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The Analysis of Solid Waste Transportation System in The District of North Lombok

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Abstract. This study aims to provide an assessment of the current condition of solid waste transportation system, as well as to predict future transportation with an estimate of the population following the growth in the research area. The research location is in North Lombok district, West Nusa Tenggara Province. Currently, from 15 heavy equipment for hauling solid waste, it is stated that they are in good condition so that they can work well. The waste disposal system is carried out using a sweeping method on the main roads and priority zones, while for domestic waste a transportation system is carried out with 7 different picking up service maps in a week. As a result of this weeks' time, natural decay occurs at the location of the solid waste transportation. This makes this condition under serious treatment in the future.

Keywords: assessment, solid waste, sweeping, transportation system

INTRODUCTION

As a developing area, North Lombok Regency is also experiencing waste problems. The pace of the economy with an increasingly consumptive lifestyle has an impact on increasing the amount of waste production. The lack of public awareness of solid waste has led to the accumulation of garbage in several places. The behavior of the people who tend to be indifferent by throwing garbage in any place further exacerbates the conflict in the solid waste problem.

The solid waste from various sources is transported to a final processing site located in Jugil Hamlet. Destruction of solid waste at Jugil is carried out by covering the landfill with soil (sanitary landfill).

When viewed from the population of North Lombok Regency in 2019, which was 220,412 people, there was 26,549 tons of solid waste generated.

While the amount of waste that can be transported by the local government in 2020 is 17,118 tons, so the percentage of transportation services is 64.48%.It means that the local government's target to transport 70% of the total waste generation has not been achieved. So it is necessary to conduct research at that location about the things that cause the solid waste not to be transported according to the target. The regulation used to determine the target number is Presidential Regulation of the Republic of Indonesia number 97 of 2017.

Furthermore, the incompleteness of the waste transportation will be assessed from the condition of the vehicle, transportation system and future predictions of the growth of waste generation due to population growth.

SOLID WASTE

Waste is solid waste consisting of organic and inorganic materials which are considered useless and must be managed so as not to harm the environment and protect development investment. Law of the Republic of

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Indonesia number 18 of 2008 concerning waste management states, that waste is the residue of human daily activities and/or natural processes in solid form.

In the Regional Regulation of North Lombok Regency number 3 of 2018, waste is the residue of human daily activities and/or natural processes in solid form consisting of household waste and other types of household waste. Household waste is waste that comes from daily activities in the household, which mostly consists of organic waste, excluding feces and specific waste. Meanwhile, household waste is waste that does not come from households and comes from commercial areas, industrial areas, special areas, public facilities, social facilities, and/or other facilities.

Law of the Republic of Indonesia number 18 of 2008 defines the source of waste as the origin of waste generation. Sources of waste are divided into two major groups (Seadon, 2006), namely:

1. Waste from settlements or household waste.
2. Waste from non-residential or similar types of household waste, such as markets, commercial areas, and so on

Solid waste on the earth's surface come from (Sahil, 2016):

1. Residential settlements, the type of waste generated is usually food scraps and leftover materials from food processing or wet waste (garbage), dry waste (rubbish), household furniture, ashes or garden plant residues.
2. Public places and trade places, the types of waste generated from such places can be in the form of food scraps (garbage), dry waste, ashes, building residues, special waste, and sometimes hazardous waste.
3. Government-owned public service facilities, which are referred to here, include, among others, entertainment and public places, public roads, parking lots, health care facilities (such as hospitals and health centers), military complexes, conference halls, vacation beaches, and government facilities. These places usually produce special waste and dry waste.
4. Heavy and light industry, including the food and beverage industry, wood industry, chemical industry,
5. metal industry and sewage and drinking water treatment plants, and other industrial activities, whether distributive in nature or processing raw materials only. The waste generated from this place is usually wet waste, dry waste, building remains, special waste and hazardous waste.
6. Agriculture, agricultural locations such as gardens, fields or rice fields produce waste in the form of rotting food ingredients, agricultural waste, fertilizers, and plant insect repellents.

Based on SNI 19-2454-2002, waste generation is the amount of waste that arises from the community in units of volume and weight per capita per day, or expand buildings, or extend roads (Kinantan et al., 2018). The amount of waste generated will usually be related to the elements of waste management, including(“A Glance at the World,” 2013):

a. Selection of equipment, e.g. containers, collection and transportation tools
b. Transport route planning
c. Facilities for recycling
d. Area and type of landfill.

Solid waste growth follows population growth and forms a linear line(Sahil, 2016). There are other factors that affect the amount of waste generation, namely the population density that makes up the city class. The lifestyle and habits of the population are also supporting factors that make up the percentage of types of waste.(Saidah et al., 2021)

In terms of transporting waste, the movement of waste transport vehicles has a strong relationship with the completeness of transportation (Sideman, 2021)

The movement of the vehicle has a unique characteristic because it is influenced by several factors from the vehicle's internal and external factors.

