A selection method of municipal solid waste reduction in East Lombok, West Nusa Tenggara Province

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Abstract. Waste management is an important activity in human life that aims to find solutions to the waste problem. The province and local governments in Indonesia are responsible for waste management. The volume of municipal solid waste (MSW) in West Nusa Tenggara province, specifically in East Lombok, reached 2.792 m³/day. The public area for waste processing is technically limited. In East Lombok, there are 58 Transfer Post (TPS) units, although the majority are not operational. In East Lombok, the majority of the population (86.9%) did not separate their MSW. The volume of MSW in East Lombok, particularly MSW from urban areas, is affected by population expansion; therefore, the purpose of this paper is to investigate the best scenarios for implementation in the East Lombok district using four approaches: waste reduction through recycling, composting, incinerating and pyrolysis in the TPS. According to the modelling, scenarios 2 and 3 have the same impact on waste reduction. The percentage of total waste reduction can be seen. It has the potential to reduce complete waste by up to 50%. It applies to the method in East Lombok.

1. Introduction

As one of the world's emerging market economies, Indonesia has challenged MSW issues in recent years. With a land area of 1.9 million km², Indonesia is home to 274 million people in 2020, accounting for 3.5 percent of the world's population. On average, Indonesia’s 384 cities generate about 2.2-2.7 kg of MSW per capita per day [1]. Waste management is a critical activity in human life that aims to solve the problem of waste. Waste management has a complex and lengthy process, considered as an engineering problem and as a management paradigm. The solution is not limited to the end-of-pipe system, but management system such as waste reduction from its source, waste-sorting, until recycling process [2]. The Indonesian government is developing wastewater and solid waste plans for the years 2015 to 2019. This design allows for a 20% reduction in solid waste, generally landfilled through 3R (reduce, reuse, and recycle) programs [3]. MSWM has recently become the responsibility of local governments and communities. However, waste management is frequently fragmented and disorganized [4]. The province and local governments in Indonesia are in charge of trash management. Regulation No.18 of the year 2008 governs this task. Municipal solid waste (MSW) in West Nusa Tenggara province, specifically in East Lombok, reached 2.792 m³/day [5].

MSW is a heterogeneous collection of wastes produced in urban areas. In Indonesia, the MSW mainly consists of organic waste, paper, and glass [6]. General collecting of MSW in Indonesia consists of the collection, transport, limited separation and treatment, and final. It is collected generally by hand-
carts, motorcycles, or trucks. Separation of MSW components in 3R facilities was done manually, conveyor, or gravitational sorting machine [7]. Municipal solid waste is classified as domestic waste, equivalent and specific waste; the management process ends with disposal at landfill [8]. In countries with limited space for landfill sites or those that find it challenging to find areas for landfills, thermal treatment, including incinerators, pyrolysis, and gasification, is becoming an alternative to reducing waste in landfills [9]. Generally, MSW management focuses mainly on waste collection, treatment, and disposal. Thus, most local authorities prefer open dumping, creating a sad situation in the landfill site.

Technically, the public area for waste processing is the smallest. East Lombok has 58 Transfer Post (TPS) units, but the majority of them are not operational. The majority of the population in East Lombok (86.9%) did not separate their MSW. MSW from urban areas is collected by informal infrastructure recycling 2.1%, collected and disposed of at TPS 5.4%, thrown into vacant land or garden and left to rot 14.7%, and thrown away to rivers 31.2% and 40.9% burned [5]. As we know, burning processing harmed the environment. MSW will release methane gas into the atmosphere. Therefore, MSW is considered one of the significant contributors to the greenhouse effect, increased global warming, extreme weather and floods [8].

As a result, the local government in East Lombok has implemented a program to create TPS in every village, with TPA Ijobalit serving as the centre of the landfill site. Ideally, regardless of the methods (composting, recycling), the amount of waste entering the Ijobalit landfill site can be reduced from its source, which is the goal of PerBup No 46 the Year 2018. Waste recycling activities are quite practical to reduce the amount of waste. Based on Samadikun et al. [10], 3R programs conducted in the informal sector can reduce 15.9% of paper waste [10]. If the reductions at the source are successful, the amount of waste transported into the landfill (TPA) at the district level can be reduced. The only thing that matters in this concept is Indonesia's social culture, making it challenging to reduce waste generated by household activities. Therefore, the purpose of this paper is to investigate the best scenarios for implementation in the East Lombok district using four approaches: waste reduction through recycling, composting, incinerating and pyrolysis in the TPS.

2. Methodology
Since there are four activities (recycling, composting, incineration and pyrolysis) that can reduce the waste significantly, cause; it is necessary to design the capacity of TPS for doing these processes. The design of each TPS could handle four activities to reduce waste.

There are three designed scenarios to reduce the waste in TPS:

a. Government target: The TPS is operated but without the waste reduction on its source
b. Scenario 2: The TPS is operated together with the recycling, composting and incineration process

Scenario 3: The TPS is operated with a pyrolysis process for reducing the waste

The assessment is based on the assumption that all inorganic fraction waste is recycled completely on waste banks. Organic fraction waste is composted partially and incinerated partially. However, in the other scenario, TPS is partially pyrolyzing. Some assumptions are made in these scenarios, which are as follows: 1. In TPS, the fraction of inorganic that is recycled is 19% of MSW, 2. Fractions such as biomass and some MSW that cannot be separated will be incinerated at the machine's maximum capacity, while organic waste will be composted using a composter, and the remainder of the waste will be disposed of of the Ijobalit landfill. These assumptions are used in the third scenario, which uses the pyrolysis process to reduce waste to the maximum capacity of the pyrolysis machine. Using data from the East Lombok statistical office, the population growth in East Lombok is stagnant at 2%, and it can provide a population prediction for the next ten years.

