

Implementation of the Electronic Waste Management to Achieve Environmental Sustainability in Indonesia

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ABSTRACT

Technology strongly dominates human activities in the industrial 4.0 era, in which the industry continues to issue the most high technology electronic devices to compete with the increasingly complex human needs. The accelerated increase in technology makes the life cycle of electronic devices faster so that it produces e-waste (electronic waste). This research aims to examine the implementation of the electronic waste management in Indonesia. Private sectors have a big role in socializing to the public about the importance of minimizing the negative effects of e-waste by implementing the e-waste management in Indonesia. This research is a qualitative descriptive study using secondary data from scientific journals, prior researches, publications in the last five years, and regulations regarding e-waste management in China, Japan, Malaysia, and India. Government is also expected to have concrete actions to reduce e-waste in Indonesia. For this reason, the role of Indonesian government in the field of e-waste regulation is needed considering the capability of solving this problem in order to lead to the better environment for the society in Indonesia.

Keywords: *e-waste, environmental, developed country, developing country, electronic waste management*

1. INTRODUCTION

Nowadays, several emerging megatrends are recognized, including the increased urbanization of the world's population, interconnectedness among economies and economic power shifts, and climate change, impacting the need for more efficient and effective technology diffusion and technology transfer. Several key areas ranging from mobile internet and pervasive social media to advanced robotics, artificial intelligence, next-generation genomics, and biotechnology, are influencing the occurrence of these trends. As a result, the capabilities of individual humans, and humanity in general, are changing rapidly and profoundly [1]. On average, the number of e-waste continues to increase 3% - 5% per year. 5% of the solid waste produced by the world is e-waste which is three times faster than other types of waste. This number can only be rivalled by the number of plastic bag waste [2].

Electronic waste (e-waste) is an electronic devices waste such as smartphones, computers, laptops, televisions, washing machines, and others. It contains hazardous materials including heavy metals, beryllium, mercury, polyvinyl chloride, lead, cadmium, printed circuit board, brominated flame retardants, and etc. that can bring a damage for the health and environment as follows: [3]

1. Mercury can damage the brain's nervous system, and cause congenital defects;
2. Lead can disrupt the circulatory system, kidneys, brain development of children and damage the nervous system. Lead can be harmful to plants, animals and microorganisms as well;
3. Chromium can be absorbed into cells causing a variety of negative effects, allergies and DNA damage;
4. Cadmium is very likely to damage the kidneys;
5. Polybrominated diphenyl ethers can damage the endocrine and reduce the level of the thyroxine hormone in mammals and humans that the development of body becomes disrupted;
6. When polybrominated biphenyl are mixed with cow food, then humans who consume the beef has higher risk of digestive cancer.

Based on these thoughts, it is necessary to conduct research relating to the implementation of e-waste management in Indonesia to answer the following issues:

1. What are the differences of the e-waste management in developed countries and developing countries in Asia?
2. How does the implementation of the e-waste management in Indonesia?

3. What is the suggestion for the private sectors to implement the e-waste management in Indonesia?

The research conducted to obtain main objectives as follows:

1. To identify the differences of the e-waste management in developed countries and developing countries in Asia;
2. To examine the degree to which the implementation of the e-waste management in Indonesia;
3. To suggest ways for the private sectors in terms of implementing the e-waste management in Indonesia.

2. BACKGROUND

Nowadays, almost everyone has smartphones and other type of electronic devices that will certainly affect the number of e-waste. The second highest e-waste is a television and followed by refrigerator for the household use. The increasing number of e-waste is related to the increasing number of electronic devices use that have become the new lifestyle of the global citizen. [4]

According to the data from the UNEP (United Nations Environment Program) in 2019, e-waste grows 40 million tons annually. Smartphones and computers waste are the biggest contributors, followed by gold and silver waste (3%), palladium (13%), and cobalt (15%). The increasing of electronic devices use will lead to a high rate of e-waste in the future. It is predicted that there will be 200% increase of e-waste in China as developed country and 400% increase of e-waste in South Africa as developing country by 2020. As the situation is hardly uncontrollable, it might certainly have a massive impact to Indonesia as an upper middle-income country, recently stated by the World Bank. Basically, e-waste can be classified as follows: [5]

