Current Issues and Situation of Producer Responsibility in Waste Management in Indonesia

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ABSTRACT

Producer responsibility for wastes has been encouraged in Indonesia since 2008. The Ministry of Environment of the Republic of Indonesia also promoted the reduce, reuse, and recycle (3R) concept using the community-based approach of waste banks integrated with the extended producer responsibility (EPR) concept. However, related research and implementation are still limited. This study aims to identify the challenges of fulfilling producer responsibility in waste management and determine whether the integration concept could generate outcomes expected from the EPR concept. A semi-structured interview survey of several stakeholders from the government, industrial, and waste management sectors was conducted and the data generated was used to simulate an integration scheme using a system dynamics approach. Secondary data and information from Bandung municipality were used as input for the simulation. The interview survey found that the concerns and issues of fulfilling producer responsibility in waste management include lack of awareness, unavailability of clear guidelines, and the limited capacity of the current recycling sector. The results of the simulation suggested that if the integration scheme is applied, each business entity might bear the responsibility of IDR 29.4 million per year and 14.7 tons of waste per year for the scope of four sectors and IDR 34.1 million per year and 17 tons of waste per year for the scope of two sectors.

1. INTRODUCTION

Indonesia introduced a new law on waste management in 2008, which was followed by several regulations including Government Regulation No. 81 in 2012 regarding household waste management (written in Indonesian) and Ministry of Environment Regulation No. 13 in 2012 regarding the implementation of the reduce, reuse, and recycle (3R) concept through waste banks. The recent regulations promote producer responsibility for the waste of their products and encourage them to be involved in the activities carried out to reduce the impact of the wastes (Republic of Indonesia, 2008; Republic of Indonesia, 2012). Ministry of Environment of the Republic of Indonesia, through a regulation in 2012, also promoted the implementation of the 3R concept by using community approaches such as waste banks, and proposed the idea of integrating the extended producer responsibility (EPR) concept with the waste bank concept.

Indonesia's producer responsibility regulations are based on the EPR concept. According to the Organization for Economic and Development-OECD (2001), EPR is a policy framework based on the principle of extending producer responsibility to cover post-consumer waste products. By extending producer responsibility, the burden of waste management can be shifted from the government and taxpayers to the producers and promote environmentally friendly designs of the products. In most cases of EPR implementation, producers are required to contribute physically as well as financially towards reducing the impact of post-consumer wastes.

Several factors will determine the success of the current EPR implementation cases, including the involvement of the upstream and downstream sectors and the ability to deal with implementation issues, such as the negative impact of the informal sector (Gupt and Sahay, 2015). According to Gupt and Sahay (2015), the informal recycling sector provides an alternative route for the management of post-consumer waste and decreases the effectiveness of EPR implementation. Akenji et al. (2011) suggested a phase-based approach for EPR implementation in developing countries. The first phase involves the improvement of the waste management systems as well as the capacity of the actors in the system (Akenji et al., 2011).

Waste bank is a concept of waste management in Indonesia that enables people to earn money in the form of savings by depositing their recyclable wastes in the waste bank. In several studies, a similar concept is discussed together with the community-based waste management concept (Singhirunnuson et al., 2012; Wijayanti and Suryani, 2015; Raharjo et al., 2017). Singhirunnuson et al. (2012) discussed the contextual factors that influence household recycling behavior using a case study on Mahasarakham municipality. Pasang et al. (2007) studied the potential of neighborhood-based waste management systems in the case of Jakarta in Indonesia. Raharjo et al. (2017) studied the community-based solid waste program in Padang city, Indonesia. They proposed a strategy to improve the community-based solid waste banks using the SWOT approach. Wijayanti and Suryani (2015) studied the role of waste banks in Surabaya, Indonesia.

In 2012, there were approximately 471 waste banks in Indonesia distributed over 22 cities (Ministry of Environment Republic of Indonesia, 2012b). The operation of waste banks usually relies on the participation of the community where the waste bank is located and on the cooperation of the recycling sector. In the ministry regulations, the waste bank concept is intended to promote the 3R concept in Indonesia.

Recycling in Indonesia still relies on the informal sector, which has its own hierarchy and conducts activities that are conducive to its own economic interests. Informal sector recycling in Indonesia often involves multiple stakeholders, including scavengers and waste traders. Their activity is not well organized and their capacity is limited (Damanhuri and Padmi, 2012). For example, in the city of Bandung, recyclables collected by the informal sector are approximately 13% of the total amount of waste generated (Sembiring and Nitivattananon, 2010). The amount of waste recycled is also limited. In fact, the amount of municipal waste recycled by the informal sector in Bandung is not more than 10% of the total generated (Damanhuri et al., 2009) and the amount of plastic packaging waste recycled is only 1.78% of the total generated (Chaerul et al., 2014).

