MASTER THESIS

Extended Producer Responsibility Scheme for Mobile Phone Waste: The Case of Bandung City, Indonesia

PRANANDYA WIJAYANTI
(S2779943)

Supervisors:

1. Dr. Maria-Laura Franco Garcia
2. Dr. Gül Özerol

Leeuwarden, 4 July 2022

UNIVERSITY OF TWENTE.

ABSTRACT

Indonesia became the tenth highest electronic waste (e-waste) producer globally and the highest producer in Southeast Asia. Bandung City, one of the metropolitan cities with a high population, potentially generates a high amount of e-waste, which contains precious and hazardous materials. However, an absence of e-waste legislation, a lack of recycling facilities, and the domination of the informal sector lead to a low recycling rate and improper e-waste management. The Extended Producer Responsibility (EPR) for e-waste is a potential solution, but it needs the integration of stakeholders. The stakeholders seem to have different perspectives. Therefore, it is highly recommended to synchronize them to face the challenges of attaining an efficient e-waste management system. Thus, this research aims to find preferable EPR instruments based on the stakeholders' perspectives, such as producers, consumers, recyclers, and the government. Eventually, the preferred EPR instrument is accommodated under an EPR scheme for mobile phone waste desirable for Bandung City. This research uses a mixed-method, qualitative and quantitative data collection and analysis through interviews and surveys. Moreover, this research adopts the components of the theory of planned behavior to understand the stakeholders' perspectives concerning the preferred EPR instrument. Due to the highest type of e-waste generated in Bandung City being mobile phones, this research focused on mobile phone waste. The major finding related to the life cycle of mobile phones is that most of the raw materials are imported. None of the recycled materials conducted by legal recyclers returned to the production process of mobile phones. From the consumer side, most of them store their used mobile phone at home. All stakeholders agreed that EPR for mobile phone waste significantly contributed to the proper e-waste management. Based on the availability of resources and ease of implementation, most stakeholders prefer take-back requirements as EPR instruments that could be applied in the short term. Consumers could drop their mobile phone waste at drop boxes provided directly by producers or indirectly by other stakeholders, such as environmental agency. Additionally, the roles of stakeholders at the national and local levels should be clearly defined to implement take-back requirements. To conclude, based on stakeholders' perspectives, a desirable EPR scheme for mobile phone waste in Bandung city used take-back requirements as the instrument.

Keyword: Electronic Waste, Extended Producer Responsibility, Mobile Phone Waste Management, EPR Instrument, Stakeholders' Perspectives, Theory of Planned Behavior, Take-back Requirements, Bandung City

ACKNOWLEDGEMENT

First and foremost, I would like to express my gratitude to my supervisors, Dr. Maria-Laura Franco Garcia and Dr. Gül Özerol, who guided me patiently and provided invaluable feedback throughout this research. Furthermore, I would also like to acknowledge the help, support, and knowledge provided by the program coordinator, study advisor, and all lecturers that are favored during the study and in the future.

Besides, I am profoundly grateful to the survey respondents and interviewees. Due to their willingness to participate in my research, I could get valuable information that could help me finalize my research. Moreover, I would like to thank the University of Twente, which has funded a year of study through the University of Twente for scholarships (UTS). Without the fund from the UTS, it was impossible to join and complete the MEEM (Master of Environment and Energy Management) program.

Last but not least, I would like to offer my endless gratitude to my family, who always send their prayer and mentally support me during my study. Furthermore, I wish to extend my special thanks to my friends in Indonesia who spent their time discussing and giving insight into my research. I would also like to thank MEEM classmates, housemates, the Indonesian Student Association in Leeuwarden (PMI Leeuwarden), and the Indonesian Student Association Belanda (PPI Belanda), who provided enjoyable experiences and unforgettable memories during living in the Netherlands.

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LIST OF ABBREVIATIONS

ADF	Advanced Disposal Fees
AIPTI	Asosiasi Industri Perangkat Telematika Indonesia – Indonesian Telematics Equipment Industry Association
BLUD	Badan Layanan Umum Daerah – Regional Public Service Agency
BPDLH	Badan Pengelola Dana Lingkungan Hidup – Environmental Fund Management Agency
CAR	Citra Asia Raya
CSR	Corporate Social Responsibility
DLH	Dinas Lingkungan Hidup – Environmental Agency
EPR	Extended Producer Responsibility
IET	Industri Elektronika dan Telematika – Electronic and Telematics Industry
MoEF	Ministry of Environment and Forestry
MoF	Ministry of Finance
MoI	Ministry of Industry
MoT	Ministry of Trade
MML	Mukti Mandiri Lestari
PCB	Printed Circuit Boards
PPLI	Prasadha Pamunah Limbah Industri
PT	Perseroan Terbatas – Limited Liability Company
TKDN	Tingkat Komponen Dalam Negeri – The Level of Domestic Components
TPB	Theory of Planned Behavior

CHAPTER 1. INTRODUCTION

1.1 Background

Global economic and technological developments increase the demand for innovative electrical and electronic equipment. Consequently, the consumption of such equipment has increased, leading to a rapid increase in waste electric and electronic equipment (WEEE/e-waste) generation in the last five years (Forti et al., 2020). Besides overconsumption of electrical and electronic equipment, a short lifespan with limited repair options is also the reason for the high rates of e-waste generation (Andrade et al., 2022).

In Indonesia, fast-growing e-waste is expected to increasingly contribute to the national waste generation. Indonesia was estimated to generate 1,618 kilo ton of e-waste in 2019, with e-waste per capita being 6.1 kg (Forti et al., 2020). This makes Indonesia the tenth highest e-waste producers globally and the highest producer within Southeast Asia (Forti et al., 2020). In 2021, the estimated e-waste generation was 1,989 kilo ton and e-waste per capita 7.3 kg (Mairizal et al., 2021). The amount of e-waste generated was projected to increase until 3,200 kilo ton in 2040 with e-waste per capita being 10 kg (Mairizal et al., 2021).

Moreover, the highest amount of e-waste generated by quantity in Indonesia is mobile phones due to their short lifespan, which is less than five years (Santoso et al., 2019). Mobile phone waste is feature phones and smartphones that reach end-of-life, and consumers are not using anymore (Bruno et al., 2022). Even though the weight has not been significantly affected, mobile phone waste contains critical raw materials and precious metals, including gold, silver, copper, platinum, and palladium, with a high economic value, worth US$ 1.8 billion in 2020 (Mairizal et al., 2021). However, mobile phones, specifically smartphones, also contain toxic materials, such as heavy metals and brominated flame retardants, harmful to human health and the environment (Singh et al., 2020).

An effective management system is needed to reduce the impacts of e-waste. However, an effective e-waste management system in emerging countries such as Indonesia is not fully adopted. There is an absence of e-waste legislation, storage facilities, recycling, and refurbishing centers (Kitila & Woldemikael, 2019). Indonesia currently implements Extended Producer Responsibility (EPR) schemes for packaging waste, showing how the country is trying to incorporate circular economy principles into its waste management approach. Nevertheless, a comprehensive strategy and regulatory framework regarding EPR in e-waste are still non-existent. There is merely a Government Regulation regarding specific waste, including e-waste generated by households, established in 2020 (Government Regulation

No. 27/2020, 2020). The regulatory instrument only categorizes e-waste and allocates responsibilities between different stakeholders, which includes local governments. It has yet to provide technical guidance on operationalizing e-waste management at the local level.

The EPR scheme for electronic waste becomes a potential solution to have an effective waste management system in Indonesia. It has been implemented worldwide, including developing countries such as India, Thailand, and the Philippines (Damanhuri et al., 2019). However, implementing the EPR scheme for e-waste in Indonesia faces the challenges of coordination among stakeholders, such as the government, producers, recyclers, and consumers (Ministry of Industry, 2021). Hence, the perspectives of all relevant stakeholders related to EPR should be aligned (Damanhuri et al., 2019). Accordingly, the criteria should be identified for feasible EPR schemes and implementing them in Indonesia to establish an efficient e-waste management system (Andarani & Goto, 2014; Damanhuri et al., 2019).

1.2 Problem statement

Bandung City is the capital of West Java, the highest populated province in Indonesia. As one of the metropolitan cities in Indonesia and the top five cities with a high population, Bandung has 2.4 million inhabitants (BPS, 2021). Due to a high population, Bandung City potentially generates a high amount of e-waste. In 2020, the highest type of e-waste generated by Bandung citizens by quantity was mobile phones (63%), which is 0.61 tons/day (Widyarsana et al., 2021). It makes sense because the number of active mobile phone users in Indonesian households for internet-capable and primary mobile phones is reached 78% and 98% (Puspitasari & Ishii, 2016).

In Indonesia, merely 10% of e-waste is recycled in the formal sector by recycling companies (Yunita et al., 2019). This is supported by the fact that Bandung citizens prefer to store their e-waste in their houses and sell it to the informal sector (Widyarsana et al., 2021). Due to its economic value, e-waste collection, particularly from households, is dominated by the informal sector, such as scavengers or waste pickers, leading to a low recycling rate (Yunita et al., 2019). In Bandung City, the informal sector has been conducting metal recycling from e-waste since 1970. Initially, metal recycling was conducted by utilizing used television and radios, whereas in the last decade, the focus shifted towards used computers and mobile phones (Damanhuri et al., 2019). Moreover, a lack of infrastructure for e-waste recycling also becomes another reason for the low recycling rate (Magista et al., 2018). Consequently, un-recycled or improperly treated e-waste becomes a critical problem due to its impact on the environment, contaminating soil, water, and air (Ardi & Leisten, 2016).

Successful e-waste management practices to increase recycling rate in developed countries depend highly on policies or regulations related to e-waste issues (Garg, 2021). One of the e-waste management solutions that many countries have applied is EPR. It can contribute in reducing the financial and physical burdens for waste management authorities caused by inadequate waste management facilities (Tojo, 2004). Since 1990, EPR has already been implemented worldwide, 35% of which is applied to e-waste (OECD, 2016).

However, developing countries like Indonesia would experience challenges because a strong economy is required to support its implementation (UNESCAP, 2021). Consequently, EPR for e-waste has not been implemented yet in Indonesia. Furthermore, the producers feel that EPR is not obligatory due to a lack of an e-waste regulatory framework (Ardi & Purwojatmiko, 2019). Therefore, formulating regulations on e-waste management, including EPR, will encourage producers to be responsible for their products and encourage consumers to manage their e-waste (Pandebesie et al., 2019). As suggested by one of the electronic producers in Indonesia, assigning responsibility solely to the producers to carry out product take-back and recycling operations is not preferable: other relevant stakeholders also need to participate in a take-back process (Samsung Electronics Indonesia, 2021). Therefore, to start implementing EPR, producers, consumers, recyclers, and the government must also consider the perspective of producers, consumers, and recyclers.

1.3 Research objective

Based on the problem statement, this research aims to design a desirable EPR scheme for mobile phone waste by focusing on stakeholders' perspectives. The stakeholders, such as producers, consumers, recyclers, and government as policymakers, may have different perspectives on what kind of EPR instrument is desirable for them. Those perspectives will be accommodated under an EPR scheme for mobile phone waste desirable for Bandung City. Eventually, the findings of this research can support the realization of a circular economy in the electronic waste management sector by extending the product life to become secondary raw materials.

1.4 Research question

The main research question below is developed to achieve the research objective mentioned in ***Section 1.3***.

"How to design a desirable EPR scheme for mobile phone waste in Bandung City based on stakeholders' perspectives?"

To answer the main research question, sub-research questions are formulated as follows:

1. What is the life cycle of purchased and used mobile phones in Bandung City?
2. What are the stakeholders' perspectives regarding their preferred EPR instrument for mobile phone waste in Bandung City?
3. How to integrate stakeholders' perspectives regarding their preferred EPR instrument within a desirable EPR scheme for mobile phone waste in Bandung City?

1.5 Thesis outline

This master thesis starts with the first chapter, which discusses a general overview and the motivation to address the topic, the problem statement, the objective and questions of this research, and research outlines. It is followed by the second chapter, which elaborates on the relevant literature and theory that systematically analyzes the topic. This chapter also explains the fundamental theory used in the research. The third chapter explains the methodology used to conduct this research and to answer the research questions. The fourth chapter presents the collected data and findings from the survey and interviews. The fifth chapter provides the analysis of the collected data and the discussion of the findings from the fourth chapter. Finally, the last chapter provides conclusions and recommendations as well as further research needs.

CHAPTER 2. LITERATURE REVIEW

This chapter reviews the relevant literature regarding mobile phone waste, extended producer responsibility, and how such things could contribute to the creation of a circular economy through the recycling process. Furthermore, this chapter also describes the fundamental theory used in the research, which is Theory of Planned Behavior.

2.1 E-waste management

Based on the European Union (EU) Directive 2012/19/EU, electrical and electronic equipment (EEE), including its components and materials, become e-waste while it is not used anymore and discarded (European Parliament, 2020). E-waste is generated when EEE is damaged or its technology and design become outdated (Brando et al., 2020). E-waste is categorized into six categories: temperature exchange equipment, screens and monitors, lamps, large equipment, small equipment, and small IT and telecommunication equipment, including mobile phones (Forti et al., 2020).

E-waste, including mobile phone waste, has the potential to be recovered as secondary raw materials because it contains valuable metals (Garg, 2021). The total valuable metals in mobile phone waste are 80,949 kg silver, 9,873 kg gold, and 2,547 kg palladium from 2001-to 2015 (Siringo et al., 2019). Aside from that, mobile phone waste also contains recyclable plastics, such as ABS (Acrylonitrile Butadiene Styrene) and PC (Polycarbonate), which come from plastic cases and screens (Alassali et al., 2019). However, mobile phone waste also contains hazardous materials, such as lead, mercury, arsenic, and polychlorinated biphenyls that could harm human health and the environment if improperly managed (Ardi et al., 2020; Forti et al., 2020).

E-waste management is a process of collecting e-waste, recovering and recycling its material (e.g., metal and plastic), and disposing of the residues using environmental sound treatment to reduce its harmful impacts on the environment (Forti et al., 2020). For instance, in Korea, e-waste is collected by the local governments or dropped by consumers in retailers through take-back or specific programs (e.g., discount vouchers) to be further recycled in recycling centers, as seen in ***Figure 1*** (UNESCAP, 2021). Furthermore, recycled material is used in the metal industry and reused by producers to close the material loops, thus realizing a circular economy, as discussed in ***Section 2.2*** (OECD, 2014). Besides producers, consumers, local governments, and recyclers, the Producer Responsibility Organization (PRO) have also been involved in managing the fee received from the producers to be used by recyclers to recycle e-waste

(OECD, 2016). However, not every country uses PRO to manage e-waste, as each country has its own goals (Brouillat and Oltra, 2012).

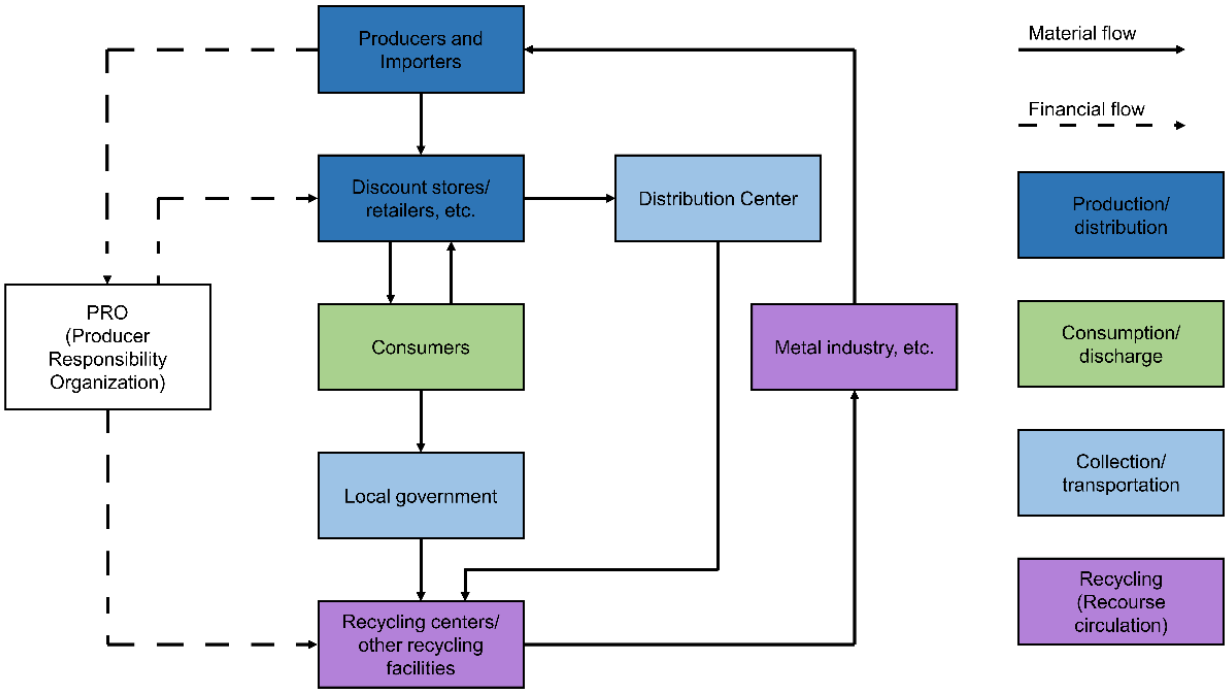

Figure 1. *E-waste management in Korea*

Source: UNESCAP (2021)

2.2 Circular economy

Circular economy is a concept focusing on closing material loops and extending the materials' lifespan by using them for an extended period and increasing their use as secondary raw materials (OECD, 2014). Besides, circular economy is also described as a business model that replaces the end-of-life concept by reducing, alternatively reusing, recycling, and recovering materials in production/distribution and consumption processes, as presented in ***Figure 2***. As a result, a circular economy will accomplish sustainable development, which implies enhancing environmental quality, economic prosperity, and social equity to benefit current and future generations (Kirchherr et al., 2017).