1. Large household appliances (labelled *Large HH*) such as air conditioner, washing machines, refrigerators, refrigerators, and ovens;
2. Small household appliances (labelled *Small HH*) such as fans, stoves, blenders, toasters, and vacuum cleaners;
3. IT & telecommunications equipment (labelled *ICT*) such as computers, laptops, printers, telephones, modems, smartphones, fax machines, scan machines, batteries, and calculators;
4. Consumer equipment (labelled *CE*) such as television, radio, and DVD or VCD player;
5. Lighting equipment (labelled *Lighting*);
6. Electrical and electronic tools (labelled *E&E Tools*) such as drilling machines;
7. Toys, leisure and sports equipment (labelled *Toys*);

8. Medical devices (labelled *Medical Equipment*);
9. Monitoring and control instrument (labelled *M&C*).

3. RESEARCH METHODOLOGY

The literature study will be conducted to examine the e-waste management in developed countries in Asia which are China and Japan as well as the e-waste management in developing countries in Asia which are Malaysia and India. This research is a descriptive study using secondary data from scientific journals, prior researches, publications in the last five years, and regulations regarding e-waste management in each of these countries. From this research, e-waste management recommendations in Indonesia will be obtained.

4. RESULT AND DISCUSSION

4.1 E-Waste Management in Developed Countries

A. CHINA

E-waste is imported into Asia ranges from 50% - 80% of the world's e-waste per year where 90% of it is imported into China. In 2007, there were 350 million televisions, 130 million refrigerators, and 170 million washing machines made in the 1980s that used throughout the country [6]. If the product lifetime is between 10 to 15 years, there are at least 5 million televisions, 4 million refrigerators, and 5 million washing machines that become e-waste every year.

The number of e-waste generated in Beijing was approximately 1.5 million tons in 2010 with an average growth of 5.2% [4] annually according to the National Development and Reform Commission in 2008. The number of e-waste is generated from within the country and e-waste imports. Whereas in Macau, the number of e-waste reached 9,000 tons in 2010, 80% of the e-waste in Macau is generated from households and the rest are generated from the business, institutional, and government sectors. In 2019, China is the second largest e-waste producer in the world after the US with 6.1 million tons of e-waste annually compared to the data from 2007 [7].

The e-waste in China is regulated in Regulations on Recovery Processing of Waste Electrical and Electronic Products which effected immediately on January 1, 2011. But the reality says that the e-waste management in Beijing is not going well. About 70% of e-waste cannot be recycled because it is stored at home and offices for months or even years [8]. Only 12% of e-waste are recycled into industrial raw materials and will

be sold in the second-hand market after the e-waste has been repaired and renewed.

B. JAPAN

The number of e-waste in Japan has been increasing ever since 1990. In 2006, production of electronic devices showed an increase of 105.8% from 2005. The number of computers used also increased from 30.000 tons in 1995 to 100.000 in 2010. 10 years after, Japan is still dealing with the e-waste issues by creating up to 550,000 tons [9].

The e-waste in Japan is mostly generated from household appliances such as televisions, refrigerators, washing machines, and air conditioning, computers, and smartphones. As a result of the high number of e-waste from household appliances, Japan exported the e-waste to other Asian countries generally and to China especially to be recycled [10].

In Japan, the users of electronic devices pay a certain amount of money when returning their used electronic devices to merchants. Since 1998, Japan has been making e-waste return system of televisions, refrigerators, washing machines, and air conditioning. Until 2004, the number of e-waste recycling facilities in Japan was up to 41 units funded by ministries, governments, and manufacturers [11]. Nowadays, there are 24-30% of total e-waste that has been recycled in Japan [3].

E-waste from households is collected and transported to a recycling facility. The recycling system in Japan is to dismantle the big part of e-waste more accurately so that the recycler can handle the residue properly [11]. The government has agreed to form an Association for Household Electronic Devices as a legal entity for electronic devices that are not collected by the sellers. The e-waste transportation system from households can be seen in Figure 1.

