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Comparative Study of Electronic Waste Management in Developed Countries and Indonesia

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Abstract Electronic waste management in Indonesia is currently not a major concern for various parties and is relatively left behind when compared to developed countries. This study aims to evaluate the existing conditions of electronic waste management in Indonesia and compile recommendations for electronic waste management programs in Indonesia. This research was conducted by collecting primary data from questionnaires and collecting secondary data from the literature on electronic waste management in developed countries (United States, Japan, and Switzerland) and Indonesia. The collected data were compared and analyzed for compiling strategy in the SWOT (Strengths, Weaknesses, Opportunities, Threats). The recommendation programs for electronic waste management in Indonesia were established based on SWOT Matrix. The study suggests that the existing conditions of electronic waste management in Indonesia are lagging compared to developed countries. The 4R programs (Reduce, Reuse, Recycle and Remove) should be applied to electronic waste management program. It includes *dropbox* for electronic waste collection, development of formal electronic waste management infrastructure, industrial revitalization / private electronic waste recycling facilities, development of electronic waste landfill, application of economic instruments for electronic manufacturers, *Extended Producer Responsibility* (EPR) for electronic equipment, trade-in for all electronic products, and cooperate with the informal sector.

Keywords: Developed countries, Electronic waste, Program recommendations, SWOT analysis, Waste management.

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1. Introduction

Using technology today is almost inseparable from everyday life. The development of various kinds of technological products continues to progress, both in terms of models and the use of technology. The need for the use of various kinds of technological products will continue to increase along with the population growth rate which also continues to increase, but because of people who frequently replace their electronic goods, a problem arises, namely the production of waste comprising electronic goods or what is commonly called with electronic waste [1]. Electronic waste (e-waste) is a general term that includes various forms of old electrical and electronic equipment, electronic equipment that is no longer durable and no longer valuable to its owner [2].

Based on the 2018 Indonesian Environmental Statistics, in 2016 the amount of domestic waste generation in Indonesia reached 65,200,000 tons [3], while based on the report of The Global E-waste Monitor 2017 in 2016, Indonesia produced an electronic waste of 1,274,000 tons [4]. It means that the percentage of electronic waste compared to domestic waste is only 1.95%. However, the waste is categorized as hazardous waste because it contains components that have dangerous and toxic properties such as mercury, lead, cadmium, chromium, arsenic, polychlorinated biphenyls, etc. which are harmful to human health and the environment [1]. These components are toxic materials that are very persistent and can accumulate so that if electronic waste is not managed properly, these chemicals can be released and pollute the environment. The high rate of electronic waste generation causes the accumulation process of pollution to be fast and has a very dangerous impact on health and the environment [5].

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Using electronic devices in developed countries is greater than in developing countries. It causes the amount of electronic waste generated in developed countries are higher than in developing countries [6]. Based on The Global E-waste Monitor 2017 report, the United States, Japan, and Switzerland are considered the best-developed countries in their respective continents in e-waste management, because, on the American continent, the United States collects more electronic waste compared to Canada, on the Continent. Asia, Japan is among the first countries in the world to implement an EPR (Extended Producer Responsibility) -based system for electronic waste, and in Europe, the best-performing country in terms of e-waste collection in Switzerland [4]. E-waste management in developed countries involves consumers, producers, recyclers, and the government, also, developed countries have specific regulations regarding electronic waste management [7]. In Indonesia formally, there is no national or local level regulation to manage electronic waste in Indonesia. The industry as a producer of electronic devices does not yet have the obligation to manage its electronic waste [8]. Electronic waste disposal is a very complex activity and requires better technology and knowledge. The toxicity and hazardous content of the waste are a major source of environmental degradation and can threaten health [9]. Management of electronic waste that ignores environmental management will cause uncontrolled contamination of heavy metals and toxic compounds that are cross-border [1].

