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Environmental Policy in Managing E-Waste Recycling: Promoting a Clean Environment in Public Policy

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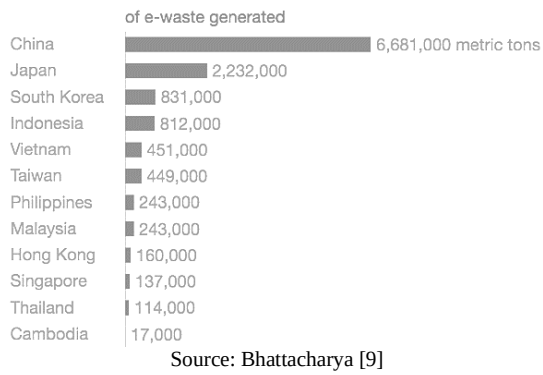
ABSTRACT

Rapid internet-based technological developments have a tremendous impact on the production of electronic devices. The management of electronic waste or e-waste has become a problem for both developed and developing countries. In global scale, e-waste is the fastest growing waste, around 3-5% per year or about three times faster than normal household waste generation. Accordingly, Indonesian government classified e-waste as hazardous and toxic waste. Yet, Indonesia has not provided an adequate and comprehensive electronic waste management system. It is caused by lack of relevant environmental policy and regulations made specifically to handle e-waste management. This research aims to investigate the environmental regulations and the methods of managing e-waste and the role of the government in managing the recycling of e-waste by considering the intertwined interests to balance a clean environment in one side and economic growth on the other. By using an empirical juridical approach, the results showed that insofar the relevant regulation to cope with the problems is Government Regulation No. 101 of 2014 concerning Management of Toxic and Hazardous Waste. There are some provisions to manage e-waste in Indonesia such as by clinical processing methods, physical processing methods, biological processing methods and hazardous waste disposal method. However, in general electronic waste in Indonesia until now does not have clarity in management, regulation, and economic potential that can be worked on.

1. INTRODUCTION

All countries in the world experience the problem of waste as an inseparable part of human life. Garbage generally consists of organic waste and inorganic waste. Organic waste is waste that comes from the rest of living things that are easily decomposed naturally without human intervention processes to decompose. Meanwhile, inorganic waste is waste generated from non-biological materials, either in the form of synthetic products or the result of technological processes for processing mining materials. Examples are plastic, beverage bottles/cans, crackle, used tires, glass iron, cables, electronic goods, light bulbs. Inorganic waste is waste that is no longer used and is difficult to decompose. Inorganic waste buried in the ground can cause soil pollution because it is classified as a substance that is difficult to decompose and this waste if buried in the ground for a long time causes damage to the soil layer [1]. Electronic waste, also known as e-waste or e-scrap or Waste Electrical and Electronic Equipment (WEEE) is the fastest growing waste, around 3-5% per year or about three times faster than normal household waste generation [2]. With the development of technology and information, the use of electronics in society continues to increase, either in developing or developed countries as caused by rapid consumption of internet devices [3-7].

Hanafi et al. [8] stated that in Indonesia in 2007 more than 3 billion units of household electronic equipment and IT equipment were produced, such as televisions, mobile phones and computers. In the same year, the annual consumption of television reached 4.3 million units, while refrigerators reached 2.1 million units, and air conditioners and washing machines each reached 900,000 units. Indonesia is one of the largest consumers of household electronic equipment in Asia. Figure 1 also showed that Indonesia is the major producer of e-waste in Asia. There are some estimates that there will be an e-waste boom in the coming years. There is no official data regarding the illegal electronic waste entering Indonesia. However, it is estimated that the amount is high. However, this data also does not include the amount of electronic waste that enters Indonesia from developed countries illegally.



