Evaluation of solid waste management operational techniques in Kebonsari Urban Village, Citangkil sub-district, Cilegon City

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Abstract. The increase of population is equal to the increase of solid waste generation. Domestic solid waste generation that is not managed properly will cause problems. Solid waste management in Kebonsari Urban Village, Citangkil Sub-District, Cilegon City still uses the old paradigm (collect-transport-dispose) and low service level. This study aims to evaluate solid waste management activities from storage, collection, and transportation to the final disposal. This study used the method of field observation to analysis current service coverage and compare operational technical conditions in Kebonsari Urban Village with SNI 19-2454-2002 of Operational Techniques of Municipal Solid Waste Management. Data analysis was performed by calculating based on SNI 3242-2008 Residential Solid Waste Management. The results showed that only 41% of the population of Kebonsari Urban Village were served, this was due to the fact that there were still many people who did not put garbage in their bin and solid waste operational techniques in Kebonsari Urban Village were still not entirely applying SNI 19-2454-2002 one of them is shown by the low participation of the community in solid waste management. The average of solid waste generation in Kebonsari Urban Village are 0.71 l/person/day or 0.12 kg/person/day and the solid waste composition are 60.2% organic and 39.8 inorganic.

1. Introduction
According to Law No. 18/2008 on Waste Management, waste is defined as humans and/or natural processes residual of daily activities in solid form [1]. The amount of waste every year continues to increase in line with the increasing number of residents and the people’s quality of life which are also influenced by the advances of technological science. This progress certainly brings consequences for example changing people's lifestyles into a more consumptive way [2]. The increase in population and changes in consumption patterns is not only contributed to the increasing volume of waste, but also results in increasingly diverse types and characteristics of waste. Waste management that is not in accordance with environmentally friendly methods and techniques will have a negative impact on public health and the environment [3]. The results of research conducted in sub urban areas in Sri Lanka show that waste management is carried out by the municipal public health department [4]. This illustrates that waste management is a form of community collaboration with the city government.

Citangkil District, Cilegon City is the district with the highest population in Cilegon City. At the moment, Citangkil District has a number of waste banks are located in Kebonsari Urban Village [5].
The existence of waste banks in Kebonsari Urban Village is one of the efforts to reduce waste, which is only available through the collaboration between the government and the local community. Efforts to reduce waste are carried out at the source of waste especially for non-organic waste that still possesses economic value. Kebonsari Urban Village was chosen as a research location based on a consideration that Kebonsari Urban Village has the most active waste banks among other surrounding villages. These banks are Mandiri Waste Bank and the Berling Waste Bank that operate within their respective service areas. Generally, in municipal waste management 84% of waste is collected and the rest of it is recycled. Although, most of its still dumped or landfilled, especially in low-income per capita countries [6].

Kebonsari Urban Village, Citangkil District, Cilegon City has an area of 225,095 Ha. The population of Kebonsari Urban Village shows a declining trend from 2012 to 2019 with a population of 9,728 people or 4,706 households in 2019 [7]. The purpose of this study is to evaluate the existing condition of waste management technical aspects practiced in Kebonsari Urban Village, which includes waste collection and transportation from the waste source to the designated Final Disposal Site. This evaluation activity is an important component for ensuring the sustainability of good waste management, as the results of the evaluation will become an important input in the preparation of waste management system plan over the next few years.

2. Research methodology

2.1. Research location and time
This research was conducted in Kebonsari Urban Village, Citangkil District, Cilegon City for three months, from March to May 2020.

2.2. Type of data and data collection method
Data collected in this research consist of:
- Population data and general description of Kebonsari Urban Village, obtained from Kebonsari Urban Village Office.
- Data of waste generation and composition rates of residential waste produced in Kebonsari Urban Village, which acts as primary data by performing waste sampling on selected households. Household samples were determined based on SNI 19-3694-1994 regarding Methods for Taking and Measuring Examples of Urban Waste Generation and Composition [8]. Waste sampling is carried out for 8 consecutive days.
- Data of waste management existing conditions in Kebonsari Urban Village, which includes data on facilities and infrastructure for waste management, storage, collection and transportation, and waste processing. Data regarding waste collection and transportation pattern in Kebonsari Village is categorized as primary data, which obtained through direct field observation.
- Data of waste banks and waste processing practiced by it in Kebonsari Urban Village. The data is categorized as primary data, which obtained through direct field observation.

| No. | Type of Data                                                                 | Method                      |
|-----|------------------------------------------------------------------------------|-----------------------------|
| 1   | Population number and general description of Kebonsari Urban Village          | Secondary data (Kebonsari Urban Village Office) | - |
| 2   | Waste generation and composition rates of waste produced in Kebonsari Urban Village | Primary data                | SNI 19-3694-1994 |
| 3   | Waste management existing conditions including facilities and infrastructure, waste storage, collection and transportation, and processing | Primary data                | Field Observation |
| 4   | Waste bank and waste processing practiced by it                              | Primary data                | Field Observation |
2.3. Data analysis
The collected data was then tabulated and descriptively analyzed to evaluate the technical aspects of waste management operational in Kebonsari Urban Village, Citangkil District, Cilegon City.