Based on the description above, a solution is needed to overcome those problems, therefore this study aims to study the regulations and policies for electronic waste management in developed countries. The policies and regulations for electronic waste management in developed countries will then be a basis for studies in analyzing the application of electronic waste management following conditions in Indonesia. The best practices are then used in the SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis in making strategies and compiling recommendation programs for electronic waste management in Indonesia.

2. Experimental Methods

The research stages began with literature studies conducted to find information and theory which would later a reference and basis for carrying out this research related to electronic waste management in developed countries and Indonesia, the data collection comprising primary data and secondary data was carried out. This primary data is used to support data got from articles or literature and can also be useful to complement data that cannot be got from articles or literature. Secondary data were got from articles/literature on electronic waste management in developed countries and Indonesia.

Primary data got from filling out a questionnaire. There were two respondents to this questionnaire, namely the Padang City Environment Agency as the government and community representatives. Retrieval of primary data from the two respondents in this study is considered representing the existing conditions of electronic waste management in Indonesia because the government is the allowed party and makes regulations related to electronic waste management and the public who are the largest consumers and source of electronic waste in Indonesia. The questionnaire for the Padang City Environmental Service will be filled in by representatives of the Padang City Environmental Service Office. The limitation of the sample area for the questionnaire to the public as long as it is in the territory of Indonesia so that the results can be more representative of the community, The minimum number of respondents was determined, namely 60, with details divided into two target groups differentiated by the location of residence. The purpose of dividing into two target groups is so that the questionnaire is more representative because it is assumed that there are differences in habits, knowledge, and management of electronic waste from people living in urban areas and people living in Nagari / rural areas, where the minimum number of respondents is 30 for people who live in urban areas and 30 for people living in Nagari / rural areas, this figure is based on Roscoe's statement [10] that is if the sample is divided into categories/subsamples (in this study, the location of the respondent's residence) then the number of sample members for each category/subsample is at least 30. The purpose of distributing this questionnaire is to determine the condition of electronic waste management carried out by the government and public knowledge regarding electronic waste and its management so that it can use for seeing the existing condition of electronic waste management in Indonesia and its problems.

Secondary data were got from literature studies to collect information on electronic waste management in developed countries and Indonesia. Another information got is the existing condition of electronic waste management in Indonesia. The weaknesses that exist in this evaluation of existing conditions are then recommended to be corrected by referring to electronic waste management in developed countries, this evaluation is carried out before compiling recommendations for electronic waste management programs. This aims to see a picture of electronic waste management in Indonesia today, where this is the output of evaluating existing conditions so that later the recommended program is adjusted to the existing conditions of electronic waste management in Indonesia.

The SWOT analysis carried out involves the relationship between internal factors and external factors in the existing conditions of electronic waste management in Indonesia, which will be analyzed based on strengths, weaknesses, opportunities, and threats to strategies and standards decision making and to reinforce the rationale of the recommended program. The steps in conducting a SWOT analysis in this study started from determining the aspects of strengths, weaknesses, opportunities, and threats related to the existing conditions of electronic waste management in Indonesia which were got from the results of a literature review and questionnaire then carried out determining the rating/value of influence and weight on the analysis of internal and external factors to see the value of the internal and external factors determined using expert judgment or expert judgment in their field, in this study the lecturers of the Expertise Group of Management of Solid Waste Management Environmental Engineering, Andalas University, which consists of four people. The rating/value of influence and weight on the analysis of internal and external SWOT factors are then used to see the position/quadrant of the existing condition of electronic waste management in Indonesia. The position/quadrant of electronic waste management in Indonesia in the SWOT analysis is then used as a reference and consideration in providing strategic recommendations in the SWOT matrix. The strategy in the SWOT matrix is the result of a combination of information got based on a SWOT analysis of internal and external factors on the existing conditions of electronic waste management in Indonesia with information on the proposed evaluation results of the existing conditions of electronic waste management in Indonesia, then a conclusion is drawn about the electronic waste management program Indonesia which is appropriate and suitable for implementation, where these recommended programs are expected to create a good and well-established electronic waste management system in Indonesia as has been implemented in advance by developed countries.