Given these challenges, some studies provide valuable insights into the waste management problem in Indonesia. Chaerul et al. (2014) studied the recycling practices of plastic packaging wastes in the Bandung area and discussed some aspects of the EPR framework. Sembiring and Nitivattananon (2010) discussed an approach for promoting a more inclusive solid waste management system that considers the role of the informal sector in Bandung municipality. The EPR concept was briefly mentioned in some of the reviewed literature (Chaerul et al., 2014; Raharjo et al., 2017). However, specific studies on the issues and challenges of EPR implementation have not been carried out.

Given that the producer responsibility concept has been mentioned in previous Indonesian regulations, this study addresses the challenges in fulfilling such responsibilities and discusses more on how the waste bank mechanism can be a consideration to further formulate tools for EPR policy introduction in Indonesia.

2. METHODOLOGY

2.1 Interview survey

The research framework of this study is shown in Figure 1. A semi-structured interview survey of several stakeholders in Indonesia was conducted to acquire their perspective on the concerns, challenges, and recommendations regarding the implementation of producer responsibility in waste management. For this purpose, representatives from 12 institutions were interviewed, consisting of one representative from a national government entity, one representative from provincial level government entity, one representative from municipal level government entity, one representative from municipally owned enterprise, one representative from waste management business entity, one representative from a waste bank entity, and one representative each from four industry associations and two brand owner entities.

The first survey was conducted in August-September 2015 and a follow-up survey was conducted in March 2016. Table 1 presents the details of the interviewees. The survey used a semi-structured interview approach that covered the following points:

- Background information on the activities and the profile of the institution that the interviewee belongs to
- Available programs to support the EPR approach for waste management
- Opinions, concerns, and recommendations regarding the implementation of producer responsibility

• Current challenges in performing existing activities to decrease impact from post-consumer waste

The results of the survey were analyzed to determine the problems associated with the implementation of producer responsibility in Indonesia.

2.2 Simulation

Before simulating the integration scheme of waste banks and producer responsibility, a causal loop diagram was designed to understand how the waste bank concept could help fulfill producer responsibility. Then, a simulation was conducted using a system dynamics approach and the logical framework from the causal loop diagram.

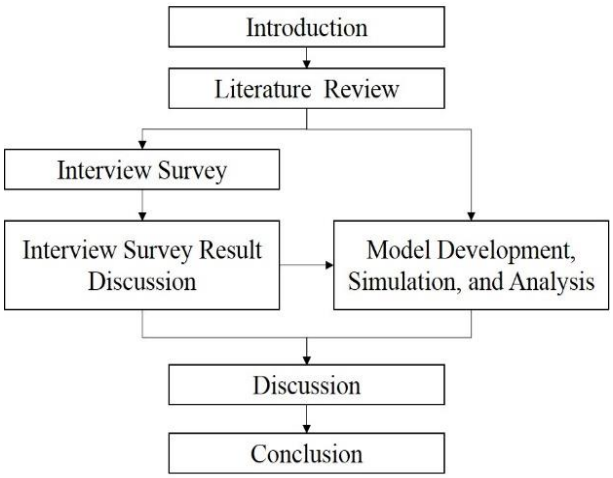

Figure 1. Research framework

Table 1. List of interviewees

Name of the entity	Interview method	Location
Ministry of Environment and Forestry	Direct interview	Jakarta
Sanitary Agency of DKI Jakarta Province	Direct interview	Jakarta
PD Kebersihan Kota Bandung (municipality-owned enterprise for sanitary business)	Direct interview	Bandung
Environmental Agency of Bandung municipality (BPLH Kota Bandung)	Direct interview	Bandung
Indonesia Packaging Federation	Direct interview	Jakarta
Indonesia Plastic Recycler Entrepreneur Association (APDUPI)	Direct interview	Bekasi
Indonesia Pulp and Paper Industry Association (APKI)	Direct interview	Jakarta
Indonesia Downstream Plastic Industry Association (APHINDO)	Phone interview	
Packaged Drinking Water Company	Direct interview	Jakarta
Aseptic Packaging Company	Direct interview	Jakarta
Alternative waste management business	Direct interview	Bekasi
Waste Bank Malang (Bank Sampah Malang-BSM)	Direct interview	Malang

In the simulation, producer responsibility is classified into physical and financial responsibility. Physical responsibility represents the amount of waste to be managed by the producer, while financial responsibility represents the amount of money that should be paid to the waste banks by the producer as compensation for the collection of wastes. The simulation was conducted using the STELLA software version 9.1.3.

