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Research article

Estimation of Domestic Waste Volume as A Sustainable Waste Management Efforts In Mataram City

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Abstract

In this research, the problem formulation is based on the central issues in sustainable domestic waste management. In domestic waste management, information is needed regarding the existing volume and the projected volume of domestic waste in the next ten years. This study's objectives are (1) to determine the volume of domestic waste in Mataram, (2) to project the volume of domestic waste in the next ten years in the city of Mataram. Based on the data analysis results, it is found that the generation of domestic waste in Mataram City in units of weight is 0.4 kg/person/day, while the amount of domestic waste generation in Mataram City in volume units is 0.0020 m^3/day. The composition of domestic waste in Mataram City is dominated by wet organic waste at 64%, followed by dry organic waste, non-medical hazardous waste, and plastic packaging, which have the same percentage, namely 6%. The type of waste with the least amount is metal and hazardous medical waste, only 1%. The projected population growth for the City of Mataram has increased with an average growth per year of 1.99%. An increase followed this in the projected waste generation. In 2020 the population is 496,401 people with a waste generation of 1,005 m^3/year. Meanwhile, in 2029 the total population of 583,571 people will generate 1,182 m^3/year of waste.

Keywords: domestic waste, forecast, management, volume

1. Introduction

The city is a dynamic and complex socio-economic ecosystem. As the center of all economic and cultural activities, the city is required to meet various needs such as land, water, and energy which then has implications for the production of domestic waste generated by its residents. The high population affects the volume of domestic waste produced. Domestic waste is waste generated by residents with various activities. It is common knowledge that waste is one of the causes of environmental damage in a city if it is not managed correctly. Waste has a direct impact, such as polluting the environment or being a source of disease and providing long-term effects such as global warming. The waste sector contributes 3-4% of Greenhouse Gas (GHG) to the atmosphere from global GHG emissions (Arifin, 2019). The waste problem has become a massive urban problem. Therefore, the impact that can be caused by waste is very complex. Not only in terms of beauty and health but also cause economic and environmental losses that can lead to natural disasters (Yustikarini, 2017).

From year to year, the population of a city is increasing, including the City of Mataram. Based on Central Bureau of Statistics (BPS) data for the City of Mataram (BPS, 2019), compared to 2017, the population density of Mataram City shows an increase of 4% in 2019. The increase rate is high for Mataram City, which only has a land area of 61.30 km2. The more people there are, the higher the waste

generation and the characteristics of the waste produced (Chaerul and Rahayu, 2019). Mataram City is the capital city of West Nusa Tenggara Province and the city center on the island of Lombok. Besides, the city of Mataram is also a link between various tourist destinations on the island of Lombok. This means that the City of Mataram can become a source of waste for domestic waste and waste originating from tourism activities.

In the end, domestic waste can not be separated from a city. In domestic waste management, information is needed on the volume of domestic waste and the projected volume of domestic waste. Therefore, this study aims to determine domestic waste volume in Mataram and the projected volume of domestic waste in the next ten years Mataram. This research is essential to do because it can be an effort in sustainable waste management in Mataram. The resulting data or conclusions can become the basis for policymaking in regulating landfills, determining the optimum route for waste transportation, and structuring land use (Satya and Rahardjo, 2013). Besides, this study's results can be used as a reference in maximizing the use of waste management facilities and infrastructure.

2. Methodology

2.1. Location and Time of Research

This research was conducted in Mataram, the capital of West Nusa Tenggara (NTB) Province. Administratively, the city of Mataram is divided into six sub-districts and 50 sub-districts. The districts in Mataram City are Ampenan District, Cakranegara District, Mataram District, Sandubaya District, Sekarbela District, and Selaparang District. Mataram City's position as the provincial capital makes it a densely populated city because it is the center of government, education, trade, and services. The Central Bureau of Statistics for the City of Mataram (Badan Pusat Statistik, 2019) states that the total population of Mataram City is 486,715 people in 2019, with a population density of 7,940 people / km^2. Mataram City's population has not spread evenly; most of them are in Ampenan District with a density of 9,975 people/km^2. Primary data collection was carried out in August 2020 during the hot/dry season.

