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ORIGINAL ARTICLE

# EVALUATION OF THE EFFICIENCY OF WASTE SORTING BY WASTE PICKERS AT THE FINAL PROCESSING SITE TPA SARI MUKTI

**Sri Murda Niati[1] • Idha Silviyati[1] • Endang Supraptiah[1] • Gemala Cahya[2]**

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**Abstract** At the Sari Mukti Landfill, the reduction in the volume of waste entering the final processing is achieved through landfill management, composting, and sorting. The sorting that has been carried out so far is done by scavengers. Based on data and studies conducted at the landfill, it was concluded that the sorting efficiency, on average, between January and February is 0.81%. This efficiency of 0.81% was obtained from sorting in 5% of zones B and C, with a total of 385 scavengers. If we apply the same efficiency to 100% of the area, the number of scavengers required would be 7,700. However, the results of the study do not recommend increasing the number of scavengers. Instead, it is recommended to sort waste at the source. With the sorting mechanisms outlined in the discussion, it is hoped that only a small portion of organic waste will enter the landfill.

**Keywords**: Waste Sorting · Scavenger · Efficiency · Sari mukti landfill

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✉ Sri Murda Niati
sri.murda.niati@polsri.ac.id

[1]Department of Chemical Engineering, Sriwijaya State Polytechnic, Indonesia.

[2]Department of Food Technology, Sriwijaya State Polytechnic, Indonesia.

## Introduction

Waste is the byproduct of human activities, encompassing both solid and semi-solid materials, consisting of organic and inorganic substances that are no longer deemed useful. Despite this, these materials can potentially be reutilized through recycling processes and must be managed effectively to mitigate environmental harm (SNI T-19-2454-2002). As an inevitable consequence of human activities, the generation of waste continues to increase. The rapid advancement of technology, rising living standards, and expanding human activities contribute to the growing volume of waste, particularly inorganic waste. To address this, strategies aimed at minimizing waste accumulation, such as the implementation of the 3Rs—reduction, reuse, and recycling—are essential. These strategies are critical for waste management, with the objective of decreasing the volume of waste entering final disposal processes, thereby reducing the strain on landfills. This study on waste sorting was conducted at the Sari Mukti Landfill to evaluate the effectiveness of such management practices (Zakaria, 2008).

According to the Law on Waste Management (Law No. 18 of 2008), the primary objectives of waste management are to enhance public health, improve environmental quality, and transform waste into a valuable resource. The scope of waste management encompasses the principles of reduction, reuse, and recycling, which are achieved through various handling processes, including sorting, collection, transportation, processing, and final disposal. Additionally, the government provides incentives and support to individuals and organizations that

contribute to waste reduction efforts (Government of Indonesia, 2008).

According to the Republic of Indonesia Law (2009) No. 32 concerning Environmental Protection and Management, Chapter 1, General Provisions, Article 1 defines hazardous and toxic waste, hereafter referred to as B3 waste, as the residual material from a business and/or activity that contains B3 substances. The management of B3 waste encompasses activities such as reduction, storage, collection, transportation, utilization, processing, and/or disposal in landfills.