According to SNI 19-3964-1994 , if field observations are not yet available, then to calculate the system size, the following waste generation figures can be used:

• Big city waste generation unit = 2 – 2.5 L/person/day, or = 0.4 – 0.5 kg/person/day
• Medium/small municipal solid waste generation unit = 1.5 – 2 L/person/day, or = 0.3 – 0.4 kg/person/day.

RESEARCH METHOD

The research method is situation analysis and uses secondary and primary data as material for analysis.

Data analysis conducted in this study is as follows:

1. Observation and data collection of the existing condition of the waste transportation system in Tanjung and Pemenang sub-districts, North Lombok Regency with the characteristic method of waste transportation patterns, was carried out to determine the pattern of collection or the applied waste transportation system.

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2. Observation and review of the pattern of waste transportation applied in Tanjung and Pemenang sub-districts.
3. Analysis of population projections in Tanjung and Pemenang sub-districts, North Lombok Regency for the next 5 (five) years. Projection analysis with mathematical methods.
4. Analysis of the projected volume of waste generation in Tanjung and Pemenang sub-districts, North Lombok Regency for the next 5 (five) years.
5. Analysis of the number of trips to transport waste in Tanjung and Pemenang sub-districts, North Lombok Regency using the Hauled Container System (HCS) and/or Stationary Container System (SCS).
6. Analysis of the need for a waste transportation fleet in Tanjung and Pemenang sub-districts, North Lombok Regency for the next 5 (five) years.

The data used in this research is quantitative data, the use of qualitative data is only on data on vehicle eligibility conditions that are sourced from secondary data and serve as supporting other data. Data collection techniques were carried out by direct observation and recording and interviews. Data processing is done by using the excel program as a tool and presenting it in a graph to make it easier to read. Inference analysis is carried out using the induction method, where research is carried out on specific objects which can then be applied as general conclusions.

Based on the limitations of the researcher and considering the extent of the factors that influence this research, the researcher uses the following problem boundaries:

1. This research only focuses on the waste transportation service system.
2. This study does not discuss waste management and costs, both user fees and vehicle operating costs

DATA ANALYSIS

The Department of Environment (DLH) of North Lombok Regency is an agency that handles waste problems in North Lombok Regency. Administratively, North Lombok Regency has 5 sub-districts with 43 villages, but the waste transportation service does not cover the entire area. This is due to the limitations of the number of transporters and waste transport fleets.

The number of transport fleets owned by the Environmental Service is 15 units of vehicles in 2 types, namely dump trucks and arm roll trucks.

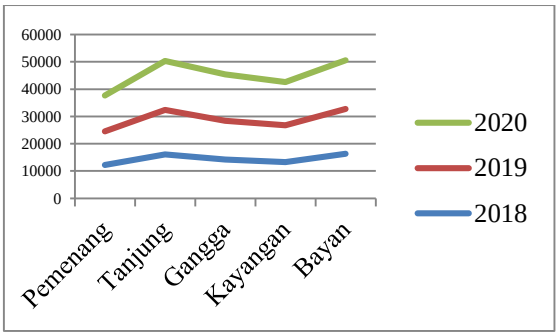

FIGURE 1. The volume of solid waste

The graph in Figure 1 shows that Tanjung sub-district is the sub-district that provides the largest volume of waste every day, which is around 21.9%. For this reason, research is needed that can answer the relationship between land use and the volume of waste it generates. So the local government can form a pattern of waste transportation in accordance with the regional designation.

Pemenang sub-district as the capital of North Lombok district, in fact only provides 16.1% of the total volume of the district's waste. This raises the suggestion to re-examine the pattern of settlements that support the formation of urban areas, as well as the types of office waste that are recycled or reused so as to reduce the volume of waste.

Furthermore, an analysis of population growth which has an impact on the growth of waste volume is carried out.

When referring to population growth rate of Tanjung Sub-district, which was 0.053 or 5.3% and Pemenang District, was 0.039 or 3.9%, it means the volume of solid waste in 2025 in the two sub-districts is 23220 kg/day and 15964 kg/day. This figure requires in-depth research on the landfill's ability to process the waste perfectly. Research is also needed that can answer the number of tools and the optimal working ability of waste transport equipment to landfill, as well as the traffic impact it causes while moving on public roads. so as not to cause a decrease in road performance and not to cause new pollution throughout its movement.

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From the condition of waste transportation in North Lombok district, there are two types of mobilizing waste, namely sweeping and picking up. Sweeping is a pattern of waste transportation carried out by taking waste from the source and then loading it into a transport truck until the final route or truck is full. Sweeping is carried out for 7 (seven) working days with different routes. The sweeping covers all sub-districts in North Lombok Regency, but does not cover all areas because the sweeping route is only carried out along the main roads and priority zones.