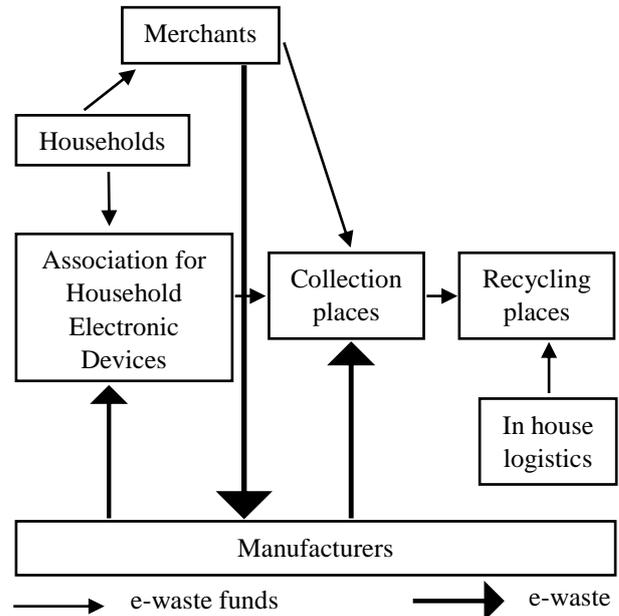


Figure 1. E-waste Transportation System from Households in Japan

The e-waste in Japan is regulated in Law for the Promotion of Effective Utilization of Resources (LPEUR) in 1998 which focuses on steps to increase e-waste recycling and minimization and consumers. LPEUR regulates the e-waste management in terms of computers and small secondary batteries designed as products that can be recycled [12]. The e-waste in Japan is also regulated in Law for the Recycling of Specified Kinds of Home Appliances (LRHA) in 2000 which enforces certain obligations related to e-waste recycling that apply to consumers and manufacturers. LRHA regulates the e-waste management in terms of televisions, refrigerators, washing machines, and air conditioning. LRHA adopts the principle of Extended Producer Responsibility (EPR) where producers are responsible for the product life cycle of the electronic devices from the production stage to the disposal stage. When customers dispose their electronic devices, they are responsible for paying transportation costs from 2,400 Yen for washing machines, to 4,600 Yen for refrigerators [3].

4.2 E-Waste Management in Developing Countries

A. MALAYSIA

The number of e-waste increased from 53,000 metric tons in 2007 to almost 103,000 metric tons in 2008 based on Department of Environment (DOE) in Malaysia. Meanwhile, the number of e-waste produced by five manufacturers operating in Bangi industry center reaches 35 metric tons per month. In 2016, Malaysia generated 280 kilotons [4].

In Malaysia, there are two types of e-waste recycling systems which are full recycling system and partial recycling system. The full recycling system recycles all components of the electronic devices and generated from private sectors (90%), educational institutions (5%), and households (5%). While the partial one only recycles some components of the electronic devices and generated from private sectors (60%), educational institutions (5%), households (5%), government offices (20%), and street sweepers (10%) [14].

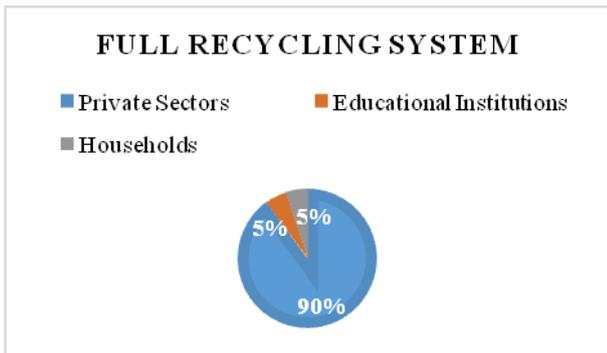


Figure 3. Full Recycling System in Malaysia

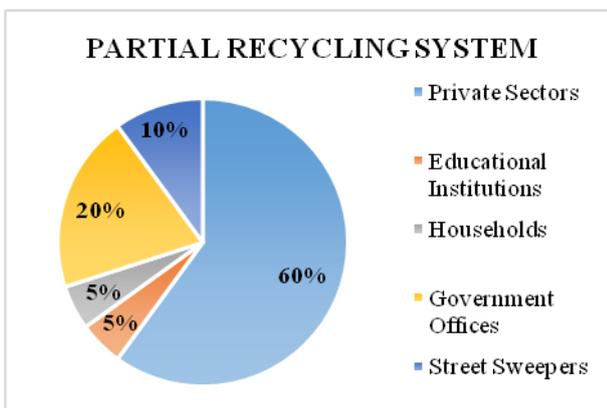


Figure 4. Partial Recycling System in Malaysia

The e-waste in Malaysia is regulated in Environmental Quality (Scheduled Wastes) Regulations (EQSWR) issued by the Department of Environment (DOE) under the Ministry of Natural Resources and Environment (NRE). In 1989, the EQSWR regulation was based on the concept of “cradle to grave” from the generation, storage, transportation, processing to disposal of the electronic devices [15]. In 2005, the regulation has been renewed and focused more of the types of e-waste than the original source of the e-waste [15].