The 2010 Regulation of the Minister of Home Affairs of the Republic of Indonesia states that waste sorting is to be carried out by classifying household waste according to its type. Waste sorting involves providing separate bins for organic and inorganic waste at every household, residential area, commercial area, industrial zone, special area, public facilities, social facilities, and other establishments (Wen et al., 2023). Collection, as intended, is carried out from the moment the waste is transferred from the household waste bin to the TPS/TPST (Temporary Waste Collection Site) and then to the TPA (Final Disposal Site), ensuring that the waste is sorted according to its type. According to Saputra (2021), the feasibility of developing the Sarimukti TPA for implementing a Waste Industrial Zone, based on a financial feasibility analysis, is viable. This is evidenced by the positive NPV value, Net B/C ratio greater than 1, and an IRR higher than the applicable interest rate of 5.25%. Additionally, the return on investment (Payback Period/PP) is shorter than the project life, at 3 years and 7 months. The 3R (Reduce, Reuse, Recycle) approach is beneficial in waste management as it aims to reduce the volume of waste entering the final processing phase, thereby prolonging the lifespan of the landfill. Waste sorting is implemented at the Sari Mukti Landfill, which serves as a disposal site for waste from Cimahi City (Hardiana, 2023), Bandung Regency, and West Bandung Regency. Originally, the Sari Mukti Landfill was established as an emergency response site following the landslide at the Leuwigajah Landfill. It has been in use since May 28, 2006. The landfill, located in Sarimukti Village, Cipatat District, Bandung Regency, was designated as one of the Final Waste Processing Sites (TPSA) serving the areas of Bandung City, Cimahi City, and West Bandung Regency due to the Leuwigajah Waste Landfill disaster (Adrikni, et al. 2023).Waste Management includes Waste reduction and Waste handling. Waste Reduction is carried out through Waste reuse activities, Waste Handling is carried out through Waste sorting activities Waste collection; and/or waste processing (Regulation of the Minister of Environment and Forestry, 2021). According to the Regulation of the Minister of Public Works and Public Housing Number 03/PRT/M/2013 of 2013 concerning the Implementation of Waste Infrastructure and Facilities in the Handling of Household Waste and Household Waste, for landfill management, the sanitary landfill method is recommended to be applied in big cities and metropolises so as not to cause negative and safe impacts on humans and the surrounding environment.

At the Sari Mukti Landfill, strategies to reduce the volume of waste entering the final disposal phase involve the control of landfill operations, composting, and waste sorting. Waste sorting is primarily conducted by scavengers. As of now, there has been no documented research on the specific role of scavengers in sorting recyclable waste at this landfill. Therefore, this study aims to investigate the extent to which scavengers contribute to the sorting of recyclable materials. This case study focuses exclusively on the waste sorting practices carried out by scavengers, a subject that has not been previously reported in the context of this landfill

## Materials and Methods

The method employed in this study is a qualitative approach. According to Hardani et al. (2020), qualitative research emphasizes the processes and meanings that are not rigorously studied or quantitatively measured. It focuses on understanding socially constructed realities, the close relationship between the researcher and the subjects, the contextual pressures that shape the investigation, and the inherent value-laden nature of the research. This approach highlights how social experiences emerge and how meaning is acquired through these experiences.

The research employs both primary and secondary data, collected in the field and guided

by literature reviews and theoretical frameworks. The first step in the process is to assess the current conditions of the study area. Next, the efficiency of waste sorting practices at the landfill site is evaluated, followed by drawing conclusions and proposing potential solutions.

Data collection is conducted through direct field observations, including interviews with relevant authorities on waste management issues, as well as direct interviews with scavenger leaders, waste dealers, and other stakeholders. Additionally, a review of existing literature and theoretical foundations related to the research topic is undertaken. The goal is to produce actionable recommendations that can contribute to the improvement of the 3R (Reduce, Reuse, Recycle) waste management system by scavengers in Bandung, both in the present and for future implementation.

Primary data was collected on several key factors, including the current conditions of the landfill and the waste management methods in place, the volume of waste processed by trucks per day, the number of scavengers, the health status of the scavengers, the types of waste sorted, the time required by scavengers to sort trucked waste, the average daily income of scavengers from sorting activities, and the lifestyle of the scavengers. Secondary data was obtained from relevant institutions, particularly the West Java Waste Management Headquarters. This data included information on the volume of waste piles, the organizational structure of the Sari Mukti operational management unit (UPO) to assess sections related to scavengers, operational processing data, the number of operational staff, and other relevant supporting data.

## Results and Discussion

### Evaluation of Waste Sorting Efficiency at Sari Mukti Landfill

According to Ilman (2024), the amount of waste disposed of at the Sari Mukti TPA exceeds 300 tons per truck delivery, while the ideal amount should be only 215 tons per day. This target aligns with the West Java Provincial Government's goal for the management of the Sari Mukti TPA in 2024. However, the average waste disposed of at the Sari Mukti landfill continues to exceed the set limit of 1,000 tons per day, with records showing 1,750 tons per day up until October 2024. To assess the efficiency of waste sorting at the landfill, the efficiency percentage is calculated. This percentage is derived by comparing the volume of incoming waste, subtracting the volume of waste after sorting, and then dividing by the total volume of incoming waste, multiplied by 100%. Once the sorting efficiency percentage is obtained, conclusions can be drawn, with the efficiency process being evaluated monthly. The sources and volume of waste entering the Sari Mukti TPA are shown in Table 1.

