Assessment of knowledge, attitude, practice on households related to e-waste management: a case study in DKI Jakarta

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Abstract. All countries of the globe pay attention very serious to the existence of e-waste considering the content of toxic and hazardous substances in electrical and electronic equipment. This is due to the lack of appropriate electronic waste management that could potentially trigger negative effects on the environment and human health. E-waste management in Indonesia has not provided significant information, especially regarding knowledge and public awareness related to e-waste management. In addition, the absence of government regulations on proper management and disposal practices may have other impacts. Thus, this study aims to analyze the level of knowledge, behavior and public attitudes in the management of e-waste, especially waste associated with washing machines, refrigerators, air conditioning, and television. A survey of questionnaires adapted from UNEP and modified has been distributed to households in DKI Jakarta to evaluate current e-waste recycling practices. Questionnaires were distributed randomly to approximately 400 households. From the results of the study, we conclude that the majority (60%) of the community do not know about e-waste and its problems; therefore, there is a strong requirement to spread awareness about the dangers that arise from e-waste.

Key Words: e-waste, UNEP, household, survey, knowledge, practice, DKI Jakarta.

Introduction. Manufacturing and processing industries are experiencing a significant increase in the world currently. Thus, these encourage the change of technology and desire in order to increase efficiency in its production. As a result, there is an exponential global growth in the production and consumption of electrical and electronic equipment. E-waste is known as electrical and electronic equipment that has exceeded its useful life and is discarded or undesirable. Globally there is no specific definition of e-waste that can be accepted. This is because each country has its own definition. However, to facilitate the understanding of electronics waste can refer to some previous research which states that electronics waste is all components that are not used and discarded (Wath et al 2010).

One of the problems facing the world today is the waste of electronics. The global generation of e-waste is estimated at about 40 million tonnes per year (Schluep et al 2009). This is influenced by the increase in human population from each period of time (Tan et al 2015). In addition, there are several influencing factors such as the penetration of product markets in developing countries, the development of replacement markets in industrialized countries and the high rate of product obsolescence (UNEP 2004). Several studies have shown that e-waste is one waste stream that increases significantly with 4-5% growth rate per year (Baldé et al 2015). It makes e-waste as one of the fastest-growing waste in the world (Widmer et al 2005; Khetriwal et al 2009). The shifting flow of sales of electronics products and equipment from developed countries has increased rapidly, causing significant impacts of e-waste in developing countries.

Negative effects resulting from the increase in electronics waste is the occurrence of environmental damage and decline in human health (Perkins et al 2014). One contributor to the cause of environmental damage due to e-waste is the recycling activity of the waste in order to obtain valuable materials in electronics waste.

E-waste recycling activity in the informal sector is also a source of persistent pollutants such as polychlorinated biphenyls (PCBs) in developing countries such as China (Zhao et al 2008; Wang et al 2013) and India (Chakraborty et al 2016) in Asian and African countries (Gioia et al 2011). Furthermore, research conducted by Wen et al (2009) showed a high level of PCB concentration detected in bark trees collected in Luqiao recycling areas in China. Homologous and congener PCBs profiles indicate that these pollutants are derived from recycling electronically discharging electronics and dismantling outdated transformers.

Generally, the potential risks arising during the e-waste recycling process are carried out with very simple methods in developing countries (Robinson 2009; Ongondo et al 2011). Recycling e-waste process has generally used technology such as physical disassembly using simple equipment such as hammers, screwdrivers, and chisels (Puckett et al 2002; Wen et al 2006; Amoyaw-Osei et al 2011) removal of components from circuit boards by heating methods (Puckett et al 2002); release of metals by using acidic solutions to retrieve gold or other precious metals (Wong et al 2007); break down and recycle plastics (Wong et al 2007); burning cables to gather copper (Wong et al 2007; Amoyaw-Osei et al 2011); refilling the toner cartridge (Puckett et al 2002). The process of recycling e-waste that is still simple and not using environmentally friendly technology can pose a very serious threat to human health and the environment. Thus, effective intervention efforts have been made by many countries in order to reduce the potential negative impact of e-waste.

