EPR Approach for Better Waste Management System for Mobile Phone Design in Indonesia

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Abstract. The influence of toxic electronic waste or electronic goods will occur if it is disposed of carelessly or managed in the wrong way. Open dumping and crude waste handling in landfill sites in Indonesia creating even more miserable situation (Damanhuri, 2010). Mobile phone or cell phone is considered as one of the fastest growing device in global society. More than 60% of global population have mobile phone, end even an individual may have more than one device. EPR could be taken as strategy in order to find better e-waste management of renewable and non-renewable resources specifically for Indonesia situation. EPR related action of WEEE in Indonesia is still uncertain especially for mobile phone product. It is observed that many used mobile phones are still disposed improperly by unauthorized party and may danger the people and environment. This study will observe how the mobile phone waste is handled by unorganized organization, how EPR is taken into account in mobile phone waste management system and what kind of solution that is based on EPR that could enhance environmentally save property of mobile phone design in the future, especially for Indonesia situation. It is important by considering Indonesian situation; the producers need to employ new design strategy not merely in order to meet regulation compliances but should extend the responsibility for better waste management friendly product design that is more suitable with Indonesia situation with minimum waste management infrastructure by involving End-of-Life Design Solution; better collection, separation, recyclability, reuse and ease of manufacture

Keywords: EPR, waste management, product design

1. Introduction
The problem of electronic waste or E-Waste can hazardous to human health and environment. This is due to the effect of dangerous toxic substances such as lead, mercury, chromium, cadmium, PBDE, and other heavy material if they are not managed properly. The influence of toxic electronic waste or electronic goods will occur if it is disposed of carelessly or managed in the wrong way. Open dumping and crude waste handling in landfill sites in Indonesia creating even more miserable situation (Damanhuri, 2010), Aboughaly and Gabbar (2019) in their study mentioned over 50 million metric tonnes of electronic-waste annually across the world from abandoned equipment. Jakarta Provincial Environment Agency has processed more than one ton of electronic waste for the accumulation period from January to June 2019 (merdeka.com). Most of the waste were still being kept in large storage and the local government still need to collaborate with other third party for further recycling processes. However, the number of waste will increase significantly in near future due to the rapid development of
technology and electronics industry that lead to the increasing consumption of electronic products which already becoming daily necessities.

Mobile phone or cell phone is considered as one of the fastest growing device in global society. More than 60% of global population have mobile phone, and even an individual may have more than one device. Heavy consumerism and tight competition among manufacturers also lead fast consumption by releasing new models each year. In Indonesia, the increasing numbers of electronic-waste of mobile phone should be taken into account by the manufacturing industry (producers), brand distributors and governments to draw attention to deliver better waste management system, and it is related to Extended Producers Responsibility (EPR) and Waste of Electrical and Electronic Equipment or WEEE (Börner and Hegger, 2018). EPR concept could be taken as strategy in order to find better e-waste management of renewable and non-renewable resources specifically for Indonesia’s situation. EPR related action of WEEE in Indonesia is still uncertain especially for mobile phone industry. It is observed that many used mobile phones are still disposed improperly by unauthorized party and may danger the people and environment. This study will study how the mobile phone waste is handled by unorganized organization, how EPR is taken into account in mobile phone waste management system and what kind of solution that is based on EPR that could enhance environmentally save property of mobile phone design in the future, especially for Indonesia situation.

2. Method

This study employs qualitative method through three steps of processes:

![Study Method](image)

This method is adapted from previous research by Börner and Hegger (2018) and Thorpe, et.al (2004) that build theoretical framework by taking E-Waste Governance (government regulation) and EPR strategy. Firstly, it will investigate WEEE related problems with Indonesian government regulations and EPR related issues by examining the literature of previous studies. Secondly, it would observe waste management problems of mobile phone concerning EPR cycle in society. By investigating the observed situation of unauthorized mobile phone service centre, to find some insights for proposed concept. Mobile phone components will be examined from the aspect of ease of dismantle through simple simulations with standard equipment. This is to see how difficult the component is disassembled and how it will effect on the EPR cycle. Thirdly, alternative design solutions of how EPR approach might be implemented in the design development of new products.

3. Results and Discussion

3.1. Regulations and EPR issues

The Government of Indonesia Hazardous Waste Management Regulation: Act No.32/2009 concerning Environmental Protection and Management: Definition of Hazardous Waste Management (Article 1, point 23): Hazardous Waste Management shall be an activity covering the reduction, storage, collection, transportation, utilization, treatment and/or the pilling.

