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# Performance Review of Final Waste Processing at Banjarsari Landfill, Bojonegoro Regency in 2024

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**ABTRACT**

The increasing volume of waste entering the Banjarsari Landfill in Bojonegoro Regency has caused serious issues in land management. Evaluating the effectiveness of the sanitary landfill system is crucial to ensuring the sustainability of waste management at the landfill. This research aimed to assess the final waste processing at the Banjarsari Landfill in Bojonegoro Regency in 2024. This descriptive evaluative study used observation, interviews, and measurement methods. Respondents included the head of the waste management division of the Bojonegoro Environmental Office and the manager of the Banjarsari Landfill. The variables examined were waste generation, facilities and infrastructure, waste recording, compaction, soil covering, leachate treatment, and gas handling. The data analysis technique was descriptive, and presented as graphs, diagrams, or tables. The research findings showed that daily waste generation was 55.7 tons, categorized as moderate. The human resources consisted of 18 qualified personnel. The waste recording was done manually, compaction had a ratio of 2:3, waste was covered once a week, leachate was treated with a processing facility, and methane gas was used as a fuel substitute. Implementing a control schedule, improving facilities, and providing outreach and technical training for final waste processing operations were recommended.



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## INTRODUCTION

Indonesia experiences a significant increase in population every year. This increase causes various problems, one of which is the increasing amount of waste (Alfian & Phelia, 2021). Increasing the population also increases the amount of waste produced (Siombo, 2022). Indonesia's population reached 275 million people in 2022 and is expected to continue increasing every year (BPS-Statistics, 2023).

Based on the Environment and Forestry, it shows that in 2021 the amount of waste produced reached 29 million tons/year or 80 thousand tons/day, and in 2022 it increased to 36 million tons per year or 98 thousand tons per day. This shows a significant increase of 24% each year. This waste mostly comes from food waste (41.27%) and the household sector (38.28%). Indonesia is also the second largest producer of plastic waste in the world, with the emergence of plastic waste reaching 64 million tons, of which 5% is dumped into the waters and 85,000 tons of plastic bags are dumped on land (Lestari, Santoso and Mulyana, 2021)

East Java Province is among the top three provinces with the largest waste production in Indonesia in 2022, reaching 7.43% or 1.63 million tons per year. In Bojonegoro Regency, annual waste production in 2022 reached 137,271 tons per year (Directorate of Social Resilience Statistics, 2023). Based on data from the National Waste Management Information System (SIPSN), it was revealed that the waste that could be managed in Bojonegoro Regency was only 23.8% in 2020, decreasing to 23.1% in 2021, and increasing to 33.9% in 2022.

Bojonegoro Regency has encouraged every village to create a waste bank, this is an effort by the government to reduce and handle the waste problem. A waste bank is a system for managing dry waste that is supported by the active role of the community. In 2022, Bojonegoro Regency will have 168 waste bank units. In addition, this district also innovates in processing waste into methane gas, methane gas into electricity, plastic waste into fuel, and leaf waste into compost at TPS 3R, Banjarejo Village and Banjarsari landfill.

The final Processing Site is the last place in waste management which includes source, collection, transfer/delivery, delivery, and disposal. Based on the preliminary study that has been conducted, it was found that Banjarsari landfill in Bojonegoro Regency has been operating since 1991 and serves waste transportation from 12 sub-districts with 44 TPS. This landfill has a land area of approximately 4.9 hectares, with 2 hectares already filled with waste so that the remaining active land is 59%. The average waste entering Banjarsari landfill per day is 65 tons, and per month it reaches 1,950 tons. The waste generation at this landfill has reached 11 meters, exceeding the maximum limit of 1.2 meters according to the Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia No. 03/PRT/M/2013..