2.2. Method of Collecting Data

This study uses quantitative methods in answering research questions. The data used in this study are primary data and secondary data. Primary data is obtained by taking data directly to the research location. Primary data in this study is waste generation data obtained from household waste samples. Measurement of waste generation is done by directly measuring the unit of waste generation at the household waste source that is sampled. The samples were determined by the stratified random sampling method. The sampling method is based on the local population's income composition, assuming that the community's economic life influences the quantity and quality of waste. The waste in each household sample will be measured for eight consecutive days using a weight measuring device and a volume measuring device. This is following the method of calculating the waste generation contained in SNI 19-3964-1995.

In addition to primary data collection, this study also uses literature studies to answer research questions. Literature studies are used to calculate the number of research samples used and consider before going to the research location to obtain primary data. This study's secondary data sources came from publications from government offices or agencies related to research, such as the NTB LHK Office and the Mataram City BPS.

2.3. Data Analysis

Data analysis was carried out on household waste samples obtained to obtain waste generation and waste generation projections. To analyze waste generation, the method used is analysis with Microsoft Excel. After the data on the generation of waste in volume units is obtained, the waste generation projection is analyzed. The projection of waste generation is calculated by first calculating the projection of the population of Mataram City. In this study, the City of Mataram population's

projection was calculated using three methods, namely the geometric method, the arithmetic method, and the exponential method. After that, the best projection method is chosen by paying attention to the R2 value and its standard error. The geometric method assumes that the population will increase or decrease at a fixed rate of growth (percentage), with the following equation:

$$P_n = P_o(1+r)^n \quad (1)$$

Where:
Pn = number of population in the nth year (souls)
Po = total population in the initial year (souls)
n = projection period
r = average percentage of population growth per year (%)
(SNI 19-3983-1995)

The Arithmetic (linear) method is a projection method that assumes that the population in the future will increase or decrease by the same amount every year (Hartati *et al*., 2010). The arithmetic method equation is as follows:

$$P_n = P_o(1+r\,n) \quad (2)$$

Meanwhile, the exponential method assumes the increase in population occurs slowly, little by little, over the year (BPS, 2010). The equation is as follows:

$$P_n = P_o e^{rn} \quad (3)$$

After the population projection is carried out, a projection analysis of the waste generation in volume units is then carried out. The calculation of waste generation for the next ten years in the City of Mataram is based on the baseline data on waste generation from the current year and the projected population of Mataram City.

3. Result and Discussion

The number of samples that have been determined based on the stratified random sampling method is 71 samples. The sample is spread across six sub-districts in the city of Mataram. The number of samples was obtained by paying attention to Mataram City's classification, a medium-sized city with a population of 486,715 people. The distribution of sample point locations can be seen more clearly in Figure 1.