The general waste generation pattern in Bandung municipality over a period of ten years was simulated. There were five scenarios used in the simulation as listed in Table 2 and described in Table 3. Since the scope of producers is still not specified in the Indonesian regulations, the scope of industries, from the statistical data of the manufacturing sector in Indonesia, was selected for the simulation study. Certain assumptions were made for the simulation and the comparison of the assumed conditions with the actual conditions can be seen in Table 4. The general overview of the simulation process and steps can be seen in Figure 2.

Table 2. Scenario matrix

Scenario	Parameter input			
	Target area coverage	EPR obligation target	EPR scenario	Responsible business entities
1	0	0	No	7,362
2	100%	0	No	7,362
3	100%	0	Yes	7,362
4	100%	100%	Yes	7,362
5	100%	100%	Yes	6,349

Table 3. Scenario description

Scenario	Description
1	No producer responsibility integration and without development of waste bank infrastructure
2	No producer responsibility integration, but with development of waste bank infrastructure
3	Producer responsibility integration, but without the obligation to comply
4	Producer responsibility integration with the obligation to comply, with the scope of 4 industry sectors
5	Producer responsibility integration with the obligation to comply but with the scope of 2 industry sectors

Table 4. Comparison between assumption and actual condition

Assumed condition	Actual condition
The participants of the waste bank program are required to fully separate their waste prior to submitting it to the waste bank.	Not all citizens separate their waste. According to BPS (2015), only 8.75% of Indonesians their waste. However, people who participated in the waste bank program separated their waste prior to submission.
The informal sector will be entirely responsible for waste recycling if there were no waste banks.	The informal sector is the prevalent actor in the waste recycling system of Indonesia
The model for the waste banks limits the simulation to the event where the waste is at the source, just before it is disposed to the general waste stream.	In general, people participating in the waste bank program separate their recyclables from the general waste before disposal.
The waste bank finds a way to recover at least the costs of handling the waste input.	The waste bank is a non-profit entity. However, it still requires financial income in order to cover the operating costs like any other organization.
The take-back obligation targets the non-recyclable inorganic wastes.	Currently, there are no take-back guidelines available for producers in Indonesia. This assumption is used as a suggestion for the implementation of the waste bank-EPR integration.
The number of waste banks is increasing with the increase in population.	In there is a guideline that specifies the number of households to be served by a single waste bank. Based on this information, the relationship between the population size, number of households, and number of waste banks was simulated.

The population growth of Bandung municipality was simulated to estimate waste generation in 10 years. The population growth output was then used to simulate the required increase in the number of waste banks based on relevant government regulations.

The output of the waste generation simulation was used to simulate the recyclable material input to the waste bank system. The waste output from the system was also simulated. The cost simulation was derived from the waste input simulation and the

revenue of waste bank was derived from the waste output simulation. The gap between the cost and revenue of the simulated trade in waste bank system was considered as the financial obligation in terms of EPR. The gap between the waste input and waste output from trade was considered as the physical obligation for take-back in terms of EPR.