Banjarsari landfill uses the Sanitary Landfill method which is considered the best method compared to other landfill methods (Lesman, et al., 2021). The facilities at Banjarsari landfill include basic facilities, supporting facilities, and environmental protection that function well. However, the number of officers at this landfill is still limited, namely 18 people, and there are no officers for methane gas management, wastewater/leachate management, and B3 waste. The existence of these technicians is very important for optimal management according to the 2008 NSPM of the Department of Public Works.

Recent studies have shown that the application of innovative management technologies, such as waste-to-energy conversion and the use of waste banks, can significantly improve the effectiveness of waste management in densely populated areas in Indonesia (Lesman et al., 2021). However, there is still a gap in understanding the effectiveness of implementing waste management systems in certain locations, such as the Banjarsari landfill in Bojonegoro Regency, especially related to challenges in managing methane gas and limited human resources. With the background of the problems that have been explained, this study aims to activate the final storage of waste at the Banjarsari landfill, Bojonegoro Regency in 2024. The results of this study are expected to provide suggestions for improving the waste management system to be more efficient and sustainable in the future.

## RESEARCH METHODS

This type of research uses descriptive evaluative with an observational approach. The subjects of this study were the head of the waste division of the Bojonegoro Regency Environmental Service and the manager of the Banjarsari landfill. The variables studied were the generation of waste, landfill facilities and infrastructure, and final waste processing.

The method of data collection was interviews, observations, and measurements to measure the weight of the waste. The research instrument used interview sheets and observation sheets. Data analysis techniques are presented in the form of graphs, diagrams, or tables to make it easy to understand the characteristics of the data which are ultimately used as evaluation material for final waste processing.

## RESULT AND DISCUSSION

Based on the results of the calculation of waste generation at the Banjarsari landfill, the following results were obtained:

**Table 1**
Waste at Banjarsari Landfill

| No | Day | Date | Heavy (ton) |
|---|---|---|---|
| 1. | Monday | 20th May 2024 | 69.76 |
| 2. | Tuesday | 21st May 2024 | 60.15 |
| 3. | Wednesday | 22th May 2024 | 59.92 |
| 4. | Thursday | 23rd May 2024 | 50.31 |
| 5. | Friday | 24 th May 2024 | 49.94 |
| 6. | Saturday | 25 th May 2024 | 58.20 |
| 7. | Sunday | 26 th May 2024 | 41.76 |
| **Total** | | | **390.04** |
| **Average** | | | **55.72** |

From Table 1, the total generation was 390.04 tons for 7 days with an average of 55.72% per day. Waste generation at the Banjarsari landfill is included in the moderate category. Based on data from the Minister of Environment, (2022) the average waste generation at Indonesian landfill is 60 tons per day. Based on research by Utami and Rosariawari, (2022) the volume of waste from residents in Bondowoso district produces 42 tons/day. The dominant composition of waste is food waste, which is 70%. The condition of the Paguan landfill is concerning because the available empty land can no longer be used as a landfill.

Jatibarang landfill is the largest landfill in Central Java which can accommodate 800-900 tons of waste per day. The composition of waste entering Jatibarang landfill is 62% organic waste and 38% inorganic waste. Food waste occupies the top position for waste in Jatibarang landfill with a

volume reaching 48%. Jatibarang landfill implements recycling and composting activities in waste reduction (Harjanti and Anggraini, 2020). In a study conducted by Detiar et al., (2023) at Ciangur landfill, from a population of 716,155 people, 324.4 tons of waste/day were produced and it was recorded that 222.2 tons/day entered the landfill. The highest waste composition was food waste which reached 48%.

Strategies that can be used to reduce waste generation through waste recycling activities. From the research of Otivriyanti et al., (2023) the total waste generation in Toba Regency in 2022 was 32,794 tons/day with a reduction rate of around 0.94%. The reduction activity is recycling, from recycling activities, the amount of waste that can be managed reaches 0.82 tons/day and the proportion of recycled waste (paper, plastic, glass, and metal) is 32.25%.