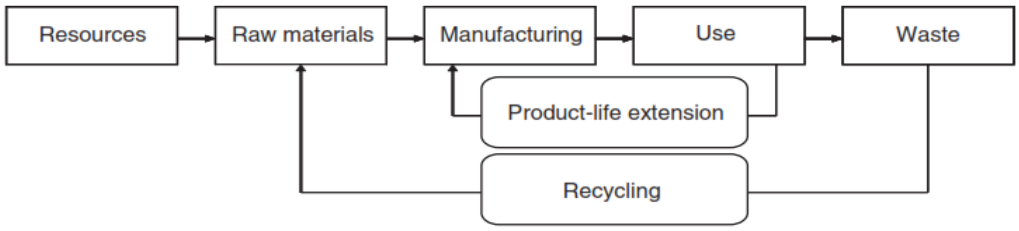

Figure 2. *Circular product chain*

Source: Brouillat & Oltra (2012)

E-waste recycling plays an important role in implementing a circular economy (Misra et al., 2021). E-waste contains valuable components that could potentially become secondary raw materials. As a result, it will reduce the use of critical raw materials (Aminoff & Sundqvist-Andberg, 2021). For mobile phone waste, the circular economy principle has been applied in China to reuse or repair mobile phones during their product life (Welfens et al., 2013). When mobile phone waste reaches the end-of-life stage, recycling is conducted to reuse the recycled metals in the production process and utilize plastics for energy recovery, as shown in ***Figure 3*** (Welfens et al., 2013). Therefore, an environmental policy approach, such as EPR, is needed to ensure the recycled materials will be reused in the production process (Aminoff & Sundqvist-Andberg, 2021).

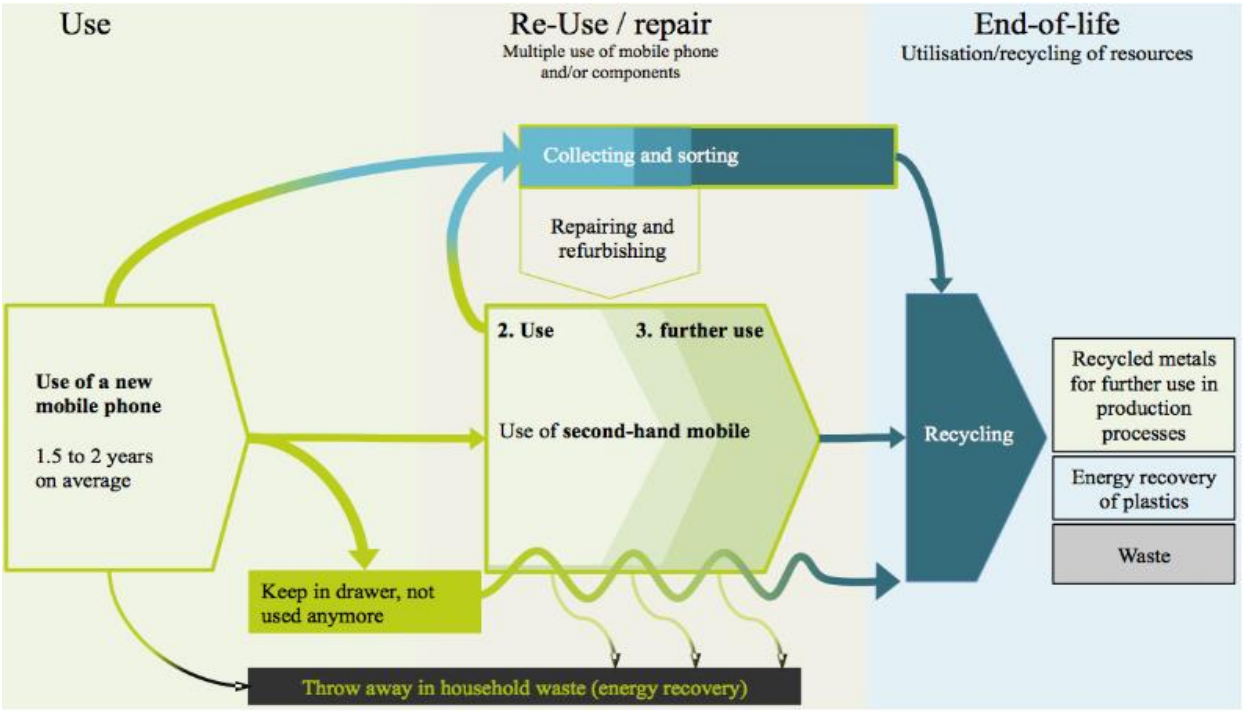

Figure 3. *Utilization of mobile phone waste*

Source: Welfens et al. (2013)

2.3 Extended Producer Responsibility

Extended Producer Responsibility (EPR) is an environmental policy approach that has been developed by several governments in which producers take responsibility for their post-consumer (used) products to extend the products' life cycle (OECD, 2016). Eventually, this approach will increase the efficiency of recycling and in a more advanced way, will encourage producers to shift to a more environmentally conscious design (eco-design) to extend their products' life cycle (Aminoff & Sundqvist-Andberg, 2021). The schemes of EPR can allow producers to implement their responsibility, individually

or collectively, by providing the financial resources required or by directly handling the operational and organizational aspects of the collection, sorting, and recycling process (OECD, 2016). Eventually, EPR leads to an increased and improved recycling process and reduces waste transported to landfills (Brouillat & Oltra, 2012).

In the early 1990s, EPR was first adopted by several European countries, such as Germany, Sweden, and France. At the EU level, all Member States have implemented EPR schemes for four waste streams: packaging, batteries, end-of-life vehicles, and e-waste (OECD, 2014). EPR has been rapidly adopted worldwide with different instruments and schemes during the last decade. For e-waste, it was implemented not only in Europe, but also in America, Australia, Africa, and Asia. There are four major types of EPR instruments that can be implemented, either mandatory or voluntary (OECD, 2016):

1. ***Product take-back requirements:*** Producers or retailers are responsible for setting up product collection and recycling targets. Such incentives can encourage consumers to return the used product to a specified location, for instance, retailers.
2. ***Economic and market-based instruments***
    a. ***Deposit-refund:*** Consumers pay a deposit when purchasing a product that gets refunded when returned to the producer or retailer.
    b. ***Advanced Disposal Fees (ADF):*** Consumers are charged a fee when purchasing a certain product. The fees are collected by government or private entities and will be used for the post-consumer treatment of the products. The unused fees will be returned to consumers.
    c. ***Material tax:*** Producers who use virgin materials (difficult-to-recycle materials or contain hazardous materials) have to pay a tax to encourage them to use recycled or less toxic materials. The amount of tax should cover the treatment costs. Subsequently, used products from consumers will be collected, sorted, and treated using this tax.
    d. ***Upstream combination tax/subsidy (UCTS):*** Producers should pay a tax to subsidize recycling and waste treatment. In addition, there could be incentives for producers to improve their used materials and product design.
3. ***Regulation and performance standards:*** A minimum number of recycled materials in electric and electronic equipment manufacturing can stimulate producers to take back their used products. This standard could be combined with a tax to strengthen incentives for product redesign.

4. ***Information-based instruments:*** Awareness raising through products labelling, communication to consumers about producer responsibility and waste separation, and information to recyclers about the materials used in products.

EPR programs have several intended outcomes, such as improving waste management practice, reducing environmental impacts, and increasing economic efficiency (Tojo, 2004). For example, closing material loops and conducting design for the environment improves the total life cycle environmental impacts of products, as seen in ***Figure 4*** (Tojo, 2004). The most common instruments are take-back requirements, advanced disposal fees, and deposit-refund systems (Dimitropoulos et al., 2021). Furthermore, to implement these EPR instruments, the understanding of all relevant stakeholders needs to be aligned (Damanhuri et al., 2019).

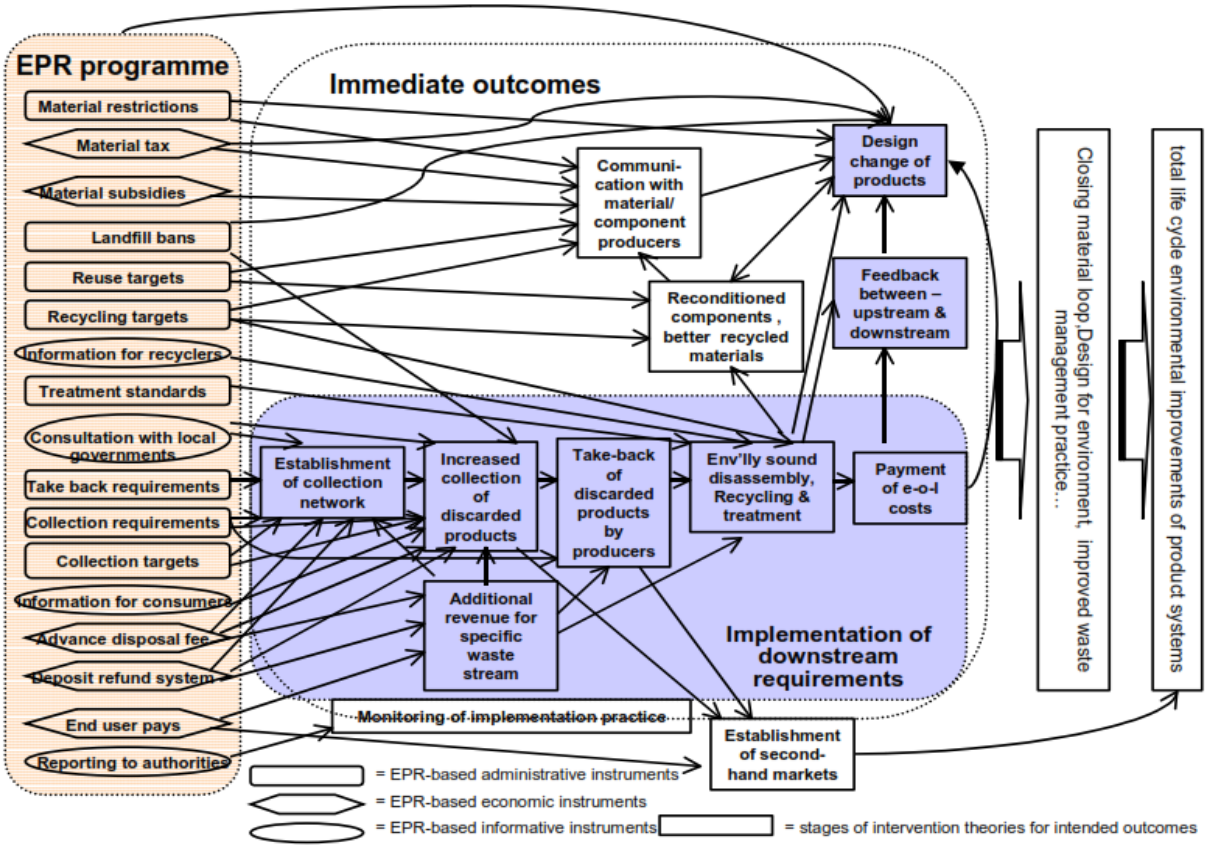

Figure 4. *Theory of EPR program*

Source: Tojo (2004)

2.4 Theory of Planned Behavior

Theory of Planned Behavior (TPB) focuses mainly on the intention of individuals, such as motivational factors, to perform certain behaviors. Besides, non-motivational factors, such as

opportunities and resources, including time, money, skills, and cooperation with others, can also influence behavior, known as perceived behavioral control (Ajzen, 1991). TPB is modified from the Theory of Reasoned Action (TRA). The key components of TPB consist of attitudes and subjective norms, similar to TRA. The attitudes show people's beliefs, while subjective norms show the likelihood of people agreeing or disagreeing in performing certain behaviors. However, TPB also has an additional component, perceived behavioral control (Ajzen, 1991), as presented in ***Figure 5***. Perceived behavioral control depends on the availability of resources and opportunities and explains how easy or difficult this behavior could be.

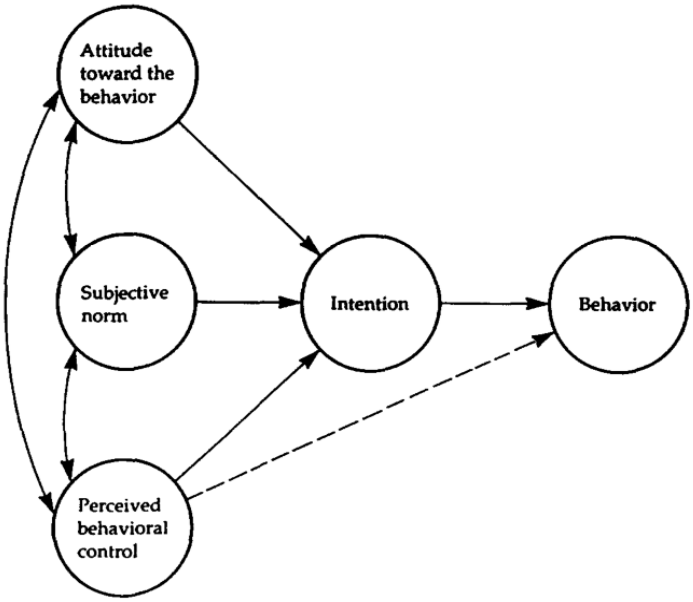

Figure 5. *Theory of Planned Behavior*

Source: Ajzen (1991)

TPB has been used extensively by social scientists, albeit this theory used to be applied by social psychologists (Ajzen, 1991). Over the years, this theory has also been applied worldwide (e.g., in Brazil, Vietnam, Bangladesh, United Arab Emirates, and Indonesia) in e-waste management sectors, including the behavior of people, particularly consumers, in storing, disposing, and recycling e-waste and paying advanced recycling fees (Aboelmaged, 2021; Ananno et al., 2021; Ardi et al., 2020; Brando et al., 2020; Echegaray & Hansstein, 2017; Nguyen et al., 2019). Moreover, this theory has also been adopted for a more specific study on e-waste management, which is producers' perspectives on EPR for e-waste (Ardi & Purwojatmiko, 2019). The intention refers to the producers' willingness to try an EPR system and how much effort they put into planning an EPR system. Subsequently, those two things will indicate the

producer's readiness to take back and process their used products as a behavior for the EPR adoption (Ardi & Purwojatmiko, 2019).

Therefore, three main components of TPB are used to understand the stakeholders' perspectives on the EPR implementation for mobile phone waste:

1. ***The attitude:*** to find the stakeholders' beliefs about whether the EPR implementation is good for the environment and health and contributes to others and future generation's life or not.
2. ***The subjective norm:*** to understand stakeholders' likelihood of implementing EPR. For instance, the influence of the family and friends, media, or community where they live to participate in the EPR implementation.
3. ***The perceived behavioral control:*** to understand the resource availability and ease of implementation for such EPR instruments.

CHAPTER 3. RESEARCH DESIGN

This chapter explains the methodology used to achieve the research objective, including the research framework, key concepts, research questions, research strategy, data collection and analysis, and research ethics.

3.1 Research framework

In order to achieve the research objective, a research framework presenting structured research steps is needed, as explained below (Verschuren & Dooreward, 2010).

Step 1: Characterizing the objective of the research project

As mentioned in **Section 1.3**, this research aims to:

1. Find preferable EPR instruments from different perspectives of stakeholders, including producers, consumers, recyclers, and the government.
2. Design a desirable EPR scheme for mobile phone waste in Bandung City based on stakeholders' perspectives.
3. Support the realization of a circular economy in the electronic waste management sector.

Step 2: Determining the research object

Because the research focuses on a specific case, Bandung City, therefore, Bandung City has become the object of research.

Step 3: Establishing the nature of the research perspective

This research provides a design for the EPR scheme for mobile phone waste desirable for Bandung City based on stakeholders' perspectives. Moreover, the research perspective is design-oriented research because the stakeholders' perspectives can become the parameters used for designing a policy plan for e-waste management sectors, such as an EPR scheme. Design-oriented research considers the conditions, wishes, and demands of stakeholders involved in the implementation of the EPR scheme in the future. Therefore, the research perspective takes a conceptual model for understanding the mobile phone life cycle and finding the preferences of EPR instruments of relevant stakeholders, such as producers, consumers, recyclers, and the government.

Step 4: Determining the sources for attaining a research perspective

A list of concepts explains in ***Table 1*** are the sources to develop the research perspective.

Table 1. *The sources of the research perspective*

Key concepts	Theories and documentation
• Mobile phone waste • Life cycle of mobile phone • EPR scheme	• Literature on mobile phone waste management • Literature on circular economy-related to e-waste management • Literature on EPR instrument • Theory of planned behavior

Step 5: Making a schematic flow of the research framework

A visual representation of the research framework can be seen in ***Figure 6***.