Effective management of e-waste which aims to reduce e-waste and increase the recycling of electronics is highly dependent on consciousness and behavior. An important step in the optimum waste management of electronics can be done by developing a coherent communication and awareness strategy to the public. This is based on the idea that by building people's understanding in the context of e-waste management especially the serious impacts on the environment and human health will be able to provide behavioral changes related to e-waste management (Pesa 2013).

Understanding in community management and behavioral strategies on e-waste is strongly influenced by the assessment of public awareness and active participation at the individual level. Studies related to electronics waste have been largely done by researchers in almost all countries in the world. However, there is little information about the knowledge and awareness of Indonesians about the management of e-waste such as the content of toxic and hazardous materials in electronics waste, government regulations on proper management and disposal practices. Assessment of the level of knowledge, behavior and public awareness in each individual is a very important factor in identifying the missing factors of the management strategy. To realize waste recycling behavior among communities, the identification of appropriate attributes needs to be identified. By identifying the right attributes to facilitate the community to recycle their e-waste. Therefore, there is a need to identify attributes to facilitate e-waste recycling behavior. Thus, the purpose of this study is to identify attributes that encourage e-waste recycling behavior in DKI Jakarta Indonesia.

Material and Method. This research was conducted in February to September 2018 in DKI Jakarta, a province which is also the capital of Indonesia. The determination of the location of this study was chosen purposively (intentionally). Several electronics products such as washing machines, refrigerators, air conditioners and televisions are selected because they are electronic products containing polychlorinated biphenyls (PCB) compounds. The research aimed to understand the level of knowledge, behavior, and attitude of the community in planning the appropriate e-waste management scheme. To determine the average of e-waste generation, sampling is taken from the household. The sample of research is determined by using purposive sampling technique. Surveys were conducted among community members aged 18 to 55 years above. To ensure an

adequate level of confidence in the research findings, a sample size of 400 is targeted. Key documents collected include material in the form of publications such as reports, journals, books and the internet. Data are collected from sources such as reports on E-waste Inventory projects in Indonesia. The questionnaire is designed and distributed to obtain information related to the level of community knowledge, behavior, and attitudes. The questionnaire was validated and adapted from the Waste Management Instrument from WHO and the e-waste management guide from UNEP (2007). This questionnaire addressed to household respondents. The questionnaires prepared and pre-tested for 15 respondents. Then, every statement in the questionnaire will be evaluated and correction made to minimize bias. Furthermore, the questionnaire consists of several sections such as demographic profiles including age, gender, occupation, income, and education. In addition, there are several information about the use of electronic devices such as e-waste knowledge level, type of device, usage period, and storage method. Furthermore, awareness about e-waste and the practice of e-waste disposal to evaluate individual perceptions and methods of e-waste disposal. Furthermore, the questionnaire is also designed to identify consumer behavior. Face-to-face interviews are considered more reliable for obtaining accurate information from respondents, as they come from different backgrounds and have different levels of education. It also helps ensure that all questions are answered and that answers are recorded consistently.

Results and Discussion

Demographic. The demographic profile of respondents showed in Figure 1. A greater percentage of respondents were women (53%). The majority of respondents belong to the group > 46 years (26%). The majority of respondents are educated at High School (60%). In addition, the majority of respondents' occupations are private (46%). Meanwhile, the number of people living in most houses was 3-4 people (53%) and the average income of respondents was 5-10 million (37%).