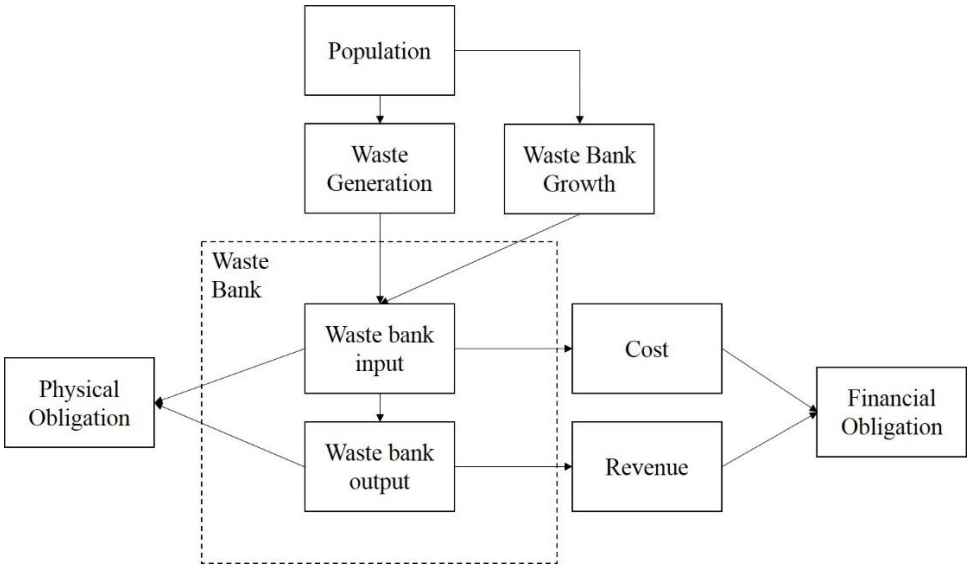

Figure 2. Simulation process

Since it was difficult to collect all of the required information, some quantitative data from the reviewed literature and the interview survey with the waste bank entity were used in the simulation. The waste composition data for Bandung were obtained from the studies of Damanhuri et al. (2009) and Sembiring and Nitivattananon (2010), and from a document of the environmental agency of Bandung municipality (2014).

Other statistical data for Bandung were taken from the publications of the Statistics Indonesia; the population of Bandung was estimated at 2,470,802 in 2015 (BPS-Statistics of Bandung City, 2015) and is projected to grow at a rate of 1.16% per year (BPS-Statistics Jawa Barat, 2015). The waste generation factor in Bandung is 0.6 kilogram per person per day (BPLH Kota Bandung, 2014).

3. RESULTS

3.1 Interview survey

The concerns and issues identified in the interview survey can be divided into four groups: national level, local government level, downstream level, and upstream level.

- National level

The national level issues focus on policy making related to EPR in Indonesia. At the national level, EPR was regarded as a means for waste reduction. Further implementation and follow-up of the waste management roadmap were still under negotiation with the industrial sector as the EPR implementation was considered a costly approach. Integration of EPR with waste banks was intended to manage the informal sector.

- Local government level

At the local government level, the national capital region of DKI Jakarta Province produced roughly 6,700 tons of waste per day, which was sent to the final disposal sites. The transportation of wastes to the final disposal sites was regarded as a costly activity. Another concern was the lack of awareness of people regarding the waste management options. At the municipal level, Bandung municipality generated roughly 1,500 tons of waste per day, a majority of which was sent to the final disposal sites. According to the interviews, one of the main concerns was the inadequate revenue, which led to inadequate infrastructure. In addition, the current final disposal site was already inadequate and scheduled to be closed in 2017.

- Downstream level

Besides the local sanitary agencies or utilities that are responsible for formal waste management, some entities involved in waste management

activities, especially collection and recycling, were interviewed. Most of these entities were established in recent years. The Malang waste bank was established in 2011; an alternative waste management business with a source-separation waste management model was established in 2013; and the plastic recycler entrepreneur association (APDUPI) was established in 2015. The members of the APDUPI were mostly from small business entities related to the informal recycling sector.

Interviews with representatives from these entities revealed their concerns regarding the current waste management practices. Since the APDUPI members had strong economic interests, they did not recover all the types of plastic waste from the waste stream due to their low economic value. According to the interview, considering the availability of technology and the economic value, plastic waste composed of only a single type of plastic was more easily recovered and recycled than multi-layered plastic waste. Low economic value of waste discourages its recovery from the waste stream.

The Malang waste bank (BSM) serves about 24,000 members in Malang municipality. It serves not only individual households but also schools and offices. The waste bank received support from the local municipality and the corporate social responsibility (CSR) program of the national electric company of Indonesia. They collected about 70 different types of waste items, which were sold to the recyclers in order to provide savings to their customers.

In their operations, the price of commodities fluctuated significantly because of the challenges in the collection practices. The quality of the collected recyclables was inconsistent although they had been separated at the source. They could work in cooperation with the existing players in the informal sector; however, this was not always the case since there was a competition in obtaining the recyclables. The main concerns identified from the interviews at this level also include the lack of public awareness about waste separation and clear guidelines in the system.

- Upstream level

At the upstream level, representatives from various industry associations and some brand owners were interviewed. The interviews revealed that the brand owners had conducted voluntary business and non-business activities to reduce the impact of their product packaging and improve the capabilities of the existing recycling sector. According to Triwidiyanni et al. (2015), the paper industries in Indonesia collect 3 types of waste paper from households, printing businesses, and offices to be used as input for their industry. The challenge faced by the existing initiatives is the poor quality of the collected materials. The quantity collected is also small and the scale of the activity is limited. Consumer lifestyle can also contribute to the quality of the materials. Some interviewees were also concerned about the high transportation costs associated with the take-back program considering the geographical challenges. The interviewees also expressed concerns about the inadequate recycling system and guidelines.

