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Abstract

Community participation is required for managing solid waste. In Indonesia, community acceptance and participation in solid waste management are assessed by the presence of a waste bank at the village or neighborhood level. This study aimed to find out the source, economic potency, and handling system of solid waste in a village setting. This study took place at Ketapang Village, Mauk Sub District, Tangerang Regency, Indonesia. This study evaluated the community participation in the waste bank in Ketapang Village, which is called, Sakumis Bersalaman Waste Bank, and its potential to manage solid waste and generate some profits for the community. Some steps were performed to obtain the answer to the research question. A desk review was conducted to analyze the current waste management practice. Solid waste generation data was taken from an 8-days survey of the collected waste managed by the waste bank. In-depth interviews with 96 households were conducted to find out the potential of future waste bank development. It was found that from 1,988 households in Ketapang Village only 448 households participated in Sakumis Bersalaman Waste Bank. Based on the results of the analysis on the questionnaire which was distributed randomly to 182 households which are communities around the waste bank, it was found that 51.4% of respondents were not yet members of the waste bank. From this percentage, 94.4% of them declared that they want to be waste bank members. It is suggested to Shakumis Bersalaman Waste Bank to add members so that more waste will be recycled. In this way, the community will receive more benefits. From the results, we concluded that community participation through a waste bank, especially a better waste management system, is the potential way to increase the economic level of the village. Moreover, a waste bank could facilitate better solid waste management and produce a sustainable circular economy at the village level.

1. Introduction

Solid waste management is expected to be run effectively in a municipality. Waste management is associated with various efforts regarding efficient resource use, the application of 3Rs (reduce, reuse, and recycle) strategies, and the establishment of supply chain interconnection between all stakeholders (Tseng et al., 2018). In practice, this interconnection is not going well, which leads to an improper waste management system (Tseng & Lin, 2009). Municipal governments must work hard to solve the problems since they have the most powerful influence to create successful waste management in a city.

However, other stakeholders such as informal waste actors, industries, non-government organizations (NGOs), and community-based organizations (CBOs) also play an important role in the success of waste management in an area. Waste banks as part of a community-based organization in Indonesia manage the inorganic waste at the neighborhood scale and are subjected to be the available solution to waste management problems (Budiardjo et al., 2022). In Tangerang Regency, waste generation has become an ongoing unresolved problem.

The government and community have been unable to handle all the waste problems as indicated by the amount of solid waste generation in several city roads of Tangerang Regency. However, Tangerang Regency already has recycling centres that handle sorted solid waste in several places. Factors that influence the success of waste management, in this case, include collaboration between the government and the community to participate in environmental improvement, holding 3R seminars, and contributing to community service (Rachman et al., 2020).

The community's lifestyle has a significant effect on the amount and type of solid waste as there are many non-biodegradable plastics packaging because of the habit of the community in buying fast food and packaged household needs. Then, there are many organic domestic wastes from kitchen activity (Rachman & Septiana, 2020). The public awareness of sorting and utilizing solid waste has been unformed. The community's behavior of disposing mixed solid waste and directly disposing to the temporary waste processing site and then to landfill has been a habit for long-ago times, whereas the government has given environmental education of solid waste management (Khair et al., 2019a). The government has also

campaigned to sort solid waste and invite the community to be waste bank members (Raharjo et al., 2019). However, the condition is still unchanged. There is not much community support to manage their solid waste (Raharjo et al., 2016).

Increasing community participation could be the best solution to waste management problems (Tsai et al., 2021). One of the well-known strategies to increase awareness within the communities in Indonesia is the establishment of a waste bank in the waste management system (Oh & Hettiarachchi, 2020; Putra et al., 2019). Therefore, behavior becomes the major factor that influences the willingness of the communities to manage their waste by themselves (Pandebesie et al., 2019). Soesanto et al. (2021) claimed that the subjective norms are the biggest contributor to the recycling intention through the waste bank. Furthermore, the frequency of the involvement of a person in the social community activities, education, and income level also contribute to the willingness of a person to implement a solid waste management policy (Brotosusilo et al., 2020). Even though the waste bank is claimed to be the facility to increase community environmental awareness, Ulhasanah and Goto (2017) explained that the waste bank could be ineffective because of the diversity of the social condition. Moreover, good practices and strategies of sustainable waste management through the waste bank are still rare in the current works of literature. The previously mentioned works of literature only focused on the factors that may influence the sustainability of waste banks as recycling facilities driven by the community.