3. Results and discussion

3.1. Waste generation and composition in Kebonsari Urban Village
Based on the results of sampling in high income, middle income and low income settlements we acknowledge that the average rate of waste generation in Kebonsari Urban Village is 0.71 l/person/day or 0.12 kg/person/day. With a population of 9,728 people in 2019, the amount of waste generation in Kebonsari Urban Village in 2019 is 6,809.60 liters/day or 6.81 m$^3$/day. Table 2 shows the rate of waste generation in Kebonsari Urban Village based on settlement types.

| Settlement Types  | Waste Generation Rate |
|------------------|-----------------------|
|                  | l/person/day          | kg/person/day |
| Low Income       | 0.56                  | 0.09         |
| Middle Income    | 0.81                  | 0.10         |
| High Income      | 0.77                  | 0.16         |
| Rata-rata        | 0.71                  | 0.12         |

Domestic waste consists of any materials that vary in composition, depending on the civilian’s income, lifestyles and the level of education [9]. The composition of waste in Kebonsari Urban Village consists of 60.2% organic waste and 39.8% non-organic waste.

| No. | Composition      | Weight (kg) | Component (%) |
|-----|------------------|-------------|---------------|
| 1   | Paper            |             |               |
|     | Book paper/HVS   | 3.02        | 1.81%         |
|     | Duplex           | 6.67        | 3.99%         |
|     | Cardboard        | 0.92        | 0.55%         |
| 2   | Plastic          |             |               |
|     | 1. PETE/PET      | 4.12        | 2.47%         |
|     | 2. HDPE          | 14.56       | 8.72%         |
|     | 3. V/PVC         | 1.14        | 0.68%         |
|     | 4. LDPE          | 2.10        | 1.26%         |
|     | 5. PP            | 2.25        | 1.35%         |
|     | 6. PS            | 1.34        | 0.80%         |
|     | 7. Other plastic | 2.30        | 1.38%         |
| 3   | Ceramic          | 0.57        | 0.34%         |
| 4   | Rubber/leather   | 1.43        | 0.86%         |
| 5   | Glass            | 1.51        | 0.90%         |
| 6   | Metal/tin        | 3.58        | 2.14%         |
| 7   | Textile          | 0.22        | 0.13%         |
| 8   | Rock/sand        | 0.04        | 0.02%         |
| 9   | Others           | 20.77       | 12.44%        |
|     | Total Non-organic Waste | 66.54 | 39.85% |
| 10  | Leaves and Foods | 63.08       | 37.77%        |
| 11  | Woods and Branches | 37.37 | 22.38% |
|     | Total Organic Waste | 100.45 | 60.15% |
|     | Total Waste      | 166.99      | 100.00%       |
Organic waste has the potential to be processed into compost, while non-organic waste such as newspapers, magazines, clothing, and electronic wastes can be recycled or sold to the resellers and recyclers. In Table 3 show that the largest component of non-organic waste is categorized as other components, which consists of disposable diapers, sanitary napkins, and tissues.

3.2. Waste containment

Individual waste containers are generally placed in front of each house, while communal waste containers are placed in an open area that is easily accessible. The results of the evaluation of the existing conditions of waste containment in Kebonsari Urban village showed that in temporary communal waste containment facility, the separation between organic and non-organic wastes has not been practiced.

In high and middle income settlements, the type of garbage container used is generally in the form of concrete tubs and garbage bin made of HDPE plastic whereas in low income settlements, individual waste containers used are generally in the form of plastic bags. The location of communal containers placement is quite distanced from the source of waste. The capacity of the container used is generally adjusted to the amount of waste and the frequency of waste collection. Procurement of individual containers is done privately by households, while communal containers are provided by local government or waste management agencies.

3.3. Waste collection and transportation pattern in Kebonsari Urban Village

Kebonsari Urban Village applies indirect individual and direct communal collection patterns. Indirect individual pattern is practiced in RW 01, 02, 03, 04, 07, and 08 where the waste is transported first to the waste bank, namely Mandiri Waste Bank and the Berling Waste Bank. Besides receiving waste savings delivered by their customers, the waste bank also picks up waste at the households. The waste bank in Kebonsari Urban Village is a waste bank integrated as 3R-Temporary Disposal Site (3R-TPS). Non-organic waste that is temporarily accommodated in the waste bank is then sold to resellers and recyclers.