3.2 Causal loop diagram

From the causal loop diagram in Figure 3, we can see that waste generation is affected by the increase in population. The generated waste is divided into recyclable and non-recyclable inorganic waste. The recyclability factor determines the amount of recyclable inorganic waste. The generated recyclable inorganic waste will be recovered by the informal sector at the source, reducing the amount of waste going to the waste bank. The number of waste banks is expected to increase, and so is the coverage of the waste bank service. The increasing waste bank coverage will promote the separation and submission of recyclable inorganic wastes to the waste banks, which will supposedly reduce the amount of recyclable inorganic wastes available at the source for the informal sector to recover.

When the integration scheme is applied in the simulation, the inorganic waste input to the waste bank system is expected to increase, and so is the cost of handling. Part of the handling cost and the additional burden is expected to be shared with the producer. The producer is responsible for the take-back recovery (physical EPR) and for providing financial support (financial EPR). Figure 4 shows the modified integration scheme of the waste bank and the EPR concept that was adopted from the integration scheme proposed.

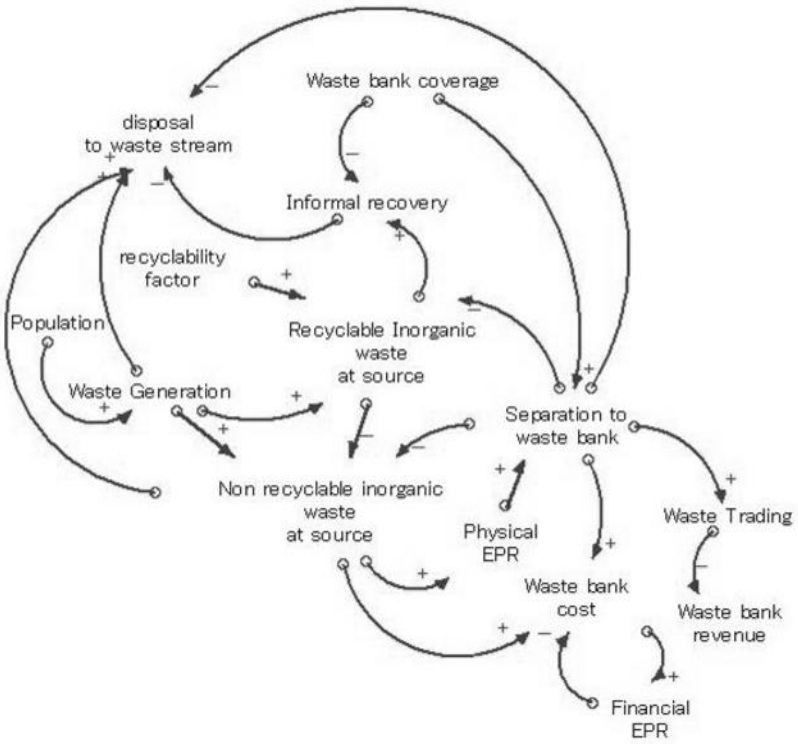

Figure 3. Causal loop diagram

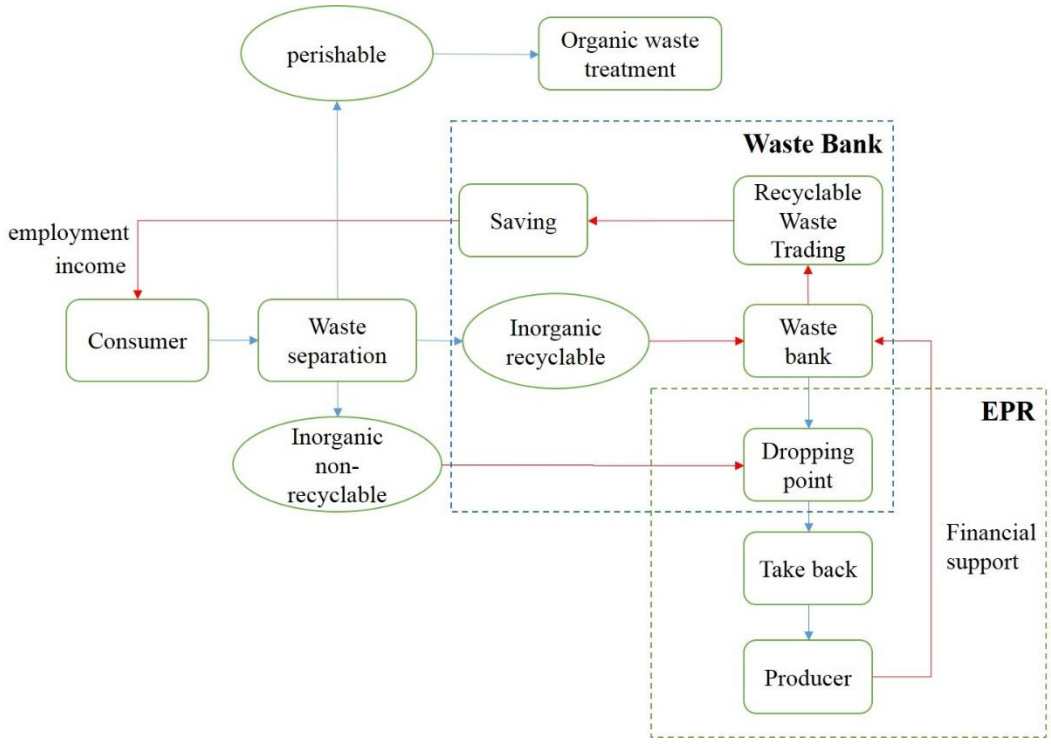

Figure 4. Proposed waste bank-EPR integration scheme (modified after the integration scheme proposed by Ministry of Environment Republic of Indonesia in 2012a)

3.3 Simulation

The simulation results of the integration scheme are shown in Figures 5(a)-(d). Figure 5(a) shows the marginal EPR obligation per kilogram of waste submitted to the waste bank. Marginal EPR obligation quantifies the financial responsibility of