Looking forward to the gap in the scientific knowledge, this study examines the potential of community participation and develops several strategies in managing solid waste, taking waste bank in Ketapang Village as an example. This study begins from the desk review to find the current waste management practice in the Ketapang Village. Then, waste banks, as part of the waste management facility in the Ketapang Village will be explored and evaluated based on their impact on the environment and local economy. People in Ketapang Village will also be interviewed to gain their insights into the sustainability and operational of the current waste bank. This study will give an example of successful community participation and provide some strategies to recycle and manage waste and give a potential circular economy benefit to the environment.

2. Methods

This study consists of 4 stages **to** answer all the research questions. The first stage in this research was the collection of statistical data related to waste and the required documents obtained from the Sakumis Bersalaman (Prosperous Indonesian Family) West Bank and UPTD (Regional Integrated Service Unit) Waste Management Region VIII, Environmental and Forestry Service, Tangerang Regency. The data that has been collected was then analyzed. The data was useful to see the current waste management practice in the Ketapang Village, Mauk District. Second, the desk study to the local and national regulation was conducted**.** This aimed to see how the implementation is of the regulation at the community scale. Third, solid waste generation data of the Sakumis Bersalaman Waste Bank members was generated by weighing the waste collected by the members during 8 non-sequentially days from October, 1st 2020 to December, 10th 2020.

This data was essential to analyze the effect of the increasing number of the member on the economic potency of the waste bank. Fourth, in-depth interviews were conducted to gain people's perceptions about the waste bank. The respondents around the waste bank (which include members and non-members of the waste bank) were interviewed to find the detailed information of the waste bank management and the number of appropriate samples for analyzing data to produce a research conclusion (Khair et al., 2019b). The questionnaires were randomly distributed by using google form tools to 182 householders/people around Ketapang Village. The number of respondents was determined using the Slovin method as shown in equation (1). The population of Ketapang Village is 1,988 households. The number of respondents with the confidence level is 90% and the margin of error is 10% or 0.1can be seen in equation (1).

$$n = \frac{N}{1+Nxe^2} \tag{1}$$

Where:

N = the number of households

e = margin of error

Result:

$$n = \frac{1988}{1+1988x0.01^2} = \frac{1988}{1+19.88} = \frac{1988}{20.88}$$

$$n = 95.2196 \text{ households/samples}$$

The minimal sample should be taken from 1,988 households is 96 households. As a result, 182 households are considered very representative of the population. This study used mixed methods (qualitative and quantitative) approach adapted from Kubota et al. (2020) and Budiardjo et al., (2022) to analyze the community participation in Ketapang Village. The comparative analysis was adapted from Mian et al. (2017). It was used to compare the present and future solid waste management and economic potential through the waste bank. The qualitative data taken from interviews were analyzed by using text mining to gather the community's perception of the waste bank (Wu et al., 2021).

3. Results and Discussions

3.1. Overview of Study Location

This study took place at Ketapang Village, Mauk Sub District, Tangerang Regency, Indonesia. Tangerang Regency is located between 6000'-6020' Southern Latitude and 106020'-106043' East Longitude, and the part of the administrative area of Banten Province. This regency has a large area divided into 29 sub-districts, 28 urban villages, and 246 villages with a total area of 95,961 Ha or 959.61 km^2. Several areas, namely the border of the Tangerang Regency include:

    a. The northern boundary is the Java Sea.

    b. The eastern boundary is South Tangerang City, Tangerang City, and DKI Jakarta Province.

    c. The southern boundary is Bogor Regency.

    d. The western boundary is Serang Regency and Lebak Regency.