Source: Bhattacharya [9]

Figure 1. E-waste arising in east and southeast Asian countries, 2015

In Indonesia, e-waste is classified as hazardous and toxic waste and refers to Government Regulation No. 101 of 2014 concerning Management of Toxic and Hazardous Waste due to the content in it. However, this regulation only regulates in general terms and does not specifically regulate the definition, criteria or flow of electronic waste management. In addition, public awareness of the problem of e-waste in Indonesia is still relatively lagging behind. In 2017 the government issued a regulation through Presidential Decree No. 97 of 2017 concerning National Policies and Strategies for the Management of Household Waste and Types of Household Waste, through this regulation it is planned to reduce 30% of waste from the source, process and manage 70% of waste so that it does not accumulate and with this policy it is hoped that by 2025 it can be realized Waste-Free Indonesia by reducing waste by 30%, and handling waste by 70% [10].

Along with the times, the pattern of people's lives has changed to tend to be consumptive, so that people's purchasing power is also relatively high [11]. Likewise, for items that are no longer used, whether these items can be recycled or not, or even just thrown away. Until now, household electronic waste in many cities in developing countries is still unclear in terms of management, regulation and economic potential that can be worked on [12-16]. One example is what happened in Semarang City, based on the Semarang City Regional Strategic Policy (Jakstrada) document, the 2019 Semarang City waste generation was 1,276 tons/day, and it is estimated that in 2025 it is predicted that the amount of waste generated will increase to 1,437 tons/day. Of the total waste, almost 80% is household waste, but there is no specific data that mentions the amount of electronic waste in that amount. Based on the description, this research is conducted to examine the management and methods as well as the economic potential of recycling e-waste from the household sector. Based on the foregoing, the problems that can be formulated in this research are to investigate the environmental regulations and methods for managing e-waste and the role of the government in managing the recycling of e-waste. The novelty of this research is to formulate the right legal policy in dealing with hazardous electronic waste which is transacted illegally and across borders. In addition, the novelty of this study is to consider environmental sustainability aspects as an important consideration in the regulation of electronic waste.

2. LITERATURE REVIEW

Along with the times, more and more technologies are increasingly sophisticated so that they have a major influence on people's activities. This is evidenced by an increase in industrial production of computers, electronics and optics, especially micro and small by 22.03% [17]. The level of consumption of electronic goods in Indonesia is increasing. A person's desire for electronic goods has become a major need to help with their work. Of all the types of electronic goods used, each has a certain service life so that there will be times when the goods must be replaced or discarded. Thus, the goods will become waste [18].

In the case of Indonesia, as reported by Greenpeace, this country produced 812 kilotons of e-waste in 2014. The Global E-waste Monitor 2020 as explained in research Sri Wahyono [19] there are examples of 4 cases of electronic environmental pollution in Indonesia namely what happened in Munjul (East Jakarta), namely the case of heavy metal pollution from electronic waste which polluted heavy metals due to electronic waste recycling activities so that it threatened the health of the local community, other examples occur in Cinangka (Bogor) & Curug (Tanggerang), Serpong (South Tangerang), Pasarean (Tegal) , and many more cases that occurred in Indonesia [20].

Due to its adverse effects on health and the environment, as well as its illegal cross-border circulation, e-waste has received international attention. The need for environmentally sound electronic waste management for environmental protection from pollution. In general, developing countries, including Indonesia, do not yet have specific regulations governing e-waste management. As a result, a good management system on e-waste which includes collection and transportation, dismantling, recycling, and final processing is still not running well. Considering the bad impact caused by the informal sector in the management of e-waste, firm and directed steps are needed. In developed countries, e-waste management activities are strictly regulated and have clear regulations. However, the investment and O&M costs are high because it operates on environmentally friendly technology. Because the financing is expensive, it is not uncommon for some rogue industries to illegally export electronic waste to other countries such as to Ghana, Nigeria, India, China, Thailand and Indonesia. These countries are the target of 'disposal' of toxic and hazardous waste [21].