The Picking up Waste System (PWS) is a waste transportation pattern that has just been implemented in several places. The PWS is a program that was initiated to improve waste transportation services. PWS is considered to be able to cover people living in villages, so that waste transportation is smoother and reaches the transportation target according to applicable regulations. Another goal of PWS is for the community to play a more active role in overcoming the waste problem.

The PWS transportation pattern is carried out with a schedule of 1 time a week for 1 (one) location. The arm roll truck from the pool will go to the PJS location that has been determined according to the applicable schedule. Arm roll trucks will wait for the community to bring their garbage to be loaded and taken to the Jugil TPA. The transport officer is scheduled to be at the pick-up location for 2 (two) hours, starting from 8.00-10.00 WITA. However, this condition adjusts to the enthusiasm of the community. If in less than 2 hours the people at the pick-up location have collected all the garbage they have stored, the arm roll truck will transport the waste to Jugil landfill and return to the pool.

Regarding the condition of the equipment, it can be conveyed that all heavy equipment for transporting garbage in this district is good and suitable for using. The comparison of the number of heavy equipment transporting waste from the source of the waste to the Jugil landfill is shown in Figure 2

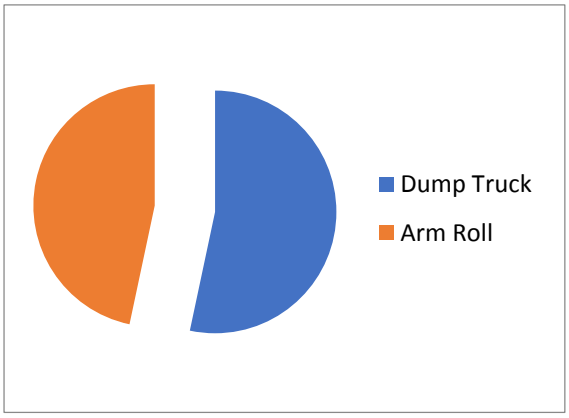

FIGURE 2. Composition of heavy equipment waste transport

Figure 2 shows that the composition of heavy equipment is close to balance, but further research are needed to determine the performance of each mobilization regarding movement barriers in traffic and public roads. Road performance and traffic performance as well as safety against accidents are studies that have great opportunities to be carried out. It is also necessary to analyze the geometric condition of the road being passed and the problems that arise due to the movement of the heavy equipment transporting the solid waste.

Due to various limitations, this research uses a waste transportation method in the form of a Hauled Container System (HCS) which is a collection system in which containers used as waste storage are transported to landfills, emptied, and returned to their original locations, namely the five sub-districts in North Lombok. so that each sub-district on average has responsibility for 3 units of heavy equipment.

If the waste density value of 389.58 kg/m^3 is used to convert the load capacity of heavy equipment in the unit of m^{3}then each dump truck with a capacity of 6 m3 and arm roll of 8 m^3 will load respectively 2337.48 kg and 3116.64 kg. so that the analysis of the existing waste transportation in the district is as shown in table 3.

TABLE 1. Once Movement of waste transportation

Equipment	Number	Conversion (kg/m3)	1 movement (kg)	% of waste volume
Dump truck	8	389.58	18,699.84	21.53
arm roll	7	389.58	21,816.48	25.11
Total	15	389.58	40,516.32	46.64

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Table 3 shows that the completeness of waste transportation with 1 cycle is only 46.64%. This value is lower than the target by 70%, so a simulation is carried out with 2 cycles as shown in table 2.

TABLE 2 Twice Movement of Waste Transportation

Equipment	Number	Conversion (kg/m3)	Twice movement	% of waste volume
Dump truck	8	389.58	37399.68	43.05395605
arm roll	7	389.58	43632.96	50.22961539
Total	15		81032.64	93.28357144

Based on the simulation with 2 times of transportation, the completeness exceeds the target, even if 2 cycles are simulated against the conditions in 2025, it can still meet 70% completeness of waste transportation in the district, as shown on the table 3.

TABLE 3 Twice Movement in the year of 2025

Equipment	Number	Conversion (kg/m3)	2 movement	volume of waste in 2025	% of waste volume
Dump truck	8	389.58	37399.68	111,332.08	33.59
arm roll	7		43632.96	111,332.08	39.19
Total	15		81032.64	111,332.08	72.78463093

From table 3, it can be seen that with 2 movements of the 15 units of heavy waste transporting equipment currently available, it is predicted that the capacity of the garbage transportation service in North Lombok Regency is 72.78%. This concludes that what is needed by the district of North Lombok to complete the transportation of 70% of the volume of waste is 2 times the movement and a valid movement map.

CONCLUSION

The conclusion that can be drawn is that West Lombok Regency able to complete the transportation of 70% waste to landfill in 2 times the movement of 8 units of dump trucks and 7 units of arm rolls, and it will be able to apply until 2025.

The research needed is research on the need for transportation time and the relationship between land use and waste generation so that the strategic plan for waste transportation can be recorded in a digital system to reduce the potential for traffic disturbances, road quality degradation and environmental safety.

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