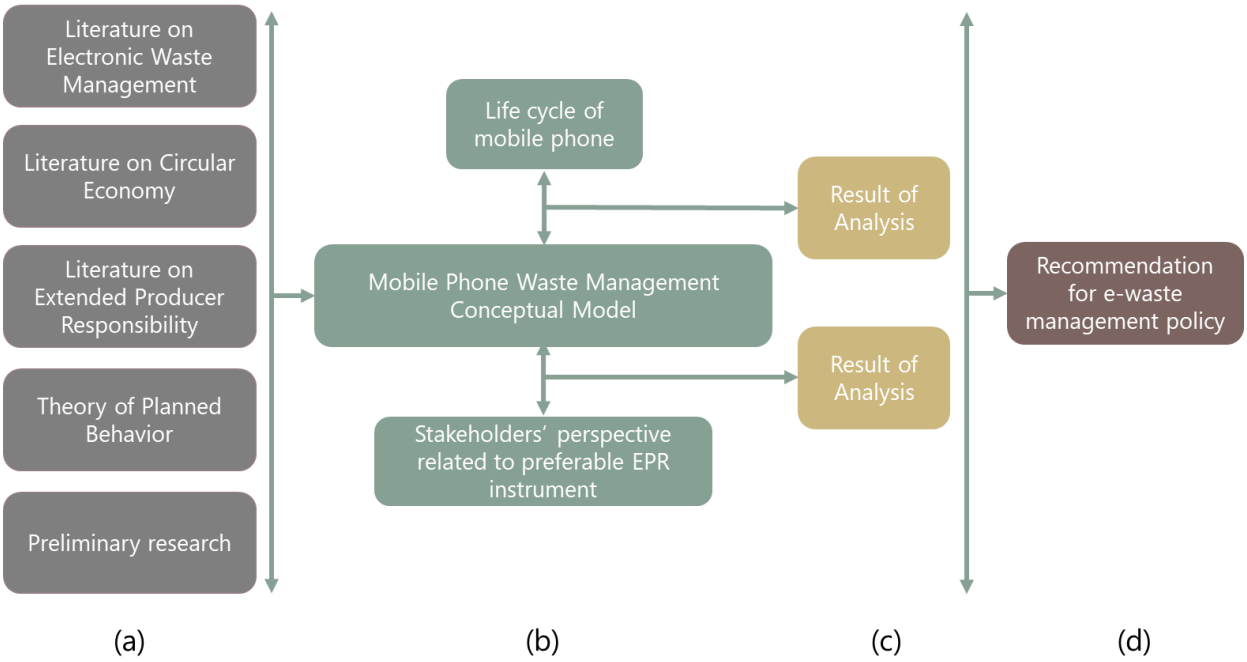

Figure 6. *Schematic flow of the research framework*

Source: Own interpretation

Step 6: Formulating the research framework in the form of arguments

Based on ***Figure 6,*** the step-by-step process is formulated as follows:

(a) A study regarding e-waste management, particularly mobile phone waste, circular economy, EPR instrument, EPR scheme, and theory of planned behavior through literature review and preliminary research (e.g., discussion with e-waste management experts).
(b) Understand the life cycle of mobile phones and find the perspective of stakeholders related to their preferences on specific EPR instruments.
(c) Compare the analysis results, integrating the stakeholders' perspectives on an EPR scheme for mobile phone waste with desk research of previous studies. The result of analysis will be further used for the recommendation.
(d) Propose an EPR scheme for mobile phone waste that will be recommended to relevant ministries and agencies in Bandung City as a policy approach in the e-waste management sector.

3.2 Research strategy

3.2.1 Research unit

Research units for this research consist of stakeholders, such as producers, consumers, recyclers, central government, and local government, who are involved in the life cycle of mobile phones and mobile phone waste management in Indonesia, particularly in Bandung City.

3.2.2 Research boundaries and limitations

The limitations of this study are the capacity and time available. Therefore, the scope of this research is focused merely on specific electronic waste, which is mobile phone waste. Besides, this research only focuses on three EPR instruments instead of seven EPR instruments due to a more common use instrument. Those instruments are take-back requirements, a deposit-refund system, and advanced disposal fees. Aside from that, the TPB used in this research only considers the three key components: attitude, subjective norms, and perceived behavioral control but does not count the correlation to stakeholders' behavior. From those components, only consumers' perspective that consider all of the components, but for other stakeholders were only consider the perceived behavioral control.

Furthermore, this research is also limited to a specific location, Bandung City. Hence, the stakeholders interviewed are limited to those located in Bandung City. However, due to the absence of producers and recyclers in Bandung City, the producers and recyclers interviewed are located in the same province as Bandung City, West Java Province, or the neighboring province, Banten Province. As a result, only the minimum number of producers were successfully interviewed. Additionally, the retailers and informal sectors were not included as the research units in this research.

3.3 Data collection

To answer the research and sub-research questions, data was collected through online semi-structured interviews, online survey, and desk research. The desired information, sources, and accessing method per sub-research question are presented in ***Table 2***. The questionnaire for the interview and survey, presented in ***Appendix B*** and ***Appendix C***, was constructed based on the desired information and sources. Hence, there were different questions for different stakeholders, particularly to answer sub-research question 1.

Table 2. *Desired information and accessing method*

Sub-research question	Desired information	Sources	Accessing method
Q1. What is the life cycle of purchased and used mobile phones in Bandung City?	Production and distribution chain of mobile phone	Producers	Semi-structured interview (online)
	Collection of mobile phone waste	Local government	
	Materials that can be recycled and current mobile phone waste recycling activities	Recyclers	
	Post-consumer treatment	Consumers, scientific literature	Online survey, desk research
Q2. What are the stakeholders' perspectives regarding their preferred EPR instrument for mobile phone waste in Bandung City?	Preferable EPR instrument (take-back requirements, deposit-refund system, or advanced disposal fees)	Producers, recyclers, central government, and local government	Semi-structured interview (online)
		Consumers	Online survey with Likert scale
Q3. How to integrate stakeholders' perspectives regarding their preferred EPR instrument within a desirable EPR scheme for mobile phone waste in Bandung City?	EPR scheme using a preferable EPR instrument from different stakeholders	Scientific literature, interview, and survey data	Desk research, analyzed interview and survey data

The semi-structured interviews were conducted to collect data from thirteen interviewees representing each stakeholder from 28 April 2022 until 9 June 2022. The list, date, and code of the interviewees are presented in ***Table 3.*** As previously mentioned in **Section 3.2.1**, the interviewees were selected based on their involvement in the life cycle of mobile phones in Bandung City (production and distribution, post-consumer treatment, collection, and recycling). The interviews were conducted with individuals who were the stakeholders' representatives, except for Interviewee 8, because two representatives from two different departments were involved in the interviews. First, they were

contacted through personal communication, such as e-mail and personal messages. Then, the interviewees stated their availability, and the researcher set up an interview schedule using online meeting platforms (e.g., Zoom Meeting, Microsoft Teams, or Google Meet).

Table 3. *List of interviewees*

Name	Type of stakeholder	Institution name	Interview date	Interviewee code
Untung Ariadi	Producer	Bright Mobile Telecommunication (OPPO & Realme)	25 May 2022	Interviewee 1
Ali Subroto	Producer	Indonesian Telematics Equipment Industry Association (AIPTI)	27 May 2022	Interviewee 2
Interviewee 3	Producer	Producer 3	30 May 2022	Interviewee 3
Chandra Paramita	Recycler	Tes-AMM Indonesia	6 May 2022	Interviewee 4
Eko Swastoto	Recycler	Citra Asia Raya (CAR)	13 May 2022	Interviewee 5
Alvin Hidayat	Recycler	Mukti Mandiri Lestari (MML)	12 May 2022	Interviewee 6
Interviewee 7	Recycler	Recycler 4	28 May 2022	Interviewee 7
Muhammad Yusuf Firdaus, Arum Tri Puspasari	Recycler	Prasadha Pamunah Limbah Industri (PPLI)	9 Jun 2022	Interviewee 8
Deti Yulianti	Local Government	Environmental Agency (DLH) of Bandung City	18 May 2022	Interviewee 9
Resmiani	Local Government	Environmental Agency (DLH) of West Java Province	25 May 2022	Interviewee 10
Widayati	Central Government	Ministry of Environment and Forestry (MoEF) - Directorate General of Waste and Toxic Waste Management	28 Apr 2022	Interviewee 11
Andriati Cahyaningsih	Central Government	Ministry of Industry (MoI) - Green Industry Center	18 May 2022	Interviewee 12
Astien Setianingrum	Central Government	Ministry of Industry (MoI) - Directorate of Electronics and Telematics Industry (IET)	28 May 2022	Interviewee 13

Besides interviews, data was also collected through the survey, particularly for consumers. The number of consumers or mobile phone users needed for the survey was calculated based on Bandung's population. The population of Bandung City in 2019 was 2.480.464 people (BPS, 2021). Therefore, using the Slovin formula with an error margin of 5%, the minimum number of respondents needed was 400.

$$n = \frac{N}{(1 + Ne^2)} = \frac{2.480.464}{(1 + (2.480.464\ x\ (5\%)^2)} = 400$$

n = sample size

N = total population

E = margin of error

The survey was conducted for two weeks, from 28 April 2022 until 12 May 2022, using Qualtrics as one of the online survey platforms. The survey link was shared through several platforms, such as LinkedIn, WhatsApp, and Instagram, to acquire a minimum number of respondents. Besides, this survey was focused on respondents who lived in Bandung City and had mobile phones. Hence, the respondents were people above 16 years old and had at least high school for their educational level. To ensure the respondents were lived in Bandung City, a question provided to answer the district where the respondents lived, as shown in ***Appendix C***. As a result, the total number of respondents was 517, which exceeded the minimum sample size. However, 99 out of 517 respondents had not finished their survey. Therefore, the total number of respondents who finished the survey was 418.

3.4 Data analysis

3.4.1 Analysis methods

For data analysis, the type and method per sub-research question are explained in ***Table 4***. Data from the survey questionnaire for consumers using the Likert scale were analyzed with descriptive statistics using statistical software, SPSS (Statistical Package for the Social Sciences). The structured questionnaire used statements with a five-point Likert scale to quantify the agreement or disagreement statements from the stakeholders' perspective (Manstead and Semin, 2001).

Moreover, data from the semi-structured interviews were summarized and analyzed using content analysis with thematic categorization. For answering the first question, the themes depended on the stage of the life cycle chain. This content analysis categorized the process and stakeholders involved in each stage. Subsequently, the content analysis results were combined with quantitative data analysis related to the post-consumer treatment of mobile phone waste. Hence, a life cycle chain of mobile phones is described in a schematic flow.

Table 4. *Type and method of analysis*

Sub-research question	Desired information	Type of analysis	Method of analysis
Q1. What is the life cycle of purchased and used mobile phones in Bandung City?	Production and distribution chain of mobile phone	Qualitative	Analyzing the production and distribution chain of mobile phones, collection of mobile phone waste, current recycling activities, and materials that can be recycled using content analysis with categorization based on the stage of the life cycle chain
	Collection of mobile phone waste		
	Materials that can be recycled and current mobile phone waste recycling activities		

	Post-consumer treatment	Quantitative	Analyzing the post-consumer treatment using statistical software (SPSS)
Q2. What are the stakeholders' perspectives regarding their preferred EPR instrument for mobile phone waste in Bandung City?	Preferable EPR instrument (take-back requirements, deposit-refund system, or advanced disposal fees)	Qualitative	Analyzing preferable EPR instrument of producers, recyclers, and the government using content analysis with categorization based on three key components of TPB (attitude, subjective norms, and perceived behavioral control)
		Quantitative	Analyzing preferable EPR instrument of consumers based on three key components of TPB (attitude, subjective norms, and perceived behavioral control) using statistical software (SPSS)
Q3. How to integrate stakeholders' perspectives regarding their preferred EPR instrument within a desirable EPR scheme for mobile phone waste in Bandung City?	EPR scheme using a preferable EPR instrument from different stakeholders	Qualitative	Integrate the preferable instrument from different stakeholders and extract the element from the content analysis and statistical results from the first and second questions that will be used to design an EPR scheme

To answer the second question, the theme of content analysis was based on the components of TPB and three types of EPR instruments. Similar to the previous paragraph, this content analysis combined with quantitative data analysis related to the preferred instrument of consumers. As a result, an EPR scheme based on preferred instruments from different stakeholders was designed to answer the third question through a point system; every instrument has one point. Therefore, the most selected instrument became the chosen instrument to be further designed as an EPR scheme. In addition, the reason why stakeholders prefer those instruments also became a consideration in designing the scheme.

3.4.2 Data validity

The first step to ensuring data validity was used multiple data sources and data collection methods, such as interviews, surveys, and desk research. Moreover, in the second step, data validation used a comparison of the research results with the previous study. Those two steps are also known as the triangulation technique. For the interviews, ensuring that the representation of each stakeholders' group consists of at least two institutions was also conducted to validate the data.

For the quantitative measure, to validate the statistical data, before the questionnaire was distributed, the content validity was conducted through a pilot to test the content and usability of the questionnaire. Hence, the questions would accurately provide answers for the necessary data. The pilot was conducted by testing the questionnaire with friends and relatives who have an expert in the e-waste management field and who have no knowledge of e-waste management, then asking for their feedback. Besides, external validity was also conducted to ensure the sample represents the population in Bandung City. For instance, the sample considered the different educational backgrounds, ages, genders, et cetera. Therefore, the research results could also be used for cities with similar population numbers to Bandung City.

3.5 Research ethics

All research involving humans as the subjects or participants, through surveys, interviews, and potentially sensitive data, should comply with the ethics policy provided by the Behavioral, Management, and Social Sciences (BMS) Faculty. Therefore, the consent forms were prepared to be filled out by the interviewees before conducting the interview. The consent form considers their privacy and the confidentiality of data, as attached in ***Appendix A***. If they request to keep their personal data, they could write as anonymous. Hence, the interviewee and institution names in ***Table 3*** are only for the interviewees who agreed with the condition in the consent form. There was also an introduction statement for an online survey to ensure their participation was entirely voluntary, as attached in ***Appendix C***. They could ignore any questions if they had any objections, and their answers were safely stored and remained confidential. Besides, the collected data were stored safely based on BMS Data Lab Procedures.

CHAPTER 4. FINDINGS

This chapter presents the collected data and findings from the survey and interviews related to the mobile phones' life cycle component and stakeholders' perspectives concerning the preferred EPR instrument for mobile phone waste.

4.1 Life cycle of mobile phones

Understanding the life cycle of mobile phones is salient for the EPR implementation because there will be an overview of how the mobile phones are produced and distributed, how the consumers treat their mobile phones, and how they will be treated and recycled. Besides, there will also be an indication of the stakeholders involved in each stage. Those stakeholders can collaborate to implement EPR in the future. The life cycle of mobile phones, which includes the production and distribution chain of mobile phones, post-consumer treatment of mobile phone waste, collection of mobile phone waste, and recycling of mobile phone waste, is presented in ***Figure 7*** and described in detail below.

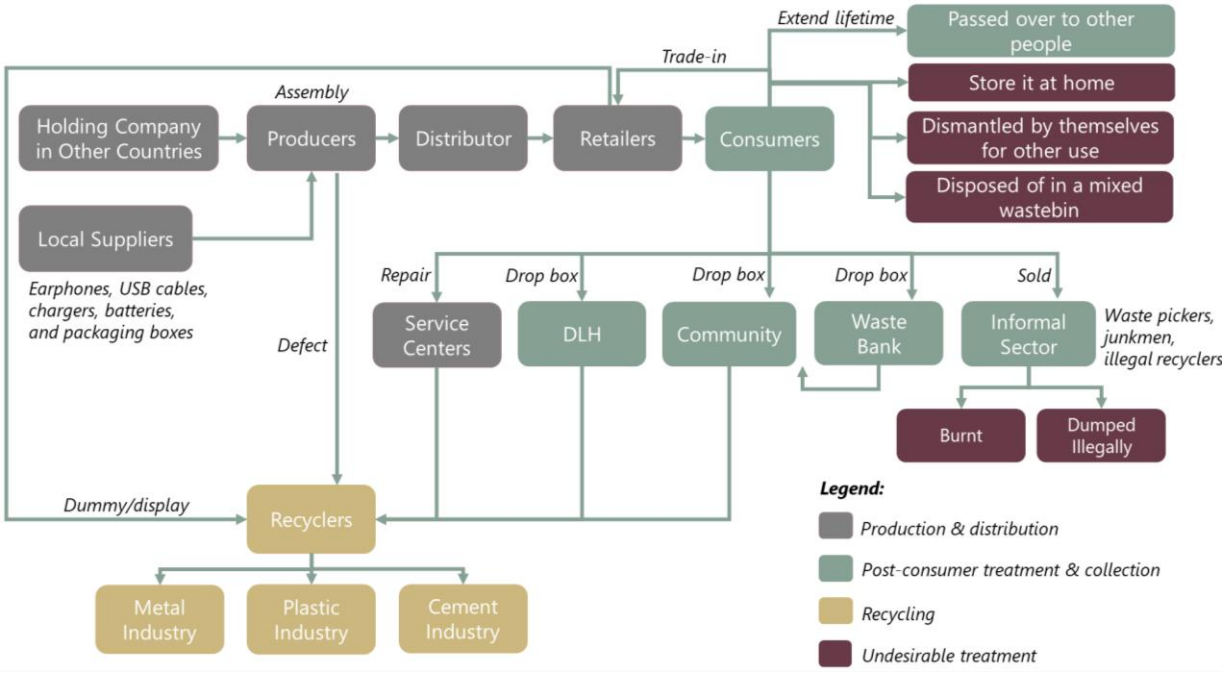

Figure 7. *Life cycle of mobile phones*

Source: Own interpretation

4.1.1 Production and distribution chain of mobile phones

Most materials for mobile phones production are imported from their holding companies in other countries (e.g., China and Korea) due to the difficulty of ensuring the quality of local suppliers (Interviewee 1; Interviewee 3). For instance, local suppliers can only produce two layers of Printed Circuit Boards (PCB) while the company standard is nine layers (Interviewee 3). Therefore, PCB and other components, such as FPC (Flexible Printed Circuit Board), motherboard PCB, Liquid Circuit Display (LCD) screen, camera, flash, power and volume key, fingerprint reader, Subscriber Identity Module (SIM) bracket, battery cover, vibration motor, and light sensor small plate, are imported and assembled in Indonesia to become mobile phones (Interviewee 1; Interviewee 3). Afterward, it is injected with the software and packaged in the packaging boxes. However, some additional components, such as earphones, USB cables, chargers, batteries, and packaging boxes, are produced locally to comply with the regulation from the MoI regarding the level of domestic components (TKDN) (Interviewee 1; Interviewee 3).