3. Result and Discussion

This online questionnaire was filled in by the community and the Padang City Environmental Service from 29 to 31 May 2020. The number of respondents on the questionnaire to the community was 108 respondents (35 respondents lived in Nagari / rural areas and 73 respondents lived in urban areas), while the second questionnaire was The Environmental Office of the City of Padang is filled with 1 respondent. In Table. 1 can be seen recapitulation of electronic waste problems from the results of the questionnaire.

Table 1. Recapitulation of Electronic Waste Problems from the Questionnaire Results

Item	Problem
Technical Aspects	
Source	• Based on this questionnaire, 70% of people have electronic waste at home, this figure is high. • Electronic waste, which is mostly owned by the community, is electronic equipment that is often found in everyday life, namely cellphones, fans, TVs, lights, and DVD / VCD players. • Based on the results, it can also be seen that public knowledge regarding electronic waste has not been maximized, especially regarding electronic waste management. • Most actions taken by the community towards electronic waste are storing it at home (by 51%), and there are still people who just throw away their electronic waste.
Collection / transportation	Based on the questionnaire filled out by Padang City Environment Agency, there has been no action of collection/transportation in electronic waste management.
Processing	• Based on this questionnaire, there is no evidence of any electronic waste processing actions carried out by the Padang City Government.
Landfill	• This non-existent processing of electronic waste shows that so far electronic waste has been mixed with municipal waste in the landfill.

Item	Problem
Non-Technical Aspects	
Regulation	Padang City Environment Agency stated that currently in Padang City there is still no specific regional regulation/regulation regarding electronic waste.
Institutional	The institution that is supposed to handle the problem of electronic waste in Padang City is the Padang City Environmental Service.
Financing	• Another problem faced by Padang City Environment Agency Kota Padang is the limited funds it has. • There are no regulations regarding user fees related to electronic waste management in Padang City.
The role of society	Public knowledge regarding electronic waste is quite good, but the actions taken by the community towards electronic waste vary because they do not have clear management references.
The role of the producer or manufacturer	• The results of the questionnaire stated that the public did not know that electronic equipment manufacturers in Indonesia handled the electronic waste they produced. • This shows that electronics manufacturers have not processed the generated electronic waste.
The informal sector	The results of the questionnaire show that many community actions choose to repair electronic waste, just throw away electronic waste and also sell electronic waste. It can be assumed that these actions usually involve the informal sector, such as repairmen, scavengers, collectors, and collectors, so it is likely that electronic waste is mostly handled by the informal sector rather than by the formal sector.

A literature review is carried out on electronic waste management in developed countries and its comparison in Indonesia. The aspects that are compared comprise technical aspects and non-technical aspects. In Table. 2 can be seen recapitulation of electronic waste management in developed countries and Indonesia.

Table 2. Recapitulation of Electronic Waste Management in Developed Countries and Indonesia

Item	Country			
	United States of America	***Japan***	***Switzerland***	***Indonesia***
		Technical Aspects		
Source	• The generated of e-waste is 6,295,000 tons or 19.4 kg / capita [4]. • Sources of electronic waste in the United States come from factories, households, the business sector, public facilities, and imported products [11].	• The generated of e-waste is 2,139,000 tons or 16.9 kg / capita [4]. • The major source of electronic waste in Japan comes from household appliances, such as televisions, air conditioners (AC), washing machines, refrigerators, computer monitors, and cell phones [7].	• The generated of e-waste is 184,000 tonnes or 22.2 kg / capita [4]. • Most electronic waste in Switzerland comes from office equipment, IT and telecommunication s equipment, consumer equipment, graphic equipment, and household electronic equipment (white goods) [12].	• The generated of e-waste is 1,274,000 tons or 4.9 kg / capita [4]. • The source of electronic waste in Indonesia comes from domestic consumption, electronic waste is also found from imports, the black market, and comes from ports throughout Indonesia [7].
Collection / transportation system	Current e-waste collection programs in the US include roadside collection, short-term drop-off events, permanent drop-offs, and take-back programs [13].	Residential electronic waste is collected by retailers for transport to recycling facilities [14].	The generated electronic waste must be collected by consumers [15].	The unavailability of collection patterns and means of electronic waste transportation [16].
Processing system	Small-scale pyrometallurgical processing plants are the choice for	Manufacturers can recycle electronic waste at their recycling facilities or through third parties [18].	The e-waste recycler is contracted by one of the PRO (Producer Responsibility Organization) or	There are still few industries that have permits for the use (dismantling, recycling, and

