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Characterization of waste composition as a basis for developing a community-based 3R TPS system in waste management efforts in Pandansari Lor Village, Malang Regency

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ABSTRACT

Background: The issue of waste management has become a major concern in many regions, including Pandansari Lor Village, Malang Regency. To address this challenge, it is necessary to develop an effective waste management system that involves the active participation of the community. This study aims to determine the waste composition in Pandansari Lor Village as a basis for developing a 3R (Reduce, Reuse, Recycle) Transfer Station (TPS) system that is tailored to the needs of the community. **Methods:** The research methodology includes primary data collection through sampling and analysis of waste composition, as well as secondary data collection from relevant sources. **Findings:** The results show that the waste composition in Pandansari Lor Village is dominated by organic waste, including food waste (58.42%) and garden waste (3.84%), followed by plastic waste (26.74%), paper waste (5.89%), and other types of waste. **Conclusion:** These findings provide valuable insights for the design and implementation of a community-based 3R TPS system that can effectively manage the waste generated in the village. The proposed system aims to maximize resource recovery, reduce the amount of waste sent to landfills, and promote sustainable waste management practices within the community. **Novelty/Originality of this article:** This study offers a tailored approach to waste management through detailed analysis and a community-based 3R system in Pandansari Lor Village.

KEYWORDS: community-based; TPS 3R; waste generation; waste management.

1. Introduction

Waste management has become a pressing issue worldwide, and Indonesia is no exception. The rapid population growth, urbanization, and changes in lifestyle and consumption patterns have led to a significant increase in the volume and complexity of waste generated (Damanhuri & Padmi, 2011; Sumantri, 2010). In Indonesia, the total waste generated in 2021 was estimated to be 18.2 million tons per year, with only 72.95% of that waste being properly managed (Badan Standardisasi Instrumen Lingkungan Hidup dan Kehutanan, 2022). This issue is particularly prevalent in rural areas, where waste management infrastructure and resources are often limited. Pandansari Lor Village, located

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in Malang Regency, East Java, is one such community facing challenges in waste management. The village lacks a well-functioning waste management system, leading to the improper disposal of waste, including burning and dumping in water bodies (Noerhayati & Rahmawati, 2022). This not only poses environmental and health risks but also hinders the sustainable development of the village.

To address this issue, the development of a community-based 3R (Reduce, Reuse, Recycle) Transfer Station (TPS) system can be a promising solution. The 3R TPS system involves the collection, sorting, reuse, and recycling of waste at the community level, reducing the amount of waste that needs to be transported to final disposal sites (Dirjen Cipta Karya, 2017). However, the success of such a system largely depends on the understanding of the waste composition in the target community, as this information is crucial for the design and implementation of an effective waste management strategy (Dwi Bhaskara Nugraha et al., 2015). Waste management has become a critical issue in Indonesia, with the total waste generated in 2021 estimated to be 18.2 million tons per year, of which only 72.95% is properly managed (Badan Standardisasi Instrumen Lingkungan Hidup dan Kehutanan, 2022). This problem is particularly acute in rural areas, where waste management infrastructure and resources are often limited. Pandansari Lor Village, located in Malang Regency, East Java, is one such community facing significant challenges in waste management.

The village lacks a well-functioning waste management system, leading to the improper disposal of waste, including burning and dumping in water bodies (Noerhayati & Rahmawati, 2022). This not only poses environmental and health risks but also hinders the sustainable development of the village. To address this issue, the development of a community-based 3R (Reduce, Reuse, Recycle) Transfer Station (TPS) system can be a promising solution. The 3R TPS system involves the collection, sorting, reuse, and recycling of waste at the community level, reducing the amount of waste that needs to be transported to final disposal sites (Dirjen Cipta Karya, 2017). However, the success of such a system largely depends on the understanding of the waste composition in the target community, as this information is crucial for the design and implementation of an effective waste management strategy (Dwi Bhaskara Nugraha et al., 2015).