In RW 01 and RW 02 waste collection is carried out in an indirect individual pattern that is wastes from each household is collected every day using 2 units of 2 m$^3$ and 1 m$^3$ motorized carts to Mandiri Waste Bank. The indirect individual pattern applied in RW 03 and 04 is carried out by daily transporting wastes from each household by using two motorized cart units with a capacity of 0.8 m$^3$ to Mandiri Waste Bank. Wastes that have no sale value will be moved to a container with a capacity of 8 m$^3$ and then transported by an arm roll truck once a week with a frequency of one time per day. In 2019 the number of households in RW 01, 02, 03, and 04 was 2,277 households [7] and as many as 300 households or around 13.18% of the total households had been served by Mandiri Waste Bank on an integrated manner with 3R TPS.

In RW 05 and 06 the direct communal pattern is carried out by directing the community to place their waste independently into a communal container located at KH Tubagus Soleh Street, which located 9.8 km away from Bagendung Final Disposal Site. This communal container has a capacity of 5 m$^3$ and is transported three times a week by arm roll truck. Judging from the number of residents in RW 05 and 06 as much as 82% of its population has placed their waste in the communal container located at KH Tubagus Soleh Street. The overall technical diagram of waste management operations in Kebonsari Urban Village can be seen in Figure 1. Communal containers are located close to railroad tracks with enough space from main roads, so it would not disturb road users when the waste transportation process is carried out.
Figure 1. Waste management diagram in Kebonsari Urban Village.

3.4. Waste bank condition description in Kebonsari Urban Village

Mandiri and Berling Waste Bank in addition to receiving savings from waste delivered by the customer also pick up trash to the resident's house or as a TPS-3R. then the garbage is put together to be sold to the waste collectors. Wastes collected at Mandiri Waste Bank are wastes delivered by customers and wastes picked up from households. Mandiri Waste Bank functions as a 3R-TPS for 250 households. An illustration of the increase number of Mandiri Waste Bank customers can be seen in Table 4. From the table we can see that the average increase of waste bank customers is quite low with only 4 people per year even in the last two years the number of customers stays the same.

| Year | Number of Customer (People) | Number of Improvement (people) | (%) |
|------|-----------------------------|--------------------------------|-----|
| 2014 | 22                          |                                |     |
| 2015 | 30                          | 8                              | 26.7%|
| 2016 | 37                          | 7                              | 18.9%|
| 2017 | 44                          | 7                              | 15.9%|
| 2018 | 50                          | 6                              | 12.0%|
| 2019 | 50                          | 0                              | 0.0% |
| 2020 | 50                          | 0                              | 0.0% |
| Average Number | 4 | 0.0% | 10.5% |

Mandiri Waste Bank processed 62.80% of organic waste by composting, while the other 37.20% of residual organic waste that cannot be composted will be transported to the landfill. The amount of non-organic waste sold to reseller or recycler is 63.38% and 36.62% of non-organic residue with no sale value will be transported to the Final Disposal Site. Compost is incorporation in soil in suitable conditions increases fertility it is a wonderful conditioner for the soil [10].

Wastes collected at Berling Garbage Bank are wastes delivered by customers and wastes picked up from households. Berling Waste Bank functions as a 3R-TPS which collect wastes from 160 houses. Table 5 shows that Berling Waste Bank was start in 2018 with 4 customers and increased in every year with average increase 33 percent.
### Table 5. Berling waste bank customer improvement.

| Year | Number of Customer | Improvement | Improvement Percentage (%) |
|------|--------------------|-------------|---------------------------|
| 2018 | 4                  |             |                          |
| 2019 | 9                  | 5           | 56%                       |
| 2020 | 10                 | 1           | 10%                       |
|      | Average Improvement| 3           | 33%                       |

Berling Waste Bank had been served 170 family heads. The amount of non-organic waste sold to reseller or recycler is 34.69% and 65.31% of non-organic residue with no sale value will be transported to the Final Disposal Site. For organic waste it will be transported to the Final Disposal Site without any treatment.

### 4. Conclusion

The composition of waste in Kebonsari Urban Village consist 60.2% organic waste and 39.8% non-organic waste. Based on the sampling results the average waste generation rate in Kebonsari Urban Village is 0.71 l/person/day or 0.12 kg/person/day so that the total waste generation in Kebonsari Urban Village is 6.9 m$^3$/person/day or 1167.4 kg/person/day. Solid waste operational techniques in Kebonsari Urban Village are partially adapting operational technical systems as regulated in SNI 19-2454-2002 [11]. The waste removal and waste processing operations are already met the criteria while the operations of waste containment collection and transportation still does not meet the criteria as regulated in SNI 19-2454-2002.

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