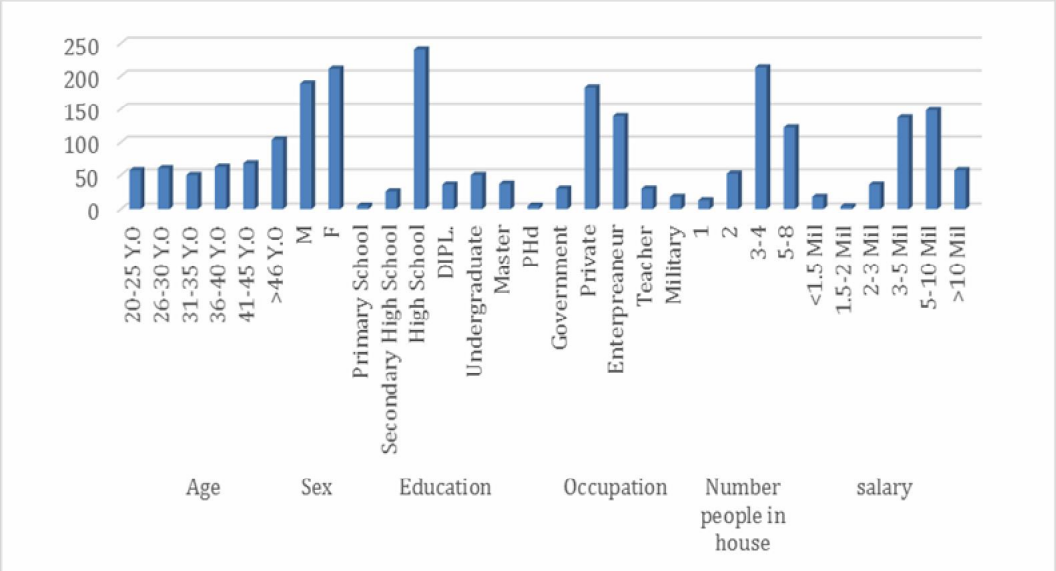

Figure 1. The demographic profile of respondents.

One of the main sources that generate electricity and e-waste is the household sector. Household sectors cover various small volumes to large electronics waste. In this study, large household items such as refrigerators, washing machines, air conditioners, and televisions were investigated. Figure 2 illustrates the information on the ownership of various devices among the respondents in DKI Jakarta. Furthermore, in the category of large electronic equipment, it is found that two-door refrigerators are the most widely used equipment (21%) and the small number is side by side refrigerators (1%). The most used washing machine by the respondent is the type of two tubes that is around

17% and the least is front load type (2%). Meanwhile, the most widely used air conditioner is the 1/2 PK type of roughly 21%.

Previous research by Saritha et al (2015) in India shows the use of washing machines by 80%, refrigerators about 55% and air conditioning about 70%. The study did not provide details of the type of each electronics product used by the household. Meanwhile, a study conducted in Ahvaz-Iran found information that AC produces the highest quantity of e-waste, followed by refrigerators and freezers, washing machines, and televisions (Alavi et al 2015). The survey by Cultura et al (2013) in the city of Cagayan de Oro-Philippines reported the use of approximately 1.2% air conditioning, washing machine around 4.1%, the refrigerator about 5.2% and television 8.5%. In addition, Kalana (2010) notes ownership of electronics products in Malaysia Selangor city consists of washing machines 66%, refrigerators 70% and television at nearly 80%. A study conducted by UNEP (2016) on electronics waste management in ASEAN countries reports that ownership of electronics products in Laos is as follows, washing machine 0.075 of total respondents of 1000 people. Meanwhile, for air conditioning products 0.017 and refrigerators 0.187. Furthermore, the UNEP study in Thailand also reports that there are 796 thousand air conditioning in 2016 which becomes e-waste and cooling machines of 1.023 thousand which become e-waste (UNEP 2016).