According to Damanhuri (2012), the waste management practices in Indonesia are as follows: 68.86% of waste is managed through landfilling, 7.19% through composting, 4.79% by open burning, 2.99% is dumped into rivers, 6.59% is handled by small-scale incinerators, and 9.58% is managed through non-landfilling methods. From Table 2, it can be observed that the waste most frequently sorted is plastic cracker waste, totaling 160,300 kg, followed by double box paper at 17,245 kg, PE plastic at 33,900 kg, and the least sorted being iron/metal waste at 220 kg. The volume of sorted waste can vary each month depending on the incoming waste types and conditions. Paper waste is divided into two categories: paper for books and duplicate paper/boxes. Book paper is generally not sorted, as waste books entering the landfill are typically destroyed. In addition to these waste types, other materials, such as money, gold, and perfume bottles, are also frequently found and sorted. Notably, large quantities of both domestic and foreign currency are often discovered in landfills. The cumulative results of the sorting efficiency at the Sari Mukti TPA are presented in Table 3.

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**Tabe 1.** The volume of waste entering the Sari Mukti Landfill

| No. | Volume ($m^3$) | | | | | |
|---|---|---|---|---|---|---|
| | Bandung | Induk Caringin Market | Cimahi City | Bandung Regency | West Bandung Regency | Total per month |
| 1 | 77.942 | 2.128 | 4.889 | - | 2.019 | 86.978 |
| 2 | 71.931 | 2.664 | 5.100 | - | 1.921 | 81.616 |
| 3 | 80.432 | 2.546 | 5.764 | - | 2.095 | 90.837 |
| 4 | 80.102 | 2.564 | 5.580 | - | 2.134 | 90.380 |
| 5 | 80.321 | 2.350 | 5.425 | 42 | 2.004 | 90.142 |
| 6 | 76.339 | 2.340 | 5.364 | - | 1.686 | 85.729 |
| 7 | 76.376 | 2.304 | 5.448 | - | 1.682 | 85.810 |
| 8 | 75.652 | 2.136 | 5.359 | - | 1.718 | 84.865 |
| 9 | 75.182 | 2.314 | 5.712 | - | 1.790 | 84.998 |
| 10 | 62.314 | 1.856 | 5.264 | - | 1.940 | 71.374 |
| 11 | 49.806 | 2.082 | 5.728 | - | 1.945 | 59.561 |
| 12 | 52.742 | 2.350 | 5.993 | - | 1.963 | 63.048 |
| 13 | 54.072 | 2.468 | 6.134 | - | 2.296 | 64.970 |
| 14 | 49.595 | 2.100 | 5.799 | - | 1.830 | 59.324 |
| Σ | 962.806 | 32.202 | 77.559 | 42 | 27.023 | 1.099.632 |

**Table 2.** Potential for Inorganic Waste Sorting at Sari Mukti Landfill

| No | Types of Waste | Volume (kg) |
|---|---|---|
| 1 | Plastic Cracker | 160.300 |
| 2 | PE Plastic | 33.900 |
| 3 | Buckets/Aqua glasses and bottles | 11.295 |
| 4 | Glasses, bottles, and glasses | 16.050 |
| 5 | Tin | 3.370 |
| 6 | Iron/Metal | 220 |
| 7 | Aluminum | 321 |
| 8 | Paper | |
| | a. Double/Box | 17.245 |
| | b. Plain Paper | |
| 9 | Rubber | |
| | a. Used Tires | 840 |
| | b. Bare | 6.450 |
| | Sum | 249.991 |