Damanhuri and Padmi (2009) explain some of the central issues regarding EPR of Law No. 18/2008 for example; every producer should indicate a label on their product how to proper handling of hazardous waste. Furthermore, the government regulations also imply how to manage hazardous waste as follows:

- The entire chains of waste transporting system shall apply for waste and recycling system since their first origin until final disposal;
- Selection of waste processing and dumping technologies that are safe and healthy, and conform with Indonesian situation;
• Open dumping and burning are forbidden and during five years after the passing of the law, open dumping would be completely banned; and prohibition to import waste into Indonesia territories, and to mix waste with dangerous wastes.

EPR or Extended Producer Responsibility or also called “Producer Takeback” (Thorpe, et.al. 2004) is the policies that should involve closed loop scenario in material management and should be thereof managed and processed by reusing or recycling the materials into new product or other packaging products with less energy consideration rather than producing new product from new material. This approach replaces traditional linear thinking and is based on the concept of supply chains manufacturing system, retailers and the consumer all share in end-of-life product management. In addition, recycling programs as part of the EPR, like existing now, cannot handle all of the hazardous waste. Thorpe, Kruszeska and McPerson (2004) mentioned that producers shall take bigger responsibility in recycling process from the product they had produced and design new product from the reused or recycled materials.

Chatterjee (2012) mentioned that there are two common practices in e-waste management system conducted by organized and unorganized sectors. The unorganized operators in India for example, according to Chatterjee are facing difficulty of save recycling technology. Furthermore, this practice needs to be reconsidered by providing alternative collecting mechanism by the unorganized operators. Therefore, unorganized operators will concentrate on collection, disassembly, segregation of e-waste, while, organized sector will concentrate on processing the PCBs to extract precious metals.

Thorpe et.al (2004) suggested that in order creating a strong, long-lasting Extended Producer Responsibility (EPR) program, the following elements should be included in the program design:
• Individual responsibility that is when a producer takes the end-of-life management of their own products, whereas they involve on cost sharing in the recycling process of their end-of-life products.
• Company can redesign their products to enhance durability, ease of repair, reuse, disassembly or recycling by their own initiative.
• Government mandate and regulations in the participation of takeback programs that will stop unorganized/illegal party from ruining the overall program.
• Reuse and recycling requirements: the number of minimum reuse and recycling materials as a major driver for design change need to be established. In addition, other method of waste processing with using large amount of energy should not be considered, this will imply to new directive of design to achieve full recover materials by employing reuse and recycling method.
• EPR programs need to consider for orphan (products still in used but whose producers no longer exist) and historic waste, as well as current end-of-life product waste. Years ago product designers did not design for reuse or recyclability. However, this waste must be dealt with. Designers or producers need to rethinking the possibility of the product become orphan waste. For example; Blackberry which no longer producing mobile phone, who is taking this responsibility?

3.2. End Of Life Phase and Design Implementation
Huang, et.al. (2019) implied that there is strong correlation between durability and recyclability choices. They further explained that the more rigid recycling targets, it would lead to the increase recyclability and durability. So in terms of EPR, producers might need to find better recycling method to find valuable recycling materials in order to create more durable products as well as recyclability. Huang et.al. (2019) also stated that easier recycle of product design will increase recycling value at the end-of-life phase and durable product design will reduce the total volume has to recycle, and will lead to cost reduction as well.

The example of design implementation in end of life phase is conducted by Apple, Inc. Since 2017, Apple has been trying to use recycled and renewable raw materials. The raw material is designed so as not to produce too much waste and to have a long service life. When the product reaches the end of life phase, Apple ensures that the product returns back to the company using the trade in system, and the material will be recycled to become a new product. The strategy used is to create a circular supply chain
with strategies as follow; designing and building products and packaging. Make a durable product by designing a durable hardware, providing repair services in various places. Collect products in the end of life phase through ‘Apple Trade In’ to extend the service life or utilize existing materials.