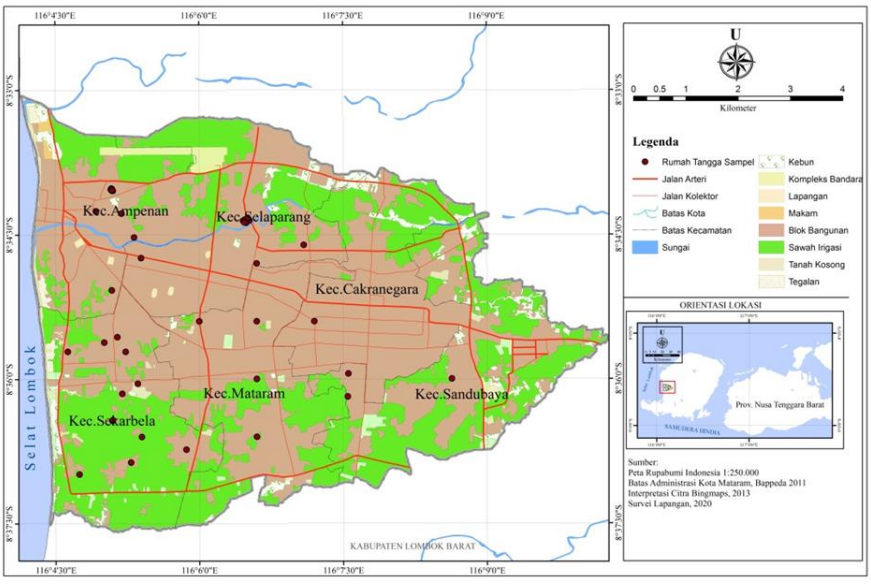


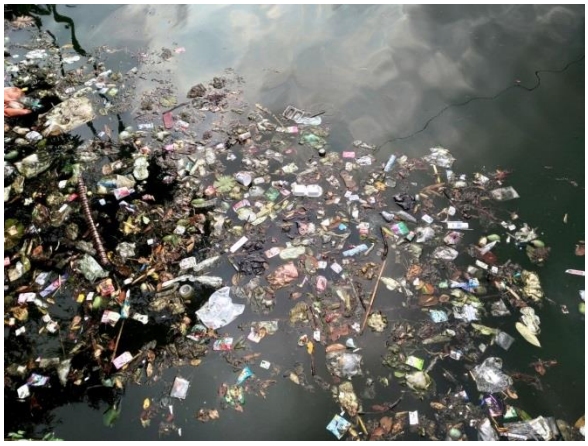
Figure 1. Location of research sample points

3.1. Waste Condition in Mataram City

Garbage is a big problem in the city of Mataram. Public awareness to manage waste starting from home is still lacking. This can be seen from the number of locations in Mataram that have been used as illegal dumping points by the community. This condition destroys Mataram City's beauty and clogs waterways during the rainy season, as happened in the Unus River in Mataram City (Jannah and Itratip, 2017). The condition of garbage at several public points in Mataram city can be seen in Figure 2 below.

NTB Cultural Park Intersection

Behind NTB Languange Office



Jangkok River

Tanjung Karang Beach

Figure 2. Waste condition in Mataram City
Source: Personal documentation

Meanwhile, documentation of waste generation data collection activities can be seen in Figure 3 below.

Figure 3. The situation of arising data collection
Source: Personal documentation

3.2. Waste Generation

Waste generation is defined as the amount of waste generated by individuals measured in weight or volume units per capita. Based on the results of calculation and data analysis, it was found that the amount of waste generation in Mataram was 0.40 kg/person/day with a waste volume of 0.0020 m3 / day. Table 1 shows the solid waste generation and volume of Mataram City based on samples taken from six sub-districts.

Table 1. Waste generation and waste volume of Mataram City by district

No	District	Waste Generation (kg/person/day)	Waste volume (m^3/day)
1	Ampenan	0,32	0,0004
2	Cakranegara	0,44	0,0001
3	Mataram	0,49	0,0007
4	Sandubaya	0,37	0,0003
5	Sekarbela	0,37	0,0003
6	Selaparang	0,43	0,0002
	Total	**0,40**	**0,0020**

For more details, Mataram City waste generation in weight and volume units can be seen in Figure 4 and Figure 5.

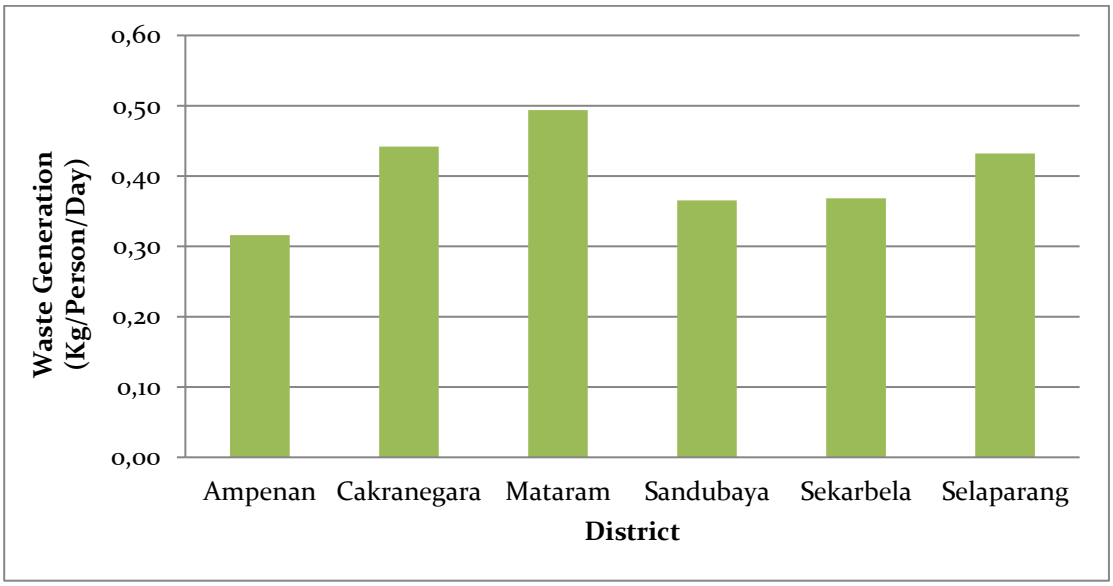


Figure 4. Graph of waste volume in Mataram City by district

According to the sub-districts in Mataram City, figure 4 shows the waste generation of Mataram City in weight units (kg/person/day). Of the six sub-districts in Mataram City, the highest waste generation generated in Mataram District is 0.49 kg/person/day. Meanwhile, the lowest amount of waste generation is in Ampenan District, namely 0.32 kg/person/day.