Seeing the many cases that have occurred in Indonesia, it shows that Indonesia still has an inadequate electronic waste management system and Indonesia also does not have regulations made specifically to handle e-waste management. However, the Government itself has issued Government Regulation (PP) No. 27 of 2020 concerning Waste Management which is a derivative of Law (UU) No. 18 of 2008 concerning Waste Management, so that the regulation is one of the legal umbrellas for electronic waste management. E-waste is generally classified into hazardous and toxic waste, so that it refers to Government Regulation No. 101 of 2014 concerning Management of Toxic and Hazardous Waste due to the content in it.

The classification in electronic waste is carried out because the content contained in electronic waste is in the form of heavy metals such as cadmium, chromium, lead, mercury, nickel, selenium, and other heavy metals. Heavy metals and compounds in electronic waste can be harmful to health because they are toxic, carcinogenic (causing cancer) and mutagenic (causing birth defects). In 2017 the government issued a regulation through Presidential Decree No. 97 of 2017 concerning National Policies and Strategies for the Management of Household Waste and Types of Household Waste, through this regulation it is planned to reduce 30% of waste from the source, process and manage 70% of waste so that it does not accumulate and with this policy it is hoped that by 2025 it can be realized Waste-Free Indonesia by reducing waste by 30%, and handling waste by 70% [10]. However, this regulation only regulates in general terms and does not specifically regulate the definition, criteria or flow of electronic waste management.

3. RESEARCH METHOD

E-waste is a type of waste that grows rapidly, faster than the generation of ordinary household waste. In handling e-waste waste, Indonesia has not provided an adequate and comprehensive waste management system. This is due to the

absence of relevant environmental policies and regulations specifically designed to deal with e-waste management. Therefore, the method used in this study is a normative research method, namely empirical legal research. This empirical legal research highlights the main research problem regarding the application of positive law, in this case the specific policies or regulations that exist in Indonesia in handling e-waste waste [22]. Furthermore, in terms of the focus of the research objective, this research is also intended to conduct a study of problem identification and problem solving. This research is intended to obtain deeper knowledge about a certain legal phenomenon, also to obtain information about the frequency of occurrence of certain legal events, and is intended to obtain data regarding the relationship between one legal phenomenon and another.

4. RESULT

4.1 Methods for managing e-waste in Indonesia

There is still a lot of electronic waste in Indonesia that has not been managed properly and correctly. As explained in research Hanafi et al. [8] that in Indonesia in 2007 more than 3 billion units of household electronic equipment and IT equipment were produced such as televisions, mobile phones and computers. In the same year, the annual consumption of television reached 4.3 million units, while refrigerators reached 2.1 million units, and air conditioners and washing machines each reached 900,000 units, making it difficult for the government and the public to manage due to the large amount of garbage piled up. However, nowadays many people have managed electronic waste in various ways, namely: recycling, repairing, exporting, to burial. However, in general, Indonesia has several methods in handling Hazardous and Toxic Waste or commonly referred to as hazardous which is generally divided into 4 methods, namely Chemical Processing Method, Physical Processing Method, Biological Processing Method and Hazardous Waste Disposal Method [23].

The first method is Chemical Processing Method. The chemically hazardous waste treatment process that is commonly carried out is stabilization/solidification. Stabilization/solidification itself can be defined as the process of changing the physical form and/or chemical compounds by adding certain binders or reagents to minimize/limit the solubility, movement, or spread of the toxic power of the waste, prior to disposal. Where it is carried out Chemical wastewater treatment is usually carried out to remove non-precipitating particles (colloids), heavy metals, phosphorus compounds, and toxic organic substances; by adding certain chemicals that are needed depending on the type and level of the waste.

The second is Physical Processing Method. In the physical treatment method, prior to further treatment of the wastewater, an allowance is made for large and easily settled suspended materials or floating materials. Screening is an efficient and inexpensive way to remove large suspended materials. Suspended material that settles easily can be removed easily by a precipitation process. The main design parameters for this deposition process are the settling velocity of the particles and the hydraulic retention time in the settling basin.