3.3. Observations

| No. | Observation | Results | Pictures |
|-----|-------------|---------|----------|
| 1.  | Friday, 18 October 2019 – E-centre Supermall Karawaci Christine Phone Cell | • Parts / components that can still be used will be used for personal testing.  
• Spare parts that are not used or outdated parts will be collected and thrown into the trash bin, because no people or institutions want to take or buy.  
• There is no specific waste management system for e-waste components. | ![Picture 1] |
| 2.  | Friday, 26 October 2019 – E-centre Supermall Karawaci Cinta Karya Cellular | • Parts / components that can still be used will be stored inside.  
• Parts that cannot be used anymore will be thrown to trash bin, because there are no people or institutions that want to take or buy.  
• There is no specific waste management system for waste parts around the location.  
• Phone Distributors do not care about broken cell phones or spare parts waste in the individual service center area. | ![Picture 2] |
| 3.  | Friday, 26 October 2019 – E-centre Supermall Karawaci Permata Service | • Parts or components that can be used will be stored  
• Parts that are not used are only stored / for shop displays  
• Most of the waste spare parts collected are LCD and batteries  
• There are people who want to buy LCD parts that still work | ![Picture 3] |
| 4.  | Wednesday, 6 November 2019 - E-centre Supermall Karawaci Bagas Cellular | • Spare parts that are still have function will be reused. Broken parts were sold to waste collectors.  
• PCB parts can actually still be used, but because of the small number of requests, so inevitably they are discarded  
• There is no special processing or management system in this service place.  
• Theres is no special waste disposal site for electronic waste around, and there is no system / regulation that requires the safe sorting and disposal of electronic waste | ![Picture 4] |
| 5.  | Wednesday, 6 November 2019 - E-centre Supermall Karawaci King Service | • Parts that cannot be used are immediately thrown in the trash.  
• There is no spare parts waste management system. Cause: there is no special waste disposal site for electronic waste, and there is no system / regulation that requires the safe sorting and disposal of electronic waste.  
• The owner feels there is no need for an unused component management system, because all this time when the component is disposed of, he feels safe | ![Picture 5] |
3.4. Analysis of EPR stages and current situation

Table 2. Analysis of EPR stages, issues and current situation

| No | EPR stages | Regulations and issues | Current situation |
|----|------------|------------------------|-------------------|
| 1. | Collection | The entire chains of waste transporting system shall apply for waste and recycling system since their first origin until final disposal. Incentive mechanism for takeback program. | There is no spare parts waste management system. Cause: there is no special waste disposal site for electronic waste, and there is no system or rules that requires the safe sorting and disposal of electronic waste. Spare parts that are not used or outdated parts will be collected and thrown into the trash bin, because no people or institutions want to take or buy. There is no government mandate in terms of incentive mechanism for takeback program. |
| 2. | Processing/separation | Selection of waste processing and dumping technologies that are safe and healthy. In the case of everybody being incapable of treating Hazardous Waste individually, the treatment shall be entrusted to other party. | Plenty of unorganized party still practicing unsafe process and there is no safety standard applied. There are only 2 dry cell batteries collection and smelters in Central Java. |
| 3. | Recycling | Hazardous Waste Management shall be an activity covering the reduction, storage, collection, transportation, utilization, treatment and/or the piling. | Most of existing Municipal Solid Waste management system in Indonesia, relies on the existence of landfill (open dumping) (Damanhuri and Padmi, 2009) |
| 4. | Reuse | Make recondition based on the product standard regulation. Responsible for managing their waste from the production process. | Spare parts that are still have function will be reused. Broken parts were sold to waste collectors. There is no control from the producer regarding standard regulation compliance. |
| 5. | Material extraction | Material extraction process should be conducted by employing environmental friendly process and not to consider other unsafe methods. | Most of the e-waste are disposed in open dumping and there is unclear situation regarding material extraction process from the e-waste especially from mobile phone e-waste. Some illegal parties are practicing unsafe process of extracting, and mostly use incinerating process to eliminate the rest of unused parts. |
| 6. | Manufacturing | Producers are responsible to monitor the waste handing from collecting, processing, and recycling to manufacturing. Producers are obligated to design environmentally safe product design. | All mobile phone producers are located outside Indonesia. |

3.5. Analysis of mobile phone components
Ease of dismantling/disassembly is one of the key points in EPR process (Thorpe et.al, 2004). Table 3 shows three different types mobile phones that were dismantled to simulate how difficult the dismantling process is undertaken by illegal party or personal user. Four major components were dismantled by using ordinary tools such as screwdriver, pliers, heat gun etc. Each component is given score range 5 (the most difficult) to 1 (the easiest). It is shown that iPhone has lower average score (2.75) that is easy to dismantle, and ASUS has highest score (4.75). It is indicated that in overall, the separation process is considered has medium to high ease of separation. For uni-body type of phone employs adhesive and
make it harder to get dismantled. There are still plenty of mobile phone designs which do not provide ease of dismantling.

Table 3. Analysis of mobile phone dismantling process

| Mobile Phone Type | Battery pack | LCD screen | PCB | Housing structure | Score |
|-------------------|--------------|------------|-----|-------------------|-------|
| A. iPhone          | 5            | 2          | 3   | 1                 | 2.75  |
| B. ASUS            | 5            | 5          | 5   | 4                 | 4.75  |
| C. Samsung         | 1            | 4          | 4   | 3                 | 3     |

3.6. The importance of mobile phone waste management
The importance of mobile phone waste management is eminently needed for following reasons;
• The amount of mobile phone waste is bad for the environment. It is often neglected by the unorganized sector that will lead to environmental damage and depletion of natural resources of secondary material.
• Electronic waste containing precious metal base materials (some are dangerous) need to be processed properly and cannot just be reused just like that.
• Lack of effort in e-waste collection in Indonesia. The recycling technology used is improper or lack of knowledge.
• Recycling electronic waste with proper handling will reduce the share of mining and therefore will reduce glass house effect emissions.
• Recycling with the use of appropriate systems and technologies, and safe for the environment reduce carbon footprint.

