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Journal of Evrimata: Engineering and Physics
Vol. 03, No. 01, June, 2025, p.01 – 06 e-ISSN: 3025-1265

Analysis of the Waste Management System at Tombro TPS Kelurahan Tunjungsekar, Lowokwaru - Malang – INDONESIA

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Article Information

Manuscript Received 2025-01-07
Manuscript Revised 2025-03-02
Manuscript Accepted 2025-03-11
Manuscript Online 2025-03-17

ABSTRACT

Currently, there is no adequate waste processing system based on the 3R principle (Reduce, Reuse, Recycle) at the Temporary Waste Collection Point (TPS Tombro), which essentially serves as the first waste collection site before it is transported further to the Final Disposal Site (TPA Supit Urang). Although there are sorting facilities, the inorganic waste here only relies on the activities of scavengers for sorting, and there is no organic waste processing. Each of these systems needs to be analyzed and integrated well so that the waste management system at TPS Tombro can operate effectively and efficiently. The infrastructure as well as facilities and infrastructure at TPS Tombro are basic aspects that are very important in supporting TPS operations. This research discusses the waste management system at TPS, which covers infrastructure and supporting facilities and infrastructure for TPS operations as well as the capacity of TPS in accommodating waste from the served area. Interviews, field observations, and observations are the methods used to obtain data. The identification results show that the criteria for facilities and infrastructure at TPS Tombro, a small portion of which have not yet been operationalized as they should be; nevertheless, TPS Tombro is still capable of accommodating waste from the served area so that there is no significant waste accumulation at TPS.

Keywords: Waste management system, infrastructure, supporting facilities and infrastructure, effectiveness and efficiency

1. INTRODUCTION

Waste Management System, Infrastructure, Supporting Facilities and Infrastructure, Effectiveness and Efficiency

Waste is one of the most common environmental problems. Residential areas have the highest levels of organic and inorganic waste [1]. It is estimated that 64 million tons of waste are generated in Indonesia every year. The Ministry of Environment and Forestry (KLHK) reports that organic waste constitutes the majority of the waste mixture. The next most abundant wastes are plastic, paper, and rubber. Glass, textiles, metals, and various other materials are examples of other wastes [2].

In urban areas, rapid population growth is accompanied by increased social and economic activities, which ultimately cause urban problems. The limited resources available to central and local governments to address these issues exacerbate the situation. This makes it difficult for local and district governments to create conditions that improve the quality of life for every resident. The increasing amount of waste is another problem caused by rapid urban population growth. Waste production is closely related to the daily needs of the population and the amount of goods they consume. Furthermore, the materials used by society have a significant impact on the type of waste generated. Therefore, waste management and community life are closely interconnected [3].

Environmental pollution, declining public health, and neglect of the economic potential of waste are just some of the negative impacts caused by the increasing amount of household waste that is not balanced with effective disposal techniques [4].

The waste management provisions in Law No. 18 of 2008 can also be implemented efficiently through waste management disposed of in landfills using the sanitary landfill technique (environmentally sound waste management) and the 3R principle (Reduce, Reuse, and Recycle).

The paradigm of dirty, smelly landfills and waste accumulation before being handled needs to be changed. Community habits that only view waste as something to be thrown away without considering its economic value need to be changed. Although serious, waste problems are often ignored, especially regarding their impact on the environment in residential areas. The practice of littering in certain areas without

Journal of Evrimata: Engineering and Physics
Vol. 03, No. 01, June, 2025, p.01 – 06 e-ISSN: 3025-1265

thinking about long-term impacts is a source of this waste accumulation, which endangers public health. This still frequently occurs in many residential environments. The lack of adequate infrastructure and facilities for waste disposal is one of the main causes of this behavior [5].

With the issuance of Presidential Regulation No. 97 of 2017 on Jakstranas, the Government of the Republic of Indonesia sets national goals. Strategies for waste reduction and management are outlined in the Presidential Regulation related to Jakstranas. The goal by 2025 is to reduce waste volume by 30% and recycle 70% of all waste. To reduce household waste, Indonesia uses the 3R technique, which stands for reduce, reuse, and recycle [6]. To improve the efficiency of waste reduction and management in the City of Malang, local governments are required by Malang City Regional Regulation No. 7 of 2021 on waste management to establish 3R waste collection points (TPS 3R) in every village or sub-district. In 2020, the Malang City Government began implementing the waste management plan for the 3R Waste Management System (TPS 3R).

Currently, there are only three TPS 3R in Malang City: one is under construction in Buring, while the others are located in Balearjosari, Bandungrejosari, and Merjosari [7].