B. INDIA

In India, e-waste is generated from the formal sectors such as producers, merchants, importers, consumers, and scrap metal dealers as well as the informal sectors such as recyclers, dismantlers, and smelters. The flow of e-waste in India can be seen in Figure 2.

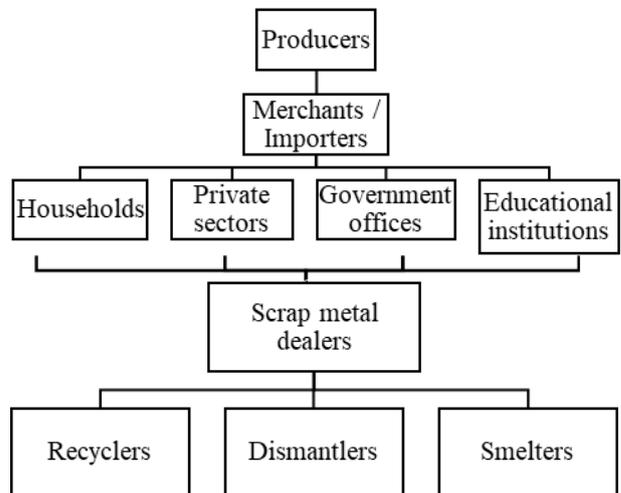


Figure 3. Flow of E-waste in India

Materials such as plastic, glass, and copper cables that can be recycled will be sold back to suppliers of raw materials for reuse. E-waste is also processed to obtain high-value materials such as gold, silver, aluminium, and copper. In 2018, India generates about 3.3 million tons, way higher compared to the data from prior years [16].

In 2003, the e-waste in India was regulated in Hazardous Wastes (Management and Handling) Rules that focused on industrial waste management. The regulation didn't focus much on the e-waste recycling system from households and e-waste must go through the procedure of handling industrial waste in advance which is more complicated instead. Therefore, the e-waste in India is now regulated in E-waste (Management and Handling) Rules which effected

immediately on May 1, 2012. The e-waste category based on the E-waste (Management and Handling) Rules in India can be seen in Table 1.

Table 1. The E-waste Category Based on the E-waste (Management and Handling) Rules in India

No.	Electronic Devices Category	Type of Devices
1.	Information technology and telecommunication devices	Centralized data processing, mainframes, computers, laptops, notebooks, notepads, printers, copy machine, electronic typewriters, faxes, telephones, and smartphones.
2.	Consumer electronic devices	Televisions (LCD and LED), refrigerators, washing machines, and air conditioning.

4.3 The Implementation of the E-Waste Management In Indonesia

In Indonesia, e-waste is generated from domestic consumption which is the high number of electronic devices use at the household scale. Due to its high technology and affordable prices, many Indonesians are using more than one electronic devices.

In a research study, e-waste recycling in Indonesia is said to be unique, by extending the life of electronic products that have been damaged by bringing it to the service providers. However, the safe components of the damaged electronic devices can be recycled and become other useful items. But extending the product lifetime will also extend the flow of e-waste and B3 which are dangerous [17].

Apart from households, the high number of e-waste caused by the high demand of the electronic devices from foreign countries as well as in black market. In Indonesia there are at least 100 million cellular phones, and the contents of the electronic devices include copper and materials that is included into the B3 category [18].

In the informal sector, e-waste are generated from electronic devices that has been damaged. It is taken by scavengers and electronic services before delivered to a garbage agent. The electronic devices will be repaired, disassembled, and recycled so that it will have a sale

value to be sold to consumers later. While e-waste that no longer has a sale value will be disposed to the landfills. However, there was no significant number of e-waste found in the landfills. [18]

To provide a solution, an Extended Producer Responsibility (EPR) program is needed. EPR is the responsibility of the producer which extends to the physical production stage and it's financing to the after-use stage. Unfortunately, there are a lot of protests coming from Indonesian Electronic Business Association as it will burden the producing cost of the electronic devices, rises a high competition in the marketing electronic devices, and the diverse scale of electronic production.