After mobile phones are produced and packaged, they are ready to be distributed to distributors and retailers (Interviewee 3). Based on the Ministry of Trade (MoT) regulation, the distributors are divided into three areas of Indonesia: western, central, and eastern. Because Bandung City is a part of west Indonesia, the distributor will be the one who has a responsibility to distribute mobile phones in the western area, which is PT (Perseroan Terbatas or Limited Liability Company) World Innovative Telecommunication (Interviewee 1). After mobile phones are transported to the distributor warehouse, the distributor distributes mobile phones to sub-distributors and retailers. In addition, mobile phones are distributed daily because mobile phone orders are always there daily (Interviewee 1).

4.1.2 Post-consumer treatment of mobile phone waste

Based on survey results, the most dominant treatment of mobile phone waste from 418 respondents is storing it at home (39%). However, the second and third highest treatment is passed over to other people who still could use it (32%) and trade-in (17%), as presented in ***Figure 8***.

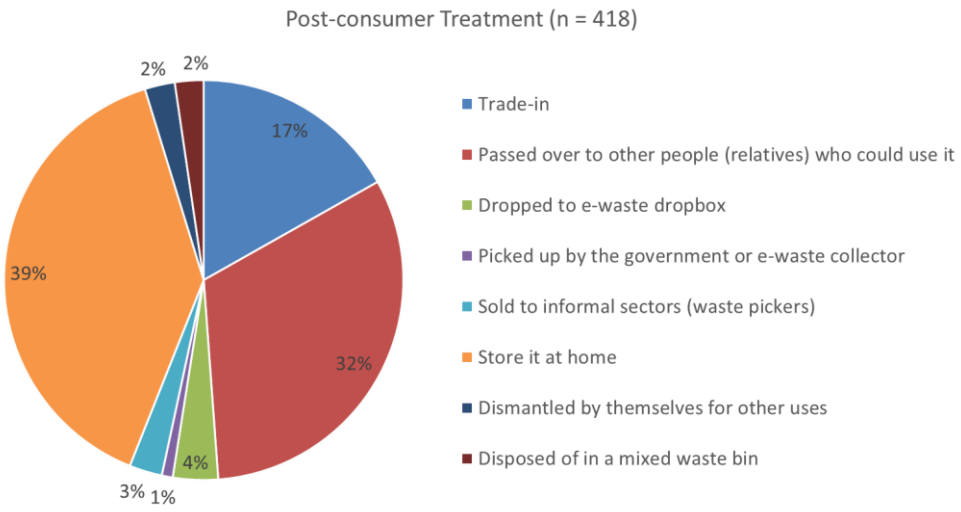

Figure 8. *Post-consumer treatment of mobile phone waste based on survey data*

The survey results show similar results when compared to previous studies. According to a study by Widyarsana et al. (2021), most respondents store their mobile phone waste in their homes (52%), as presented in ***Figure 9***. Passing over or giving their phones to others is also preferred by most respondents (Widyarsana et al., 2021). However, there is a significant difference between the current survey results and the previous studies regarding the percentages of storing phones at home and trade-ins. Compared to previous studies, the number of respondents who stored their phones at home is lower, and those involved in a trade-in program are higher. It could happen because some trade-in programs are offered by producers and retailers (Blibli, 2022; Eraspace, 2022; Samsung, 2022; Tokopedia, 2022).

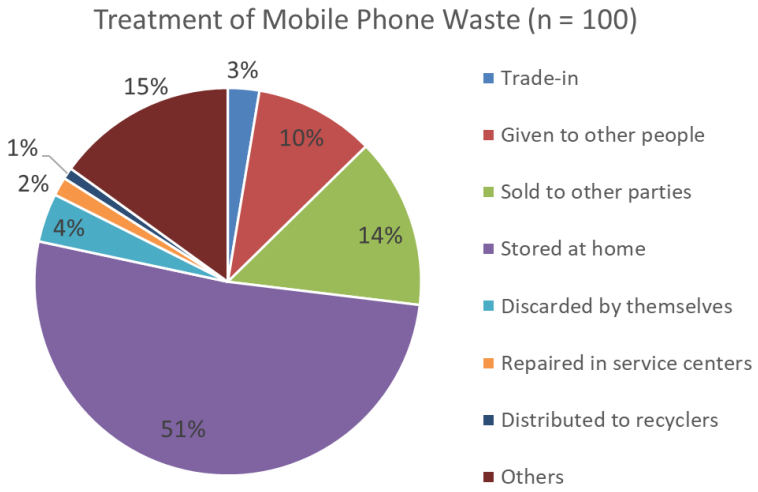

Figure 9. *Treatment of mobile phone waste based on previous research*

Source: Widyarsana et al. (2021)

Based on the interviews with the producer, there is no take-back scheme from the consumers and in situ treatments provided for post-consumed mobile phones (Interviewee 1; Interviewee 2; Interviewee 3). Moreover, they are solely producing the ready-to-use product, and consumers who used it until it became a waste are the people who should be responsible for mobile phone waste (Interviewee 1; Interviewee 3).

4.1.3 Collection of mobile phone waste

As stated in Government Regulation 27/2020 regarding specific waste management (Government Regulation No. 27/2020, 2020), the local government is responsible for collecting and providing a warehouse for specific waste, including e-waste (Interview 11). Therefore, based on an interview with the local government, DLH of Bandung City, e-waste from households is collected through drop boxes. Those drop boxes are given by MoEF to DLH of Bandung City to be placed in several locations, such as government offices, schools, and shopping centers, as seen in ***Figure 10*** (Interviewee 9). Twelve drop boxes cover 9 out of 30 districts in three areas: North, East, and South Bandung. The detailed location of drop boxes is presented in ***Appendix D***.

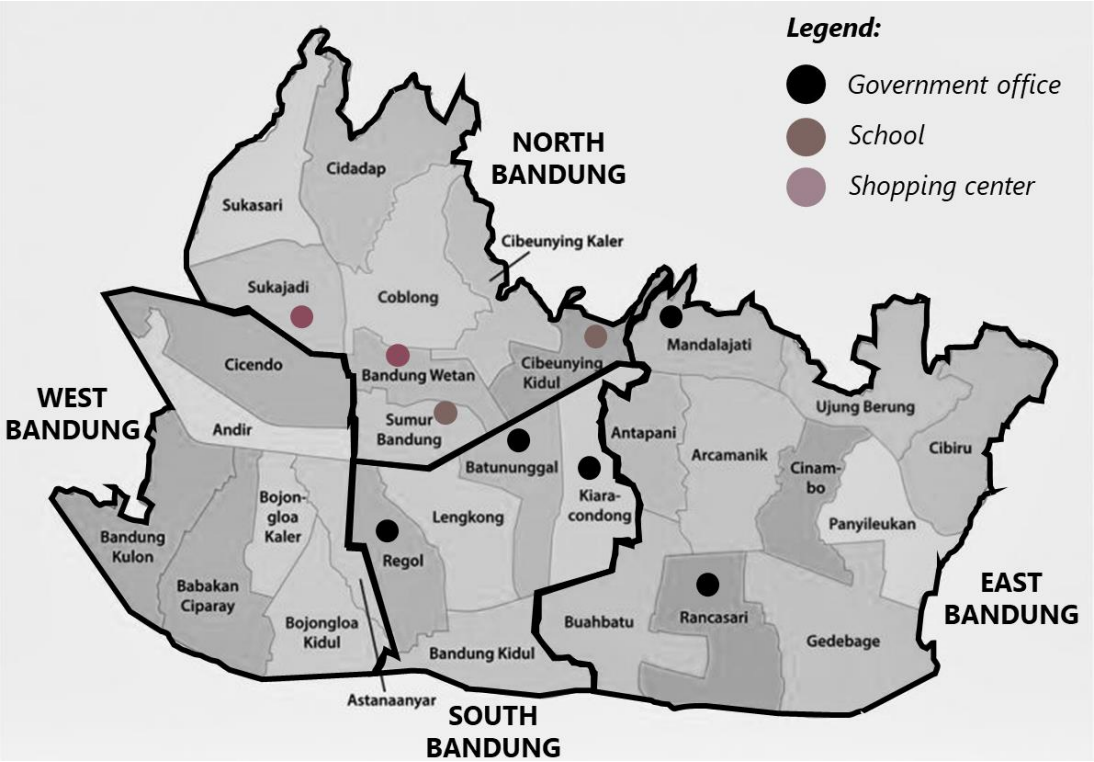

Figure 10. *Location of e-waste drop boxes provided by DLH of Bandung City*

Source: Interviewee 9

The public can drop their e-waste voluntarily at the drop boxes. DLH of Bandung City monitors the e-waste collected in drop boxes annually. Subsequently, once the drop boxes are complete, the e-waste collected is transported to a shelter for specific waste and then transported to the recycler to be further processed in the e-waste recycling plant (Interviewee 9). Furthermore, at a provincial level, DLH of West Java Province also provides a drop box in their office (Interviewee 10).

Besides the local government at the city and provincial level, informal sectors (e.g., waste pickers, junkmen, illegal recyclers), several waste banks, and several communities, such as EwasteRJ community and Komunitas E-waste Bandung, also collect e-waste in Bandung City (Interviewee 9). In addition, a regional waste bank, Bank Sampah Bersinar, collects e-waste from Bandung City and the surrounding cities. Moreover, e-waste collected from the drop box in the office of DLH of West Java Province sends to this waste bank. Bank Sampah Bersinar collaborates with the EwasteRJ community to further process the e-waste collected (Interviewee 10). Nevertheless, e-waste collected in informal sectors assumes that treated improperly and after they collect the valuable materials, they are only burnt or dumped illegally (Interviewee 9). A private sector (start-up company) is also interested in providing the application's e-waste collection services, albeit they are still obtaining the permit (Interviewee 10).

4.1.4 Recycling of mobile phone waste

This sub-section explains the sources of mobile phone waste received by recyclers and the amount of mobile phone waste collected and recycled. This sub-section also explains the recycling process, the materials that could be recycled from mobile phone waste, including what are they used for and by whom, and the possibility of using the recycled materials back in the production process of mobile phones.

The sources of mobile phone waste received and processed by recyclers are varied. First, the recyclers receive mobile phone waste from producers, mainly from marketing activity and in-store displays (Interviewee 4; Interviewee 6; Interviewee 8). Because defective mobile phones from the production process that does not comply with the quality control standards could not be re-exported to the holding company, it is also sent to the recyclers (Interviewee 1; Interviewee 3). Nevertheless, some recyclers solely receive from producers in a particular year, which were 2010-2011 and 2017, respectively (Interviewee 6; Interviewee 8).

Second, the recyclers receive mobile phone waste from service centers provided by the producers and other legal service centers (Interviewee 4; Interviewee 5). At the service center, mobile phone waste and its components come from the repair process and defective phones returned by consumers who still have a warranty (Interviewee 1; Interviewee 3). The producers would temporarily collect mobile phone

waste in the waste shelters in each service center before being transported to the recycler annually or biannually (Interviewee 1).

Third, the recyclers receive mobile phone waste from the employee of corporate, electronic stores, and informal collectors (Interviewee 4; Interviewee 6; Interviewee 7). In addition, some of the recyclers receive mobile phone waste from households through the Corporate Social Responsibility (CSR) program by collaborating with the community, school and university, and environmental agency (DLH) (Interviewee 7; Interviewee 8). They provide drop boxes to be placed in public spaces and transported regularly when the drop boxes are full.

Recyclers face difficulty in obtaining e-waste to be recycled, albeit there are varied sources of waste suppliers. Only a limited amount of mobile phone waste is collected, less than 10% compared to other types of e-waste (Interviewee 5; Interviewee 6; Interviewee 7; Interviewee 8). The amount of mobile phone waste or component of mobile phone waste (PCB) collected is one ton. One ton of those waste is estimated equal to 2000-3000 units of mobile phones (Interviewee 6; Interviewee 7). In addition, less than one percent of mobile phone waste can be recycled. For example, the gold recovered from one ton of mobile phone waste is only 20 grams (less than 0.01%) (Interviewee 6; Interviewee 7).

The recycling process of mobile phone waste has three steps. First, the recycling process starts with dismantling to separate the components, such as plastic, metal, rubber, glass, and other electronic parts (Interviewee 5; Interviewee 6; Interviewee 7; Interviewee 8). Some recyclers dismantle manually, and other recyclers use physical separation to dismantle component of mobile phone waste. Afterwards, the electronic parts are separated between hazardous or explosive and harmless parts (Interviewee 5).

Second, metal contained in mobile phone waste will be recovered. Four out of five recyclers smelt the metal into alloy ingots (metal bars), while one recycler merely does the crushing to make powder materials (Interviewee 5; Interviewee 6; Interviewee 7). However, some recyclers' metal recovery process is conducted in other countries, such as Singapore and Japan (Interviewee 4; Interviewee 8). Additionally, the metal is recovered from the PCB, one of the components of mobile phone waste that is difficult to process (Interviewee 6).

Third, handling materials that could not be or are difficult to be recycled by e-waste recyclers. For instance, none of the recyclers can recycle the battery. Instead, one recycler processes the battery by removing its charge and then encapsulating it before it is finally landfilled (Interviewee 8). The other recycler exports the battery to their holding company in another country, Singapore (Interviewee 4). Nevertheless, one recycler is currently obtaining permission to recycle batteries into rare carbon that can be used for making new batteries (Interviewee 5). Furthermore, the crushed plastic and other

components that could not be recycled are sent to a third party to be further processed (Interviewee 4; Interviewee 5).

Materials from mobile phone waste that could be recycled are precious metals (gold, palladium, rhodium, silver), other metals (copper, aluminium, tin), plastic, and rubber (Interviewee 4; Interviewee 5; Interviewee 6; Interviewee 7; Interviewee 8). Aside from that, the material that could also be recycled from the component of mobile phone waste, such as batteries and LCD screens, are carbon, cobalt, and glass (Interviewee 5). The recycled materials, particularly metal recovered, are used by the metal industry but are exported to other countries. For instance, the copper alloy ingot processed in Indonesia will export to other countries to be separated more advance because the ingot that processes is still a mix between copper, gold, and tin (Interviewee 5). Another example is PCB which is exported to Japan and recycled to become gold and other metals and used by Tanaka Holdings Co. Ltd, a metal industry based in Japan. Accordingly, those metals are used to make Tokyo Olympics medals (Interviewee 8).

Besides ingots, mobile phone waste is recycled to become powder materials, both ferrous and non-ferrous. For non-ferrous powder materials, it will be used as an alternative fuel in the cement industry (Interviewee 7). Otherwise, the ferrous powder materials are merely stored in the recycling plant because there is a restriction to exporting those materials, albeit there are many requests from overseas (Interviewee 7). In addition, the plastic industry will use the crushed plastic recycled by a third party (Interviewee 4).

Moreover, the recycled materials do not return to the production process of mobile phones because, as mentioned in ***Section 4.1.1***, there is only an assembly process in Indonesia (Interviewee 6; Interviewee 7). The producers also confirmed that there is no possibility of using recycled materials as the secondary raw materials for the production process due to the holding company's policy, which requires the subsidiaries to recycle in each country (Interviewee 3). Additionally, recycled materials' specifications will differ from virgin raw materials (Interviewee 2). However, using recycled materials is still possible, but it depends on the market and should consider the cost and value (Interviewee 2). Recycling mobile phone waste and recovering its materials is a complex issue. Hence, it needs to develop innovative technological solutions to optimally process mobile phone waste and save the environment (Mairizal et al., 2021).

4.2 Perspective of stakeholders related to the EPR instrument for mobile phone waste

For implementing EPR, the stakeholders involved in the four phases of the life cycle should coordinate and collaborate, and their perspectives should be aligned. Hence, this section explains the

preferred EPR instrument of stakeholders, including producer, consumer, recycler, and the government based on the availability of resources (money, time, and human) and the easiness of implementation.

4.2.1 Perspective of producer

Several electronic industry associations wrote a letter to the MoI in 2019 stating that they refused the EPR policy because there was not their responsibility (Interviewee 13; AIPTI et al., 2019). However, they still believe the EPR implementation will contribute to e-waste management and positively impact the environment (Interviewee 2; Interviewee 3). Furthermore, they will be involved if the government ensures the EPR mechanism, the stakeholders involved, and how the recycled materials will be further used (Interviewee 3). To have a more comprehensive perspective of the producers related to the EPR, ***Table 5*** explains their preferred EPR instruments. The filled cells present the advantages and disadvantages of each EPR instrument, which can be considered as stakeholders' preferred instrument. Otherwise, the empty cells present no concern from interviewees regarding those instruments.