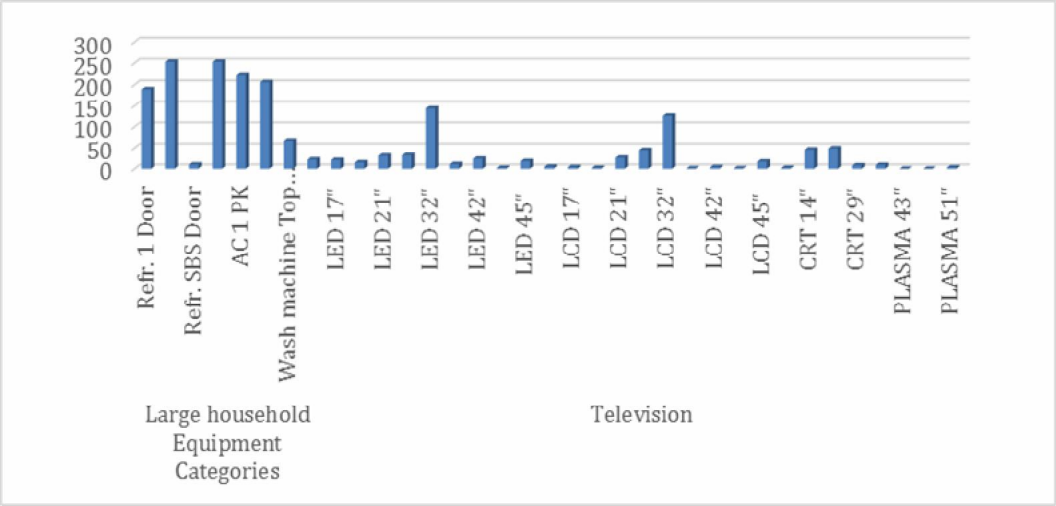

Figure 2. Devices currently in use,

Based on the survey has been carried out as shown in Figure 2 on the type of television ownership electronics products obtained information that the television type LED 32" approximately 144 units (22.3%) was the highest types of television that owned by the respondent and followed LCD 32" types around 126 units (19.5%). while the largest CRT television types were 21" around 49 units (7.5%) and CRT 14" about 46 units (7.1%). Research conducted by Saritha et al (2015) in the city of Visakhapatnam-India recorded about 90% of respondents owning television products. However, the study did not provide detailed information related to the type of television owned by the respondents. Furthermore, studies in Bangladesh by Hossain (2010) and Islam et al (2016) reported television ownership of about 170,000 units or about 94%. Meanwhile, there are roughly 73% of television owned by respondents in the city of Shah Alam, Selangor-Malaysia (Kalana 2010). In addition, there are about 72.4% of CRT television owned by respondents in Cagayan de Oro-Philippine city (Cultura et al 2013).

The results of the survey presented in Table 1 related to the level of knowledge of respondents to e-waste. Several questions that consist of knowledge of e-waste, hazardous material content, regulations on e-waste, and community participation in the management of e-waste. The majority of households roughly 234 respondents (59%) stated that they do not know related to e-waste. Meanwhile, approximately 17 people claim to have knowledge about e-waste. A study conducted by Kaijage & Mtebe (2017) on 800 students in Tanzania shows that 67% of respondents have low knowledge of e-waste. Furthermore, a random survey of around 400 people in Bangladesh's Dhaka city

also shows that the city's knowledge of the knowledge of e-waste is still relatively low (Islam et al 2016). The study obtained information that 91% of the total respondents had no knowledge of e-waste. The similar results are shown by Chibunna et al (2010) where employees and students at Universitas Kebangsaan Malaysia (UKM) have not yet learned the knowledge about e-waste. This result is similar to the research conducted by Chibunna et al (2012) which gives an illustration that around 66.5% of the total 200 undergraduate students are still lack of knowledge related to e-waste, while there are about 54% of the total 270 employees surveyed states do not know about e-waste.

Table 1

Knowledge level of respondents to electronics waste

Description	*Survey result*		
		Total	*Percentage*
Knowledge of electronics waste	• Very familiar	17	4%
	• Knowing quite well	118	29%
	• Unknow	234	59%
	• Have no idea	31	8%
The content of hazardous materials is toxic in electronics waste	• Very familiar	6	1%
	• Knowing quite well	172	43%
	• Unknow	162	41%
	• Have no idea	60	15%
Local governments have special regulations on e-waste	• Very familiar	27	7%
	• Knowing quite well	277	69%
	• Unknow	64	16%
	• Have no idea	32	8%
Participation of household in the e-waste management program	• Very familiar	25	6%
	• Knowing quite well	299	75%
	• Unknow	61	15%
	• Have no idea	15	4%

Different results appear from the research conducted by Akhtar et al (2014), which distributed 250 questionnaires to the public in Kuala Lumpur, where 52% of respondents stated that they recognized about e-waste in Malaysia. Moreover, a survey conducted by Hassan et al (2013) at Universiti Kebangsaan Malaysia (UKM) also showed similar results, where respondents stated that they have a high knowledge of e-waste. Research performed by Cultura et al (2013) in the city of Cagayan de Oro Philippines also showed similar results that generally of respondents around 60.9% have an understanding of e-waste and its impact on the environment and human health. Furthermore, a study conducted by Bhat & Patil (2012) on residents in the Indian city of Pune informed that 82% of 500 respondents indicated that they distinguished about e-waste.