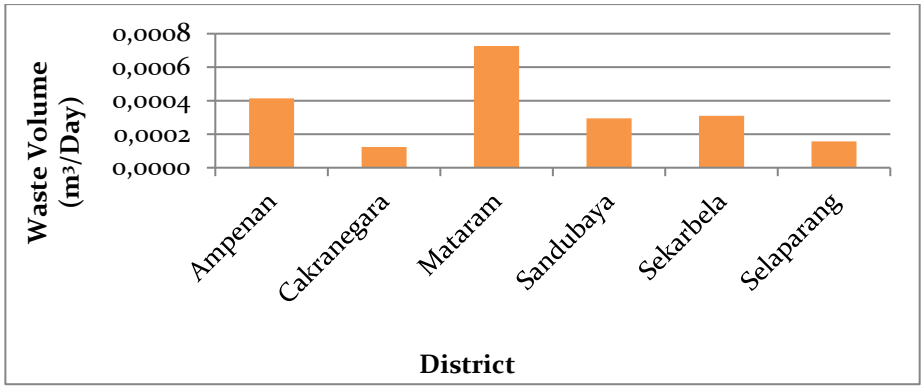


Figure 5. Graph of waste volume in Mataram City by district

Figure 5 shows the generation of waste from the City of Mataram in volume units (m^3 / day) according to the six Districts in the City of Mataram. The highest volume of waste is found in Mataram District, which is 0.0007 m^3 / day. Sekarbela and Sandubaya sub-districts have similar waste volumes, only a difference of 0.0001 m^3 / day. The lowest volume of waste is produced in Cakranegara District, namely 0.000124 m^3 / day.

According to data from DLHK NTB in 2018, the generation of domestic household waste in Mataram City was 0.34 kg/person/day. Compared with the results of this study, there was an increase in the number of generations by 0.06 kg/person/day. The increase in the amount of waste generated is a sign that there has been an increase in consumption patterns and people's lifestyles. Marliani (2014) notes that consumption patterns, people's lifestyles, and increased population increase waste generation, types, and diversity of waste characteristics. Based on researchers' observations in Mataram, there was an increase in the number of shops, shopping centers, cafes, and restaurants. According to Badan Pusat Statistik (2020), in 2019, there were 219 restaurants, an increase of 28 restaurants from 2016, which totaled 191 restaurants. Besides, the increase in waste generation in Mataram caused by an increase in Mataram City's population by 27,892 people from 2018 to 2020.

3.3 Composition of Waste in the City of Mataram

Based on the data analysis that has been carried out, the composition of domestic waste in Mataram City is shown in Figure 5. As stated in SNI 19-3964-1994, the composition of waste is a component of physically visible waste to the sense of sight. This waste can be in the form of organic and inorganic waste. In this study, waste sorting based on the type of waste in the city of Mataram was carried out simultaneously with the measurement of waste generation. A waste separation that is carried out produces a composition including dry organic waste, wet organic waste, paper, cardboard, metal, glass, plastic packaging, single-use plastic, medical, hazardous waste, non-medical hazardous waste, glass, plastic bottles, and others.