Overall, waste reduction strategies through recycling and composting need to be improved and added. The government and the community must work together to improve waste separation at the source, improve the management system at the landfill, and educate the public about the importance of waste reduction. With these steps, it is hoped that the amount of waste entering the landfill can be reduced to eliminate negative impacts on the environment and then advance the standard of living of the community.

**Table 2**
Frequency Distribution of Facilities and Infrastructure of Banjarsari Landfill in 2024

| Category | Frequency | Percentage |
|---|---|---|
| Good | 12 | 80 |
| Sufficient | 3 | 20 |
| Less | 2 | 10 |
| **Total** | 15 | 100 |

Based on Table 2, the facilities and infrastructure at the Banjarsari landfill are 80% considered good. The facilities and infrastructure function as maintenance in waste management, namely in the final maintenance of waste. The facilities and infrastructure consist of basic facilities, supporting facilities, environmental protection facilities, and operational facilities.

Basic facilities consist of access roads, operational roads, supporting buildings, drainage, fences, and nameplates. The condition of the access road at the Banjarsari landfill is in the form of paving in good condition and well maintained. On the operational road, the waste disposal is temporary which can be filled with waste at any time and the connecting road between facilities at the landfill is permanent in the form of paving. The Banjarsari landfill has a vehicle washing area and bathrooms as supporting buildings. Drainage at the Banjarsari landfill has drainage inside and outside the landfill which functions to reduce the discharge of rainwater that falls in the waste disposal area. The Banjarsari landfill has been surrounded by a fence in the form of a wire fence or wall, but in the northern part, there is no fence yet. In addition, in front of the Banjarsari landfill, a sign has been installed containing the name of the landfill, the landfill manager, and the landfill address.

Banjarsari landfill has various supporting facilities that function well. A weighbridge that can withstand loads of up to 25 tons and is used to record the weight of incoming waste, thus supporting efficiency and precision in waste data collection. Clean water used for various activities at Banjarsari landfill is obtained from PDAM with adequate quality and quantity. Banjarsari landfill has been equipped with a 300 $m^2$ workshop and a 460 $m^2$ garage which is used for maintenance of heavy equipment and waste collection equipment. For fire extinguishing facilities, Banjarsari landfill is still limited, only having 1 APAR.

Banjarsari landfill also has waste reduction facilities in the form of recycling and composting. For inorganic waste, recycling is carried out, namely processing plastic waste into fuel. One of the new steps in handling waste is to convert plastic into fuel oil. This step will reduce greenhouse gas emissions and reduce waste carried to the landfill (Aisyah, 2022). The first processing process is that the raw material for plastic waste is cleaned and shredded, then put into the reactor. In the reactor, the heating process is carried out with a furnace, the fuel oil from the processing will be stored in a storage tank and if needed will be taken as needed. Organic waste is reduced by composting. The organic waste used in the composting process comes from sweeping and cutting down trees on the streets of Bojonegoro district. The composting process is carried out using an aerobic system with the open window method. The open windrow method is one of the composting methods that utilizes natural oxygen without using a composter (Rani et al., 2020). The finished compost is then packaged with a weight of 5 kg/package which will be used for city parks and nursery activities.

Banjarsari landfill uses a ground liner coated with a geomembrane so that the base layer is airtight and leachate does not seep into the ground so as not to pollute groundwater. Banjarsari landfill has a leachate collection channel installed lengthwise in the middle of the storage zone to accommodate leachate that builds up from the base of the landfill and seeps into the groundwater below. Banjarsari landfill has vertical and horizontal pipes. The horizontal gas pipe is connected to the leachate collection pipe, in addition, it is used for the gas capture system. The Banjarsari landfill

test/monitoring well is located near the Leachate Treatment Installation (IPL) pond located around the landfill, which only has 2 units and is located close together.

