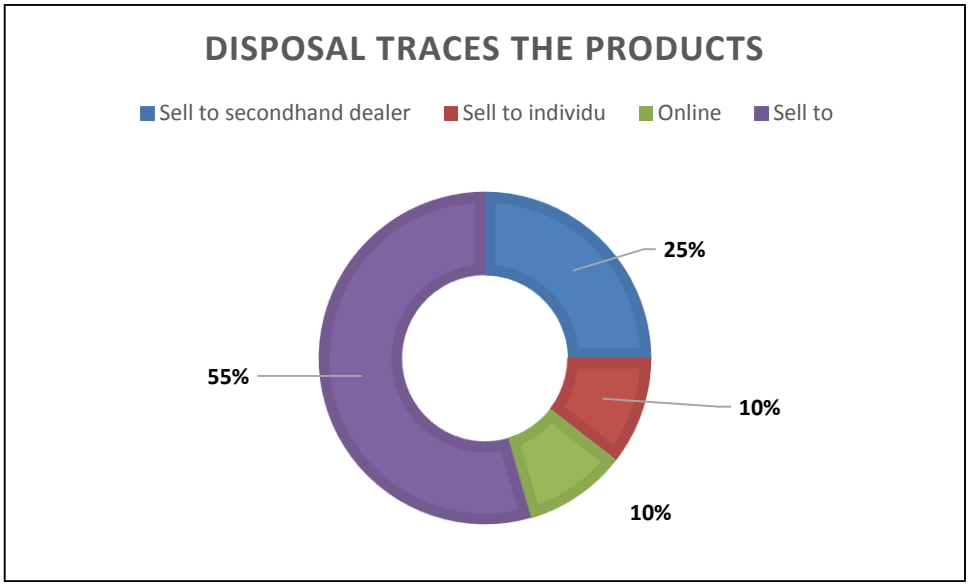

Figure 7. Disposal traces electrical and electronic equipments

There are several methods of residents in terms of disposal of electronic products when not in use anymore, such as sold back to the second-hand, and sell to someone. This study identifies information about the disposal of electronic equipment in DKI Jakarta. Figure 7 reveals that the majority of respondents approximately 55 % sell electric and electronic devices that are not used anymore to someone. Furthermore, roughly 25% of respondents stated that they sell unused electronics products to second-hand dealers. Meanwhile, respondents also gave a statement that electronics products are sold to individuals and online around 10% respectively.

In addition, the research on the issues of electronic waste in the Philippines also provides information that is similar to the condition in DKI Jakarta, where around 15% of e-waste brought into the landfill (Peralta and Fontanos, 2006) [37].

ENVIRONMENTAL LEGISLATIONS

Generally, there are the various legal framework and applied to the management of e-waste [43]. For example, one of the regulations governing e-waste is the Basel Convention. This Regulation supervises the trans-boundary movement of hazardous wastes and disposal of electronic waste. This procedure is one of the most comprehensive environmental arrangement on hazardous waste in the world. There are two primary objectives to be attained from the enactment of the Basel Convention, namely to defend human health and the environment from the adverse impact resulting from the generation, management, transboundary movements and disposal of hazardous and toxic wastes. In 2009, the Basel Convention has conducted a number of workshops related to e-waste in the Asia Pacific region. In addition, two important initiatives have been developed to the Basel Convention in order to reassure the private

sector contribution in the management of e-waste. Moreover, Japanese government to provide financial assistance to the secretariat of the Basel Convention to establish the Basel Convention Partnership on Environmentally Sound Management of e-waste in the Asia Pacific region in 2005. In 2003, Japan also proposes the development of the Asian Network for Prevention of Illegal Transboundary Movement of Hazardous waste to provide solutions that transboundary movements of e-waste.

The Indonesian government does not provide any specific regulations associated with the issues of electronic waste management. However, Indonesia has ratified the Basel Convention through Presidential Decree No. 61 Year 1993. Thus, to be able to regulate the management of e-waste is used hazardous waste regulations. The Law of the Republic of Indonesia Number 23 Year 1997 regarding Environmental Management stated that the management of hazardous waste generated from an activity is to become the responsibility of each stakeholder. Furthermore, in Article 7 of Government Regulation number 85 of 1999 governing the management of hazardous waste. This regulation provides a definition and classification of hazardous waste into three categories. For example, hazardous wastes from non-specific sources, specific sources and unused materials containing or contaminated with hazardous chemicals. Additionally, Agustina [46] noted that there are other legislations that govern the management of e-waste, such as, the Minister of Trade No. 63/M-DAG/PER/12/2009. The regulations governing the import of second-hand product reconditioning or reuse of used products. In addition, the Minister of Trade No. 39/M-DAG/PER/ 9/2009 managing the importation of Non Hazardous Wastes and Decree of the Minister of Industry and Trade No. 520/2003 concerning the prohibition of imports of hazardous waste.

Despite there are some rules that have been binding on all stakeholders related to the management of e-waste, there are loopholes that can be exploited by those who want to make a profit because the waste management is often governed by industrial consumers. This Law, however, does not state financial or legal penalty specified for meeting the requirements. Business segment which does not fulfil with compensation only has to withdraw or discontinue its product sales in the market. In addition, waste management in Indonesia was still having a problem because the policy at the national level and enforcement of environmental law was still low at the local level. For example, in 2005 the level of municipal waste management services around 41.3%. Consequently, in order to implement the Law of environmental protection laws and protect consumers, the Indonesian government established the Consumer Protection Agency which aims to protect consumers by conducting legal research and review, research on the quality of products, information dissemination and receipt of complaints about consumer protection and surveys on demand consumers.

CONCLUSION

The amount of e-waste will continue to increase in the estimates in the city of DKI Jakarta. It is influenced by the average life of products is one indicator of consumer behavior before recycling and final disposal. The majority of the population has

electrical and electronic equipment that varies in accordance with their needs. Households prefer new equipment compared to buying a second-hand product and use the product until it cannot be used anymore. The results showed that the estimated waste generated from electrical and electronic equipment will be greater in the future. Thus, it may affect the generation of e-waste and have a significant influence on the socioeconomic, environmental and human health. The e-waste management in DKI Jakarta is at an early stage, there is no doubt there are several challenges in the management of e-waste in DKI Jakarta. The decrease of the volume generated is one option that can be done in the management of e-waste. The technical standards and public-private partnerships and the government are absolutely necessary in order to handle hazardous materials contained in the e-waste stream. Reinforcement laws and regulatory sectors also strongly support the successful management of electronic waste. Public participation should be promoted within the framework of e-waste management related to the impact of e-waste on the environment and public health. In order to obtain a further situation regarding the management of electrical and e-waste in DKI Jakarta need to do further research on the entire scientific viewpoint. Thus, the management of e-waste could completely protect the environment and human health.

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