2.1. Calculating landfill capacity
This method determines the capacity of the MSW in reality and can conclude whether landfills can operate or must be rehabilitated. Some data must be available in order to calculate the Ijobalit landfill. The information has already been obtained from BPS Lombok Timur. The data used in the calculation is from 2020. East Lombok's population is expected to be 1,315,206 in 2020, with a 2972 m³/day waste
generation rate. It is possible to determine the maximum landfill capacity that can be used. It was built in 2010 for the Ijobalit landfill. Using this data, we can calculate that the landfill’s capacity can only be used until 2018. However, the reality is that the Ijobalit landfill still operates now. Figure 1 gives an overview of the amount of waste entering the Ijobalit landfill is still increasing. This total waste can be reduced at the source by applying the TPS process. The goal of this scenario is to reduce waste by utilizing government data. Ijobalit landfill was built on a 3000 m² area and will operate for eight years from when it was built. These scenarios are hoped to reduce the amount of waste that enters the Ijobalit landfill. It is possible to give the landfill more time to operate Using these scenarios.

![Figure 1. Waste entering Ijobalit landfill.](image1)

3. Results and discussion
As we all know, the amount of MSW generated in urban areas will increase concurrently with population growth. As the urban population of cities and towns grows, so do all other activities associated with population, increasing the generation of Municipal Solid Waste [11]. It has a correlation with MSW production based on population growth predictions. Figure 1 illustrates the trendline of population growth and MSW growth over the next ten years.

![Figure 2. Prospective of population growth in next ten years.](image2)

Population growth influences the amount of MSW in East Lombok, particularly the amount of MSW from urban areas. According to data from 2018 to 2020, the amount of MSW in East Lombok remains high. It correlates with population growth. There are some results from modelling scenario 1 by reducing waste in TPS. For the next ten years, waste volume entering the Ijobalit landfill can be improved by
selecting waste reduction processes such as pyrolysis, recycling, composting, and incineration. The results show that the remaining waste after the reduction process can be reduced significantly to 50% of the total waste in TPS. If we can do this effectively, it will positively impact the landfill area's ability to operate for an extended period.

Based on the data, the government has set a goal of reducing MSW. Figure 3 shows that the percentage of government targets is exceptionally high. However, these targets are still not performing well due to landfill capacity and the source's lack of a reducing process. According to the modelling, scenarios 2 and 3 have the same impact on waste reduction. The percentage of total waste reduction can be seen. It has the potential to reduce total waste by up to 50%. It applies to the method in East Lombok. However, based on the percentages obtained after modelling, scenario 2 is slightly more effective than scenario 3, even though these two scenarios cannot take the government's target.

Figure 3. The calculation result of scenarios 2 and 3 from 2018-2030.

According to the two scenarios presented above, waste will always be disposed of at the Ijobalit landfill. As a result, waste processing technology will be required until 2030 to reduce the volume and extend the life of the Ijobalit landfill. If it is necessary to choose which scenario is most likely to occur, the scenario is scenario 2, but an economic analysis must follow it. It will be more effective if the government implements regulations that encourage people to reduce the amount of waste they throw away in trash bins.

4. Conclusion
Scenario 2 is the best one to use, but it requires support from the government and the people. The support can take the form of developing a program to provide every TPS trash bin or machine and training to operate these machines. It can also support by encouraging people to reduce their waste on their own by using composting or separate waste. It can be more effective in reducing the amount of waste that enters the Ijobalit landfill.

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References
[1] Brotosusilo A and Handayani D 2020 *Data Br* **32** 106053
[2] Wijayanti D R and Suryani S 2015 *Procedia - Soc Behav Sci* **184** 171–9
[3] Kerstens S M, Priyanka A, Van Dijk KC, De Ruijter FJ, Leusbrock I, Zeeman G 2016 *Resour Conserv Recycl* **110** 16–29
[4] Kurniawan T A, Avtar R, Singh D, Xue W, Dzarfan Othman M H, Hwang G H, et al 2020 *J Clean Prod* **284** 124775
[5] Timur PKL 2021 *Strategi Sanitasi (SSK) Kabupaten Lombok Timur Tahun 2017-2021*
[6] Sudibyo H, Pradana Y S, Budiman A, Budhijanto W 2017 *Energy Procedia* **143** 494–9
[7] Lestari P, Trihadiningrum Y 2019 *Mar Pollut Bull* **149** 110505
[8] Mamad G I, Susila M D, Agung Pambudi N 2017 *Case Stud Therm Eng* **10** 357–61
[9] Kristanto G A and Koven W 2019 *City Environ Interact* **4** 100027
[10] Samadikun B P, Sinttia D A B, Rezagama A, Sumiyati S, Huboyo H S, Ramadan B S, Hadiwidodo M and Nabila F 2020 *IOP Conf Ser: Earth and Environ Sci* **623**(2021) 012077
[11] Abineh T M H T B A and Tilahum 2015 *Environ Earth Sci* **5** 83–92