There are some countries that have implemented EPR: Japan, Korea, and Taiwan. In Japan, the recycling of e-waste is repaid by consumers. While in Korea and Taiwan, the recycling of e-waste is paid by producers. [19]

In Indonesia, there is one law that regulates about EPR that is Government Regulation Number 81 of 2012. However, the regulation is more focusing to household waste rather than specific waste such as e-waste. In this regulation, producers are obligated to take back the waste that is meant to be reused and will be carried out step by step according to the 10th annual road map. [20]

Nevertheless, there are several movements conducted by the Jakarta Government in managing e-waste such as: [20]

- Socialization of e-waste to the society
- Signing the MOU with the electronic waste processors as third parties
- Placing dustbins at Bundaran HI, busway stops, several schools, and government offices and dorms
- Provide laystall and trucks for hazardous and toxic material
- E-waste pickup program at several schools and government offices and dorms
- E-waste collection program at the train station

The aim of the socialization of e-waste to the society is to educate more people in order to gain knowledge of the dangers of the disposal of the e-waste. Not only is it being harmful to the health of the society itself, the e-waste is dangerous for the environmental sustainability as well. The government will be advised the society to never dispose the e-waste carelessly as the government has provided the facilities needed to dispose the e-waste that will not be used anymore.

In the e-waste pickup program, Jakarta residents can ask the Environmental Services officer to come to their homes and transport the e-waste with a condition that the e-waste has a minimum weight of 5 kilograms. This service is free of charge. In the e-waste collection program, the e-waste will be collected in each district area and sent to the Jakarta Environmental Services warehouse in Pulomas every week before being transferred to the sub-district [17].

In addition, the Indonesian government cooperates with the Chinese government in managing e-waste and waste from persistent organic pollutants (POPs). The cooperation that will be developed by the two countries as well as an effort to support the 4.0 Indonesian Revolution which is being promoted by the Indonesian government through the Ministry of Industry [21].

4.4 The Suggestion for The Private Sectors To Implement The E-Waste Management In Indonesia

The increasing number of e-waste in Indonesia is due to several factors, including: the lack of information, inaccuracy of data and limited sources about e-waste and the number of uses of electronic devices that can be accessed by public, the absence of public awareness in managing e-waste in a minimum scale, and different understanding between government institutions regarding of the regulations of e-waste and its management procedures.

There are several ways for the private sectors in terms of implementing the e-waste management with a good approach in Indonesia. The private sectors need to make a draft of e-waste management system consisting these points below:

1. Social Act, where companies build public awareness about e-waste by providing access that makes it easy for the society to be actively involved;
2. Company Act, where the company conducts refurbishment, repair and recycle processes to process e-waste through appropriate procedures and create innovative eco-friendly products;
3. Sustainability Act, where companies synergize with the government in overcoming the problem of e-waste, minimizing its impact to achieve environmental sustainability.

By applying the management system as mentioned before, producer will be responsible for electronic devices made until they will not be used anymore for the process of recycling. The manufacturer is also responsible for the material and design of the electronic devices. Furthermore, the use of energy and raw materials can also be reduced.

5. CONCLUSION

E-waste management in developed countries is different from developing countries. Developed countries emphasises more on the Extended Produce Responsibility system with excellent approach, while e-waste management in developing countries emphasises more on the management system in the informal sector with fair approach.

The e-waste system in Indonesia is the same as in developing countries, which uses conventional methods (pickup program) that is not eco-friendly, so that it can pollute the environment and endanger the health of workers.

There are already several programs has run by the government in a regional level in terms of managing the e-waste in Jakarta, the capital city of Indonesia. However, the majority of provinces in Indonesia haven't run any programs yet and the national government still does not have specific regulations regarding the management of e-waste.

The pillar of the smart environment can be achieved by implementing good e-waste management system and clear law enforcement of electronic waste as well as educating the society about the risk and the negative impact of e-waste with the participation of households, private sector, and government respectively.

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