The third is Biological Processing Method. In this Biological Treatment Method there are terms bioremediation and phytoremediation. Bioremediation is the use of bacteria and other microorganisms to degrade/decompose hazardous waste. While phytoremediation is the use of plants to absorb and accumulate toxic materials from the soil. Both of these processes are very useful in overcoming pollution by hazardous waste and the costs required are cheaper than chemical or physical methods. However, this process also still has drawbacks. Bioremediation and phytoremediation processes are natural processes so that it takes a relatively long time to clean up hazardous waste, especially on a large scale. In addition, because it uses living things, it is feared that this process can bring toxic compounds into the food chain in the ecosystem.

The fourth is Hazardous Waste Disposal Method. There are some specific methods for disposing of hazardous waste, such as deep wells, surface impoundments and landfill. Deep wells or injection wells dispose of hazardous waste so as not to harm humans by pumping the waste through pipes into deep rock layers, below shallow groundwater layers and deep groundwater. In theory, this hazardous waste will be trapped in that layer so that it will not pollute the soil or water. Moreover, liquid hazardous waste storage ponds or surface impoundments can be accommodated in ponds specifically designated for hazardous waste. These pools are covered with a protective layer that prevents the seepage of sewage. When the wastewater evaporates, the hazardous compounds will be concentrated and settle to the bottom. The weakness of this method is that it takes up land because the waste will be buried in the pond, there is a possibility of leakage of the protective layer, and the evaporation of hazardous compounds along with the waste water so that it pollutes the air.

Lastly, landfill for hazardous waste or secure landfills for hazardous waste can be stored in landfills, but must be with a high level of security. In the secure landfill disposal method, hazardous waste is put into drums or barrels, then buried in a specially designed landfill to prevent contamination of hazardous waste. Landfill must be equipped with complete monitoring equipment to control the condition of hazardous waste and must always be monitored. This method if applied properly can be an effective way of handling hazardous waste.

Table 1. The largest e-waste producing country in the world, 2016

No.	Country	Total waste generated (in million metric tons)	Kg per capita
1	China	7.2	5.2
2	USA	6.3	19.4
3	Japan	2.1	16.9
4	India	2.0	1.5
5	Germany	1.9	22.8
6	Brazil	1.5	7.4
7	Russia	1.4	9.7
8	France	1.4	21.3
9	Indonesia	1.3	4.9
10	Italy	1.2	18.9

Source: Andrew [24]

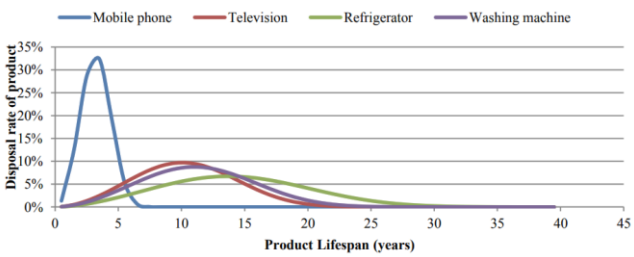
Utilization of electronic waste management also has positive aspects for society and the government, if electronic waste can be managed optimally, then electronic waste has a high economic value if processed (handled) properly. What's more, the low economic value of electronic components that cannot be recycled or repaired, which in the end will only be buried. So, it requires good and correct management. And it is hoped that this can be applied by the government and the community, namely by utilizing electronic waste into

handicrafts that have a higher economic value than just throwing it away.

4.2 Environmental policy approach adopted in Indonesia in managing the recycling of e-waste

Handling electronic waste or e-waste is not the same as ordinary waste, such as organic, inorganic, paper, and others. Management must be carried out properly and carefully considering that electronic waste contains hazardous chemicals that are not good for humans and the environment. Therefore, it is necessary to have special regulations or regulations that specifically regulate the management of the waste. In Indonesia, the current regulation on electronic waste management is contained in Law No. 18 of 2008 concerning Waste Management, Government Regulation No. 101 of 2014 concerning Management of Hazardous and Toxic Waste, Government Regulation No. 27 of 2020 concerning Specific Waste Management, and Government Regulation No. 22 of 2021 concerning the Implementation of Environmental Protection and Management [25].