Considering the availability of resources, to implement take-back requirements, the producers should prepare high costs to provide collection points and incentives for consumers to ensure they return their mobile phones (Interviewee 1). Moreover, considering the easiness of implementation, ADF would be challenging to implement because there should be a clear fee collection mechanism, many stakeholders should be involved, and difficult to control the implementation (Interviewee 2). Consequently, the producers who increase the product prices will face problems when the implementation is not going well (Interviewee 3). Therefore, from the producers' perspective, the preferred instrument is a deposit-refund system because the cost would be charged to the consumers, not the producers (Interviewee 1; Interviewee 2). However, there is still a need to raise consumers' awareness to be willing to pay a deposit and return their mobile phones to get their refund (Interviewee 1; Interviewee 3).

Table 5. *The preferred instrument based on the producers' perspective*

Stakeholder	Take-back requirements		Deposit-refund system		Advanced disposal fees	
	Advantage	**Disadvantage**	**Advantage**	**Disadvantage**	**Advantage**	**Disadvantage**
Representative of Bright Mobile Telecommunication			The cost is charged to the consumers due to their responsibility. Hence, there is no increased cost charged to the producers.	Need a raising awareness for the consumers so they are willing to return voluntarily.		
Representative of AIPTI		There is no obligation of the producers to take it back their product.	The producers can get money from this system, albeit it is necessary to calculate the benefit of this system.			This instrument will be difficult to control.
Representative of Producer 3	Producers can provide collection points	• Need a high cost to provide collection points. • There is no guarantee that consumers will return their phones because the habit of most consumers is keeping their phones at home. • Producers need to give consumers an incentive, such as a voucher. • The government should provide a direct incentive for producers to collect a certain number of mobile phones.		Not all consumers are willing to pay a deposit.		Fee collection mechanisms are often challenging to manage and will become a problem for producers who increase the product prices.

4.2.2 Perspective of consumers

Based on the survey results and the Likert scale calculation, as presented in ***Appendix E***, consumers have positive beliefs and the likelihood of agreeing to the behavior of contributing to EPR implementation. More than 90% of respondents strongly agree that EPR implementation is good for the environment and health and can contribute to others and future generations' life. Besides, a majority of respondents would participate in the EPR program. More than 84% of respondents thought that family and friends are the most influential things that encouraged them to participate in the EPR program, and the second-highest influential things are media. Media, such as newspapers or magazines, TV (television), radio, websites, and social media, also significantly provide information about mobile phone waste management, including the EPR program. Aside from that, 77.80% of respondents agree that the community where consumers live also influences them to participate in the EPR program, albeit not as influential as family, friends, and media.

In the TPB, the availability of resources and easiness of implementation affect the consumers' perspective in choosing their preferred EPR instrument that would further influence their behavior in contributing to the EPR implementation. ***Table 6*** presents the survey results for specific questions regarding those three EPR instruments stated in ***Appendix C***. As presented in ***Table 6***, consumers agree with all instruments. Considering the money available, they are willing to pay a deposit or fee and voluntarily drop their mobile phone waste. In addition, considering the time availability, they have time to drop mobile phone waste at a specific collection point.

Table 6. *The preferred instrument based on the consumers' perspective*

Take-back requirements		**Deposit-refund system**		**Advanced disposal fees**	
Have time to drop mobile phone waste to a specific collection point	79.09%	Willing to pay a deposit when purchasing mobile phones and will get a refund when dropping back the after-used mobile phones	77.13%	Willing to pay a fee when purchasing mobile phones to treat mobile phone waste in environmental sound	76.84%
Willing to drop mobile phone waste to a specific collection point if it is located near their houses	87.99%	Will be more likely to do deposit-refund system if there is a clear system from the paid deposit	82.06%	Will be more likely to pay a fee if there is an information about how the mobile phone waste will be treated	79.9%
Willing to drop mobile phone waste at a specific collection point voluntarily	84.11%				

Furthermore, the easiness of implementation is also considered by consumers. For example, they are likelier to drop off mobile phone waste if the collection point is near their house. They are also more likely to pay a deposit or fee if there is enough information on a transparent deposit-refund system and how the mobile phone waste will be further treated.

Based on the number of percentages, the instrument with the highest percentages is take-back requirements, followed by the deposit-refund system and ADF. Nevertheless, take-back requirements would be chosen if only the collection points are close to their house. On the other hand, if the collection points are not close to their house, consumers could prefer a deposit-refund system, as long as the system is informed clearly.

The survey results correlate with the socio-economic condition of respondents, such as age and educational level. As presented in ***Figure 11***, most respondents are 25 – 34 years old. Based on a survey conducted by the Ministry of Communication and Information Technology in 2017, 20 – 29 years old is the group age with the highest level of smartphone use in Indonesia, followed by 30 – 49 years old (Ministry of Communication and Information Technology, 2017). Moreover, the Y generation, aged 25 – 40, has the highest interest in environmental issues. Aside from that, most respondents are individuals with higher education levels; 60% and 25% have bachelor's and master's or doctoral degrees, respectively. Higher education levels cause individuals to be more concerned with current environmental conditions and, accordingly, have more environmentally friendly habits (Meyer, 2015). Therefore, those reasons influence most respondents to agree with all of the EPR instruments.

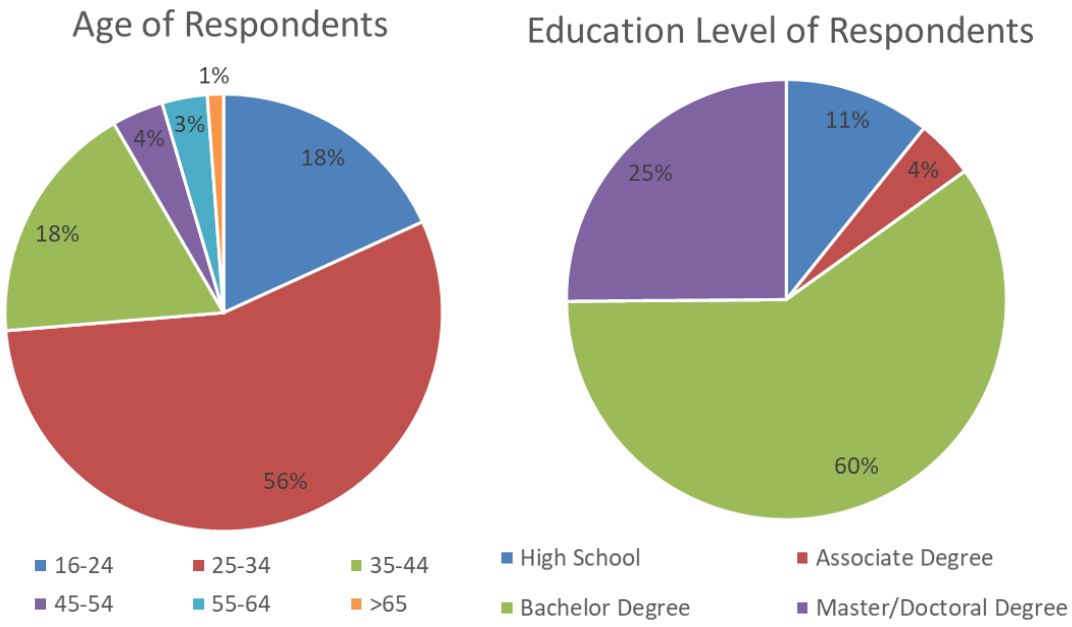

Figure 11. *Demographic data of survey respondents*

4.2.3 Perspective of recyclers

Like the producers, the recyclers also state that the EPR will significantly impact the environment, particularly long term (Interviewees 4; Interviewee 5). However, in the short term, due to Indonesian consumers' habit of often keeping their mobile phones at home or giving it to someone else when it is still functioning, the contribution of EPR will be insignificant (Interviewee 4). Additionally, the EPR will increase the recycling rate, but it depends on the type of instrument implemented (Interviewee 7). Hence, there is a need to understand the perspective of recyclers regarding their preferred EPR instrument, as seen in ***Table 7***.

Based on the recyclers‘ perspective, the resources will be available for ADF because they can use those fees to recycle mobile phone waste (Interviewee 6; Interviewee 7). Nevertheless, considering the easiness of implementation, the recyclers state that ADF will be difficult to implement due to consumers' complaints when there is an additional cost in the product (Interviewee 5). Furthermore, after consumers pay fees upfront, it does not guarantee that the mobile phone waste will be returned (Interviewee 4). Besides, because the perception regarding EPR between the MoI and MoEF is still different, this instrument can only be feasible to be implemented in the long term (Interviewee 7).

The most preferred instrument of the recyclers is the take-back requirements due to the easiness of implementation, albeit it needs costs to provide collection points and develop marketing programs, such as buy-back programs or giving incentives to the consumers (Interviewee 4; Interviewee 5; Interviewee 7). Moreover, it has already been implemented in Thailand, a country with a similar condition to Indonesia (Interviewee 8). Besides take-back requirements, the recyclers also prefer to choose a deposit-refund system considering the socio-economy condition of consumers in Indonesia who would be interested in getting a money refund when they return their mobile phones (Interviewee 4; Interviewee 8).

Table 7. *The preferred instrument based on the recyclers' perspective*

Stakeholder	Take-back requirements		Deposit-refund system		Advanced disposal fees	
	Advantage	**Disadvantage**	**Advantage**	**Disadvantage**	**Advantage**	**Disadvantage**
Representative of Tes-AMM Indonesia	It is possible to make mobile phone waste returned.	Need costs for collection points and marketing costs, such as providing incentives for consumers.	Consumers will return their phones because they need to get a refund.	Need an incentive for consumers to return their phones.		Upfront payments can be collected, but it does not guarantee that the mobile phone waste will be returned.
Representative of CAR	The most feasible instrument, albeit the collection and financing mechanism and who is involved should be clear.	The producers have to develop programs / strategies and collaborate with recyclers.		Consumers often complain if there is a price increase or an additional cost.		Consumers often complain if there is a price increase or an additional cost.
Representative of MML					Recyclers could use this fee to recycle mobile phone waste	Need a raising awareness for consumers.
Representative of Recycler 4	It is feasible to be implemented in the short term because it can provide many collection points that are further transported to the recycler.	Need a buy-back program or incentives for consumers to make it more attractive, hence they would like to return their mobile phone waste.			Will be beneficial for the recycler to recycle the waste using the fees paid by consumers.	Can only be feasible to implement in the long term because there is still a difference in perception between the MoI and MoEF.
Representative of PPLI	Based on the UNDP report, the EPR scheme (take-back) of Thailand could be adopted by Indonesia.	Due to consumers' habit that often keep their phones at home, the incentive such as cash, should be provided.	For the socio-economy condition of Indonesian people, getting a money refund when they return their mobile phones would be interesting.			

4.2.4 Perspective of the government

From the government's perspective, EPR will significantly contribute to the national target for waste reduction and handling that should be achieved in 2024, so the increase in recycling rate will potentially reduce waste transported to landfills (Interviewee 11). Furthermore, Bandung City has an insufficient budget to provide e-waste collection facilities. Therefore, EPR will be beneficial for the government to sort and collect e-waste, which has the highest cost for waste operational (Interviewee 9; Interviewee 10). In addition, EPR will encourage the informal recyclers to meet the technical requirements and provide personal protective equipment (PPE) for their operations (Interviewee 11). Besides, EPR will give more information regarding the amount and type of recycled materials that could be used to produce new mobile phones. As a consequence, the producers will be encouraged to limit the imported materials, increase the TKDN, and produce green products (eco-labels or green certifications) (Interviewee 12; Interviewee 13). However, EPR implementation will still be challenging because producers in Indonesia only have the assembly process, and the consumers' habit is often keeping their phones at home (Interviewee 9; Interviewee 13).

As presented in ***Table 8***, ADF and deposit-refund systems are not preferred instruments based on the governments' perspective due to implementation difficulties. Those instruments need many stakeholders involved to ensure the accountability of the deposit/fee collected and should consider the consumers' socio-economic level (Interviewee 9). Similar to the producer and recyclers' perspective, the government also think Indonesian consumers would be reluctant to pay deposits or additional fees due to lacking awareness (Interviewee 10). Moreover, those instruments could also impact the competitiveness among brands, and some producers could not compete in the market (Interviewee 11; Interviewee 12). However, the deposit-refund system is still possible to implement in the long term as long as the plan on how the consumers pay and get a refund, how retailers are involved, how the cash flows are, and who manages the deposits is provided clearly (Interviewee 12).

Table 8. *The preferred instrument based on the government's perspective*

Stakeholder	Take-back requirements		Deposit-refund system		Advanced disposal fees	
	Advantage	**Disadvantage**	**Advantage**	**Disadvantage**	**Advantage**	**Disadvantage**
Representative of DLH of Bandung City	• Based on the Waste Management Law (18/2008), every waste producer should reduce waste. • The simplest instrument compared to other instruments. • It does not have to be directly provided by the producers. Instead, it can use start-up companies to manage, operate, and provide the system.			• Unfamiliar to consumers and depends on consumers' socio-economic level. • Ensure the accountability and who will manage the money. • The government cannot easily withdraw the additional fees.		Need many stakeholders involved (producers, distributors, consumers) and depends on consumers' socio-economic level.
Representative of DLH of West Java Province	Take-back will be a responsibility of the producer.			Indonesian people are reluctant to pay deposit due to a lack of awareness regarding e-waste management.		Indonesian people are reluctant to pay some additional fee due to a lack of awareness regarding e-waste management.
Representative of MoEF	Take-back mechanism has been stated in one of the articles in the draft of Ministerial Regulation, the producers will provide collection points within the producers' coverage and outside (districts and public spaces). Besides the producers, based on Law 18/2008 and Government Regulation 27/2020, the	There is a reluctant from producers because from the producers' perspective, the EPR is not entirely their responsibility but also the consumers' responsibility.	This instrument can encourage people to return their mobile phone waste.	The producers will be reluctant because they have to provide more costs to have a further treatment.		If the implementation will only be pilot scale, some producers cannot compete in the market because they have to provide this fee.

	local government can provide collection facilities and infrastructure on the city scale.					
Representative of MoI – Green Industry Center		The producers should provide costs for this instrument.		• Producers need extra marketing costs and take back the waste. • There will be an increase in the product price which will impact the competitive-ness among brands. • Need to plan on how consumers pay for deposits, how they can get the refund, how retailers are involved, how the cash flows are, and who manages the incoming deposits, this instrument is possible to be implemented in the long-term but not in the short-term.	Fees that are paid by consumer could be used to recycle the waste.	
Representative of MoI – Directorate of IET	Combination of take-back and deposit-refund because there will be the producers' responsibility to take back their product	Several electronic industry associations wrote a letter to the Minister of Industry that they were not accept the policy on EPR. They stated that e-waste should be the responsibility of consumers, not producers.	Combination of take-back and deposit-refund because there will be the consumers' responsibility to pay a deposit and ensure they return their phone.			Increasing the product price may be acceptable to producers, but consumers will be reluctant.

A majority of the governments' representatives prefer the take-back requirement as an EPR instrument due to the ease of implementation and availability of human resources. Moreover, despite the producers' reluctance due to cost provision, this instrument is the simplest compared to other instruments (Interviewee 9). Recently, MoEF stated a take-back mechanism in one of the articles in the draft of Ministerial Regulation, a derivative regulation of Government Regulation 27/2020 (Interviewee 11). Subsequently, the producers will provide collection points within the producers' coverage, districts, and public spaces (Interviewee 9). However, this instrument does not have to be directly provided by the producers because, as stated in Government Regulation 27/2020 (Government Regulation No. 27/2020, 2020), local government could provide collection facilities on the city scale (Interviewee 11). Aside from that, start-up companies could also manage and operate the e-waste collection process (Interviewee 9). Additionally, a combination of take-back and deposit-refund would be interesting because producers will be responsible for taking back their products, and consumers will be responsible for paying a deposit and returning their waste (Interviewee 13).

Additionally, there is an opinion from one representative of the local government that it would be better to use an environmental tax instrument paid by the producers. Moreover, the regulation related to the environmental economic instrument is already available, Government Regulation 46/2017, to internalize the environmental needs into production costs (Interviewee 9; Government Regulation No. 46/2017, 2017). Nevertheless, producers pay an environmental tax that only covers the impacts of extraction processes, not wastes disposal or treatment; it should be combined with other policy instruments (Milios, 2021). Besides, there should be tax exemption for producers using secondary materials (Milios, 2021). Hence, a feasibility study should be conducted to assess the possibility of implementing an environmental tax instrument (Interviewee 9).

4.3 EPR scheme for mobile phone waste

This section presents a desirable EPR scheme for mobile phone waste that is considered the life cycle of mobile phones and the preferred instrument of stakeholders from the previous section. Besides, the stakeholders' role, current regulations, the government's plan, and the interviewees' suggestions to support the EPR implementation were also considered to integrate within an EPR scheme.

4.3.1 Stakeholders' preferred EPR instrument

The preferred EPR instrument based on stakeholders' perspectives considering the availability of resources and the easiness of implementation is concluded in ***Table 9***. Take-back requirements is the most

favored instrument; 9 out of 13 stakeholders prefer to choose this instrument. 7 out of 13 stakeholders prefer a deposit-refund system, making it the second-most favored instrument. Lastly, ADF is the least favored instrument because solely four stakeholders chose this instrument. As shown in ***Table 9***, producers prefer a deposit-refund system, while the local and central governments prefer take-back requirements. Furthermore, the recyclers have a preference to choose between take-back requirements or a deposit-refund system, and the consumers have a neutral option on those three instruments.