Item	Country			
	United States of America	***Japan***	***Switzerland***	***Indonesia***
	recycling e-waste in the US [17].		another suitable scheme [19].	recovery) of electronic waste in Indonesia [1].
End system	The US EPA estimates that of the 3.4 million metric tonnes of e-waste are ready for disposal by 2012. 2.42 million tonnes (71%) end up in landfills using landfill technology [20].	With the exit Law for the Promotion of Effective Resource Use (LPEUR) hence the reduction and recycling of electronic waste is increasingly needed, before finally the electronic waste is disposed of in smaller and smaller landfills [21].	Approximately 3% of the weight of the material that enters the recycling system ends up in landfills [22].	Electronic waste no longer has a selling value is thrown into the landfill [7].
	Non-Technical Aspects			
Regulation	There are no national regulations on e-waste yet, but 25 states have their regulations [7].	It has two main regulations, namely the Law for the Promotion of Effective Utilization of Resources (LPEUR) 2000 and the Law for the Recycling of Specified Kinds of Home Appliances (LRHA) 2001 [7].	The regulations that regulate electronic waste are Ordinance on The Return, the Taking Back, and the Disposal of Electrical and Electronic Equipment (ORDEE) in 1998 [15].	There are no national or local level regulations for managing electronic waste in Indonesia [8].
Institution or organization	The handling of e-waste in the United States is nationally regulated by the US EPA (*Environmental Protecting Agency*) [7].	The responsibility for managing electronic waste in Japan is carried out by two ministries, namely the Ministry of Economy, Trade, and Industry (METI) and the Ministry of Environment (MOE) [23].	The handling of electronic waste in Switzerland is carried out by four organizations, namely SWICO, SENS, SLRS, and INOBAT [14], [15].	The agency that regulates the problem of hazardous and toxic waste in Indonesia, such as electronic waste, is the Ministry of Environment and Forestry [24].
Financing	Some states do not charge consumers a fee, but states like Florida charge fees ranging from $6-$10[13], [25].	Ranging from 1,500 to 4,800 yen [26]	Charges depend on the type of electronic equipment, ranging from 1 CHF to 1500 CHF [27].	In developing countries, such as Indonesia, there are no charges for transportation and recycling of electronic waste [7].
Community participation	The role of consumers in the United States namely deliver electronic goods to delivery centers (drop off) [28].	The consumer hands overused household appliances properly, incurring costs for the collection and recycling of used household appliances [29].	Duties and responsibilities of consumers, namely return used electronic equipment to the merchant or e-waste collector and pay a recycling fee every time you buy a new electronic device [14].	Electronic equipment that is no longer in use condition has a different treatment, society has different ways of treating electronic products that are no longer functioning [30].
Manufacturer / manufacture / factory	The role of the producer is to provide recycling services, consolidation, transportation from the consolidator to the	Reclaiming used household appliances that are produced or imported in-house from retailers, recycling used	Producers are fully responsible for the implementation and operation of electronic waste management and the financial	The industry as a producer of electronic devices does not yet have the obligation to manage its electronic waste [8], meanwhile,

Item	Country			
	United States of America	***Japan***	***Switzerland***	***Indonesia***
	processor, and processing costs [28].	household appliances by investing in building recycling infrastructure, and issuing household appliance recycling costs [29].	system in financing electronic waste recycling. Traders, importers, and factories must take back their products that are no longer used by consumers [14].	manufacturing plays a role to buy electronic components from wholesalers for reuse [30].
The informal sector	Much of the e-waste generated in the state is not recycled by state programs and does not comply with environmental standards, but is more likely to go to landfills or incinerators or to be recycled by unauthorized processors [25].	In Japan, the informal sector is only a secondary stakeholder group, local informal traders can collect equipment directly from consumers and export it to other countries [31].	In Switzerland, there is almost no informal sector, because many control and monitoring mechanisms exist for externalities such as emissions and health hazards. Financial and material flows are also monitored [18].	Electronic waste from the household sector is almost entirely handled by the informal sector because they are brave enough to pay high prices and there has not yet been a targeted system for collecting and transporting electronic waste [1].