Ideal waste management is supported by the availability of proper heavy equipment. At Banjarsari landfill, 1 heavy equipment is in a damaged condition, namely a bulldozer, so there are only 2 excavators that can be used. This condition can be said to be still inadequate. According to Islami, et al., (2023), the allocation of heavy equipment at the Lempeni landfill can be said to be inadequate because there are only 2 bulldozers and excavators, the availability of heavy equipment at the Lempeni landfill which is still lacking can result in inefficiency in the process of compacting waste and moving waste at the Lempeni landfill. The Samarinda landfill in 2011 consisted of 7 units consisting of 4 Bulldozers, 1 Backhoe, 1 Dumptruck, and 1 Roller with 4,411 $m^3$ of waste per day using the sanitary landfill system. The number of heavy equipment expected later in waste management with the sanitary landfill method can run optimally. (Islami and Moelyaningrum, 2023). This target cannot be achieved with all types of heavy equipment. For this reason, knowledge is needed about the determination and application of heavy equipment and its maintenance techniques to ensure that the heavy equipment is in working conditions and can be produced in large quantities with inexpensive funds. Understanding the technical specifications and production capacity of heavy equipment is very important before choosing the type of heavy equipment to be used.

**Table 3**

Human Resources of Banjarsari Landfill in 2024

| No | Position | Total | Education |
|---|---|---|---|
| 1. | Coordinator | 1 | Elementary school |
| 2. | Weighing | 2 | High school |
| 3. | Heavy Equipment | 3 | High school |
| 4. | Compost | 3 | High school |
| 5. | Security | 3 | High school |
| 6. | Cleaning | 3 | Elementary school |
| 7. | TPS Manager | 1 | Junior high school |
| 8. | Night guard | 2 | Junior high school |
| | **Total** | 18 | |

Based on the results of research on human resources, it has been shown that they have met the requirements. The number of waste management officers at the landfill depends on the needs, conditions of facilities and infrastructure, and the size of the reach and quality of service. Each manager is expected to be able to manage 3-4 tons of waste per day, from the average waste entering the Banjarsari landfill, there are 14-19 officers.

In the study of R. Dadan et al., (2022) Waste generation in Purwakarta Regency is 2,118 tons/day. This amount is the amount of waste disposed of at the Cikolotok landfill, Purwakarta Regency. For waste management resources at the Cikolotok landfill, there are 17 people consisting of 5 heavy equipment drivers, 4 compost officers, 5 guards, and 2 administration officers, but there are no methane gas management officers, leachate, and B3 waste managers.

The Banjarsari landfill does not yet have officers for methane gas, leachate, and B3 TPS, there are no special officers in that section so officers in other sections handle that section. The number of officers certainly requires more than 2 people, so a minimum of 3 officers are needed, namely methane gas officers, wastewater officers, and B3 waste officers (R. Dadan, 2022).

Based on the results of interviews regarding the level of education of landfill managers, it was found that the average level of education of Banjarsari landfill management officers is high school, but some have elementary and junior high school education. Officers who have an elementary school education level are 17%, officers with a junior high school education level are 22% and officers who have a high school/vocational school education level are 61%. The Banjarsari landfill coordinator has an elementary school education level based on the Regulation of the Minister of Public Works of the Republic of Indonesia Number 03/PRT/M/2013 concerning the qualifications for the head of landfill, namely S1.

According to research conducted by Ummi Fadlilah Kurniawati and Vivin Setiani in 2021 with the title Analysis of understanding of Community Waste Management at the Surabaya Main Waste Bank (BSIS) through Transfer Knowledge, states that the level of education influences a better understanding of waste management. Based on research conducted by Anisa in 2021 with the title Relationship between Education Level, Knowledge, Knowledge and Attitude with Medical Waste Management Actions at Hadji Boejasin Pelaihari Hospital, the level of education has a relationship that is quite influential in influencing the behavior of officers in waste management, the higher the level of education, the higher the behavior of officers in handling waste and vice versa. One of the efforts that can be made to develop the knowledge of landfill officers is by providing training and counseling to officers as a means of providing educational knowledge based on the field of work being carried out.