Some rivers which flow through Tangerang Regency from south to north are Cisadane, Cidurian, Cimanceuri, Cirarah, Kali Angke, and Pesanggrahan. Besides, this district also has several lakes including Cipondoh, Kelapa Dua, Situ Pamulang, Situ Gintung, Situ Garukgak, and Situ Patrasana. The total area of Mauk Sub District which is located in northern Tangerang Regency is 4,009.5 km2 and 4 m above ocean level. This sub-district has 93,274 inhabitants spread out 11 villages, 56 hamlets, and 241 neighborhoods. Mauk sub-district has agriculture, marine potential, and beach tourism, such as Tanjung Kait Beach, Madatho Beach, and

Shangrila Beach. Kemiri Sub-District borders Mauk District in the west, Sukadiri Sub District in the east, Rajeg Sub-District in the south, and the Java Sea in the north. Mauk Sub-District has a flat topography with a slope average of 0-3%. Based on monthly data in 2008, the average temperature of Mauk District is 25-350C.

Ketapang Village is one of the villages in Mauk District, which has solid waste problems, whether from the land area, river, or ocean areas. The community of Ketapang Village established a waste bank as one of the solutions, namely Sakumis Bersalaman Waste Bank. This waste bank has 448 members. The community in Ketapang Village has good awareness regarding waste management, which was originally still an old scenario (collect-transport-dispose) to a new scenario (sort-collect-select-dispose organic or selling inorganic). However, waste management in this village is still conventional as illustrated in Figure 1.

The waste generated in Ketapang Village has been managed by the waste bank and the UPTD Perwasahan, Mauk Sub District. Most of the waste collected by the waste bank is inorganic waste, which then undergoes a sorting process and is calculated as the savings of members of the waste bank. The waste produced by members of the waste bank is collected directly using a garbage truck and transported from the house to the waste bank. Meanwhile, waste generated from non-members of the waste bank is collected using a dump truck and immediately disposed of at the Jati Waringin landfill.
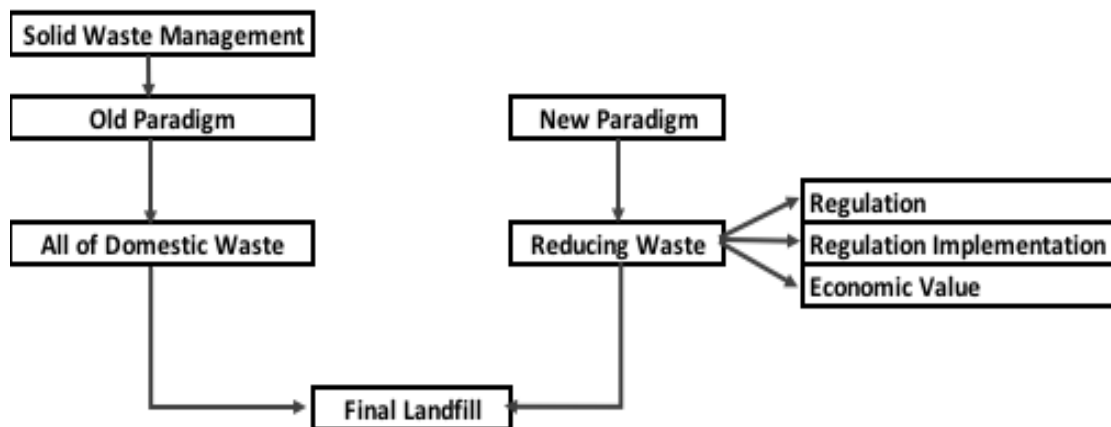

Figure 1. The old and new paradigm of solid waste management

3.2. Regulations of Solid Waste Management

It is known that people often do not realize the economic potential that can be generated in waste even though this has often been campaigned for. Despite reducing solid waste generation in landfills, solid waste with appropriate management also has economic value (Raharjo et al., 2021). The government has created laws and technical regulations for managing solid waste, from the national to the city level. The city government only needs to implement the rules that have been made. Table 1 describes laws and government regulations related to solid waste management (Rachman & Matsumoto, 2017).

Government regulations were created to help the community analyze waste characteristics by learning the composition and recycling potential because those are the essential points in solid waste management planning. The development and procedure to maintain the operation of the waste bank as a recycling facility are stated briefly in the Regulation of Minister of Environment Number 13 of 2012. The regulation also stated the importance of a waste bank as an intermediate facility from the household to the producer to facilitate the extended producer responsibility. However, this function is not implemented well in many waste banks because of the small quantity of waste that can be collected by most waste banks in Indonesia (Budiardjo et al., 2022).