the producers per kilogram of waste submitted to the waste bank. If the EPR scenario 3 is applied, the marginal EPR will decrease from the initial value of IDR 2,000 to IDR 1,333 per kilogram of waste. This is because there is an increase in the inorganic waste input to the waste bank, while the output of the tradable inorganic waste is still the same. The output of marginal EPR obligation was then multiplied by the total input of inorganic waste to the waste bank to calculate the financial responsibility.

Figure 5(b)-(d) show that the financial responsibility of a business entity is up to IDR 29.4 million and IDR 34.1 million under scenario 4 and 5, respectively, in year 10 of the simulation. The physical responsibility of one entity for the take-back was estimated at 14,700 kg in scenario 4 and 17,000 kg in scenario 5 in year 10 of the simulation. Wastes recovered from the source can increase up to 26.11% under scenario 5.

Table 5 shows the results of the sensitivity analysis of the selected input parameters to the output parameters. Increasing the recyclability of a product can help business entities lower the burden of their responsibility. The change in the marginal cost also has an effect on the EPR obligations as well as on the added value of the traded waste.

Tables 6 and 7 show the comparison of the estimated financial responsibility per entity with the average output value per business establishment for the year 2014. BPS-Statistics Indonesia (2016b) has provided the output value information for the industrial sector in Indonesia. For Bandung municipality, the comparison of financial obligations per entity with the output value per business establishment ranged from 0.0096 to 0.0641%, indicating that the burden of financial responsibility will differ depending on the scope of the industrial sector.