**Table 4**
Evaluation of Final Waste Processing at Banjarsari Landfill in 2024

| No. | Variable | Yes | No |
|---|---|---|---|
| 1. | Waste Recording | 7 | 1 |
| 2. | Waste Compacting | 6 | 1 |
| 3. | Land Covering | 4 | 3 |
| 4. | Leachate Handling | 8 | 0 |
| 5. | Gas Hadling | 6 | 1 |
| | **Total** | 32 | 6 |
| | **Persentase(%)** | 83,78 | 16,22 |
| | **Category** | Good | |

Waste recording at the Banjarsari landfill is carried out when the waste transport vehicle enters the landfill area, which is carried out by the weighbridge officer. The composition of the recording includes the vehicle police number or vehicle code, time of entry, empty vehicle weight, total weight (including waste), origin of waste, type of waste composition, and time of exit. In the study of Noor Asegaf et al., (2021), the Cahaya Kencana landfill recorded data on waste entering the landfill by recording the amount of waste based on the weighing results written in a notebook and the data was processed using the Ms. Excel application by creating a simple column table. Recording activities are carried out repeatedly every day. The Cahaya Kencana landfill will create a website-based information system, which can speed up employees in recording the volume of waste entering the landfill. With this application, it can make it easier to create and search more practically and accurately.

Waste recording at the Banjarsari landfill has used electronic recording, which is done using a computer. Based on the results of field observations, recording is done manually because the computer that does electronic recording experiences feelings. Electronic waste recording is considered more effective than manual. According to Thania, (2023) Manual recording makes it difficult to search for detailed waste weight data for a long period of time as a report document for analysis materials in improving landfill performance. Efforts to overcome the above problems are to immediately repair damaged computers so that electronic recording can run again. Routine maintenance also needs to be carried out to prevent future damage. landfill managers must ensure that there is a data backup system to prevent loss of important data. Data recorded electronically must be backed up periodically to an external storage device.

Waste compaction at the Banjarsari landfill is carried out every day with a compaction percentage of up to 37.5% using 3 heavy equipment. Compaction is carried out layer by layer with a thickness of each layer of 60 cm-1 m. Waste compaction carried out at the Banjarsari landfill has a ratio of 2:3. The waste compaction process takes place with an excavator, namely by pounding. Waste compaction takes place in a longitudinal direction on the solid plane. Waste compaction with heavy equipment is carried out to maximize land use and ensure surface stability. Compaction is carried out by rolling the excavator back and forth 6 times. Based on PerMen PUPR number 03/PRT/M/2013, waste compaction is carried out using heavy equipment to obtain a waste pile with a minimum density of 600 kg/m$^3$ and a maximum slope of the waste pile of 30$^o$.

The Banjarsari landfill uses a type of soil that is not watertight to cover the waste. The specifications of the soil used in the land covering process are soil that has the ability to stop rain and air seepage so that it can reduce the occurrence of leachate. The cover soil used has low permeability due to reducing the speed of rainwater infiltration, thus reducing direct contact between waste and rainwater which can produce leachate. Soil permeability is a basic factor in determining the balance of materials in landfill cover. Permeability depends on several variables including grain size, porosity, shape and arrangement of soil pores, fiber saturation degree (Oktaviana et al., 2018). Garbage burying with soil aims to shorten the waste disposal process and reduce the stench of waste at the sanitation landfill site. In addition, it functions to hold the methane gas content in the pile of waste. So the suggestion that can be given is to increase the frequency of daily soil covering to more often if possible because daily covering with a thickness that is very important to control the negative impacts of waste piles. And use cover soil with the right specifications and good quality to withstand rainwater infiltration.

Leachate can describe liquid waste formed as a result of air entering the pile of garbage so that it can destroy the chemical elements and organic materials resulting from the communication of garbage (Fadhila and Purnama, 2022). Leachate processing at the Banjarsari landfill is carried out by combining physical, chemical and biological. Physical processing aims to reduce the content of solids both suspended and dissolved in leachate. Chemical processing aims to reduce the content of ions in leachate and for the coagulation and flocculation process to reduce the content of suspended solids. Biological processing generally involves a combination of anaerobic and aerobic processing which aims to decompose the organic content in leachate.