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**Table 3.** Results of the cumulative calculation of election efficiency at the Sari Mukti Landfill

| No. | Total waste/month (m3) | Bj (Kg/m3) | Waste entering the landfill (kg) | Sorted garbage (Kg) | Waste after sorting (Kg) | Efficiency (%) |
|---|---|---|---|---|---|---|
| 1 | 86.988 | 400 | 34.795.200 | 249.991 | 34.545.209 | 0,72 |
| 2 | 81.616 | 400 | 32.646.400 | 249.991 | 32.396.409 | 0,77 |
| 3 | 90.837 | 400 | 36.334.800 | 249.991 | 36.084.809 | 0,69 |
| 4 | 90.380 | 400 | 36.152.000 | 249.991 | 35.902.009 | 0,69 |
| 5 | 90.142 | 400 | 36.056.800 | 249.991 | 35.806.809 | 0,69 |
| 6 | 85.729 | 400 | 34.291.600 | 249.991 | 34.041.609 | 0,73 |
| 7 | 85.810 | 400 | 34.324.000 | 249.991 | 34.074.009 | 0,73 |
| 8 | 84.465 | 400 | 33.786.000 | 249.991 | 33.536.009 | 0,74 |
| 9 | 84.818 | 400 | 33.927.200 | 249.991 | 33.677.209 | 0,74 |
| 10 | 71.374 | 400 | 28.549.600 | 249.991 | 28.299.609 | 0,88 |
| 11 | 59.561 | 400 | 23.824.400 | 249.991 | 23.574.409 | 1,05 |
| 12 | 63.048 | 400 | 25.219.200 | 249.991 | 24.969.209 | 0,99 |
| 13 | 64.970 | 400 | 25.988.000 | 249.991 | 25.738.009 | 0,96 |
| 14 | 59.324 | 400 | 25.988.000 | 249.991 | 25.738.009 | 0,96 |
| Σ | 1.099.062 | 5.600 | 441.883.200 | 3.499.874 | 438.383.326 | 11,34 |
| Average | 78.504 | 400 | 31.563.086 | 249.991 | 31.313.095 | 0,81 |

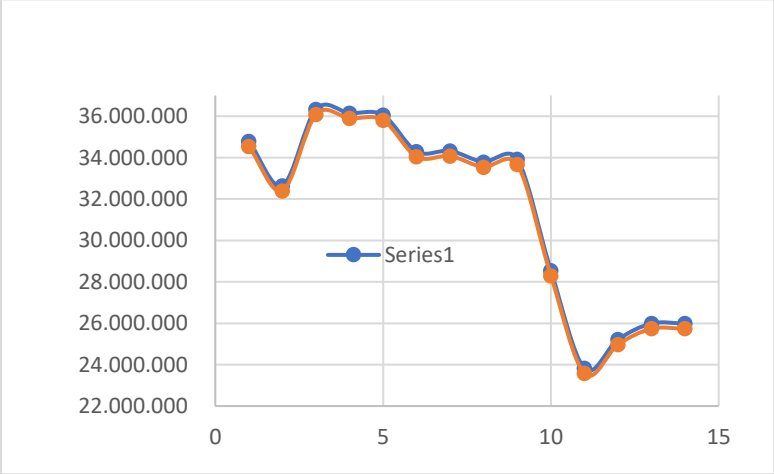



**Figure 1.** Grapp of Waste Efficiency at Sari Mukti Landfill

From the efficiency graph, it was observed that the highest sorting efficiency occurred in month 11, at 1.05%, while the lowest was recorded in months 3, 4, and 5, at 0.69%. This data reveals significant variation in sorting efficiency, with the average efficiency being 0.81%. This efficiency was achieved with a sorting area covering 5% of Zones B and C, involving a total of 385 scavengers. If this efficiency rate is applied to 100% of the area, the required number of scavengers would be 7,700. Therefore, an additional 7,315 scavengers would be needed to achieve full sorting coverage for Zones B and C at the Sari Mukti Landfill. However, the sorting efficiency of 0.81% is still very low, with a positive impact of less than 1%. In other words, it is not efficient. To achieve 100% sorting efficiency, the number of scavengers would need

to be increased drastically, which is not feasible given the current conditions of the landfill. Additionally, the negative impacts caused by increasing the number of scavengers make this approach ineffective. Therefore, it is not recommended to increase the number of scavengers. Instead, it is recommended to focus on sorting waste at the source. Given the large number of scavengers required for 100% sorting efficiency, and the unsustainable conditions at the landfill, it can be concluded that the current system of scavenger-led sorting at the Sari Mukti Landfill is ineffective and inefficient.