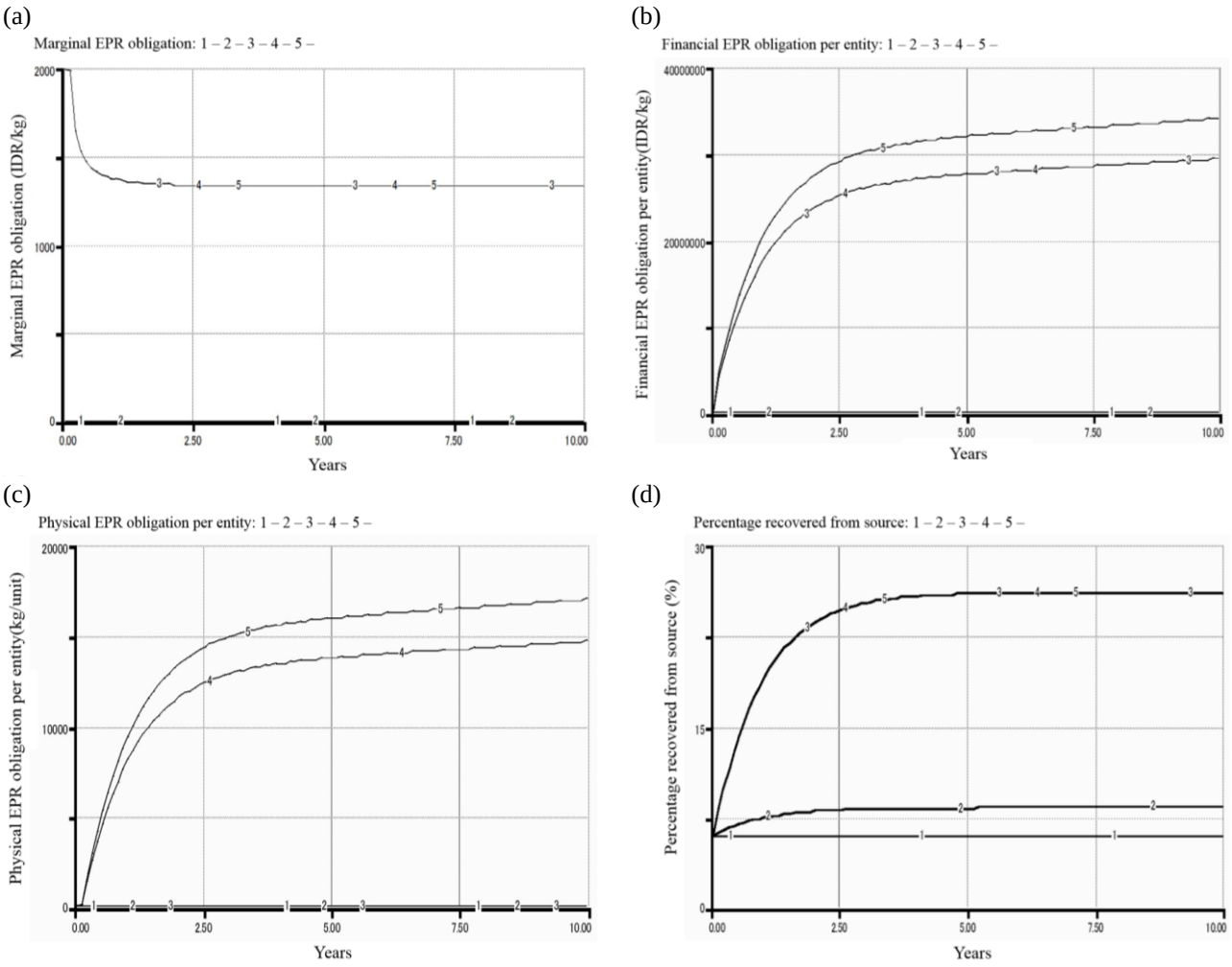

Figure 5. (a) marginal EPR obligation; (b) financial EPR obligation per entity; (c) physical EPR obligation per entity; (d) percentage of waste recovered from source

4. DISCUSSION

Brand owner entities have already taken initiatives as a part of the take-back program; examples of such initiatives are PET bottle packaging and aseptic packaging. Such initiatives established some sort of partnership with the existing informal recycling sector in order to process the collected packaging waste. However, the scale of such initiatives is limited. Brand owner entities are not the only entities that provide support for better waste management in Indonesia. According to the interview with the waste bank Malang representative, the waste bank received support from the CSR program of the Indonesian national electric company.

Regarding the issues and challenges associated with EPR implementation in Indonesia, feedback from the brand owner entities and industry associations highlighted the concern that the lack of public awareness about waste segregation options and poor attitude of the public towards waste segregation meant that the collected recyclable waste, from the current initiatives, were poor in quantity and quality. The informal recycling sector is still a major actor in the Indonesian recycling sector (Damahuri and Padmi, 2012). Additionally, Indonesia does not have clear guidelines on EPR to guide the activity of the producers.

The results of the interview survey showed that not all of the recovered wastes could be recycled due to limitations in either the technology or the capacity of the current recycling sector in Indonesia. The informal recycling sector is largely driven by economic interest so they usually only recover waste of economic value. This finding resonates with the findings of the study done by Damanhuri and Padmi (2012). Feedback from the waste bank entity in Malang shows that by encouraging their customers to separate their waste at the source, they could get a cleaner input to the waste bank, although the quality may be inconsistent. Encouraging people in the community to manage waste in a better manner is one of the main features of the waste bank system (Purba et al., 2012; Wijayanti and Suryani, 2015). The fluctuating price of the recyclable commodity is also an issue of concern.

Since the waste bank system is currently considered a community approach and no EPR system has been implemented in Indonesia, the role of the local governments is important in promoting new waste bank establishments, which is a key part of the integration scheme. The study by Raharjo et al. (2017) provides several strategies for the integration of EPR with the current MSW management system. Raharjo et al. (2017) suggested several modifications to promote behavioral change in people in order to address the issue of poor awareness and attitude regarding waste segregation.