Table 9. *The preferred instrument based on the stakeholders' perspective*

Stakeholder		Take-back requirements	Deposit-refund system	Advanced disposal fees
Producer	Representative of Bright Mobile Telecommunication		1	
	Representative of AIPTI		1	
	Representative of Producer 3	1		
Consumer	-	1	1	1
Recycler	Representative of Tes-AMM Indonesia	1	1	
	Representative of CAR		1	
	Representative of MML			1
	Representative of Recycler 4	1		1
	Representative of PPLI	1	1	
Local Government	Representative of DLH of Bandung City	1		
	Representative of DLH of West Java Province	1		
Central Government	Representative of MoEF	1		
	Representative of MoI – Green Industry Center			1
	Representative of MoI – Directorate of IET	1	1	
TOTAL		**9**	**7**	**4**

4.3.2 Stakeholders' role for the EPR implementation

To design an EPR scheme and accordingly implement the preferred instrument, there is a need to consider whom the stakeholders are involved and what their roles are, as presented in ***Table 10***. Based on the interviews, besides the government, producers, consumers, and recyclers, it is also essential to involve retailers, private sectors, informal sectors, relevant communities, academics, and media. They will have their respective roles, such as providing relevant regulations, providing waste collection services and treatment facilities, monitor and evaluate the EPR implementation, and raise public awareness.

Table 10. *Stakeholders involved in the EPR implementation*

Stakeholder		Role of stakeholder
Central government	Ministry of Environment and Forestry (MoEF)	As a regulator, provide regulations related to e-waste management. As a facilitator, provide drop boxes to several local governments, including the Bandung City government, to educate them regarding e-waste management, mainly sorting and collection. When the EPR is implemented, they will also have a role as an evaluator (Interviewee 11). They also have a role in educating the informal sector (waste pickers) and regulating informal recyclers to comply with technical requirements. (Interviewee 3; Interviewee 11).
	Ministry of Industry (MoI)	The green industry center will encourage producers to implement the green industry and develop a circular economy concept. As a regulator, they provide the circular economy roadmap that includes e-waste and regulate the product standard that uses recycled materials or recycled products to ensure quality. As a facilitator, they encourage producers to redesign their products for long life and ensure they will be recyclable after they become waste and trigger the potential recycler to process the e-waste (Interviewee 12). They also create an economic climate that can encourage producers to obtain raw materials and produce mobile phones in Indonesia, thereby reducing imported products (Interviewee 13).
	Ministry of Public Works and Housing (MoPWH)	Provide the treatment facilities (Interviewee 3; Interviewee 10; Interviewee 12).
	Ministry of Education and Culture (MoEC)	Collaborate with MoEF to raise public awareness (Interviewee 3)
	Ministry of Finance (MoF)	Regulate the financing mechanism (e.g., taxes, levies, fees) that comply with the existing regulations (Interviewee 12). If the instrument chosen is Advanced Disposal Fees, the role of MoF will be significant in setting the mechanism (Interviewee 11).
	Environmental Fund Management Agency (BPDLH)	Manage the money from companies that will further be handed over to the local government, and then the local government will send it to recyclers (Interviewee 11).
	Ministry of Trade (MoT)	Control import products, particularly the changing of international regulations related to the import products and provide marketing policy (Interviewee 12; Interviewee 13).
	Ministry of Home Affairs (MoHA)	Manage the regional public service agency (BLUD) that has responsibility for the operation of e-waste management on the city scale (storing and sorting) before it is transported to the e-waste recycler (Interviewee 11).
	Coordinating Ministry for The Economy	Lead the process and supervise relevant ministries, particularly MoEF and MoI (Interviewee 6; Interviewee 13).
Local government	DLH of Bandung City	Provide a warehouse for e-waste, transportation service from the collection point to the warehouse, and a partnership with an e-waste recycler (Interviewee 11).
	DLH of West Java Province	Provide a warehouse for e-waste, transportation service from the collection point to the warehouse, and a partnership with an e-waste recycler (Interviewee 11). When the EPR is implemented at city scale, they could facilitate cities in implementing EPR, monitor and evaluate the EPR implementation, and supervise industries that

Stakeholder		Role of stakeholder
		are under the authority of the provincial government, and facilitate cities in implementing EPR (Interviewee 10).
	Industry and trade agency of Bandung City and West Java Province	To foster industry, grant permits that are the authority of the province or city, and implement green industry (Interviewee 10).
	Municipal police	Supervise the regulation if there will be a local government regulation (Interviewee 10).
Producer	Producer	Taking back mobile phone waste or pay some fees to process mobile phone waste (Interviewee 8; Interviewee 10; Interviewee 11; Interviewee 13).
	Electronics Industry Association	Coordinating producers (Interviewee 13).
Consumer	[redacted]	Actively contribute to drop/return their mobile phone waste (Interviewee 10).
Recycler		Recycle mobile phone waste (Interviewee 8; Interviewee 11; Interviewee 12).
Retailer		Involve in mobile phone waste collection (Interviewee 2).
Private sector	Start-up company who collects e-waste	Involve in mobile phone waste collection and raise public awareness (Interviewee 10).
Informal sectors	Waste pickers	Involve in mobile phone waste collection (Interviewee 9; Interviewee 10).
	Junk men	
	Waste bank	
Relevant community	EwasteRJ, Komunitas E-waste Bandung	Involve in mobile phone waste collection and raise public awareness (Interviewee 10).
Academics	University, research center	Conduct transfer knowledge and research regarding mobile phone waste management and EPR (Kagungan et al., 2021).
Media	Local or regional media	Raise public awareness (Interviewee 10).

4.3.3 Current regulation and the government's plan for the EPR implementation

Recently, Indonesia has a regulation regarding specific waste management, including e-waste (Government Regulation No. 27/2020, 2020). According to this regulation, the Local Government is responsible for collecting and providing warehouses for specific waste and the producers to reduce the specific waste and conducting the take-back scheme from consumers (Interviewee 11). Otherwise, the MoI does not have any relevant regulation yet. However, the Green Industry Center of the MoI had already made a Roadmap of Circular Economy 2020-2030, including e-waste (Interviewee 12).

The central and local governments have plans for the EPR implementation for mobile phone waste, as presented in ***Table 11***, that should be considered in an EPR scheme. As a regulator, MoEF drafted the Ministerial Regulation as a derivative of Government Regulation 27/2020. That regulation has considered inputs from the experts, the local government that conducts e-waste collection (DLH of DKI Jakarta Province), and the relevant non-profit organizations (EwasteRJ Community) (Interviewee 11).

Table 11. The government's plan for the EPR implementation

Central government		Local government	
MoEF	**MoI**	**DLH of West Java Province**	**DLH of Bandung City**
Make a draft and accordingly ratify a Ministerial Regulation as a derivative of Government Regulation 27/2020 regarding specific waste management, which will also regulate the take-back scheme	• Conduct a study on the needs for regulations in the future, such as green industry standards for the electronics sector • The Directorate of IET: conduct a circular economy study for the electronics sector • The green industry center: disseminate information about the existence of an e-waste warehouse in Depok city • Increase the capacity of the test centers or laboratories (metal and electronics center and technology center)	• Create a roadmap for the EPR, including for e-waste • Discuss with the MoEF related to specific waste management in the household level • Facilitate collection points that can be placed in supermarkets and public spaces	• Study of e-waste generation • Mapping the informal sector • Provide the collection points • Facilitate companies who want to conduct CSR that correlate with e-waste

The content of the draft of Ministerial Regulation consists of (Interviewee 11):

- Producers will provide collection points in their coverage area, each district, and public spaces
- Consumers should drop their waste at specific locations provided by producers.
- Local government will transport the waste from the collection points to the warehouse and pay recyclers to treat the waste properly.
- For the financing mechanism, producers will pay the fees to BPLHD, which should be handed over to the local government. Hence, the local government can transport and treat the waste with those fees.

In mid-April 2022, this draft was already submitted to the Directorate General, and it will be discussed with the MoI and producers later. Eventually, this draft will be ratified in June or July 2022. In addition, there will be a study related to the producers' take-back scheme that is expected to be finished in July 2022 (Interviewee 11).

Besides MoEF, MoI will also prepare to conduct a study related to future regulatory needs, such as green industry standards for electronic sectors by the green industry center (Interviewee 13). Recently, there has been a study on the potential of circular economy implementation for the electronics sector by the Directorate of IET (Interviewee 12). That study encourages producers to implement the circular

economy concept while simultaneously ensuring production stability and increasing competitiveness and technology (Interviewee 12).

Moreover, MoI provides facilities at the national level, such as an e-waste warehouse and test centers or laboratories. The plan is to increase the capacity of the laboratories by adding the test variants related to hazardous materials or waste (Interviewee 12). Furthermore, because of the e-waste warehouse only collects a small amount of e-waste, they plan to disseminate information about the existence of this warehouse (Interviewee 12). However, further treatment for e-waste collected in this warehouse is still absent.

At the provincial level, the government plan to create the EPR roadmap for e-waste that could propose to MoEF to become a role model for other provinces (Interviewee 10). Aside from that, they also plan to immediately discuss with the MoEF to ensure that the future regulation does not burden the stakeholders involved in e-waste management (Interviewee 10). When the regulation related to e-waste management or EPR for e-waste already exists, the collection points, such as drop boxes, could be placed in supermarkets and public spaces (Interviewee 10).

At the city level, the plans are more operational. For instance, DLH of Bandung City plans to study e-waste generation and map the informal sector that has conducted e-waste collection and recycling. Besides, they plan to provide e-waste collection points while waiting for technical guidance from the central government (Interviewee 9). They also facilitate companies who want to conduct CSR activities related to e-waste management (Interviewee 9).

4.3.4 Suggestions to support the EPR implementation

Moreover, the interviewees have suggestions to support the EPR implementation, as presented in ***Table 12***. The suggestions are categorized into several topics: regulation or policy related to the e-waste management in general and EPR scheme in more specific, awareness-raising, perception of EPR, and EPR implementation. In addition, for the EPR implementation, the suggestions include the division of stakeholders' roles, piloting before implementing EPR comprehensively, mobile phone waste collection, and financing mechanism, including providing incentives for consumers and producers. Those suggestions are advantageous for designing an EPR scheme.

Table 12. *Suggestions to support the EPR implementation*

Regulation / Policy	<u>*E-waste management*</u> MoEF should immediately provide a regulation related to e-waste management as a guideline to implement at the local level (Interviewee 10). Those regulations should consider Indonesian consumers' socio-economic condition and ensure the local government clearly understands (Interviewee 1; Interviewee 3; Interviewee 12; Interview 13). Subsequently, the

	law enforcement of that regulation, particularly for illegal recyclers, should be conducted (Interviewee 3). Aside from that, there should be a national action plan for e-waste management that is handled by Coordinating Minister to coordinate the relevant ministries (Interviewee 6). *EPR scheme* For a specific regulation related to the EPR scheme, MoEF should ensure that the regulation is in line with the regulations of the MoI (Interviewee 9). Moreover, the regulation should ensure that while the producers implement the EPR, they still survive and compete with other brands (Interviewee 12). Besides, the regulation should also be discussed with the producers to understand the possibility of using recycled materials because producers need to readjust their business plan to comply with it (Interviewee 1; Interviewee 5).
Awareness-Raising	Awareness-raising should be conducted by the government for the public (consumers), particularly about the dangers of mobile phone waste and how to treat it appropriately (Interviewee 1; Interviewee 7; Interviewee 8; Interviewee 11). Moreover, MoEF could collaborate with the Ministry of Education and Culture to provide education related to mobile phone waste and EPR (Interviewee 2). Besides through socialization or public campaign, awareness-raising could be conducted by ensuring the transparency of the government services and performances related to mobile phone waste management and by providing a figure of leader that could be an example for the public (Interviewee 3). However, awareness-raising is also needed for producers, recyclers, government officers, and informal sectors (Interviewee 12).
Same perception of EPR	There should be the same perception among stakeholders involved, such as producers and related ministries (MoEF and MoI), related to the definition and purpose of EPR (Interviewee 4; Interviewee 9). Therefore, each stakeholder is aware of their role, and the producers realize their responsibility.
EPR Implementation	*Division of roles* All relevant stakeholders should have a shared responsibility to implement EPR (Interviewee 10). Therefore, there is a need to map out who is involved, determine who should be responsible, and how the division of roles of the stakeholders involved, particularly the most relevant stakeholders, such as producers, government, and recyclers (Interviewee 6; Interviewee 9). *Piloting* Before regulate the regulation regarding EPR for e-waste, it would be better for the government to have a pilot project in a particular city by providing specific task force to have a collaboration with the recycler (Interviewee 13). Hence, they could identify how significant the impacts of the EPR implementation, such as amount of mobile phone waste collected, material recovered, and revenue for the local government (Interviewee 3). *Mobile phone waste collection* The central government should give the authority to the local government to collect e-waste, including mobile phone waste, before it sent to the recycler (Interviewee 2). Consumers can drop their mobile phones to the collection point that provided by the government, or the government can provide services to collect door-to-door (Interviewee 2; Interviewee 8). For the collection, informal sector, such as home-based repair centers and waste pickers could be involved to increase the collection rate (Interviewee 8; Interviewee 9). *Financing mechanism and incentives* The government should provide a specific institution, such as a fund management agency that manages the fees paid by the producers, prepare how that institution works, and ensure the transparency of the process to producers (Interviewee 3). Besides, the government must

	prepare a financing mechanism that complies with the existing regulations in the relevant ministries, such as MoEF, MoI, and Ministry of Finance (MoF) (Interviewee 12). To have a more attractive scheme, the government could provide incentives for producers who have the initiative to implement the EPR, albeit it depends on how easy to get these incentives and whether it is worth the producers' effort (Interviewee 13).

4.3.5 Integration of stakeholders' perspectives within an EPR scheme for mobile phone waste

As mentioned in the previous section, the preferred instrument from all stakeholders is based on the availability of resources, particularly money, because it is correlated with the extra cost that should be provided. Besides, the easiness of implementation is also considered because when many stakeholders are involved, the planning, coordination, implementation, monitoring, and evaluation would be challenging. Furthermore, the preferred instrument based on the stakeholders' perspectives would be integrated within an EPR scheme for mobile phone waste. However, to design an EPR scheme, the stakeholders involved in the EPR implementation, the existing regulation and plan of the government, and the stakeholders' suggestions to support the EPR implementation are also considered.

A desirable EPR scheme is a mechanism desired by the stakeholders and could be implemented in the short term. Even though two out of three producers have reluctance with the take-back requirements and prefer to choose a deposit-refund system, a desirable EPR scheme would be used take-back requirements as an EPR instrument, as presented in ***Figure 12***. Take-back requirements are also stated in the draft Ministerial Regulation that MoEF regulated due to the responsibility of the producers for their products based on Government Regulation 27/2020 (Interviewee 11; Government Regulation No. 27/2020, 2020). Additionally, the other stakeholders state that implementing a deposit-refund system needs a longer time, so it would only be possible if implemented in the long term (Interviewee 7; Interviewee 12).

The producers will pay some fees to BPDLH as the responsibility of their products. Those fees would be handed over by BPDLH to DLH to be used for providing collection points, warehouses, and collaboration with recyclers. Besides, the producers should provide collection points within their coverage area, which were at retailers and service centers. Furthermore, DLH could make an institution under them, BLUD, that could provide and manage the collection points (Interviewee 11). As mentioned in ***Section 4.2.2***, consumers are more willing to drop their mobile phone waste if the collection points are near their houses. Hence, DLH could also collaborate with private sectors, communities, waste banks, and informal sectors to provide more collection points accessible to consumers (Interviewee 9, personal communication, May 18, 2022; Interviewee 10, personal communication, May 26, 2022). For the private

sector, because they have already had their funding, DLH does not need to facilitate them regarding funding for the provision of collection points.

Subsequently, consumers are responsible for dropping their mobile phone waste, and they can drop it to BLUD, private sectors, community, waste banks, or informal sectors (e.g., waste pickers and junk men). Besides, they could also drop it at retailers, where they buy the mobile phones or service centers. From the collection points, mobile phone waste would be collected in the warehouse provided by DLH to be further transported to the recyclers.