**Characteristics of Scavengers at the Sari Mukti Landfill**

According to Diskominfo Bandung (2024), the Bandung City Government (Pemkot) is intensifying efforts to address the growing waste crisis, particularly considering the critical condition of the Sarimukti TPA. This final waste disposal site is expected to remain operational only until March 2025. In response, the Regional Secretary (Sekda) of West Java Province, along with regional heads in the Greater Bandung area, has agreed to reduce the number of waste transportation routes from Bandung City to the Sarimukti TPA. The target is to decrease the daily number of waste transport trips from 172 to 140, starting December 1, 2024. To support this, a Waste Reduction Action Plan has been developed, which includes concrete steps to optimize waste processing facilities at the sub-district and TPS levels. Data on the characteristics of scavengers at the Sari Mukti TPA can be found in Table 4.

**Table 4.** Characteristics of scavengers at Sari Mukti TPA

| No. | Characteristics | Description |
|---|---|---|
| 1 | Tools and receptacle | The scavengers do not use tools to collect their scavenging The container used to collect waste is in the form of a sack Jute |
| 2 | Work pattern | a. Body armor; scavengers do not use body armor, The body protection used is very simple (shoes, hat, and socks) that meet the requirements for protection and provide security and comfort against the threat of interference health<br>b. Working hours; Garbage operational working hours start from 05.00 morning until 05.00 in the afternoon when the garbage trucks are collected starting to go to landfill<br>c. Many small children took part in the scavenging process |
| 3 | Accident Work | a. Work accidents often occur, caused during work Scavenging does not use gloves and shoes<br>b. Wrong work procedures where scavengers should not be allowed entered the operation area, but the Sari Mukti TPA was located in the operating area making it prone to accidents<br>c. Distance between scavengers working at the landfill site and the compactor so close that there have been several accidents that have been run over by equipment trucks |
| 4 | Place of residence | Most (98%) of scavengers live in other landfills live around the landfill and return to their respective homes after finished work |
| 5 | Habit daily scavenger | At night the scavengers do not have access to electricity, they often drink hard in residential areas in the landfill area |
| 6 | Sanitation | For scavengers who live in the landfill use cleaning facilities<br>What is available is a place for washing toilets (MCK) and a water source comes from the river |
| 7 | Habit pattern life Healthy | a. Eat; some scavengers cook themselves; others cook buy at the stall, besides being a scavenger in his daily life consuming leftover food found in landfill |

| | | |
|---|---|---|
| | | b. To clean themselves, scavengers shower only once and 2 times a day<br>c. Clothes; A small portion of scavengers in their daily lives have habits of changing clothes and differentiating rest clothes with work clothes while most work clothes and rest clothes are the same |
| 8 | Complaint disease | a. The illnesses that many scavengers complain about are headaches, stomach ache, itching, cough, backache, and aches.<br>b. Babies who live in landfill areas are very vulnerable to disease |
| 9 | Access service health | a. There is no special treatment by the Health Service towards scavengers, wives and children of scavengers as poor people need cheap and free services (free)<br>b. The remote location of the health center and the cost of transportation to the health center. This is the reason that treatment at the community health center is never used, therefore scavengers use more drugs roadside stall<br>c. Difficulty accessing health services due to low income and do not have the savings to pay for health services<br>d. There is no education about occupational health which causes problems. Scavenger knowledge about occupational health is also low |

Eating and drinking at the landfill are not the same as the food and beverage choices of ordinary people. Scavengers do not eat and drink as much as they want but in moderation, according to their abilities, and just enough to provide the energy needed to continue the scavenging process. When scavenging, if edible food is found, it is immediately eaten without being washed. If a scavenger finds vegetable waste or cooking ingredients such as chili peppers or onions, these are taken home for consumption. The scavengers' dwellings are inadequate, made from makeshift bamboo with plastic tarpaulins as the roof. There is no kitchen for cooking food, and no supply of clean water.

## Conclusion

The sorting efficiency carried out by scavengers at the Sari Mukti landfill is 0.81% for 5% of Zones B and C. Increasing the number of scavengers to improve sorting efficiency, based on the current criteria, has been deemed ineffective. The efficiency achieved is still very low, at just 0.81%, meaning it is not yet considered efficient.

## Compliance with ethical standards

### Conflict of interest

The authors declare that they have no conflict of interest.

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