Table 1. Regulations of solid waste management

No	Regulations	Level	Description
1	Act Number 18 of 2008	National	Waste management
2	Act Number 32 of 2009	National	Environmental management
3	Government Regulation Number 81 of 2012	National	Management of domestic solid waste
4	Regulation of Minister of Home Affairs Number 33 of 2010	National	Guidelines of waste management
5	Regulation of Minister of Public Work Number 03/PRT/M/2013	National	The infrastructure of domestic solid waste management

No	Regulations	Level	Description
6	Regulation of Minister of Environment Number 13 of 2012	National	Guidelines for the Implementation of Reduce, Reuse and Recycle Through Waste Banks
7	Government Regulation of Banten Province Number 8 of 2011	Province	Waste management
8	Government Regulation of Tangerang City Number 3 of 2013	Regency	Waste management
9	Government Regulation of Tangerang Regent Number 50 of 2019	Regency	Technical aspect of waste management

3.3. Solid Waste Generation in Ketapang Village, Mauk District

In this study, the waste generation is limited to the solid waste generated by Sakumis Bersalaman waste bank members. The non-waste bank members are taken by the UPTD and disposed of directly to the landfill. Therefore, waste generation cannot be considered the same as waste bank members did. Table 2 shows the data of solid waste sorting in each category from 448 households during 8 non-sequentially days, which started from 1st October 2020 to 10th December 2020.

Table 2. Data of solid waste generation in 8 days.

Waste Category	Day (kg)								Total (kg)
	1	2	3	4	5	6	7	8	
The plastic of drinking water	0.04	0.05	103	0.03	0.04	0.02	0.00	202.20	305.09
Mixed plastic	0.23	0.21	0.08	0.25	0.27	0.31	0.81	0.10	2.26
Paper, cardboard, carton	0.07	0.09	248	0.18	0.13	0.32	0.11	141	390
Metal (aluminium, iron, and others)	0.00	0.00	100	0.00	0.01	0.00	0.00	0.05	100.15

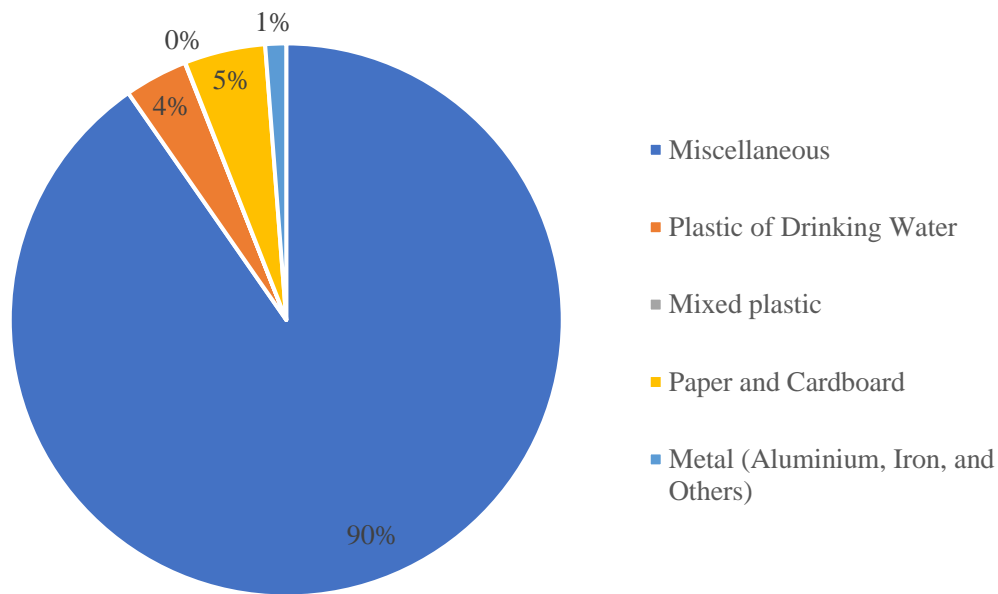| Waste | Day (kg) | | | | | | | | Total (kg) |
Category	1	2	3	4	5	6	7	8	
Miscellaneous	0.00	0.10	4,202	0.00	0.19	0.00	0.00	3,242	7,444
Total	0.34	0.45	4,653.08	0.46	0.64	0.64	0.92	3,586.95	8,241.48

Figure 2. Percentage of solid waste generation

Based on Table 2, total solid waste generation from 448 households for 8 days is 8,241.48 kg. In other words, every household contributes to generating solid waste of about 2.30 kg/day. The other things/miscellaneous category (diapers, batteries, and clothes) is the most significant percentage of solid waste generation (90.32%). However, this category has no economic value. In contrast, the plastic, paper, cardboard, and metal categories have economic value because of their possibility to be recycled. It means that only 9.68% has economic potency. Table 3 shows the economic potency of solid waste in Sakumis Bersalaman Waste Bank.

