Application of waste bank use in reducing household waste in sub-urban area?

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Abstract. Household waste becomes a problem in sub-urban area like Bekasi City. The quantity of waste to landfill increased from 2011-2015. To improve the situation the local government initiatives to reduce it by establishing Bank Sampah Induk Patriot (BSIP-waste bank in the city level) with the responsibilities to improve the participation of citizens on 3R (reduce, reuse, recycle) by educating and supporting them to build a waste bank in each rukun warga (RW-informal unit under village). This action is followed by issuing the new regulation concerning waste management based on community participation. This study aims to analyse the correlation between waste bank and household waste in term on reduction to landfill and financial benefit using Pearson correlation analysis. The results show issuing BSIP and new regulation impact on increasing the number of waste banks significantly. However, it is found the number of active waste bank is only 18.5%. The results show there is very strong correlation between the number of waste banks and the amount of waste reduction. It means the waste banks is effective to reduce waste to landfill. It’s recommended to BSIP to encourage the inactive waste banks and coordinate with the local authorities.

1. Introduction
The Bekasi City as a sub-urban area faces the problem of waste. The quantity of waste increases in line with population growth and urbanization. Data from the Central Statistics Agency [1] shows that the volume of waste sent to landfills or Final Processing Site rises from 576,479 m³ in 2011 to 1,311,822 m³ in 2015, equivalent to 395.01 to 898.54 tons per day. To overcome the waste problem, the local government formed the Patriot Main Waste Bank (BSIP) which was formalized through a mayor regulation which functioned as a government partner and as the parent of the waste bank at the RW, village and sub-district levels. The waste management can be successful with community participation and government involvement [2] [3].

The familiar method of waste management carried out by several countries is the 3Rs (reduce, reuse, recycle) such as in China [4], in Ghana [5], Bangladesh [6], and Tehran [7]. In Indonesia, waste banks are the place to implement the 3Rs. The application of the waste bank adopts the 3R method which refers to environmental regulations [8]. The more waste banks are expected to have an impact on reducing the amount of waste to landfill, changing people's behaviour in sorting waste and getting economic benefits from the waste business. This study aims to determine 1) the correlation between the number of waste banks and the amount of waste reduction to landfills, 2) the correlation between the...
number of waste banks and the value of selling waste, as an impact of the implementation of local regulations. It uses the Pearson correlation analysis. It is found there is very strong correlation between the number of waste banks and the amount of waste reduction to landfill.

2. Method

2.1 Method of Data Collection

This study was carried out through literature studies to collect and examine the results of previous studies. The data of the number of waste banks and the waste reduction are obtained from the Patriot Main Waste Bank (BSIP). Data analysis is performed using Pearson correlation through excel. The variables tested are the number of waste banks, the amount of waste reduction and the value of selling waste. The number of garbage banks uses two data, namely the number of active waste banks (only) and the number of all waste banks (active and passive). The correlation tests carried out are:

- The number of waste bank operates vs the number of waste reduction.
- The number of waste bank operates vs the value of selling waste.
- The number of active waste banks vs the number of waste reduction.
- The number of active waste banks vs the value of selling waste.
- The number of waste reduction vs the value of selling waste.

3. Result and discussion

3.1 Amount of Waste in Bekasi City

Bekasi City is a suburban area of Jakarta as the capital city of Indonesia. It has a population of 2,402,465 people in 2016. The area consists of 12 sub-districts, most of which are residential areas, trade areas, and services. The number of population and the development activities of the city are in line with the increasing amount of waste. As shown in table 1, there is a significant rising volume of waste to landfill in the period of 2011-2015.

| Year | Routes (times) | Weight (Ton) | Volume (M3) | Average (Ton/day) |
|------|----------------|--------------|-------------|-------------------|
| 2015 | 123.398,00     | 327,970,59   | 1,311,882,37| 898,54            |
| 2014 | 115.338,00     | 201,841,50   | 807,366,00  | 552,99            |
| 2013 | 107.543,00     | 188,200,25   | 752,801,00  | 6,185,22          |
| 2012 | 82.683,00      | 144,695,25   | 578,781,00  | 395,64            |
| 2011 | 82.355,00      | 144,121,25   | 576,479,00  | 395,01            |

Source: [1]

Sumur Batu TPA locates on an area 20 hectares, where 17 hectares occupied or 85%. The data in Table 1 describes the behaviour of waste producer that does not treat the waste at the source properly. The increase in waste disposal into landfills will accelerate the full landfill capacity, so that new land for waste disposal is needed. Therefore, steps are needed to slow down the full landfill facility by implementing waste management at the source. The household must sort out the waste it produces. Waste that has economic value sorted can then be deposited into the waste bank or sold directly to collectors. The local government issued a regional regulation on community-based waste management to overcome the issues. The government expects more communities to be involved in waste management at the source. The more garbage can be collected for recycling or reused will help to reduce waste sent to landfills. The authority recommends waste banks as community-based waste management sites.
The administration expects each RW initiates to establish a waste bank as a place for managing inorganic waste which has economic value. The number of RWs are 1013 with the assumption that each family consists of 4 people in one RW an average of 600 families.