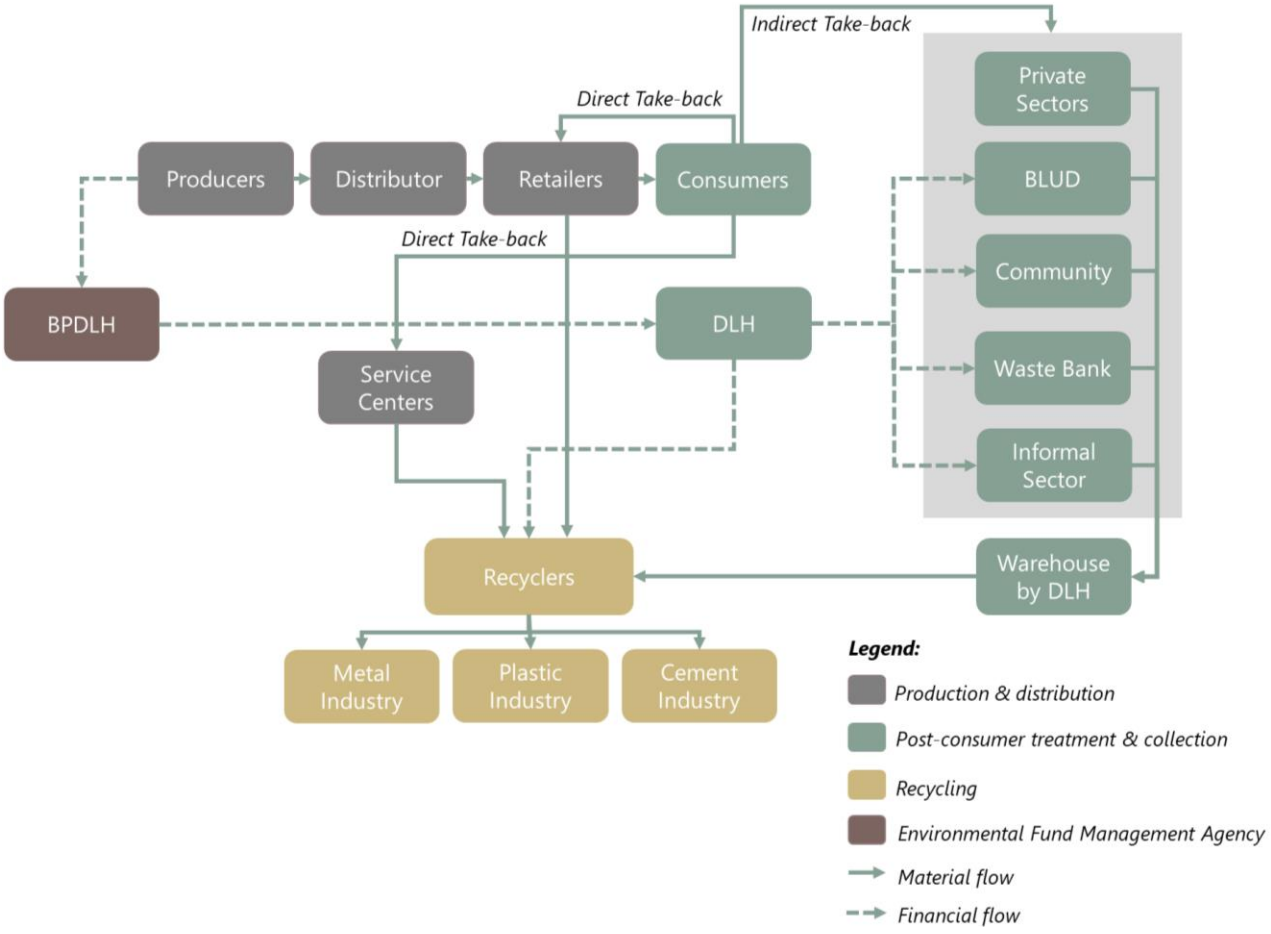

Figure 12. *An EPR scheme for mobile phone waste*

Source: Own interpretation

CHAPTER 5. DISCUSSION

This chapter explains the interpretation of the results to provide recommendations for improving the current situation and preparing to implement the EPR scheme in the future. This chapter also explains the application of TPB in this research. Besides, this chapter compares the research findings with the findings in the previous studies, whether the findings are similar or different.

5.1 Mobile phone waste collection in the EPR scheme

Results presented in ***Chapter 4*** show that take-back requirements are the preferred EPR instrument for mobile phone waste that could be feasible to implement in Bandung City in the short term. To implement the take-back requirements, producers could directly provide collection points within their coverage area (e.g., retailers and service centers) and indirectly provide money for collection points by paying fees to the fund management agency. Nevertheless, because in the Government Regulation 27/2020, the local government has also responsible for collecting e-waste from households, producers and local government could share the cost and roles in providing collection points.

The private sector is already interested in providing household e-waste collection services. However, it should be ensured that all stakeholders involved in the collection process collaborate with legal recyclers. Unfortunately, nowadays, some communities and private sectors that have already collected e-waste from households solely collaborate with informal sectors. Eventually, they only address the social issues to provide a proper job for informal sectors, but they ignore the environmental issues. As a result, the e-waste is not appropriately treated because, typically, the informal sectors merely take the valuable materials and burn or throw the other parts in the river, albeit it is a part of hazardous waste. Hence, the government should ensure that the collection and recycling process conducted by communities and private sectors complies with current regulations and are safe for the environment.

It is possible to combine the take-back requirements with the deposit-refund system in the following stages because the deposit-refund system is the second favored instrument in this research. For instance, specific areas will implement the deposit-refund system, and the remaining areas will implement take-back requirements. The specific areas could consider the socio-economic condition and environmental awareness of consumers. However, the deposit-refund system needs a firm financing mechanism and many stakeholders involved, not only MoEF and MoI, but also MoF. Besides, there should be connected regulations between relevant ministries. Hence, it would only be feasible to implement in the long term due to the longer time needed to ensure everything is well-planned.

5.2 The need for The Coordinating Ministry and the piloting at city scale to implement EPR scheme

Recently, MoEF is still drafting the regulation to implement EPR for e-waste. The regulation draft and planning for the implementation should be discussed with all relevant stakeholders, ensuring that all stakeholders have the same perception. To ensure smooth cross-ministerial coordination, it would be better if a coordinating ministry handles the e-waste issue. Furthermore, the coordinating ministry can coordinate relevant line ministries and establish a task force to accelerate EPR implementation. This approach has already been implemented in tackling marine plastic debris. The Coordinating Ministry for Maritime Affairs and Investment coordinated MoEF, MoI, Ministry of Marine Affairs, and Fisheries to draft the action plan and its division of roles.

The piloting of the EPR is an action the government should conduct in selected cities. For instance, DKI Jakarta has already conducted e-waste collection services. Bandung City could also become a pilot city because the local government already has a concrete plan, such as studying e-waste generation, mapping the informal sectors, and discussing the roadmap of EPR for e-waste. The piloting would be beneficial to realize the impact of the EPR implementation, particularly for the different socio-economic levels of consumers. To conduct a pilot, the government could prepare the database system and accordingly evaluate the mechanism. The database system is needed to record the data related to mobile phone produced and introduced to the market; the amount of mobile phone waste generated, collected, and recycled; and the type and the amount of materials recovered. Therefore, the central government could identify the off-takers for each recycled or recovered material.

5.3 Optimize the recycling process and the use of recycled materials through the EPR scheme

EPR for mobile phone waste will significantly impact the e-waste management process, particularly recycling. As mentioned in ***Section 4.1.4***, all recyclers have the technology to recycle, but there are few mobile phones they could collect. By implementing the EPR, they could get enough mobile phone waste to be processed and provide more advanced technology to produce higher-quality recycled materials. Besides legal recyclers, the government should map illegal recycling activities and provide capacity building and training for the illegal recyclers to comply with technical requirements.

Regarding the recycled materials, there are few opportunities to use recycled materials from mobile phone waste to produce new mobile phones because, in Indonesia, there is merely an assembly process. However, recycled materials have the markets that commonly use them, such as the metal, plastic, and cement industry. Hence, MoI could encourage local suppliers to use recycled materials to produce mobile phone accessories that producers need. Subsequently, it will increase the TKDN, as stated

in Ministry of Communication and Informatics Regulation 13/2021, that the minimum TKDN of smartphones is 35%. Besides, due to the MoI plan to accelerate the implementation of the green industry, MoI and MoEF could collaborate to provide incentives for producers who have successfully applied the program that supports the EPR implementation to encourage others to follow suit.

5.4 Encourage consumers to be involved in the EPR scheme

Considering the habit of Indonesian consumers to keep their mobile phone waste at their home, when EPR is implemented, there should be an incentive for the consumers to stimulate them to drop their mobile phone waste. Such incentives do not have to be in the form of money; they could be in the form of a discount voucher. For instance, the trade-in program that has already been implemented in some producers and retailers could be an attractive program to collect mobile phone waste from consumers. Besides, raising awareness is also needed to inform consumers about the hazard of mobile phone waste, how the proper treatment is, and how the recycling process is. Raising awareness could be conducted by DLH through socialization. However, due to technology development, media, especially social media, could be the most effective channels to raise people's awareness.

5.5 Involvement of informal sectors in the EPR scheme

Waste banks and informal sectors play a significant role in mobile phone waste collection. Therefore, there should be a mechanism to involve them in the EPR implementation. For the waste bank, DLH should ensure that the waste bank is only a collection point; they cannot pay for the mobile phone waste collected by consumers. Therefore, it requires training for the operator to educate people who want to drop their mobile phone waste at the waste bank. On the other hand, the informal sectors, such as waste pickers and junkmen, could be involved in collecting mobile phone waste, sending it to DLH, and getting incentives from DLH. In addition, they could also be involved in the sorting process. For instance, at DLH's warehouse, they could sort the mobile phone waste with other e-waste before it is transported to recyclers, and DLH could provide the equipment, such as personal protective equipment. Nevertheless, because the informal sectors are money and profit-oriented, DLH should provide education and training before involving them in the collection and sorting process.

5.6 The application of TPB and the comparison with the previous research

Concerning TPB's application, TPB is generally used for finding the intentions and behaviors of individuals (Ajzen, 1991). However, in the e-waste management sector, TPB is used not only for finding the consumers' intentions and behaviors but also for producers' (Ardi & Purwojatmiko, 2019). Based on this research results, TPB can also be used for understanding the perspectives of other stakeholders besides consumers and producers, such as recyclers and the government. Additionally, this research also shows that TPB can be used more practically for designing an EPR scheme as a policy approach.

Comparing this research results with the previous studies that also use TPB, there are similar results from producers' perspectives, which are producers think it is not their obligation to do EPR, and the availability of resources and ease of implementation are the most prominent things (Ardi & Purwojatmiko, 2019). From consumers' perspectives, there is also a similarity related to the consumers' willingness to pay. In this research, ADF is the least favored EPR instrument due to the unwillingness of consumers to pay a cost. Similarly, most mobile phone consumers in Bangladesh are unwilling to pay the costs of recycling and treatment (Ananno et al., 2021). Moreover, as discussed in ***Chapter 4***, the EPR implementation, particularly the take-back schemes, requires stakeholders' involvement, similar to the Vietnam case (Ngunyen et al., 2019). In addition, Brazilian consumers are more likely to be involved in e-waste management if an economic incentive is provided (Echegaray & Hansstein, 2017). In ***Chapter 4***, most interviewees also mentioned that incentives are significantly needed for producers and consumers to encourage them to be involved in the EPR implementation.

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

This chapter provides conclusions to answer the sub research questions that leads to answer the main research question. Besides, this chapter also provides the recommendations for the implementation of EPR for mobile phone waste in Bandung City and the future research needed related to this topic.

6.1 Conclusions

This research aims to find preferable EPR instruments from stakeholders' perspectives, such as producers, consumers, recyclers, and the government. Eventually, the preferred EPR instrument is accommodated under an EPR scheme for mobile phone waste desirable for Bandung City. A mixed-method of qualitative and quantitative data collection and analysis was conducted to obtain the stakeholders' perspectives on the preferred EPR instrument. The interviews were conducted with the producers and the recyclers in West Java Province, the local government in Bandung City and West Java Province, and the relevant ministries, MoEF and MoI. Aside from that, there was a survey conducted on 418 consumers of mobile phones in Bandung City.

Based on the interviews and survey, the life cycle of purchased and used mobile phones in Bandung City was analyzed. For the production process, there is only an assembly process in Indonesia. Therefore, the raw materials are mainly imported from other countries, except for mobile phone accessories and packaging that could produce domestically. The produced mobile phones are distributed to the distributor and sold through retailers. After consumers buy and use mobile phones until they become waste, they predominantly store them at home, pass them over to other people who still could use them, and return them to the retailers through a trade-in program. However, some are collected at the collection points provided by DLH, communities, or waste banks or sold to the informal sectors. Furthermore, the recyclers recycle mobile phone waste to be used by metal, plastic, and cement industries. None of the recycled materials is returned to the production process.

This research also revealed the stakeholders' perspectives regarding their preferred EPR instrument for mobile phone waste in Bandung City. All stakeholders believe the EPR implementation will contribute to e-waste management and positively impact the environment. Based on the component of TPB, particularly the perceived behavioral control, which are the availability of resources (e.g., money and time) and the easiness of implementation, the producers prefer a deposit-refund system as an EPR instrument. On the other hand, the local and central governments prefer take-back requirements.

However, the recyclers have a neutral option on the deposit-refund system and take-back requirements. Besides, the consumers agreed with all EPR instruments, albeit they are more prefer take-back requirements. Additionally, the consumers would voluntarily be involved in the take-back scheme, mainly if the collection points are close to their houses.

This research also answered the question of integrating stakeholders' perspectives regarding their preferred EPR instrument within a desirable EPR scheme for mobile phone waste in Bandung City. Based on the stakeholders' perspectives, take-back requirements become the most favored EPR instrument applicable to the short term. To implement take-back requirements, the producers will pay some fees to BPDLH to be handed over to DLH for providing collection points, a warehouse, and collaborating with recyclers to further collect mobile phone waste. Besides, the producers should also provide collection points directly at their retailers and service centers. Accordingly, the consumers could drop their mobile phone waste at retailers, service centers, DLH, communities, waste banks, informal sectors, and private sectors that provide e-waste collection services.

Lastly, this research answered the main research question of designing a desirable EPR scheme for mobile phone waste in Bandung City based on stakeholders' perspectives. All stakeholders prefer to choose take-back requirements as an EPR instrument due to the availability of resources and easiness of implementation. There will be two options in implementing take-back requirements: direct take-back by providing collection points and indirect take-back by paying some fees to BPDLH.

6.2 Recommendations

6.2.1 Practical recommendations for EPR implementation

To ensure the EPR with take-back requirements is well-implemented, at the national level, the coordinating ministry should handle the planning and implementation of the EPR. The coordinating ministry will coordinate the relevant ministries, provide a task force to accelerate the EPR implementation, draft the action plan, and discuss the division of stakeholders' roles. Besides, MoEF should conduct a pilot in certain cities that involve the local government, and they could prepare the database system to record the data and evaluate the mechanism. Aside from that, MoI could encourage local suppliers to use recycled materials to produce mobile phone accessories that producers need. In addition, due to the MoI plan to accelerate the implementation of the green industry, MoI and MoEF could collaborate to provide incentives for producers who have successfully applied the program that supports the EPR implementation.

At the local level, DLH could share the cost and roles with producers in providing collection points. Moreover, the informal sectors, waste banks, communities, and private sectors could also be involved in the collection process. However, DLH should ensure that their further process of collected waste complies with current regulations and is safe for the environment. Furthermore, the government should map illegal recycling activities and provide capacity building and training for the illegal recyclers to comply with technical requirements. Besides, they should also provide training for the waste bank operator and waste pickers related to the collection and sorting process, drop boxes, personal protective equipment, and incentives to encourage them to involve in the EPR implementation. For consumers, raising awareness should be conducted by DLH to inform about the hazard of mobile phone waste, how the proper treatment is, and how the recycling process is through socialization or media, mainly social media. Besides raising awareness for consumers, the incentives could also be provided by the producers or the government to stimulate them to drop their mobile phone waste. The incentives could be in the form of a discount voucher that could also combine with a trade-in program.

6.2.2 Recommendations for future research

For future research, because this research merely used the components of TPB but did not count the correlation to stakeholders' behavior, it would be interesting to research how the components of TPB could impact the stakeholders' behavior. Furthermore, with limited time and location boundaries, only the minimum number of producers were successfully interviewed. Hence, increasing the number of producers as interviewees are needed for future research. Moreover, on the consumer side, most survey respondents stored their mobile phone waste at home. Therefore, it would be interesting to find out why they did that for the following research. Besides, this research has not correlated the consumers' perspective with the demographic data, such as gender, age, educational background, and income level, using statistical analysis. In addition, it needs to have similar research in the next 2-5 years because there will be a different perspective of stakeholders due to technology development, level of awareness, and new policies or regulations. Aside from that, it would be more interesting to include retailers and informal sectors as a research unit besides producers, consumers, recyclers, and the government.

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APPENDIX A. CONSENT FORM

PERSETUJUAN UNTUK BERPARTISIPASI DALAM WAWANCARA PENELITIAN
CONSENT TO PARTICIPATE IN RESEARCH STUDY INTERVIEW

"Skema *Extended Producer Responsibility (EPR)* untuk Limbah Telepon Genggam: Studi Kasus Kota Bandung, Indonesia"
"Extended Producer Responsibility (EPR) Scheme for Mobile Phone Waste: The Case of Bandung City, Indonesia"

	Yes	No
- Saya, _____, secara sukarela menyetujui untuk berpartisipasi dalam wawancara penelitian ini. *I, _____, voluntarily agree to participate in this research study interview.*	☐	☐
- Saya memahami bahwa ketika saya menyetujui untuk berpartisipasi saat ini, saya dapat menarik informasi yang saya berikan sewaktu-waktu atau menolak untuk menjawab tanpa ada konsekuensi apapun. *I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind.*	☐	☐
- Saya memahami bahwa saya dapat menarik izin penggunaan data dari wawancara saya, dalam hal ini materi akan dihapus. *I understand that I can withdraw permission to use data from my interview after it, in which case material will be deleted.*	☐	☐
- Saya telah mendapatkan informasi terkait maksud dan tujuan penelitian dan saya dapat mengajukan pertanyaan terkait penelitian tersebut. *I have had the purpose and nature of the study explained to me and I have had the opportunity to ask questions about the study.*	☐	☐
- Saya menyetujui wawancara saya akan direkam secara audio maupun video. *I agree to my interview being audio-video-recorded.*	☐	☐
- Saya memahami bahwa semua informasi yang saya berikan untuk penelitian ini akan dijaga kerahasiaannya. *I understand that all information I provide for this study will be treated confidentially.*	☐	☐
- Saya memahami bahwa identitas saya dalam laporan hasil penelitian ini akan tertulis anonim jika saya memiliki preferensi untuk seperti itu. Hal ini dilakukan tidak secara eksplisit menyebutkan nama saya dan menyamarkan detail informasi yang dapat mengungkap identitas saya ataupun orang yang saya bicarakan. *I understand that in any report on the result of this research my identity will remain anonymous if preferred to be so. This will be done by not explicitly mentioning my name and disguising any details of my interview which may reveal my identity or the identity of people I speak about.*	☐	☐
- Saya memahami bahwa saya memiliki hak untuk mengakses informasi yang saya berikan setelah wawancara *I understand that I am entitled to access the information I have provided after the interview.*	☐	☐
- Saya memahami bahwa saya dapat menghubungi siapapun yang terlibat dalam penelitian untuk meminta klarifikasi dan informasi lebih lanjut. *I understand that I am free to contact any of the people involved in the research to seek further clarification and information.*	☐	☐

Berikut merupakan nama-nama orang yang terlibat dalam penelitian ini yang menjamin penggunaan persetujuan ini dan jawaban yang diberikan selama wawancara.
Here as follow the names of the people involved in this research who guarantee the agreed use of this consent and the answer provided during the interview.