3.7. Proposed Solution
From the above discussions, then solution is proposed; to create mobile phone design concept that is easily recycled using the Extended Producer Responsibility system approach. This will involve users in mobile waste management and treatment systems in a closed-loop cycle. In terms of EPR, this study would like to propose End-of-Life phase design concept that is focusing on easy recycle product design (Huang, et.al 2019) which covering several issues; collecting process, pre-treatment (separation), material recovering method, and safe disposal concept. This end-of-phase concept is taken into account as a bottom up approach to see deeper problem of Indonesia situation related to EPR life cycle. The design concept implementation into practice might rethinking that each mobile phone components are easy to dismantled and replaced when its broken and could be marked so can be separated directly by the mobile phone service parties (authorized or unauthorized). This will include the service and system design that will relate to EPR application so that can comply with government regulation (i.e. Law No. 18/2008).
Table 4 below explains the variable design solutions that are associated with values in the EPR cycle. Score 1 is considered applicable that affect in all EPR cycles, and score 0 is not applied or is not related to EPR process. In the table it can be seen that the ease of dismantle gets the highest total score (5) so that it can be used as the main focus in the design of mobile phones that are capable of supporting electronic waste management. Followed by providing safe disposal system, minimizing usage of hazardous materials and takeback program.

| Design solution variable                  | Better collecting | Better process/separation | Better recyclability | Better reuse material | Ease of manufacture | Score |
|------------------------------------------|-------------------|---------------------------|----------------------|-----------------------|---------------------|-------|
| Easy to dismantle components/parts       | 1                 | 1                         | 1                    | 1                     | 1                   | 5     |
| Provide safe disposal system             | 1                 | 0                         | 0                    | 1                     | 1                   | 3     |
| Minimizing usage of hazardous materials  | 0                 | 1                         | 1                    | 0                     | 1                   | 3     |
| Incentive system in takeback program     | 1                 | 0                         | 0                    | 1                     | 0                   | 3     |

4. Conclusion
The study shows that EPR has not well implemented in Indonesia especially in handling mobile phone waste issues. Unauthorized service and illegal party are still neglecting the safe treatment due to lack of awareness and technology. Hence, it is important by considering Indonesian situation; the producers need to employ new design strategy not merely in order to meet regulation compliances but should extend the responsibility for better waste management friendly product design that is more suitable with Indonesia situation with minimum waste management infrastructure by involving End-of-Life Design Solution; better collection, separation, recyclability, reuse and ease of manufacture. Further research might be needed to find the correlation between design variables and EPR values through statistical analysis.

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5. References
[1] Aboughaly, M and Gabbar, HA 2019 Recent Technologies in Electronic-Waste Management. In E-waste Recycling and Management (pp. 63-80). Springer, Cham.
[2] Börner, L and Hegger, DL 2018 Toward design principles for sound e-waste governance: A research approach illustrated with the case of the Netherlands. Resources, Conservation and Recycling, 134, pp.271-281.
[3] Chatterjee, S 2012 Sustainable electronic waste management and recycling process. American Journal of Environmental Engineering, 2(1), pp.23-33.
[4] Damanhuri, E and Padmi, T 2009 Current situation of waste recycling in Indonesia. 3R Policies for Southeast and East Asia; Kojima, M., Damanhuri, E., Eds, pp.23-52.
[5] Damanhuri, E 2010 Solid and hazardous waste management in Indonesia. A paper. Bandung.
[6] Huang, X, Atasu, A and Toktay, LB 2019 Design implications of extended producer responsibility for durable products. Management Science, 65(6), pp.2573-2590.
[7] Kumar, A and Holuszko, M 2016 Electronic waste and existing processing routes: A Canadian perspective. Resources, 5(4), p.35.
[8] Miah, MR, Saifuddoha, AM, Parvez, MS, Noor, A, Chakraborty, C and Tabassum, T 2013 Recycling of mobile phone waste. *Int. J. Sci. Eng. Res.*, **4**, pp.1813-1815.

[9] Thorpe, B, Kruszewska, I and McPherson, A 2004 Extended producer responsibility. *Clean Production Action*, **29**.

[10] Ylä-Mella, J, Pongrác, E, Tanskanen, P and Keiski, RL 2007 March. Environmental Impact of Mobile Phones: Material Content. In *International Conference on Solid Waste Technology and Management* (s6), pp. 1-7.