Based on Table. 2 above, it can be seen that the management of electronic waste in developed countries is better than in Indonesia. The advantages of the management concept that have been applied in developed countries are planned to be a reference in making proposals for electronic waste management programs in Indonesia. But first, an evaluation of the existing conditions of electronic waste management in Indonesia is carried out based on literature and questionnaires to see an overview of proposals or recommendations for electronic waste management in Indonesia, as seen in Table. 3.

Table 3. Evaluation of Existing Conditions of Electronic Waste Management in Indonesia

Item	Existing conditions in Indonesia	Conditions in developed countries (United States, Japan, and Switzerland)	Suggestions / recommendations
Technical Aspects			
Source	The role of consumers is to collect electronic waste from the informal sector such as collectors [30].	Consumers already have a clear role to play in the United States, Japan, and Switzerland [14], [28], [29].	Consumers will deliver the generated electronic waste to a designated or collection point and as much as possible to minimize the generated electronic waste.
Electronic waste collection	Does not have a clear collection mechanism [16], based on the results of the questioner, 67% of people choose the method of a collection with a system where producers/retailers pick up electronic waste from their homes.	Already have clear e-waste collection systems in place in the United States, Japan, and Switzerland [13]–[15].	Collect electronic waste using the community delivering electronic waste to a collection center (drop-off) or appointing parties to pick up electronic waste from the community.
Processing	There are still few industries that have permits for the use (dismantling, recycling, and recovery) of electronic waste in Indonesia. Operations have not been maximized because of difficulties in obtaining sufficient quantities of raw materials (electronic waste) to operate the equipment [1].	Both formal and private parties are active in processing electronic waste in the United States, Japan, and Switzerland [17]–[19].	Pay more attention to the electronic waste recycling industry sector, so that the performance and efficiency of electronic waste processing in Indonesia can be maximized and the government must also add to the formal electronic waste processing infrastructure.
Landfill	The Ministry of Environment admits that until now Indonesia	Landfills in developed countries, such as Switzerland, are subject to relatively strict	The government is striving for a landfill that can process electronic waste residue and/or

Item	Existing conditions in Indonesia	Conditions in developed countries (United States, Japan, and Switzerland)	Suggestions / recommendations
	still does not have an electronic waste final disposal site [32].	and restrictive emission controls regarding materials accepted for final disposal in landfills [22].	can store electronic waste safely without harming the environment.
Non-Technical Aspects			
Regulation	Does not have a national regulation regarding electronic waste management [8] However, the results of the cake commissioner show that 96% of the public agree that the government makes regulations regarding electronic waste.	The United States, Japan, and Switzerland have clear regulations regarding e-waste management [7], [15].	The government makes regulations regarding electronic waste management and maximizes the application of existing regulations related to electronic waste management.
Manufacturer / manufacture / factory	The industry does not yet have the obligation to manage electronic waste like developed countries [8] However, the results of the commissioners showed that 91% of the people will take part in electronic waste management and 94% of the people agreed to the application of the principle of Extended Producer Responsibility (EPR).	The United States, Japan, and Switzerland use the concept of Extended Producer Responsibility (EPR) [7], [14], [25].	Implementing an electronic waste management policy with the principle of Extended Producer Responsibility (EPR) and producers must be able to create innovations related to electronic waste that are following the conditions or habits of the Indonesian people.
The informal sector	Almost entirely of electronic waste from households is handled by the informal sector [1]. This is also supported by the results of a questionnaire where the actions that the community will take against electronic waste are related to informal parties.	The informal sector can still be found in the United States, Japan, and Switzerland, but its role and number can be said to be less than in Indonesia [18], [25], [31].	The government is working with informal parties to find the best solutions for electronic waste management in Indonesia.