The government must find the right methods to handle the 400 tons of waste generated in Malang City every day. The Malang City Government has undertaken several initiatives to address this issue, including the implementation of Regional Regulation No. 10 of 2010 on Waste Management [8].

The World Health Organization (WHO) defines waste as anything discarded, originating from human activities, and not occurring naturally [9]. Waste can also include anything that is no longer needed, sought, or used.

Waste is defined as residual material from daily human activities and/or natural processes. The following are categories of waste that need to be controlled: [10]

1. Domestic Waste

Waste generated from routine household tasks, excluding plastic and feces, is called domestic waste.

2. Waste Similar to Domestic Waste

Like household waste, this type of waste comes from business places, industrial sectors, specific areas, social institutions, government institutions, and other sources.

3. Hazardous and Toxic Waste (B3 Waste)

Due to its nature, concentration, and/or volume, this type of waste must be handled differently. B3 waste consists of:

a. Waste containing toxic and hazardous materials
b. Hazardous and toxic material waste
c. Natural disaster waste
d. Waste from construction or development projects
e. Waste generated periodically or that cannot be technically recycled.

There are various types of waste, including household, business, agricultural, market, livestock, plantation, and others [11].

There are two main categories of waste: inorganic and organic waste. Inorganic waste is waste that is difficult to decompose and takes a very long time to break down naturally, while organic waste is waste that can decompose organically, such as food scraps, leaves, paper, and agricultural by-products [12].

Waste collection sites are divided into several types based on function and waste management systems in those collection sites. The types of TPS are as follows:

a) Temporary Waste Collection Site (TPS)

This type of TPS is often interpreted as a waste collection location (Regular TPS), which functions as a temporary storage area for waste before being transported to the Final Disposal Site (TPA). Rules and regulations set by the government regulate the temporary storage process of general waste, especially domestic waste and similar waste, in TPS. Regional Regulations (Perda) and government regulations govern the waste disposal system management in these TPS. Government Regulation No. 18 of 2012 regulates the procedure for household waste disposal. Some important points related to TPS in this type of regulation include [13]:

1) Definition of TPS

TPS is a facility that functions to temporarily store waste before being transported to another location/TPA.

2) Responsible Party

Local government is responsible for providing and managing TPS.

3) Function of TPS

4) TPS functions as a temporary storage place, not a final processing site.

Reducing, reusing, and recycling waste are the three Rs that form the basis of the 3R concept, implemented through waste banks and waste processing facilities. Sorting, managing, and processing waste so that it can be recycled or reused is the main goal of activities in these processing facilities. This helps reduce the amount of waste dumped into the environment [14].

b) Integrated Waste Processing Site (TPST)

In addition to collecting, sorting, reusing, recycling, and processing waste up to the final stage, the Integrated

Journal of Evrimata: Engineering and Physics
Vol. 03, No. 01, June, 2025, p.01 – 06 e-ISSN: 3025-1265

Waste Processing Site (TPST), also known as the Material Recovery Facility (MRF), functions as a centralized operation center for waste separation and processing [15]. To make waste management more effective and sustainable, the main operations of TPST include further processing of waste that has been sorted at the source, separating and directly processing urban waste components, and improving the quality of recovered or recycled products.

TPST facilities are equipped with sorting rooms, waste processing installations, environmental pollution control, residue handling, supporting facilities, and buffer zones [16].

To identify the feasibility of supporting facilities and infrastructure for TPS operations, they must comply with the provisions and criteria of SNI 19-2454-2002 and also Minister of Public Works Regulation No. 03/PRT/M/2013 [17].

Criteria for Waste Collection Sites (TPS) according to SNI 19-2454-2002 and Minister of Public Works Regulation No. 03/PRT/M/2013 include nine criteria, covering aspects of location, capacity, and waste grouping facilities [18].

In analyzing the waste management system in Indonesia, it is based on the Indonesian National Standard (SNI) and regulated in related government regulations, including SNI-3242-2008, Minister of Environment and Forestry Regulation, and Law of the Republic of Indonesia No. 18/2008 [19].

An ideal waste management system must start with building basic infrastructure such as waste banks. Waste banks play an important role in facilitating waste sorting at the community level, simplifying the collection process of inorganic waste, and encouraging the community to view waste as an economic resource. In addition, waste banks can function as centers for the circular economy, where collected inorganic waste can be resold to collectors or further processed into economically valuable products [20].