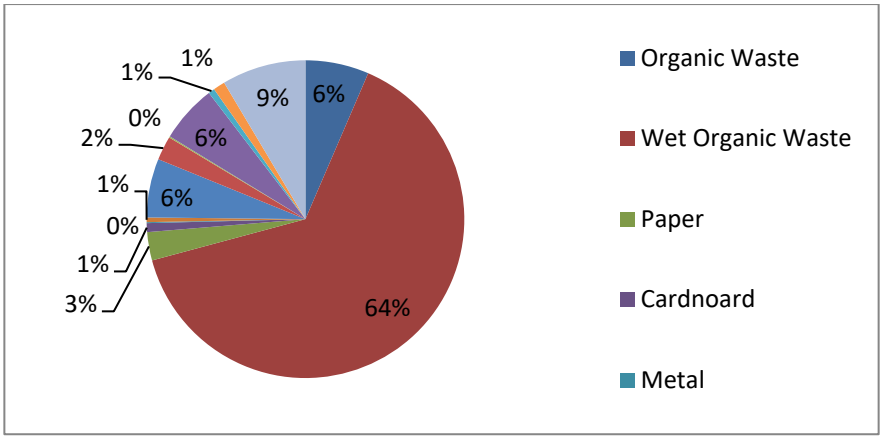


Figure 6. Diagram of waste composition in Mataram City
Source: Data analysis, 2020

The diagram above shows that the characteristics of domestic waste in Mataram City consist of 13 types. Most waste types were wet organic at 64%, followed by other waste at 9%, dry organic waste, non-medical hazardous waste, and plastic packaging had the same percentage, namely 6%. The types of waste that have the least amount are metal and hazardous waste medical waste, which is only 1%. Wet organic waste is waste that is generated mainly by households. According to our observations in the Mataram, it was influenced by the conditions of the Covid-19 pandemic, which required residents to stay at home, which had implications for increasing domestic waste production in each house. Recent data shows that there is an increase in household waste during work from home. For dry organic waste found, it is usually in the form of leaves or tree branches. Medical, hazardous waste is only a small amount because this type of waste cannot be disposed of carelessly. It must be handled with special care. Of course, much hazardous medical waste is produced by health service centers. Type of hazardous waste that is produced by household waste is a type of non-medical hazardous waste in the form of disinfectant liquid or detergent.

3.4 Projection of Waste Generation Volume in Mataram City

Before determining the projected waste generation in Mataram City in the next ten years, first, the calculation of the projection of the population of Mataram City in the next ten years is carried out using equations (1), (2) and (3) and regression analysis is carried out to determine the best method that will be used—used in the projected volume of waste generation. Comparing the coefficient of determination (R2) and the three methods' standard error is shown in Table 2.

Tabel 2. Comparing the coefficient of determination and standard error of population projected method

Method	Coefficient of Determination (R^2)	Standard Error
Arithmetic	1	0,0000000001
Geometry	0,9994	856,1716
Exponential	0,9993	856,1715

The results of the regression analysis conducted showed the coefficient of determination (R^2) of the arithmetic method was 1 with a standard error of 0.000000001. Based on the resulting value, the arithmetic method is the most suitable because the determination (R^2) coefficient is 1. If the coefficient of determination (R^2) is close to 1 or equal to 1, the better the model fit (Junaidi, 2014). Besides that, the arithmetic method's standard error is the smallest compared to the other two methods.

The projection analysis results that have been carried out using the arithmetic method show that the population of the City of Mataram has increased. The average percentage of population growth

in Mataram City per year is 1.99%, the results of the population growth projection for the City of Mataram can be seen in Table 3.

Table 3. Mataram population growth projection results in 2020-2029

Year	Growth Projections Population
2020	496.401
2021	506.086
2022	515.772
2023	525.458
2024	535.143
2025	544.829
2026	554.524
2027	564.200
2028	573.886
2029	583.571

Source: Data Analysis, 2020

If it is made in a graph, the population growth projection results for the City of Mataram are as shown in Figure 7.

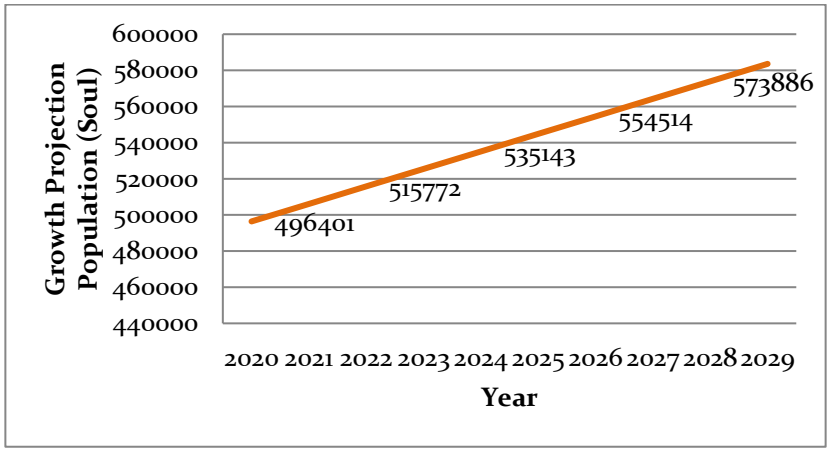


Figure 7. Projection results of Mataram City population growth in 2020-2029

Mataram city waste generation projection is obtained from the projection of population growth multiplied by the amount of waste generated from field data analysis. The projection results of Mataram City waste generation in the next ten years are shown in Table 4.