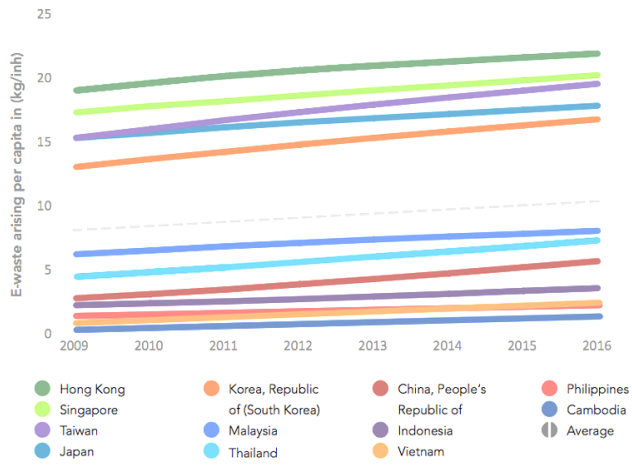
Today, the growth of electronic industry manufacturers is increasing rapidly in the market competition in Indonesia. Even in one type of electronic product can have 5-8 manufacturers. In a matter of one day manufacturers are able to issue hundreds of thousands for one type of product. In a short time, manufacturers are able to improve the specifications of these types of electronic equipment to compete in the market. Consumers are also competing to have various types of electronics with the highest specifications so that the use of electronics in people's lives is increasing which causes the growth rate of e-waste to expand [26, 27]. In Indonesia, e-waste is classified as hazardous and toxic waste and refers to Government Regulation No. 101 of 2014 concerning Management of Toxic and Hazardous Waste. So that in this case the government's role in overcoming the spread of electronic waste is needed, especially the many negative impacts that can harm the community if electronic waste is not managed properly and correctly. Moreover, some regulations have specified the management of e-waste such as Regulation of the Minister of Health No. 472/Menkes/Per/V/1996 concerning the Safety of Materials Hazardous to Health, Presidential Decree No. 97 of 2017 concerning National Policies and Strategies for the Management of Household Waste and Types of Household Waste and Law No. 18 of 2008 concerning Waste Management.



Source: Santoso et al. [28]

Figure 2. Lifetime of electrical and electronic products in Indonesia

One form of the government's role in managing the recycling of e-waste is by separating the trash bins between household waste and electronic waste, this is the process of sorting waste that still has material value to be reused is referred to as recycling (reuse) [29]. Steps taken by the government in managing electronic waste properly and correctly by facilitating human resources, one of which is scavengers, so that not only people are protected from the negative impacts due to the accumulation of electronic waste, but also scavengers. So, the government must have innovative steps, one of which is what the Makassar government has done, namely determining the location of temporary shelters, integrated waste processing site, and/or final waste processing site conducting periodic monitoring and evaluation every 6 (six) months for 20 (twenty) years on the final waste processing site with an open disposal system that has been closed and compiling and implementing an emergency response system waste management in accordance with their authority [30-32]. So, in general, the government has 3 roles, namely [33]: The waste management facilitator is carried out efficiently using city resources. This can be done by reducing the use of resources, minimizing the amount of waste, reducing the use of water, air, plants, fauna, beaches or lakes with artificial components of roads, buildings, bridges. The dynamism is carried out by waste management is also carried out to restore natural resources (resources recovery). Waste management can involve solid, liquid, gas, or radioactive substances with special methods and skills for each type of substance and regulators by separating non-hazardous waste management areas from settlements and institutions in metropolitan areas which are usually the responsibility of local governments, while waste from commercial and industrial areas is usually handled by waste processing companies.