Evaluation of electronic waste management in Indonesia can also be carried out using a SWOT analysis. The initial stage in conducting a SWOT analysis is to analyze internal factors to identify the strengths and weaknesses that exist in e-waste management in Indonesia and analysis of external factors to identify opportunities and threats in waste management electronics in Indonesia. The results can be seen in Table. 4 and Table. 5 below:

Table 4. Analysis of Internal Factors for Electronic Waste Management in Indonesia

No.	Description	Strengths /Weakness	Rating	Weight	Total Value
			Value of Influence ± (1-4)		(Weight × Rating)
1.	Institution or organization	K	3.50	0.18	0.63
2.	Regulations	L	-3.50	0.16	-0.56
3.	The informal sector	K	3.50	0.12	0.42

No.	Description	Strengths /Weakness	Rating	Weight	Total Value
			Value of Influence ± (1-4)		(Weight × Rating)
4.	Manufacturer initiative	K	3.25	0.08	0.26
5.	Recycled results	K	2.00	0.06	0.12
6.	Industry producing electronic devices	L	-3.25	0.10	-0.33
7.	Electronic waste utilization industry	L	-2.75	0.07	-0.19
8.	Collection patterns and means of transportation	L	-2.50	0.06	-0.15
9.	Environmental awareness related to electronic waste management	L	-3.00	0.10	-0.30
10.	Government oversight	L	-2.50	0.07	-0.18
	Total			1	= -0.28

Table 5. Analysis of External Factors for Electronic Waste Management in Indonesia

No.	Description	Opportunities /Threat	Rating	Weight	Total Value
			Value of Influence ± (1-4)		(Weight × Rating)
1.	Electronic waste generation	P	3.75	0.16	0.60
2.	Recycling of the informal sector is strong	P	3.25	0.11	0.36
3.	The transnational electronics industry is welcoming the EPR discourse	P	3.25	0.12	0.39
4.	Critical attitude and consumer/community opinion	P	3.00	0.06	0.18
5.	Using technology products continues to increase	A	-3.25	0.07	-0.23
6.	The Indonesian Electronic Entrepreneurs Association disagreed with the mandatory EPR discourse	A	-3.25	0.10	-0.33
7.	The informal sector which handles almost all household electronic waste	A	-2.25	0.06	-0.14
8.	The recycling process is not environmentally friendly and endangers the health	A	-3.00	0.12	-0.36
9.	Many people do not know the dangers of electronic waste components for the environment and health	A	-2.75	0.06	-0.17
10.	Sources of electronic waste originating from imports, the black market, and originating from ports throughout Indonesia	A	-3.50	0.14	-0.49
	Total			1	= -0.19

The results of the rating/value of influence and weight on the analysis of internal and external SWOT factors are useful for seeing the position/quadrant of the existing conditions of electronic waste management in Indonesia. This position/quadrant will later consider in providing strategic recommendations in the SWOT matrix. Based on the results of the rating/value of influence and weight on the analysis of internal and external factors of SWOT for electronic waste management in Indonesia, the results of internal factors are -0.28 (negative) and external factors are -0.19 (negative). These results place the existing condition of electronic waste management in Indonesia in quadrant IV (negative, negative). In a diagrammatic manner, the position of electronic waste management in Indonesia can be seen in “Figure. 1,”.