Table 3. Economic potency of solid waste managed by Sakumis Bersalaman waste bank

No	Waste Category	Price/kg (IDR)	Total Number (kg)	Revenue per 8 days (IDR)	Revenue/day (IDR)
1	The plastic of drinking water	5,250	305.09	1,601,707	200,213
2	Mixed plastic	3,700	2.26	8,347	1,043
3	Paper, cardboard, carton	2,200	390.00	857,993	107,249
4	Metal (aluminium, Iron, other)	4,000	100.15	400,608	50,076
Total revenue (IDR)				2,868,655	358,582

Total revenue from 448 households for 8 days of waste collection is IDR 2,868,655 or IDR 358,582/day so that each household can earn revenue IDR 801/day. Based on the information presented in Table 3, we can also conclude that every household contributes 2.30 kg of recyclable solid waste to the waste bank.

3.4. Questionnaire result

As many as 54.1% of the 182 respondents have not become members of the waste bank where 94.4% of them stated that they want to become members of the waste bank. Their interest indicates a potential increase in the number of members of the Sakumis Bersalaman Waste Bank.

A	: The number of households	= 1,988 households
B	: Existing waste bank member	= 448 households
C	: Percentage of non-member of waste bank	= 51.40%
D	: People who want to be waste bank member	= 94.4% of C

The increasing waste bank member $= ((A - B)C)D$ (2)

$= ((1988 - 448)x51.40\%) \ x \ 94.4\%$

$= 747$ households

Potential improvement of waste bank member = 448 households + 747 households

$$= 1,195 \text{ households}$$

The new waste bank member becomes 1,195 households. Table 4 shows the result of the questionnaire distribution.

Table 4. Result of questionnaire distribution

No	Question	Yes	No
1	Knowing about waste bank	90%	10%
2	Being waste bank member	48.60%	51.40%
3	Sorting solid waste	78.50%	21.50%
4	Disposing waste in its place	99.40%	0.60%

Based on the distributed questionnaire, there is an increased potency of waste bank members from 448 households become 1,195 households. The comparison between the existing and potential improvement of waste bank members is presented in Table 5.

Table 5. Comparative analysis of increasing waste bank member

No.	Parameter	Existing Condition (There are 448 Households as Member)	Potential Improvement (There are 1,195 Households as Members)
1	Collected solid waste (kg/day)	1,030	2,748
2	Economic value (IDR/day)	358,582	956,485

Table 5 shows that if 73% of the households in the village are willing to join the waste bank members, the number of collected solid waste and economic value will increase significantly, because it can recycle around 73% of the total solid waste generated in the village. This situation means that community participation can dramatically impact the environment. Community participation will help the government to reduce the solid waste generation sent to

the landfill and give economic value to the community. The increasing number of waste bank members from 448 households become 1,195 households is very useful for reducing solid waste generation in the landfill and increasing the economic value of the community. This number should be the target of the waste bank managers to improve their recycling and economic benefit.

The respondents were asked to give their perception and opinion of waste management through the waste bank. The text mining analysis was used to analyze this matter by analyzing the number of words and their sentiment to the waste bank management. From the 1,254 collected words of 182 respondents, it is found that there is no negative sentiment to the Sekumis Bersalaman waste bank management. The collected words consist of 74 words for *waste*, 29 words for *banks*, 25 words for *communities*, 16 words for *environments*, 14 words for *villages*, 13 words for *good*, 12 words for *nice*, 9 words for *helpful*, and other similar words. The text mining analysis showed that most of the community understands the waste bank management and the positive impact on the environment they could bring.