Source: Edwin [34]

Figure 3. Comparison of e-waste production in East and Southeast Asia

Figure 2 shows the distribution model for each product. Average lifespan can be calculated by the mean value of Weibull distribution. The average lifespan for a mobile phone in Indonesia is 3.42 years. This number shows that a mobile phone in Indonesia is almost the same as the average lifespan of a mobile phone in South Korea, i.e. 3.4 years but has a shorter average lifespan compared to Europe, i.e. 9.62 years. Average lifespan of the saturated market products in Indonesia is 10.42 years for television, 14.43 years for refrigerator, and 11.42 years for washing machine [34].

Lifespan comparison of each product observed shows that products with saturated market characteristics have a longer

lifespan than the non-saturated market products. One of the reason is sales in the saturated market usually happen to replace the old device that had reached its end of life while in non-saturated market, sales are basically caused by new users or new technology offered by the company. Dynamic technological innovation resulting in the shortening lifespan for products in non-saturated market category. This phenomenon can be seen happening in the mobile phone market.

The population balance model (PBM) is adapted to estimate the total e-waste generated. The estimation is done in a time frame of 7 years, i.e. from 2009 until 2016. The estimated result of electronic waste is expected to illustrate the condition of electronic waste in East and Southeast Asia quantitatively. Figure 3 presents the e-waste arising per capita in (kg/inh). The growth rate in e-waste volume in East and Southeast Asia include Indonesia is to increase annually.

In order to deal with the problem of electronic waste that is endemic in Indonesia, apart from the government, the community also plays an important role in proper and correct waste management. So today, many home industries and individual industries use used electronic waste as a business, which is carried out by collecting by individuals or small business groups at the homes of electronic consumers, or via online markets, then collecting them at the collectors of used goods which are then processed to produce economic value that is beneficial to the community's economy and creates a healthy environment.

The development of science and technology has led to an increasing number of electronic industry manufacturers in market competition in Indonesia. There is also the nature of consumers to compete to have a high level of electronic variation, which in turn causes the growth rate of e-waste to expand. The government has an important role to play in managing and recycling electronic waste, namely by enforcing a separation between household waste and electronic waste, and recycling. It is important for the government to take appropriate steps so that human resources, including scavengers, are protected from the impact of the accumulation of electronic waste.

Innovative steps that can be taken by the government, as a facilitator, waste management must be carried out efficiently using city resources. As a dynamist, the government can take steps to manage waste to restore natural resources (resources recovery). Finally, the government as a dynamist, where the steps that can be taken are to separate non-hazardous waste management areas from settlements and institutions in the metropolitan area which is usually the responsibility of the local government, while waste from commercial and industrial areas is usually handled by waste processing companies. It is important for the government and the people of Indonesia to have high awareness in terms of good and correct waste management.

5. CONCLUSION

The results conclude that Indonesian government has classified e-waste as hazardous and toxic waste. Government Regulation No. 101 of 2014 and Presidential Regulation No. 97 of 2017 concerning Management of Toxic and Hazardous Waste regulate the management of household waste and similar household waste. However, the findings highlight that electronic waste in Indonesia until now does not have clarity in management, regulation, and economic potential that can be worked on. E-waste is generally classified into hazardous and toxic waste so that it refers to Government Regulation No. 101 of 2014 concerning Management of Toxic and Hazardous Waste. There are several methods of managing e-waste in Indonesia, namely clinical processing methods, physical processing methods, biological processing methods, hazardous waste disposal method.

As a practical implication, utilization and proper management of electronic waste has a positive aspect to society, namely by increasing the economic value of the waste, given that unmanaged electronic components that cannot be recycled or repaired will only become a pile of garbage. The pattern of people's lives that have changed to tend to be consumptive is not equivalent to the level of public awareness of the problem of electronic waste. It is something that must be addressed for the Indonesian people to be able to have awareness of the processing of goods that are no longer used.

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