3.2 The Patriot Main Waste Bank (Bank Sampah Induk Patriot)
The Patriot Main Waste Bank established on October 27, 2016, based on the Bekasi City Mayor Regulation No. 10A of 2017 concerning Position, organizational structure, main tasks and functions and work procedures for the Patriot Main Waste Bank of Bekasi City. The purpose is to organize part of the technical affairs of environmental management, especially handling waste at its source. BSIP tasks of helping the government increase community participation in waste management through the 3R, additional the number of environmental volunteers, provide awareness on waste to cash and opportunity business from waste banks.

BSIP has a vision of "realizing a healthy and productive waste bank throughout Bekasi City" with a mission: 1) Increasing the quality and quantity of waste banks, 2) Increasing the human resource, 3) Additional the facilities and infrastructure, and 4) Improving relationship with partnerships. The impact of the establishment of the BSIP and the mayor's regulation significantly increased the number of waste banks in all sub-districts in 2017 as listed in Table 2.

Table 2. Data on the number of waste banks (WB) in 2016 and 2017 per sub-district.

| No | Sub-district   | No of village | No of RW | No of waste bank (WB) 2016 Listed | Active | No of waste bank (WB) 2017 Listed | Active |
|----|----------------|---------------|----------|----------------------------------|--------|----------------------------------|--------|
| 1  | Medan Satria   | 4             | 72       | 16                               | 5      | 69                               | 16     |
| 2  | Bekasi Utara   | 6             | 144      | 10                               | 4      | 144                              | 22     |
| 3  | Bekasi Barat   | 5             | 91       | 4                                | 3      | 92                               | 8      |
| 4  | Bekasi Selatan | 5             | 94       | 94                               | 11     | 96                               | 24     |
| 5  | Bekasi Timur   | 4             | 83       | 7                                | 6      | 84                               | 17     |
| 6  | Rawalumbu      | 4             | 97       | 35                               | 6      | 48                               | 9      |
| 7  | Mustika Jaya   | 4             | 92       | 13                               | 6      | 89                               | 31     |
| 8  | Bantar Gebang  | 4             | 37       | 4                                | 2      | 37                               | 3      |
| 9  | Pondok Melati  | 4             | 57       | 15                               | 3      | 59                               | 14     |
| 10 | Pondok Gede    | 5             | 78       | 5                                | 3      | 24                               | 4      |
| 11 | Jatiasih       | 6             | 100      | 10                               | 5      | 94                               | 15     |
| 12 | Jati Sampurna  | 5             | 68       | 55                               | 3      | 68                               | 5      |
|    | Total          | 58            | 1013     | 268                              | 57     | 904                              | 168    |

Source: [8]

The data in Table 2 shows the number of waste banks increase dramatically growing up 337% from 268 in 2016 to 904 in December 2017. However, the percentage of the active waste bank, unfortunately is very low 21% (2016) and 18.5% (2017).

The first garbage bank was first established in Thailand in 2006, while in Indonesia it was first established in Bantul in 2008 [9]. The waste bank adopts the 3Rs system and conventional banks where customers deposit waste that has been sorted and handed over to the waste bank. Customers are given a savings book to record the amount of waste saved which has been converted into a currency amount based on the calculation of the determined waste price. Savers can also withdraw their savings if needed. The principle of activities in the waste bank is to follow the 3Rs, which is to collect, sort, recycle, and reuse waste that has economic value. The 3Rs gives positive results in protecting the environment and improving environmental behaviour, reducing air, water and soil pollution including reducing the incidence of greenhouse gases, while also providing economic benefits and can stimulate the growth of micro-recycling businesses [4] [6]. Also stated by [10], garbage banks provide financial benefits that have helped the learning process in an Al-Quran Education Park.
Although the benefits of the 3Rs are known, it does not automatically inspire people to implement it. The participation of community members influences the success of the 3Rs implementation. In the housing areas, the household has significant roles to participate in the 3Rs. As mentioned by [8] the appropriate support in the term of training, adequate information dissemination, the availability of environmental cadres and the existence of a waste bank influence the participation of households. And the authority holds an important role in issuing regulations and policies [7]. The Indonesian Government Regulation states that everyone is mandatory to reduce and handle waste. However, this regulation is not well socialized and promoted to the citizens. The administrator of the Bekasi City establishes a local regulation with the aims to encourage community participation and changing people's behaviour. The people to have a view to transform the waste into the new valued products. People can create money from processing waste. It will support to improve their finances. The other benefit of this practice is better cleanliness of the area and decrease the quantity of waste sent to landfill. Community-based waste management is practiced as well in other cities such as Makassar [2], Surabaya [11], Bandung and Yogyakarta [12].