Different colors on trash bins are used to separate various types of waste, such as organic and inorganic waste. One of the methods introduced is the 3R concept (Reduce, Reuse, and Recycle), which utilizes various types of trash bins. Organic trash bins are generally marked with green color and labels reading “organic.” This waste includes materials like leaves and food scraps. The presence of these organic trash bins greatly helps accelerate the composting process. Next, inorganic trash bins are marked with yellow color and labels reading “inorganic.” This type of waste involves materials like plastic, glasses, cans, and glass [21].

Waste transportation budget can reach 60% of total waste management expenses, thus becoming one of the waste management activities that affects the overall management burden [22].

2. RESEARCH SIGNIFICANCE

The analysis of the waste management system at the Tombro Temporary Waste Collection Site (TPS) in Kelurahan Tunjungsekar, Lowokwaru, Malang, Indonesia, holds significant relevance for several key reasons.

Firstly, effective waste management is crucial to addressing the growing environmental challenges caused by urbanization and population growth. The findings of this research contribute to understanding how the infrastructure and operational capacity of waste management systems, like those at TPS Tombro, impact the effectiveness and efficiency of waste collection, processing, and disposal. By analyzing the current infrastructure, waste sorting practices, and capacity of the site, this study offers insights into potential improvements for better waste handling practices, particularly for urban areas with similar waste management challenges.

Secondly, this research supports the integration of the 3R principle (Reduce, Reuse, Recycle) in local waste management policies. The findings could aid in optimizing TPS facilities to facilitate the recycling and reusing of waste, thus aligning with national and regional goals set by the Indonesian government for waste reduction and recycling. The analysis of existing waste handling systems in Malang will also contribute to the broader discourse on improving waste management strategies in Indonesia, where waste accumulation and pollution are becoming increasingly pressing issues.

Lastly, this research provides a baseline for future studies in the area of waste management, offering valuable data for policymakers, urban planners, and local governments. It emphasizes the importance of infrastructure readiness and operational efficiency in supporting the goals of sustainable urban waste management, making this research not only relevant for Malang but also for other rapidly urbanizing regions in Indonesia and beyond.

3. RESEARCH METHODS

Researchers use a quantitative descriptive approach in this research. This quantitative research is conducted by analyzing data, explaining the collected information, focusing on current problems and phenomena, and presenting findings in the form of important numbers. Waste management at the Temporary Waste Disposal Site (TPS) Tombro, Tunjungsekar Village, Lowokwaru Subdistrict, Malang City, East Java, is one of the factors studied in this research. Direct observation and interviews are used in a survey-based research approach to collect data in this research.

At TPS Tombro, Tunjungsekar Village, Lowokwaru Subdistrict, Malang City, East Java, the authors of this paper conducted more in-depth research.

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Vol. 03, No. 01, June, 2025, p.01 – 06 e-ISSN: 3025-1265

Primary and secondary data are two types of data used by researchers in this research. Further explanation is provided below:

a. Primary Data

Information collected directly from sources, such as TPS Tombro officers or related organizations like the Malang City Environmental Agency, is known as primary data. This interview process is recorded and captured through audio or images as evidence of the conducted research. More details can be seen in the following Table 3.1.

Table 3.1 Types and Sources of Primary Data

No	Type of Data	Data Source
1	Facilities and infrastructure supporting TPS operations	Research location
2	Waste Management - Volume of waste per transport vehicle entering the TPS - Total waste volume	Research location
3	Dimensions or Measurements of TPS Infrastructure - Length and width of TPS - Width of the access road to TPS - Dimensions of transport equipment	Research location

b. Secondary Data

Secondary data consists of information obtained from various sources such as documents, books, and articles that include official reports, academic writings, theories, and others. More details can be seen in the following Table 3.2.

Table 3.2 Types and Sources of Secondary Data

No	Jenis Data	Sumber Data
1	Provisions regarding criteria for waste management locations	SNI 19-2454-2002
2	Regarding the maintenance of waste facilities and infrastructure. .	Minister of Public Works Regulation No 3 Year 2013
3	Waste management at waste banks	Regulation of the Indonesian Ministry of Environment and Forestry No 14 Year 2021
4	Waste management	Law of the Republic of Indonesia No. 18 Year2008

Figure 1 Research Location

4. RESULTS AND DISCUSSION

The waste transportation system operated by the TPS Tombro officers uses an indirect individual transportation method. Waste is transported from each source to the Temporary Waste Storage Site (TPS) using carts and other transport vehicles such as Tosa. Upon arrival at the TPS, the waste is then transferred using compactor trucks to the Final Waste Processing Site (TPA) Supit Urang.