3.5. Discussion

The result showed that the existence of a waste bank gave a positive impact on the environment. The waste bank can facilitate the area to establish circular economy benefits within the community. Even though the current recyclable solid waste is not significant enough to give economic benefit to the community, the potential improvement of waste collection is shown from the questionnaire result. The waste bank should increase their member to enhance the recycling potential and economic benefit for the community. In other cases, a waste bank can be the intermediate facility to reduce the number of greenhouse gases emission from waste transportation and burning activities (Hadiwidodo et al., 2020; Premakumaran, 2018; Ramadan et al., 2021). Solid waste management in a city should be integrated with the waste bank to establish the extended producer responsibility (EPR) scheme and close the loop of plastic and other inorganic waste supply chain (Budiardjo et al., 2022).

Furthermore, a waste bank with a wider area might also be used as a composting facility to treat organic wastes created by the neighborhood. The waste bank in this case contributes massively to the reduction of greenhouse gas emissions since organic

waste produces the highest emission compared to another waste type (Syafrudin et al., 2021). Despite the beneficial things generated, some big challenges such as proper waste bank management and increasing the community awareness of the waste bank are necessary tasks to do in the development of Sakumis Bersalaman Waste Bank.

Hence, various efforts are needed for increasing the community awareness for being a waste bank member.

1) Giving environmental education for asking the community to be actively involved in waste management (Indriyani et al., 2017; Rahmayanti et al., 2018).

2) The waste bank managers should always be the whole spirit for educating the community about the benefit of being a waste bank member and how to be an environmentally friendly community (Khair et al., 2019c). Considering the economic value in each waste, the community should be more aware of managing their waste.

3) The waste bank should conduct motivational training related to solid waste sorting to be stored at a waste bank for earning money. The money can increase the daily shopping budget (Raharjo et al., 2018). Commercial waste also has economic value.

4) The online monitoring tools are needed to make it easy for people to see the number of waste collected and recycled by the waste bank (Logan et al., 2019; Sendari et al., 2019).

5) The high level of plastic pollution in the river and marine environment is also caused by the lack of solid waste management facilities such as waste banks and waste processing facilities (Lestari & Trihadiningrum, 2019).

Scavengers may be our saviors given their important roles as the biggest recycling actors of plastic waste. Integrating scavengers with waste banks is also good idea to improve the plastic waste processing while increasing the income of the community and scavengers (Putri et al., 2018). Those efforts could be significant factors for the success of waste management, not only in Sakumis Bersalaman Waste Bank but also in other waste management practices in developing countries.

4. Conclusion

The Sakumis Bersalaman Waste Bank in its role of holding the responsibility to create sustainable solid waste management in Ketapang Village. Currently, the number of members of the waste bank is only 22% of the total household in Ketapang Village. There are many regulations available at the local, regional, and national scales related to waste management. However, the implementation and the knowledge about this regulation are not enough to make sustainable waste management in the village. Waste bank, as the recycling facility, recy**cles** waste generated from the household for about 9.68% of the total community solid waste. Given the low number of waste bank members, the results obtained from the recycling process conducted are considered unable to give a significant impact on reducing waste sent to the landfills**.** However, 48.52% of the respondent are willing to join the waste bank as a new member.

There are approximately 747 households that will be new members of Sakumis Bersalaman Waste Bank. This number will increase the economic benefit by approximately 73% from the current waste bank practices. Community participation as a waste bank member has a significant impact on the environment. The number of waste bank members is directly proportional to collecting solid waste and the economic value of the community. This study was limited to the interview results of waste bank members and manager. Therefore, further research is suggested to consider the potential benefits of establishing a waste bank for other stakeholders such as industry, non-governmental organizations (NGOs), and scavengers. This is recommended considering that the focus of this research is limited to the willingness of the people of Ketapang Village to join the Sakumis Bersalaman waste bank and the economic benefits created by the waste bank.

Author Contribution

Conceptualization, I.R.; Methodology, I.R., and I.R.H.; Software, I.R.H.; Validation, I.R., N.K., and I.R.H.; Formal Analysis, N.K.; Investigation, N.K., and I.R.H.; Writing – Original Draft Preparation, I.R.H., and N.K.; Writing – Review & Editing, I.R., and N.K.; Visualization, N.K., and I.R.H.; Supervision, I.R.

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