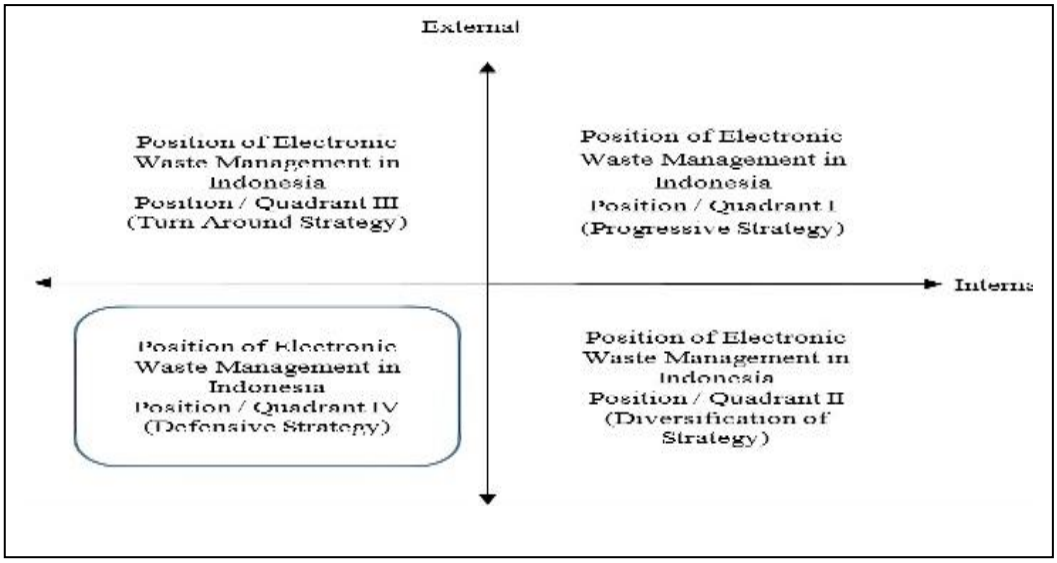


Figure 1. Position / Quadrant of Electronic Waste Management in Indonesia in the SWOT Analysis

The position/quadrant of e-waste management in Indonesia in the SWOT analysis requires Indonesia to use a survival strategy. Defensive strategy is a strategy that is used when the situation is very unfavorable, the management faces various internal threats and weaknesses so that the strategy is more defensive. Strategies and programs that are suitable for this survival strategy are strategies and programs that are suggestive or encouraging and simple but convincing, the reason is that existing threats can slowly be reduced or avoided and do not get bigger and internal factors must be corrected. so that its performance can improve from before. This survival strategy is broadly used as a reference and consideration in providing strategic recommendations in the SWOT matrix, where the points in this strategy are based on existing management studies in developed countries and the results of evaluating existing conditions in Indonesia (can be seen in Table. 2 and Table. 3) which can be seen in Table. 6.

Table 6. SWOT Analysis Matrix of Existing Conditions of Electronic Waste Management in Indonesia

External \ **Internal**	***Strengths***	***Weaknesses***
	• Institution or organization • The informal sector • Manufacturer initiative • Recycled results	• Regulations • Industry producing electronic devices • Electronic waste utilization industry • Collection patterns and means of transportation • Environmental awareness related to electronic waste management • Government oversight
Opportunities • Electronic waste generation • Recycling of the informal sector is strong • The transnational electronics industry is welcoming the EPR discourse • Critical attitude and	**S-O Strategy** 1. Electronic equipment manufacturers should make innovations that are following the conditions or habits of the Indonesian people, such as a trade-in program for all used electronic products owned by the community.	**W-O Strategy** 1. An appeal to hold a 4R program (Reduce, Reuse, Recycle and Remove) for electronic waste. 2. The government is trying to make efforts to provide drop boxes to collect community electronic waste.

consumer/community opinion	2. The government should cooperate with the informal sector (stalls, recycling, service providers, etc.).	
Threats	**S-T Strategy**	**W-T Strategy**
• Using technology products continues to increase • The Indonesian Electronic Entrepreneurs Association disagreed with the mandatory EPR discourse • The informal sector which handles almost all household electronic waste • The recycling process is not environmentally friendly and endangers the health • Many people do not know the dangers of electronic waste components for the environment and health • Sources of electronic waste originating from imports, the black market, and originating from ports throughout Indonesia	1. The government should implement economic instruments for electronic equipment manufacturers. 2. The government calls for an appeal to carry out Extended Producer Responsibility (EPR) for electronic equipment manufacturers voluntarily. 3. The government should cooperate with the private sector to carry out industrial revitalization / private electronic waste recycling facilities. 4. The government should provide a special landfill facility for electronic waste.	1. The government should build a formal electronic waste management infrastructure using environmentally friendly technology.