Waste or garbage collection by officers is carried out from 04:00 to 12:00. The waste collection process using garbage carts and Tosa vehicles is done one to three times per day.

1. Capacity of TPS Tombro to Accommodate Waste

The capacity of the TPS refers to the ability of the temporary disposal site (TPS) to accommodate waste generated from community activities in the areas served by the TPS daily. To determine the capacity of TPS Tombro in accommodating generated waste, the first step is to measure the dimensions of the waste storage area. TPS Tombro has 2 waste depot transfer sites that also serve as storage areas for waste from each garbage cart transported from each waste source in the Tunjungsekar sub-district.

For the dimensions of the second waste storage area at TPS Tombro, see the following table 4.4.

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Journal of Evrimata: Engineering and Physics
Vol. 03, No. 01, June, 2025, p.01 – 06 e-ISSN: 3025-1265

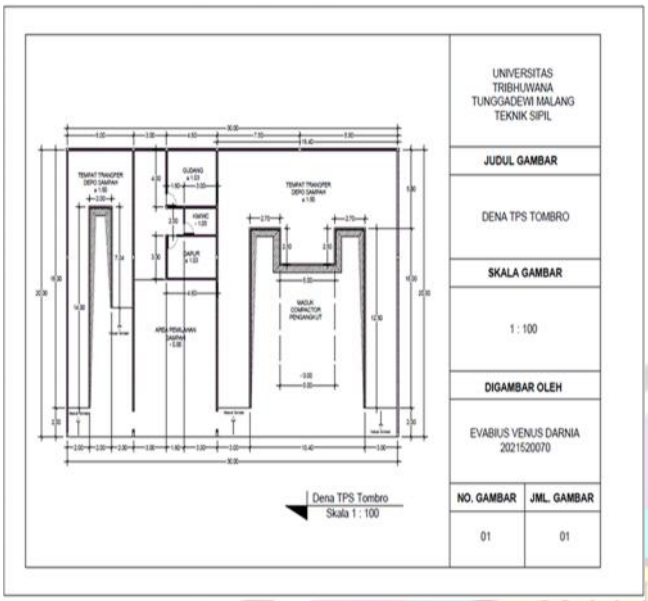

Table 4.4 Dimensions of the second waste storage area Type 1 and Type 2 at TPS Tombro

Dimensions of waste storage area Type 1		
P	**L**	**T**
10,40 m	5,50 m	3,50 m
Capacity of waste storage area Type 1 = 200.2 m³		
Dimensions of waste storage area Type 2		
P	**L**	**T**
2 m	4 m	3 m
Capacity of waste storage area Type 2 = 24 m³		
Total capacity of waste storage area at TPS Tombro = 224.2 m³/day		

Example of calculating the capacity of the waste storage area at TPS Tombro:
1. Volume of Waste Storage Area Type 1
Volume of Storage Area = L x W x H
Volume of Storage Area = 10.40 x 5.50 x 3.50 = 200.2 m³
Thus, the capacity of the Type 1 storage area at TPS Tombro is 200.2 m³.
2. Volume of Waste Storage Area Type 2
Volume of Storage Area = L x W x H
Volume of Storage Area = 2 x 4 x 3 = 24 m³
Thus, the capacity of the Type 2 storage area at TPS Tombro is 24 m³.
3. Accumulation of Waste Holding Capacity at TPS Tombro
200.2 m³ + 24 m³ = 224.2 m³
Thus, the overall accumulated capacity of the waste storage area at TPS Tombro is 224.2 m³/day.
2. Calculating Waste Production
The method of measuring waste production at TPS Tombro is based on the volume of waste per waste transport tool transported from the waste source daily over 1 week. The reason for measuring over 1 week (7 consecutive days) is that 1 week represents all days.
a) Calculating daily waste production in 1 week

Calculation of the total volume of waste accommodated at TPS Tombro over a 1-week period is all calculated based on the accumulation of daily waste volumes (Monday-Sunday) from each type of transport facility. Of the many waste transport facilities owned by TPS Tombro, only some are operated daily, while others are reserved for significant spikes in waste generation from the served areas, and the average transportation trips per day are 2-3 times.

