Indonesian Waste Management: Municipal Biowaste Inventory at Yogyakarta City in 2017

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Abstract. Municipal solid waste is the most waste problem which should be managed by the city. Biodegradable components of municipal solid wastes such as fruit and vegetable wastes are produced in large quantities in markets, and constitute a source of nuisance in municipal landfills because of their biodegradability. In this research, those wastes are known as biowaste. The objectives of this research were to calculate the inventory of municipal biowaste at Yogyakarta city and determine the source of municipal biowaste. Methods used in this research were field observation, mapping, and also municipal waste measurement and sampling based on Indonesian National Standard SNI 19-3964-1994, Method of Collecting and Measurement of Samples and Composition of Urban Waste. The result form the research showed that the waste composition generally contain 47 municipal biowaste. This research classified the result based on the waste produced by residences and waste produce by city public facility. Residences at Yogyakarta City produce around 61,12% municipal biowaste. Public facilities at Yogyakarta city produce around 30% of municipal biowaste. Most of biowaste in public facility was generate from traditional market and restaurant. From the result of inventory calculation, recommendation of biowaste treatment and management at Yogyakarta city could be determined.

Keywords: biowaste, inventory, municipal waste management, Yogyakarta.

1. Introduction
Municipal solid waste is the most waste problem which should be managed by the city. Every Indonesian generates around 0.76 kg/day of solid waste while the total population in Indonesia was more than 200 million and the total area for disposal is limited [1]. Municipal solid waste became a problem in several cities at Indonesia. On 2005, landslide disaster at Bandung disposal site has killed hundreds persons [1]. In Yogyakarta, Piyungan disposal site has limited carrying capacity. On the other hand, based on the existing land use map of Yogyakarta city, Yogyakarta has no area for disposal area site. Thus, this condition became a waste emergency condition for Indonesia, specially in Yogyakarta [2].

Biowaste which also called biodegradable waste means any waste which is capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, and paper and paperboard [3]. Based on previous research, the amount of municipal solid waste at D.I. Yogyakarta Province was up
to 470 ton/day which consisted of 77% organic fraction and 23% inorganic fraction [4]. Hence, most of municipal solid waste in D.I. Yogyakarta Province was a biowaste. The management of municipal biowaste is required in order to reduce the carrying capacity of final disposal site. The initial action to manage the municipal biowaste in Yogyakarta was calculate the inventory of the municipal biowaste composition.

The existing condition of municipal solid waste management in Yogyakarta has waste bank and temporary disposal site. Dengan ketersediaan eksisting sarana dan prasarana pengelolaan sampah di Kota Yogyakarta saat ini setidaknya dapat sedikit banyak mengurangi permasalahan sampah di Kota Yogyakarta [2]. The objectives of this research were to calculate the inventory of municipal biowaste at Yogyakarta city and determine the source of municipal biowaste. Based on the result of this research and the existing condition of municipal solid waste management at Yogyakarta, we could determine the strategies to manage the municipal biowaste.

2. Methods and Material

Methods used in this research were field observation, sampling, and also municipal waste measurement and sampling based on Indonesian National Standard SNI 19-3964-1994, Method of Collecting and Measurement of Samples and Composition of Urban Waste.

2.1. Field Observation
In order to determine the source of municipal biowaste, field observation is needed. The purposes of field observation were to decide where the sampling point and the source of municipal biowaste are. Below the explanation how we conduct the research.

2.1.1. Land use Mapping
The land use mapping is the base tools to establish the strategy of waste reduction at Yogyakarta city. The purposes of land use mapping were to identify the existing land use at Yogyakarta city and identified the source of municipal waste at Yogyakarta by land use based.

The primary and secondary data was needed to create the land use map. The secondary data that required to support the land use map were Yogyakarta city satellite imagery and the map of Rupa Bumi Indonesia which including topography, infrastructure, river, and the road. The primary data for the land use map were the existing data of public facility and the residential area. The primary data was collected by direct observation at the research field.

The existing land use map of Yogyakarta city would be classified into several categories, such as residential, facility (non-residential), and the waste reduction facility. The land use map was overlay with the result of field observation. The overlay result would be show the land use area and the problems on it, such as the variation of waste composition and how big the waste generation in the city.