Meanwhile on the question related to the content of toxic hazardous materials in e-waste there were 172 respondents or roughly 43% providing the answer Knowing quite well. In addition, people who unknow related to content of toxic hazardous materials in e-waste were 162 people (41%). While people who are very aware are 6 people (1%) and 15% of respondents stated that they do not know that e-waste contains toxic hazardous materials. Studies conducted by Alameer (2015) on residents in Saudi Arabia show similar results that people are aware about the content of toxic substances in e-waste. Furthermore, research in a number of students of various departments at Universiti Kebangsaan Malaysia (UKM) by Hassan et al (2013) also gives similar results that around 78% of students understanding that electronics waste contains hazardous substances. Similarly, a survey performed by Patrick et al (2017) on students at Federal University Wukari, Taraba State Nigeria also gives the same result that approximately 59% of students recognize the content of toxic materials in e-waste. In addition, there are 73% of 250 respondents in several areas in Kuala Lumpur who claim that e-waste contain dangerous substances (Akhtar et al 2014). However, different results are obtained from research accomplished by Saritha et al (2015) according to which around

97.6% in India's Visakhapatnam did not understand the content of hazardous substances in e-waste.

Regarding the public knowledge about the fact that the local government has special regulations on e-waste, it is showed that most people 277 (69%) are Knowing quite well and 27 respondents (7%) are very familiar about the local governments special regulations on e-waste. On the other hand, people who do not know are roughly 64 people (16%) and 32 (8%) are very unaware that local governments have special regulations on e-waste. A study by Kaijage & Mtebe (2017) in Tanzania reported that 55% of respondents do not recognize the rules or policies related to e-waste management. A previous study was performed in Tanzania by Tedre et al (2009) providing similar results related to users of Information Communication Technology and professionals not understand the policies and regulations related to e-waste management. On the other hand, a cross-sectional study conducted by Patrick et al (2017) showed that 57.7% of the students at Federal University Wukari, Taraba State, Nigeria did not know about regulations related to e-waste.

Meanwhile, for the question of citizen participation in e-waste, it is found that 299 people or 75% discern and 25 people (6%) are very familiar. However, 61 respondents (15%) stated that they did not know and 15 people or 45% explains that they did not understand. A survey by Knudsen (2010) on 322 respondents in the cities of Indianapolis and the Bloomington United States highlight that the level of public participation in both cities is very high in relation to the management of e-waste.

Table 2 shows the behavior of the people associated with the purchase of new electronic goods when there is the promotion of electronics products that attract them. Furthermore, the table also provides the information that there are 132 respondents (52%) who declare they purchase electronics products depending on the need. On the other hand, 27 respondents (7%) stated they would not buy new products despite an attractive promotion. In addition, people who buy new products if there is promotion is 132 people (33%). Research with different results is found in the city of Cagayan de Oro-Philippines where the majority of respondents will buy new electronics products because of their cheap price (Cultura et al 2013). Meanwhile, Patrick et al (2017) revealed that respondents will buy new products even though the old equipment is still working.