Tabel 4. Projected volume of waste generation for the City of Mataram in 2020 to 2029

Year	Projection of Populations(Person)	Projection of Waste Generation (m^3/year)
2020	496.401	1.005
2021	506.086	1.025
2022	515.772	1.044
2023	525.458	1.064
2024	535.143	1.083
2025	544.829	1.103
2026	554.514	1.123
2027	564.200	1.142
2028	573.886	1.162
2029	583.571	1.182

Sumber: Data Analysis, 2020

Based on the analysis results, the volume of waste generation in 2020 is 1,005 m^3/year; in 2024, the amount is 1,083 m^3/year. The value continues to increase every year; until 2029, the volume of waste generated in the City of Mataram becomes 1,182 m^3/day. Figure 8 shows the graph of the projection of the volume of waste generated in the City of Mataram more clearly.

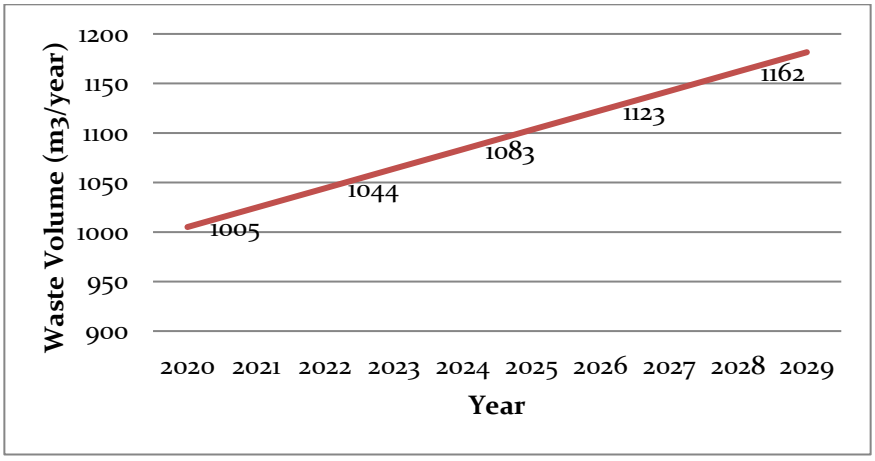


Figure 8. Projection of Mataram City Waste Generation Volume from 2020 to 2029

The graph above shows that the total volume of generation each year has increased, following the increase in population. When the population has increased, the volume of waste generated will also increase. This is caused by the high population, which results in the population's high activity, which can produce waste or become a source of waste. Several other studies also show the same thing. Research by Suwarno (2013) and Tampuyak (2016) on the projection of waste generation concluded a strong relationship between the population and the amount of waste generation.

If the waste generation is generated in an area, the government should pay attention to the facilities needed in waste management. They are increasing the number of landfills in each sub-district or district. The need for an automatic waste carrier must be added. However, the most important thing is that the government must increasingly promote or socialize waste management starting from households. Each household is expected to process its waste by applying the 3R principle and reducing waste volume and distribution. As Nugraha et al. (2018) stated, community involvement in waste management is fundamental in reducing waste volume. Community active participation in waste management can provide tangible benefits. The amount of waste transported to the trash will be reduced.

4. Conclusion

The conclusion that can be drawn from this research is that the generation of waste generated in the City of Mataram is 0.4 kg/person/day; this value is smaller than the value of waste generation for medium cities listed in SNI 19-3983-1995. However, this value is more significant when compared to the value of Mataram City waste generated by DLHK NTB in 2018, which is 0.3 kg/person/day. Meanwhile, the volume of waste generated in the City of Mataram is 0.0020 m3 / day. Besides, the projection of the City of Mataram's population in the projections of the next ten years will continue to increase. In 2029 there are 283,571 inhabitants. This results in the volume of waste produced by the City of Matarampun increasing to 1,182 m3 / year in 2029.

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