The outputs of this activity were land use map and waste reduction facility map at Yogyakarta city. The existing land use map was obtained by the integration between direct observation and the tentative land use map of Yogyakarta city.

2.2. Sampling
The sampling method for waste generation measurement was purposive sampling. Purposive sampling is the technique for sampling with specific consideration [5]. The consideration used in this research was the facility type and residential criteria [2]. Sampling points for the non-residential or public facility were school/ education institution, office buildings, shopping area, traditional market, restaurant, hotel, recreation area, medical facilities, industries, prayer building, and the road. The standard method to measure and take the sample was based on SNI 19-3964-1994 and calculation method guideline about the calculation of waste generation and waste composition from Ministry of Environment and Forestry Year 2012 with some modification [6] [7].
2.3. Municipal Waste Measurement
This method was used to obtain the existing value of waste generation and waste composition at
Yogyakarta city. The data from the measurement could be used to determine the component of
Yogyakarta city waste. From waste composition, the inventory of municipal biowaste could be
conducted.

Sampling point determination for the residential was using the standard from SNI 19-3964-1994.
The population of Yogyakarta city was 417,744 persons. The amount of the population is catego-
rized as medium city [6]. The population in the noon would be increasing 1.5 times bigger than native
inhabitants. Thus, Yogyakarta city could categorize as big city. From this statement, we assumed that
the total population of Yogyakarta city was around 600,000 persons. There is a calculation method
to determine the amount of sampling point. The equation to calculate the sampling point is stated below:

\[ S = C_d \sqrt{P_x} \]  

(1)

\( S \) = The amount of sample (person)
\( C_d \) = Residential coefficient (\( C_d \) big city = 1)
\( P_x \) = The amount of population (person)

Equation for the amount of house sampling point:

\[ K = \frac{S}{N} \]  

(2)

\( K \) = The amount of house sampling point
\( N \) = The amount of person in one house (\( N = 5 \))

From the equation above, the result calculation of sampling point for this research was 155 points.

3. Result and Discussion

3.1. The Existing Land Use Map of Yogyakarta City
Before the inventory calculation of biowaste, this research was use land use map to collect the
sampling point and investigate the source of municipal waste. Based on field observation, the existing
land use map of Yogyakarta city is showed on the Figure 1. There were 2 classifications for the
settlement, including residential sector and non-residential sector.

The residential sector divided into 3 classifications, such as permanent residential, semi-permanent
residential and non-permanent residential. The non-residential sector would be divided into several
public facilities, education, office building area, medical, business and service, industrial area, praying
building, and the public facility.

From the map, the most dominant land use classification in Yogyakarta city is settlement or
residential. Total area for residential in Yogyakarta was 64.62%. Total area land use for business and
service was 17.88%. Total area land use for office building and education were 11.94%. Total area
land use for industrial area was 1.6%. The others land use were for agricultural, tourism, and others
had total area 3.92%.
Figure 1. Land use Existing Map of Yogyakarta City

3.2. Composition of Waste Generation in the Residential Area

The percentage of composition municipal solid waste in Yogyakarta city was calculated from the measurement of waste generation. The result showed that the general municipal solid waste composition in Yogyakarta city were 61.12% organic waste, 30.55% inorganic waste, 3.7% hazardous waste, and 4.63% for the residue. Details composition of municipal solid waste could be seen at Table 1.

| Composition    | % Wet Weight |
|----------------|--------------|
| Organic waste  | 61.12        |
| Paper          | 6.18         |
| Plastics       | 10.79        |
| Textile        | 0.68         |
| Rubber         | 0.13         |
| Metal          | 2.12         |
| Glass works    | 10.66        |
| Hazardous waste| 3.70         |
| Residue        | 4.63         |
| Total          | 100          |

Organic waste was the dominant waste composition at residential area Yogyakarta City. From the Table 2 organic wastes on this composition consist of food waste, vegetables, fruits, and yard garbage. The dominant organic waste generate from food waste (45.06%), yard garbage (10.91%), and vegetables and fruits (5.15%).
### Table 2. Organic Wastes Composition

| Waste Composition | % Wet Weight |
|-------------------|-------------|
| Food waste        | 45.06       |
| Fruits and vegetables | 5.15     |
| Yard garbage     | 10.91       |