Table 2

Respondents' behavior in electronics waste

Description	*Survey result*		
		Total	*Percentage*
Will you buy new electronics if there is a promotion of electronics products if you are interested?	• Yes	132	33%
	• No	27	7%
	• Do not know	31	8%
	• Depend on the need	210	52%
Where do you sell electronics goods that are not used anymore?	• Collectors	213	53%
	• Friends	58	15%
	• Online	44	11%
	• Electronic second hand store	85	21%
How long have you used the electronics product?	• < 1 year	5	1%
	• 1-2 year	93	23%
	• 3-5 year	189	47%
	• > 6 year	113	28%
What are you going to do with the damaged / unused electronics items?	• Discard	161	40%
	• Keep	50	13%
	• Repair	163	41%
	• Donate	26	6%

Table 2 also obtained information related to the responses about where the electronics goods are sold after no longer used. Furthermore, 213 people (53%) declare to sell their electronics goods to the collectors after no longer used. Meanwhile, only 44 people stated

they would sell online. In addition, respondents who will sell to friends roughly 58 respondents (15%). Interestingly, there are several respondents who sell to electronics stores 85 people (21%). A study by Cultura et al (2013) shows that approximately 25.5% of respondents in Cagayan de Oro will sell defective electronics products on collectors and only 0.1% will sell back to electronics stores.

Based on the survey, this study obtained several information about the behavior of respondents related to the period of use of electronic products. Furthermore, Table 2 shows 189 respondents (47%) declared that they were using electronic products within 3-5 years. Moreover, only 113 respondents (29%) were using electronics products for more than 6 years. In addition, respondents who claimed to use electronics products for less than 1 year were 5 people (1%) and those who declared using electronic products between 1-2 years were 93 respondents (23%). Furthermore, research by Alavi et al (2015) stated the lifespan of electronic products in the city of Ahvaz-Iran for 15 years. Similar results were expressed by Cultura et al (2013) on the communities in the cities of Cagayan de Oro in the Philippines which states that the lifetime of electronic products in over 6 years.

Table 2 illustrated the activities of the respondent if the electronic product is damaged or not used anymore. Furthermore, the table shows that 163 respondents (41%) declare they would repair their products if they were damaged. Meanwhile, only a small number of 26 people or approximately (6%) will donate their electronics if they are damaged or are not used anymore. Furthermore, there are 161 respondents will dispose of if it is damaged or is not used anymore. While the respondents who will save is 50 people (13%). A study conducted by Cultura et al (2013) shows that 36.2% of respondents in Cagayan de Oro dispose of electronics products on the grounds that the product has been damaged or no longer functioning. Kaijage & Mtebe (2017) noted that 42% of respondents in Tanzania will store electronics products when they are no longer in use. Chibunna et al (2012) reported that 146 respondents (73.9%) will restore the electronic equipment when not in use anymore. Similar results are shown by Akhtar et al (2014) who reported that 34% of respondents will repair the devices.

Table 3 provides information relating to respondents 'attitudes which state that e-waste collection is near respondents' homes. Furthermore, based on the results of the survey that has been carried out, there are 236 respondents (59%) willing to be associated with the collection of electronics waste near the house. Meanwhile, those who are not willing are 131 residents (33%). Furthermore, the survey also showed that only a small percentage of respondents stated that they were very unwilling about 9 people (2%) and the remaining 24 people (6%) stated that they were very willing. A study conducted by Saphores et al (2006) suggests that most respondents in California are willing to bring electronics waste to the electronics waste management site.

Furthermore, there were 246 respondents (61%) who expressed their willingness that e-waste could be collected in a special place in each district. In addition, there were 118 (30%) of respondents stated very willing, not willing to 33 (8%) people and three (1%) of respondents very unwilling. Cultura et al (2013) noted that about 44% of respondents are willing to collect e-waste near homes. Furthermore, about 70% of respondents in Saudi Arabia are willing to collect e-waste at any collection site (Alameer 2015).

The survey results on respondents' willingness related to the statement that the city government will provide free containers to collect and store e-waste are presented in Table 3. The table shows that 239 people (60%) stated willing and 31 people stated very willing. Meanwhile, respondents who declared unwilling were 35 respondents (8.07%) while 3.93% stated very unwilling.