The strategy that resulted from this SWOT analysis was then proposed to become an electronic waste management program in Indonesia. The proposed program can manage electronic waste from source to final processing. The following is a flowchart of recommendations for electronic waste management in Indonesia, which can be seen in “Figure. 2,".

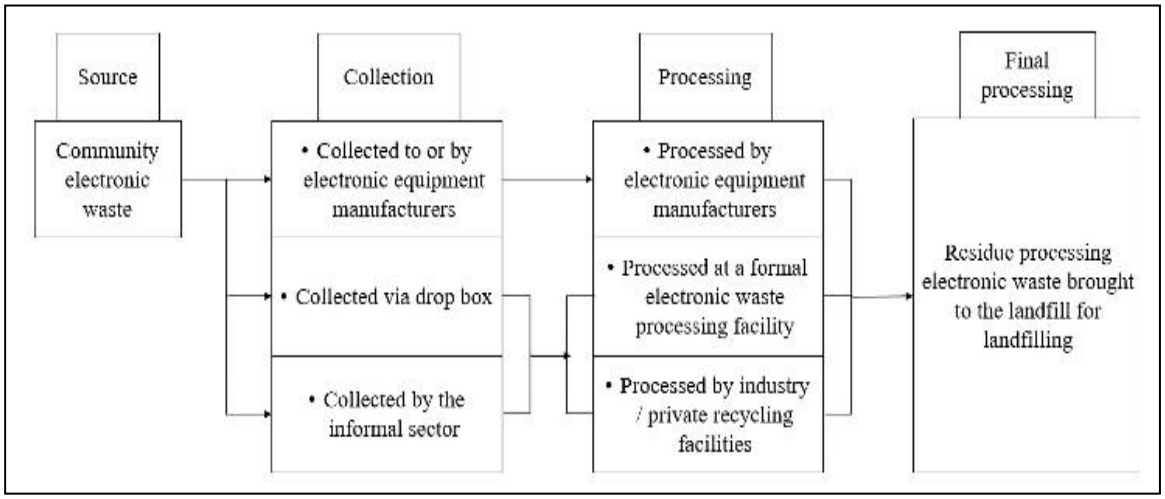


Figure 2. Flowchart of Recommendations for Electronic Waste Management in Indonesia

4. Conclusion

Based on the results of the study of electronic waste management in developed countries and its comparison in Indonesia, it shows that electronic waste management in Indonesia, both technical and non-technical, are lagging when compared to developed countries. This is also reinforced by the results of the rating/value of influence and weight on the analysis of internal and external SWOT factors for electronic waste management in Indonesia, namely -0.28 (negative) and -0.19 (negative), which places

electronic waste management in Indonesia at position/quadrant IV, so it can be concluded that the internal and external factors of the existing condition of electronic waste management in Indonesia are problematic and need to be improved. The strategy that is suitable for implementing electronic waste management in Indonesia based on this quadrant is to improve itself while continuing to strive to control internal performance.

By considering the strategies generated in the SWOT analysis and the results of questionnaires and literature reviews on electronic waste management in developed countries and Indonesia, then a recommendation program for electronic waste management in Indonesia is deemed appropriate and suitable for implementation, namely: 4R programs (Reduce, Reuse, Recycle and Remove) for electronic waste; *Dropbox* to collect electronic waste; Development of formal electronic waste management infrastructure; Industrial revitalization / private electronic waste recycling facilities; Development of electronic waste landfill; Application of economic instruments for electronic equipment manufacturers; *Extended Producer Responsibility* (EPR) for electronic equipment; Trade-in for all electronic products; and cooperate with the informal sector.

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