3.3. Composition of Waste Generation in the Non-Residential Area

The composition of municipal waste in the public facility area at Yogyakarta city could be seen at Table 3. Food waste, vegetables and fruits waste still be the dominant waste for this non-residential area at Yogyakarta city. Food wastes were generally produced by restaurants. Nowadays, a lot of restaurants become a tourist destination for culinary. Yogyakarta city is one of tourism city in Indonesia [8]. Market, especially traditional market, produced a large number of vegetables and fruits waste. Bus terminal also generates around 39.22% of food, vegetables, and fruits waste.

In this category of classification, biowaste compositions were including food, vegetables, and fruits waste. The dominant waste of this classification was different for each public facility. Beside restaurants and market, tourism also contributes the food, vegetables, and fruits waste. Tourism produced around 55.34%. One of traditional market in Yogyakarta City already had a plan to treat and produce the municipal biowaste as fertilizer. But the result was not to significant for the soil nutrition.

### Table 3. The Composition of Municipal Solid Waste at Non-Residential Area (Public Facility) (%)

| Facility          | Food waste, vegetables, and fruits | Yard Garbage | Paper | Plastics | Textile and Metal | Hazardous Waste |
|-------------------|------------------------------------|--------------|-------|----------|-------------------|-----------------|
| Education         | 15.59                              | 32.72        | 14.27 | 16.76    | 7.32              | 13.34           |
| Office/ Institution | 12.50                            | 24.85        | 12.72 | 26.63    | 19.49             | 3.81            |
| Shop Area         | 0                                 | 0.36         | 91.18 | 1.49     | 0.27              | 6.70            |
| Medical Facility  | 33.18                             | 6.36         | 12.27 | 18.18    | 20.91             | 9.09            |
| Market            | 71.73                             | 0.14         | 3.47  | 24.65    | 0                 | 0               |
| Restaurant        | 81.62                             | 7.79         | 0.0   | 10.59    | 0                 | 0               |
| Hotel             | 25.35                             | 6.58         | 39.37 | 8.62     | 10.53             | 9.55            |
| Tourism           | 55.34                             | 12.54        | 9.77  | 6.56     | 9.43              | 6.35            |
| Industry          | 28.16                             | 13.39        | 18.13 | 22.67    | 15.79             | 1.87            |
| Praying Building  | 9.78                              | 21.74        | 32.61 | 23.91    | 4.35              | 7.61            |
| Road/ Street      | 0                                 | 62.93        | 12.93 | 24.14    | 0                 | 0               |
| Bus Terminal      | 39.22                             | 21.77        | 18.48 | 20.53    | 0                 | 0               |
| Average           | 30.30                             | 17.22        | 22.43 | 16.75    | 7.34              | 4.86            |

3.4. Municipal Biowaste Inventory at Yogyakarta City

Municipal biowaste calculated in this research was the inventory of food, vegetables, and fruits wastes. From the measurement, the average of municipal biowaste produced at Yogyakarta City was 40.25 % from total waste generation in the city. The amount of municipal biowaste suggested be treating and recycling as fertilizer [2]. From the report on the year 2017, the strategy suggested was compost and liquid fertilizer [2]. Liquid fertilizer possibility is highest to be implemented and become an efficient way for municipal biowaste utilization.
Table 4. Municipal Biowaste Inventory at Yogyakarta City

| Land use Classification | Biowaste Percentage (%) |
|-------------------------|-------------------------|
| Residential             | 50.21                   |
| Non-residential         | 30.30                   |
| Average                 | 40.255                  |

4. Conclusion

a. Total amount of organic wastes for the residential in existing land use classification were 61.12%.

b. Total amount of food, vegetables, and fruits waste for non-residential were 30.30%.

c. The compositions for municipal biowaste at Yogyakarta city were food waste, vegetables waste, and fruits waste.

d. Total amount municipal biowaste for the residential and non residential were 50.21% from the total amount of residential municipal solid waste generation and 30.30% from the total amount of non-residential municipal solid waste generation.

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