Table 3

Respondents' attitudes toward e-waste

Description	*Survey result*		
		Total	*Percentage*
E-waste is collected at a special management site near your home	• Very willing	24	6%
	• Willing	236	59%
	• Not willing	131	33%
	• Very unwilling	9	2%
E-waste can be collected in a special place at each sub-district location	• Very willing	118	30%
	• Willing	246	61%
	• Not willing	33	8%
	• Very unwilling	3	1%
Local governments will provide free containers to collect and store e-waste	• Very willing	123	31%
	• Willing	239	60%
	• Not willing	35	8,07%
	• Very unwilling	3	0,07%
Willingness to pay user charges for e-waste management?	• Very willing	15	4%
	• Willing	204	51%
	• Not willing	154	38%
	• Very unwilling	27	7%

The results of the study also obtained respondents' statements regarding the willingness of the community to pay e-waste management fees. Furthermore, majority of the community, namely 204 respondents (51%) stated willing and 15 people (4%) declared very willing. Meanwhile, respondents asserted unwilling were 154 people (38%) and very unwilling 27 people (7%). A study by Oomman (2013) reported that 53.5% of respondents affirm they were not willing to pay for e-waste retribution. In addition, there are nearly 60.85% of respondents willing to pay retribution in Gorkha city, Nepal. The study by Wang et al (2011) confirmed that the willingness to pay of people in the city of Beijing is still low compared with developed countries.

Waste recycling and management programs require the active support and participation of every element of society. One of the key factors of waste management is education (Villanueva 2013; Schiavon et al 2014), where it will be able to establish a good management program for the community. Education programme to the community will potentially increase the paradigm shift of community awareness to waste management. Furthermore, the awareness that is implemented in the form of participation is an important key for the community to engage in sustainable waste management programs (Punongbayan et al 2014).

The level of knowledge and awareness of the community is one of the important factors that influence participation in the management of e-waste. The lack of knowledge and awareness of effective waste management practices is one of the major problems in developing countries. Broadly speaking, governments involved in decision-making on e-waste management are often based on political reasons (Widmer et al 2005; Noble 2008). The reality behind all the obstacles to the successful implementation of electronics waste management programs is that people are unaware of the socio-economic and environmental implications associated with inappropriate e-waste disposal (Carter-Whitney & Webb 2008).

According to McAllister (2015), a study in Gaborone, Botswana, found that awareness of citizens has not reflected as one of community participation in environmental awareness activities. When people are less interested in environmental issues, it means that they are not well informed and may influence their actions. In addition, it is not included as one of the factors in waste management decision making. Communities are still unaware of the options available for making eco-friendly decisions regarding the purchase and disposal of electronics (Schmidt 2002). Therefore, increasing the level of consumer knowledge and awareness related to environmental issues may

have a positive impact on their participation, and the success of e-waste management programs.

Environmental conscious behavior is possibly determined from various aspects such as environmental knowledge, individual feelings towards environmental conditions and personal participation (Chan & Yam 1995). Kollmuss & Agyeman (2002) assert that environmental manner is structurally formed by the interaction between environmental awareness behavior and knowledge of the environment. In addition, it can also be influenced by the experience and awareness of the environment of each individual. Thus, environmental education plays an important role in providing understanding, development of environmentally cognizant behavior (Hungerford et al 2005). Environmental knowledge is the cornerstone of understanding the impact of human behavior on the environment (He et al 2011). In addition, it can shape attitudes and change behavior for the purpose of protecting the environment (Elder 2003). This can be achieved by the solution of environmental problems together from several components such as students, teachers, and the community. Awareness of the environment is an early stage that can change the ability of individuals to do that ultimately leads to the ability to engage in responsible behavior.

Conclusions. Technological revolution and desire in the framework of efficiency in the production of manufacturing industries resulted in the global growth of production and consumption of electrical and electronic equipment. So that triggers the quantity of electronics waste has increased worldwide. This study used a survey of households in DKI Jakarta to estimate the amount of electronics waste. The results of the analysis show some of the most widely used categories of household appliances are such as two-door refrigerator, two-tube washing machine, and AC ½ PK. While for the most widely owned television category is a type of LED 32". Furthermore, the study also shows that the level of knowledge of respondents is still low. In addition, the level of community behavior is also still low, while the level of attitudes toward the management of e-waste is quite high. Therefore, various efforts need to be done such as environmental education, especially electronics waste must be applied comprehensively for all levels of society. This will reduce the potential for the high rate of e-waste generation in DKI Jakarta in the future.

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