Table 4.5 Calculation of total daily waste volume in 1 week

Day	Cart type 1 (m³)	Cart type 2 (m³)	Cart type 3 (m³)	Tosa (m³)	Total waste volume (m³)
Monday	4,72	3,05	2,70	6,30	16,77
Tuesday	4,64	3,00	2,50	-	10,14
Wednesday	4,28	2,91	2,50	-	9,69
Thursday	4,17	2,97	2,56	-	9,70
Friday	4,38	2,87	2,73	-	9,98
Saturday	4,70	3,10	2,79	5,94	16,53
Sunday	2,36	1,58	1,38	-	5,32
Total daily waste volume in 1 week (m³)					**78,13**

Based on the calculations and analysis, it can be concluded that the peak waste volume at TPS Tombro occurs on Monday with a total waste volume of 16.77 m³. For comparison of daily waste volume in 1 week at TPS Tombro, it can be seen more clearly in the following waste production graph:

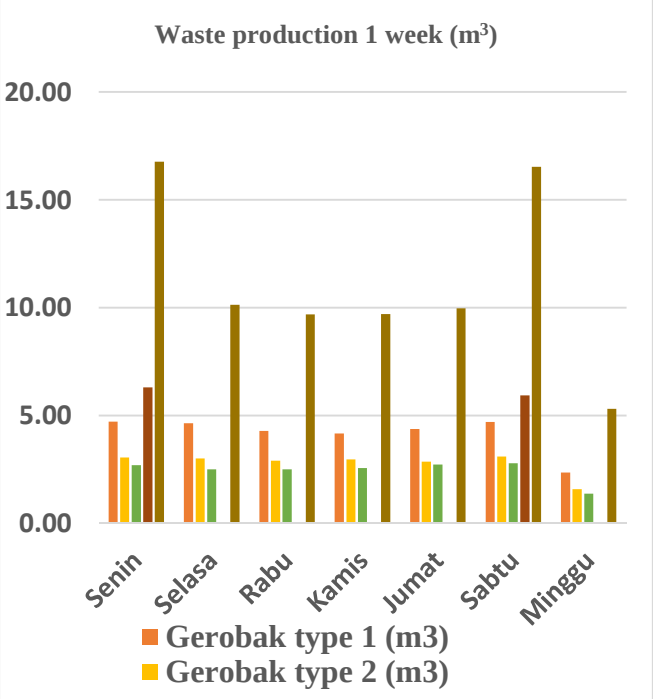

Figure 4.10 Graph of 1-week waste production at TPS Tombro

Based on the graph above, the peak day with the highest waste volume is Monday with a total waste of 16.77 m³.
b) Waste Production Per Person Per Day
Waste production per person/day = (Peak weekly waste volume (m³)) / (Population served)
= (16.77) / 2600 = 0.006 m³

3. Comparison of Per Person Daily Waste in Tunjungsekar Sub-district with SNI 19-3964-1994

Table 4.8 Comparison of per person daily waste in Tunjungsekar Sub-district with SNI 19-3964-1994.

Waste generated per person/day by the served population (m³)	Medium city (SNI 19-3964-1994) (Liters)
0,006	2,75 – 3,25

In conclusion, the per person daily waste in Tunjungsekar Sub-district is 0.006 m³, which complies with the standards set in SNI 19-3964-1994, namely 2.75 Liters – 3.25 Liters or equivalent to 0.002 m³ – 0.003 m³.

5. CONCLUSIONS

Based on the analysis results and calculations conducted by the researcher, the overall capacity of the garbage collection area at TPS Tombro is known to be 224.2 m³/day, and for the daily garbage volume, it shows that there is variation in the daily garbage volume which differs every day, with the highest peak garbage volume occurring on Monday, July 6, 2025, at 16.77 m³, and then accumulated to obtain the total garbage volume produced over one week, which is 78.13 m³, and for the amount of garbage per person/day is 0.006 m³.

TPS Tombro has adequate infrastructure so that it is capable and sufficient to serve the large amount of garbage produced from the served area, namely Tunjungsekar Village. TPS Tombro has an overall area of 30 x 20 meters and is equipped with two garbage depot transfer areas. The operational activities of TPS Tombro every day appear very efficient and clean, and the access road from the garbage source to the TPS is quite good, and the garbage transportation process to TPA Supiturang is quite orderly, thus supporting the smooth operation of the TPS.

6. ACKNOWLEDGEMENTS

The authors would like to thank Universitas Tribhuwana Tunggadewi Malang, Indonesia for the experimental supports.

7. AUTHOR CONTRIBUTIONS

Conception and design: Fifi Damayanti
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Resources, technical and material support: Yurnalisdel
Supervisor: Fifi Damayanti

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Journal of Evrimata: Engineering and Physics
Vol. 03, No. 01, June, 2025, p.01 – 06 e-ISSN: 3025-1265

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