Peneliti:
Researcher:

Pranandya Wijayanti

Tanda tangan partisipan:
Signature of Participant:

_____
Tanggal:
Date:

Pembimbing:
Supervisor:
Dr. Maria Laura Franco-Garcia
Dr. Gül Özerol

Untuk informasi lebih lanjut terkait penelitian ini, silahkan email: pranandyawijayanti@student.utwente.nl
For more information on this research, please email: *pranandyawijayanti@student.utwente.nl*

APPENDIX B. QUESTIONNAIRE FOR INTERVIEWS

INTERVIEW

"Extended Producer Responsibility (EPR) Scheme for Mobile Phone Waste: The Case of Bandung City, Indonesia

INTRODUCTION

This interview will be conducted by Pranandya Wijayanti from the Faculty of Behavioural, Management and Social Sciences at the University of Twente, The Netherlands.

This research aims to design an EPR scheme for mobile phone waste applicable to Bandung City based on stakeholders' perspectives, including producers, consumers, recyclers, and the government. By implementing an EPR, the post-consumer product will be taken back from the consumer to be recycled as secondary raw materials and eventually will support the realization of a circular economy in the electronic waste management sector.

The time needed for this interview is 30-60 minutes. Before starting the interview, I would like to thank you for sending back the signed consent form and spending your time participating as an interviewee for this research.

Interview Date	
Start Time – End Time	
Platform	Teams / Zoom / Google Meet

INTERVIEWEE DATA

Name	
Organization Name	
Position Title	

INTERVIEW QUESTIONS

Producers

Type of question	Question
Life cycle of mobile phones	How are mobile phones produced and how is the accessibility for the raw materials?
	What are the raw materials to produce mobile phones?
	Where are mobile phones distributed, how do you distribute the mobile phones, and how often are mobile phones distributed?
	Do you have in situ treatments for post-consumed mobile phones?
	If there are components of mobile phones in the service center from the repair process, how do you process those components? Do you take back those components to your production process?
	Is that possible to process components of mobile phone waste as the secondary raw materials for the production process?
Preferred EPR instrument	What is your preferred instrument for mobile phone waste of these EPR instruments: take-back requirements, deposit-refund system, and advanced

	disposal fees based on the availability of resources and the easiness of implementation?
	Besides your institution, who are the stakeholders that should be involved when implementing the preferred instrument?
	To what extent can EPR contribute to increasing the recycling rate and managing mobile phone waste? Do you have other suggestions?

Recyclers

Type of question	Question
Life cycle of mobile phones	Where do you receive mobile phone waste and how much mobile phone waste do you receive?
	How much mobile phone waste do you recycle and how much is the percentage of mobile phone waste recycled compared to other types of electronic waste?
	How is the e-waste recycling process, particularly mobile phone waste?
	What are materials from used mobile phone (waste) that could be recycled?
	How recycled materials are used and by whom?
Preferred EPR instrument	What is your preferred instrument for mobile phone waste of these EPR instruments: take-back requirements, deposit-refund system, and advanced disposal fees based on the availability of resources and the easiness of implementation?
	To what extent can EPR contribute to increasing the recycling rate and managing mobile phone waste? Do you have other suggestions?

Local government

Type of question	Question
Life cycle of mobile phones	How do you collect mobile phone waste (door-to-door pickup or provide dropbox), and who are the stakeholders involved in the collection process?
	If question 1 is answered by door-to-door pickup, how is the mechanism to collect mobile phone waste from the consumers, and how often do you pick up mobile phone waste?
	If question 1 is answered by dropbox, where is the dropbox located (public spaces, school, waste bank, retailer), and how do you monitor it (when it is full or broken)?
	Do you provide incentives for the consumers who give their mobile phone waste, or is waste collection voluntary-based?
	After mobile phone waste is collected, where do you bring it? Do you have any cooperation with recyclers?
	Besides your institution, are there any other stakeholders collecting mobile phone waste?
Preferred EPR instrument	What is your preferred instrument for mobile phone waste of these EPR instruments: take-back requirements, deposit-refund system, and advanced disposal fees based on the availability of resources and the easiness of implementation?

	Besides your institution, who are the stakeholders that should be involved when implementing the preferred instrument?
	What is your plan for implementing the EPR system for mobile phone waste in Bandung City?
	To what extent can EPR contribute to increasing the recycling rate and managing mobile phone waste? Do you have other suggestions?

Central government

Type of question	Question
Preferred EPR instrument	What is your preferred instrument for mobile phone waste of these EPR instruments: take-back requirements, deposit-refund system, and advanced disposal fees based on the availability of resources and the easiness of implementation? Do you have other suggestions for implementing EPR for mobile phone waste?
	What is your role in the implementation of EPR for mobile phone waste (observer, facilitator, evaluator)?
	Besides your institution, who are the stakeholders that should be involved when implementing the preferred instrument?
	How is the current regulation and policy regarding e-waste and what is your plan for implementing the EPR system for mobile phone waste?
	To what extent can EPR contribute to increasing the recycling rate and managing mobile phone waste? Do you have other suggestions?

APPENDIX C. QUESTIONNAIRE FOR SURVEY

SURVEY

"Extended Producer Responsibility (EPR) Scheme for Mobile Phone Waste: The Case of Bandung City, Indonesia

You are being invited to participate in a study titled "Extended Producer Responsibility (EPR) Scheme for Mobile Phone Waste: The Case of Bandung City, Indonesia". This study is being done by Pranandya Wijayanti from the Faculty of Behavioural, Management and Social Sciences at the University of Twente, The Netherlands.

This research aims to design an EPR scheme for mobile phone waste applicable to Bandung City based on stakeholders' perspectives, including producers, consumers, recyclers, and the government. By implementing an EPR, the post-consumer product will be taken back from the consumer to be recycled as secondary raw materials.

This survey will take you approximately 5 minutes to complete. The data will be used for a statistical calculation to find a preferable instrument from different stakeholders to design an EPR scheme further. Your participation in this study is entirely voluntary, anonymous, and confidential. Your answer cannot be track back. You can withdraw at any time, and you are free to omit any question.

For more information on this research, please email pranandyawijayanti@student.utwente.nl

Life cycle of mobile phones

Mobile phone waste mentioned in the question below is that mobile phones, including feature phones and smartphones, reach end-of-life, and consumers are not used anymore.

Variable	Code	Question	Answer
Post-consumer treatment	PCT	How do you usually treat your mobile phone waste? (you can choose more than one option)	☐ Trade-in ☐ Passed over to other people (relatives) who could use it ☐ Dropped to e-waste dropbox ☐ Picked up by the government or e-waste collector ☐ Sold to informal sectors (waste pickers) ☐ Store it at home ☐ Dismantled by themselves for other uses ☐ Disposed of in a mixed waste bin

Preferred EPR instrument

Here are some definitions that will help you in answering the questions below.

- ***Extended Producer Responsibility (EPR):*** Environmental policy approach in which producers take responsibility for their post-consumer (used) products to extend the product's life cycle.
- ***Take-back requirements (TBR):*** Producers or retailers are responsible for setting up product collection and recycling targets. Such incentives can encourage consumers to return the used product to a specified location, for instance, retailers.
- ***Deposit-refund system (DRS):*** Consumers pay a deposit when purchasing a product that gets refunded when returned to the producer or retailer.
- ***Advanced Disposal Fees (ADF):*** Consumers are charged a fee when purchasing a certain product. The fees are collected by government or private entities and will be used for the post-consumer treatment of the products. The unused fees will be returned to consumers.

Statements	Code	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Part 1 – Attitude						
EPR implementation is good for the environment	A1	☐	☐	☐	☐	☐
EPR implementation is good for the health	A2	☐	☐	☐	☐	☐
EPR implementation can contribute to others and future generation's life	A3	☐	☐	☐	☐	☐
Part 2 – Subjective Norms						
If my family and friends involved in EPR program, I will also do it	SN1	☐	☐	☐	☐	☐
Media (newspaper/magazine, TV, radio, website, social media) encourages me to participate in EPR program	SN2	☐	☐	☐	☐	☐
Community where I live influences me to participate in EPR program	SN3	☐	☐	☐	☐	☐
Part 3 – Perceived Behavioral Control						
I have time to drop mobile phone waste to a specific collection point if provided	TBR1	☐	☐	☐	☐	☐
I will drop mobile phone waste at a specific collection point if it is located near my house	TBR2	☐	☐	☐	☐	☐
I will drop mobile phone waste at a specific collection point voluntarily	TBR3	☐	☐	☐	☐	☐
I am willing to pay a deposit when purchasing mobile phones and get a refund when dropping back the after-used mobile phones	DRS1	☐	☐	☐	☐	☐
If there is a clear refund system from my paid deposit, I will be more likely to do that	DRS2	☐	☐	☐	☐	☐
I am willing to pay a fee when purchasing mobile phones to treat mobile phone waste in an environmentally sound manner	ADF1	☐	☐	☐	☐	☐
If there is an information about how the mobile phone waste will be treated, I will be more likely to pay a fee when purchasing mobile phones	ADF2	☐	☐	☐	☐	☐

Demographics

Variable	Question	Answer		
Residence	In which district do you live?	☐ Andir ☐ Antapani ☐ Arcamanik ☐ Astana Anyar ☐ Babakan Ciparay ☐ Bandung Kidul ☐ Bandung Wetan ☐ Bandung Kulon ☐ Batununggal ☐ Bojongloa Kaler	☐ Bojongloa Kidul ☐ Buahbatu ☐ Cibeunying Kaler ☐ Cibeunying Kidul ☐ Cibiru ☐ Cicendo ☐ Cidadap ☐ Cinambo ☐ Coblong ☐ Gedebage	☐ Kiara Condong ☐ Lengkong ☐ Mandalajati ☐ Panyileukan ☐ Rancasari ☐ Regol ☐ Sukajadi ☐ Sukasari ☐ Sumur Bandung ☐ Ujung Berung
Age	What is your age?	☐ 16-24 ☐ 45-54	☐ 25-34 ☐ 55-64	☐ 35-44 ☐ >65
Gender	What is your gender?	☐ Male ☐ Female	☐ Non-binary	
Education	What is your educational level?	☐ High school ☐ Bachelor	☐ Diploma ☐ Master	
Income	How much is your monthly income?	☐ < Rp. 4.000.000 ☐ Rp. 4.000.000 - Rp. 8.000.000 ☐ Rp. 8.000.000 - Rp. 12.000.000 ☐ > Rp. 12.000.000		

Thank you for your time and contribution to my research

APPENDIX D. LOCATION OF E-WASTE DROP BOXES

Location		Unit drop box
Government offices	Regional house of representative (DPRD)	2
	DLH of West Java Province	2
	Pendopo waste shelter	1
	Culture and tourism agency	1
	Mandalajati district	1
	Rancasari district	1
Schools	3 Senior High School	1
	5 Senior High School	1
	5 Vocational High School	1
Shopping centers	Paris van Java	1
	Bandung Indah Plaza	1

APPENDIX E. LIKERT SCALE CALCULATION

Total respondents : 418
Likert scale : 5
Conversion score : 1 – 5
Interval : 20%

The interpretation score based on interval:

Interval	Category
80 - 100%	Strongly Agree
60 - 79,99%	Agree
40 - 59,99%	Dont Know
20 - 39,99%	Disagree
0 - 19,99%	Strongly Disagree

A1: EPR implementation is good for the environment

Likert scale	Convertion score (C)	Score (S)	C x S
Strongly Agree	5	290	1450
Agree	4	117	468
Neutral	3	10	30
Disagree	2	10	20
Strongly Disagree	1	0	0
Total score		**427**	**1968**
Likert scale result:		**94,16%**	**Strongly Agree**
Total score/Max score x 100%			

A2: EPR implementation is good for the health

Likert scale	Convertion score (C)	Score (S)	C x S
Strongly Agree	5	226	1130
Agree	4	154	616
Neutral	3	38	114
Disagree	2	38	76
Strongly Disagree	1	0	0
Total score		**456**	**1936**
Likert scale result:		**92,63%**	**Strongly Agree**
Total score/Max score x 100%			

A3: EPR implementation can contribute to others and future generation's life

Likert scale	Convertion score (C)	Score (S)	C x S
Strongly Agree	5	265	1325
Agree	4	137	548
Neutral	3	16	48
Disagree	2	16	32
Strongly Disagree	1	0	0
Total score		**434**	**1953**
Likert scale result:		**93,44%**	**Strongly Agree**
Total score/Max score x 100%			

SN1: If my family and friends involved in EPR program, I will also do it

Likert scale	Convertion score (C)	Score (S)	C x S
Strongly Agree	5	171	855
Agree	4	198	792
Neutral	3	46	138
Disagree	2	46	92
Strongly Disagree	1	0	0
Total score		**461**	**1877**
Likert scale result:		**89,81%**	**Strongly Agree**
Total score/Max score x 100%			

SN2: Media encourages me to participate in EPR program

Likert scale	Convertion score (C)	Score (S)	C x S
Strongly Agree	5	126	630
Agree	4	155	620
Neutral	3	103	309
Disagree	2	103	206
Strongly Disagree	1	5	5
Total score		**492**	**1770**
Likert scale result:		**84,69%**	**Strongly Agree**
Total score/Max score x 100%			

SN3: Community where I live influences me to participate in EPR program

Likert scale	Convertion score (C)	Score (S)	C x S
Strongly Agree	5	88	440
Agree	4	148	592
Neutral	3	117	351
Disagree	2	117	234
Strongly Disagree	1	9	9
Total score		**479**	**1626**
Likert scale result:		**77,80%**	**Agree**
Total score/Max score x 100%			

TBR1: I have time to drop mobile phone waste to a specific collection point if provided

Likert scale	Convertion score (C)	Score (S)	C x S
Strongly Agree	5	79	395
Agree	4	164	656
Neutral	3	120	360
Disagree	2	120	240
Strongly Disagree	1	2	2
Total score		**485**	**1653**
Likert scale result:		**79,09%**	**Agree**
Total score/Max score x 100%			

TBR2: I will drop mobile phone waste at a specific collection point if it is located near my house

Likert scale	Convertion score (C)	Score (S)	C x S
Strongly Agree	5	166	830
Agree	4	201	804
Neutral	3	41	123
Disagree	2	41	82
Strongly Disagree	1	0	0
Total score		**449**	**1839**
Likert scale result:		**87,99%**	**Strongly Agree**
Total score/Max score x 100%			

TBR3: I will drop mobile phone waste at a specific collection point voluntarily

Likert scale	Convertion score (C)	Score (S)	C x S
Strongly Agree	5	104	520
Agree	4	202	808
Neutral	3	86	258
Disagree	2	86	172
Strongly Disagree	1	0	0
Total score		**478**	**1758**
Likert scale result:		**84,11%**	**Strongly Agree**
Total score/Max score x 100%			

DRS1: I am willing to pay a deposit when purchasing mobile phones and get a refund when dropping back the after-used mobile phones

Likert scale	Convertion score (C)	Score (S)	C x S
Strongly Agree	5	97	485
Agree	4	171	684
Neutral	3	88	264
Disagree	2	88	176
Strongly Disagree	1	3	3
Total score		**447**	**1612**
Likert scale result:		**77,13%**	**Agree**
Total score/Max score x 100%			

DRS2: If there is a clear refund system from my paid deposit, I will be more likely to do that

Likert scale	Convertion score (C)	Score (S)	C x S
Strongly Agree	5	125	625
Agree	4	197	788
Neutral	3	60	180
Disagree	2	60	120
Strongly Disagree	1	2	2
Total score		**444**	**1715**
Likert scale result:		**82,06%**	**Strongly Agree**
Total score/Max score x 100%			

ADF1: I am willing to pay a fee when purchasing mobile phones to treat mobile phone waste in environmental sound

Likert scale	Convertion score (C)	Score (S)	C x S
Strongly Agree	5	71	355
Agree	4	169	676
Neutral	3	113	339
Disagree	2	113	226
Strongly Disagree	1	10	10
Total score		**476**	**1606**
Likert scale result:		**76,84%**	**Agree**
Total score/Max score x 100%			

ADF2: If there is an information about how the mobile phone waste will be treated, I will be more likely to pay a fee when purchasing mobile phones

Likert scale	Convertion score (C)	Score (S)	C x S
Strongly Agree	5	93	465
Agree	4	182	728
Neutral	3	94	282
Disagree	2	94	188
Strongly Disagree	1	7	7
Total score		**470**	**1670**
Likert scale result:		**79,90%**	**Agree**
Total score/Max score x 100%			