In the proposed scheme, the waste bank will serve as the dropping point for the producers in the take-back mechanism. According to producers can view waste banks as the dropping point or take-back partner instead of establishing a new system. However, according to Gupt and Sahay (2015), the informal recycling sector provides an alternative to the EPR system, hence reducing its effectiveness. However, in this study, partnership with the existing informal recycling sector is seen as a key element in the simulation of the integration scheme. The operational cost of the proposed scheme is expected to be covered not only by revenue generated from waste trading but also through the contribution from the producers. In this way, the proposed system can utilize the pre-existing recycling channels instead of replacing them.

The feedback from the interview survey suggests that the current recycling sector in Indonesia has limited capabilities for recycling certain types of waste. One way to increase the recyclability factor is to make recycling technologies more accessible to the recyclers. This will enable the current recyclers to process the waste that could not be recycled previously due to the limited capabilities of the recycling sector.

The results of the sensitivity analysis imply that the integration scheme can be used to develop mechanisms to provide incentives for producer responsibility in waste management. If the producer can contribute to the recyclability of their product, their physical and the financial responsibilities can decrease. Stakeholders can learn how to integrate EPR with the existing community approach.

Further studies can focus on the feasibility of the integration scheme as well as on updating the collected data to reflect the actual conditions not only for Bandung municipality but also for other areas in the country.

Table 5. Results of sensitivity analysis

Parameter	Variation	Marginal EPR obligation (IDR/kg) T=10	Financial EPR obligation per entity (IDR/year/unit) T = 10	Physical EPR obligation per entity (kg/year/unit) T = 10	Percentage recovered from source (%) T = 10
Initial	-	1,333	2.94E+07	1.47E+04	26.11
Recyclable fraction	-20%	1,467	3.24E+07	1.62E+04	26.26
	+20%	1,200	2.65E+07	1.32E+04	26.00
Marginal cost	IDR 1,800	1,133	2.50E+07	1.47E+04	26.13
	IDR 2,200	1,533	3.39E+07	1.47E+04	26.13
Added value	+ 10%	1,267	2.80E+07	1.47E+04	26.13
	+ 20%	1,200	2.65E+07	1.47E+04	26.13

Table 6. Ratio comparison for scenario 4

Category	Output value[a] (IDR)	Number of establishments[b] (unit)	Output value per establishment (IDR/unit)	Financial EPR obligation at T=10 (IDR/unit)	Ratio comparison (%)
Food industry	9.24E+14	5,975	1.55E+11	2.94E+07	0.0190
Beverages	3.48E+13	374	9.30E+10	2.94E+07	0.0316
Pulp and paper products	1.48E+14	485	3.05E+11	2.94E+07	0.0096
Printing and reproduction of recorded media	2.42E+13	528	4.59E+10	2.94E+07	0.0641

[a](BPS-Statistics Indonesia, 2016a)
[b](BPS-Statistics Indonesia, 2016b)

Table 7. Ratio comparison for scenario 5

Category	Output value[a] (IDR)	Number of establishments[b] (unit)	Output value per establishment (2014) (IDR/unit)	Financial EPR obligation at T=10 (IDR/unit)	Ratio comparison (%)
Food Industry	9.24E+14	5,975	1.55E+11	3.41E+07	0.0220
Beverages	3.48E+13	374	9.30E+10	3.41E+07	0.0367

[a](BPS-Statistics Indonesia, 2016a)
[b](BPS-Statistics Indonesia, 2016b)

5. CONCLUSIONS

Although the concept of producer responsibility has been introduced in the current waste management regulations, its implementation still faces several challenges. However, there is evidence that companies with a high sense of responsibility have taken initiatives to reduce the impact of their products at the post-consumer stage. The issues and concerns for the implementation identified from the interviews include the lack of awareness about the waste management options, negative perception of recycled materials, limited capacity of the informal sector, and unavailability of clear guidelines and systems.

The system dynamics simulation using data and information of Bandung municipality as input

shows that in the integration scheme applied for four manufacturing sectors, each business entity can bear the financial responsibility of IDR 29.4 million per year and physical responsibility for the take-back of 14.7 tons per year. In the integration scheme for two manufacturing sectors, each business entity can bear the financial responsibility of IDR 34.1 million per year and physical responsibility for the take-back of 17 tons per year. The amount of financial responsibility ranges from 0.0096 to 0.0641% of the output value of the selected industry sectors in 2014.

The results of the simulation can be interpreted as a basis to understand the integration of the producer responsibility and community-based approaches like waste banks. The integration scheme may create an incentive system to promote producer responsibility in waste management in Indonesia. It is recommended to follow up study on the recommendations given in this study.

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