Based on AngladaI et al., (2011) in Yani's research, (2019) physical and chemical processing processes can produce a fairly good level of pollutant reduction, but require relatively expensive funds and in the biological processing

process, it requires relatively cheap costs but runs for a fairly long duration because leachate contains components that are difficult to degrade biologically and even contain components that are toxic to microorganisms.

Banjarsari landfill has a leachate treatment plant designed to process leachate produced from waste decomposition. The purpose of the leachate treatment plant is to measure the intensity of leachate pollutants to meet the specified quality standards. Leachate contains pollutants that can have an impact on environmental pollution, namely soil and air pollution. The leachate treatment process must pay attention to the rate and characteristics of leachate, as well as water bodies as the final disposal site for leachate (Islami, et al., 2023).

Based on research conducted by Elvania (2022) entitled "Analysis of leachate quality and its potential distribution in the Banjarsari landfill environment, Bojonegoro Regency", the results showed that the average pH concentration was 7.55, for the organic material content in Banjarsari landfill leachate for the BOD parameter = 91.5 mg / L; KOD = 264.5 mg / L; TSS = 83 mg / L. Based on these results, it has met the quality standards set by the government in the regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number 59 of 2016 concerning Leachate Quality Standards for Businesses and/or Activities of Final Waste Processing Sites.

Methane gas is one of the problems caused by waste disposal that can have an impact on human health and the environment. Waste that has not been properly resolved will accumulate in the final storage site which will cause problems, one of which is methane gas. The increase in waste production sent to the Landfill is related to an increase in methane gas emissions. Methane gas can be produced from the process of clogging organic waste that occurs in the landfill. According to Nurjaya, et al., (2023) Methane gas is one of the gases that has a higher global warming potential than carbon dioxide. Methane gas is a substance contained in greenhouse gases that causes an increase in temperature on the earth's surface.

The increase in gas production from landfills, especially methane gas (CH4), can provide benefits to landfill managers, and methane gas is a renewable energy source. Based on observations at the Banjarsari landfill, a perforated pipe system has been used for gas handling by utilizing methane gas for cooking activities around the landfill area. At the Banjarsari landfill, methane gas is processed into cooking fuel or as a substitute for LPG which will be distributed to residents around the landfill.

Based on research by Harjanti, et al., (2020), the utilization of methane gas (CH4) is carried out by inserting a pipe into the landfill with a depth of about 5 meters, then the results of the methane gas suction are channeled to residents' homes. The methane gas can be used for cooking as a substitute for LPG cylinder gas. From this process, 72 $m^3$ of methane gas can be distributed from the landfill waste pile, and can be distributed to up to 100 residents' homes. In addition to being used as cooking fuel, methane gas can be used as a power plant. Based on research by Abdullah et al., (2020) entitled Potential Methane Gas Content as Alternative Energy at the Kebon Kongok landfill, it was found that the potential for methane gas from the Kebon Kongok landfill in 2021 was utilized for power generation with a capacity of 1.66 Megawatts so that the Kebon Kongok landfill has the potential to be converted into a methane gas-fueled power plant.

## CONCLUSION

Based on the evaluation research of final waste processing at the Banjarsari landfill in 2024, it can be concluded that waste management at the location still faces a number of challenges. Although various efforts have been made to improve the efficiency and effectiveness of final processing, there are still problems such as limited infrastructure, lack of public awareness, and challenges in human resource management. Therefore, further efforts and collaboration between related parties are needed to achieve better and more sustainable waste management.

## SUGGESTIONS

For the Environmental Service, it is recommended to create a periodic control and repair schedule, namely once every 6 months for facilities and infrastructure, and provide training related to the technical operations of final waste processing.

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