3.3 Correlation Test
The correlation coefficient has a score between -1 and 1. If the score is <0 (negative) means the variable 1 has opposite direction with the variable 2. It means if the variable 1 increases, the variable 2 decreases. If the value > 0 (positive) means the variable 1 and variable 2 have the same directions. If the variable 1 increases, the variable 2 increases too. The score of correlation coefficient shows the strength of the relationship. It is justified based on the specified criteria [13].

| Score   | Description                  |
|---------|------------------------------|
| 0       | there is no correlation      |
| > 0,25  | very weak correlation        |
| > 0,5,75| strong correlation           |
| > 0,75,99 | very strong correlation   |
| 1       | a perfect correlation        |

Table 3 shows the data on waste reduction and selling waste, and table 4 displays the Pearson correlation test results.

| Table 3. Waste reduction data in garbage banks from December 2016 to December 2017 |
|---------------------------------------------|-----------------|-----------------|-----------------|
| Month           | No of active waste bank | Waste reduction (kg) | Selling waste value (IDR) |
|-----------------|--------------------------|----------------------|---------------------------|
| December 16     | 33                       | 17923                | 24.085.320                |
| January 2017    | 43                       | 25485                | 36.077.637                |
| February 2017   | 56                       | 30226                | 35.170.793                |
| March 2017      | 69                       | 38810                | 25.775.957                |
| April 2017      | 82                       | 40222                | 31.471.057                |
| May 2017        | 82                       | 59644                | 53.952.378                |
| June 2017       | 48                       | 20286                | 26.857.154                |
| July 2017       | 93                       | 49372                | 86.113.671                |
| August 2017     | 93                       | 43265                | 75.096.727                |
| September 2017  | 103                      | 53365                | 89.027.219                |
| October 2017    | 90                       | 46976                | 77.933.227                |
| November 2017   | 99                       | 46749                | 80.674.768                |
| December 2017   | 103                      | 46610                | 87.919.139                |
Table 4. Result of Pearson Correlation Test

| Correlation name                        | Correlation coefficient | Criteria               |
|----------------------------------------|-------------------------|------------------------|
| No of active waste bank vs waste reduction | 0.876                   | Very strong, positive  |
| No of active waste bank vs selling waste | 0.868                   | Very strong, positive  |
| No of all waste bank vs waste reduction | 0.808                   | Very strong, positive  |
| No of all waste bank vs selling waste   | 0.826                   | Very strong, positive  |
| Waste reduction vs selling              | 0.871                   | Very strong, positive  |

The results of the correlation test conclude the number of active waste banks very strongly correlated with the quantity of waste reduction, as well as the value of selling waste. It shows increasing the number of active waste banks in line with the increment of waste reduction. It means that the more waste banks the load of TPA become lighter, it will help to lengthen the TPA life. Table 2 shows the number of the active waste bank is only 18.5%. Furthermore, BSIP needs to pay attention to the passive waste bank and to find the reasons why the waste bank is not active. It is necessary for BSIP to collaborate with the other parties, such as the head of village, the head of RW and the organization of Empowerment and Family Welfare (Pemberdayaan dan Kesejahteraan Keluarga – PKK). The chief of village could motivate the chief of each RW and the PKK caders at the RW level to actively initiate the building of waste bank.

4. Conclusion

One of the household waste management in Bekasi City is a waste bank. The government takes some actions to reduce waste sent to TPA through establishing a master waste bank as a managing partner, updating the previous regulations by involving the community in waste management at its source, encouraging each RW to form a waste bank and providing incentives people who innovate in waste management. These steps show positive results with the indicators as increasing the number of waste banks in each sub-district, increasing the amount of waste collected in the waste bank to be recycled or reused, decreasing the amount of waste sent to the landfill, increasing the value of selling waste. Correlation test results show that the number of waste banks correlates very strongly with the reduction of waste to landfill, so that the more waste banks, the higher reduction waste to landfill. The high number of passive waste banks is a challenge for BSIP and local governments. It needs appropriate strategies and policies to encourage the activity of waste banks. BSIP is recommended to coordinate with the chief of village and PKK as a community empowerment organization to increase community participation in waste management.

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