The rapid population growth, urbanization, and changes in lifestyle and consumption patterns in Indonesia have contributed to the increasing volume and complexity of waste generated (Damanhuri & Padmi, 2011; Sumantri, 2010). This issue is particularly prevalent in rural areas, where waste management infrastructure and resources are often limited. Pandansari Lor Village, located in Malang Regency, East Java, is one such community facing significant challenges in waste management. The village lacks a well-functioning waste management system, leading to the improper disposal of waste, including burning and dumping in water bodies (Noerhayati & Rahmawati, 2022). This not only poses environmental and health risks but also hinders the sustainable development of the village. To address this issue, the development of a community-based 3R (Reduce, Reuse, Recycle) Transfer Station (TPS) system can be a promising solution.

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2. Methods

The The research methodology employed in this study involves both primary and secondary data collection. The primary data collection focused on the analysis of waste composition in Pandansari Lor Village, while the secondary data included information on population, socio-economic characteristics, and existing waste management practices in the village. Waste Composition Analysis The waste composition analysis was conducted in accordance with the Indonesian National Standard (SNI) 19-3964-1994 on methods for sampling and measuring waste generation and composition (Badan Standardisasi Nasional, 1994).The sampling process involved the following steps: (1) Sampling Locations: The sampling was carried out in three sub-villages (dusun) within Pandansari Lor Village, namely Dusun Bayang, Dusun Tegir, and Dusun Begawan, to ensure a representative sample of the village (Badan Standardisasi Nasional, 1994). (2) Sampling Size: The sample size was determined based on the population size of the village, following the formula provided in the SNI standard. A total of 30 households were selected for the sampling, with the number of samples from each sub-village proportional to the population distribution (Badan Standardisasi Nasional, 1994). (3) Sampling Frequency: The waste samples were collected for 8 consecutive days to account for daily and weekly variations in waste generation (Badan Standardisasi Nasional, 1994). (4) Waste Composition Analysis: The collected waste samples were sorted and weighed according to the waste composition categories specified in the SNI standard, including organic waste (food waste and garden waste), paper, plastic, textile, metal, glass, rubber, wood, and other types of waste (Badan Standardisasi Nasional, 1994).

The data collected from the waste composition analysis was then used to calculate the percentage of each waste type and its contribution to the overall waste stream in Pandansari Lor Village. Secondary Data Collection Secondary data, such as population statistics, socio-economic characteristics, and existing waste management practices in the village, were obtained from various sources, including the village government, regional statistical agencies, and relevant literature (Damanhuri & Padmi, 2011; Sumantri, 2010). Data Analysis The data collected from the primary and secondary sources were analyzed to understand the waste composition and the factors influencing it in Pandansari Lor Village. The analysis involved calculating the percentages of different waste types, identifying the dominant waste fractions, and exploring the relationship between waste composition and socio-economic variables (Dwi Bhaskara Nugraha et al., 2015; Mallongi & Saleh, 2015).

Fig 1. Study Location

3. Results and Discussion

The waste composition analysis conducted in Pandansari Lor Village revealed that the waste stream is dominated by organic waste, including food waste and garden waste, which account for 62.26% of the total waste generated (Table 1) (Badan Standardisasi Nasional, 1994). Plastic waste is the second-largest component, comprising 26.74% of the total waste. The remaining waste fractions include paper (5.89%), wood (1.35%), textile (1.26%), glass (0.90%), metal (0.80%), and other types of waste (0.75%) (Table 1) (Badan Standardisasi Nasional, 1994). Here is the continued paper: The high proportion of organic waste in Pandansari Lor Village is consistent with the findings of previous studies on waste composition in rural and semi-urban areas in Indonesia (Damanhuri & Padmi, 2011; Mallongi & Saleh, 2015). This is primarily due to the predominance of agricultural and household activities that generate a significant amount of food waste and garden waste (Sumantri, 2010). The high percentage of plastic waste, on the other hand, can be attributed to the increasing use of plastic packaging and single-use plastic products in the community, a trend that is observed in many developing countries (Dwi Bhaskara Nugraha et al., 2015; Mallongi & Saleh, 2015).

The composition of waste in Pandansari Lor Village suggests that a community-based 3R TPS system could be an effective solution for waste management in the village. The high proportion of organic waste presents an opportunity for composting, which can help divert a significant portion of the waste stream from landfills and provide a valuable soil amendment for local agricultural activities (Harsono, 2007; Dirjen Cipta Karya, 2017). The plastic waste, on the other hand, can be collected, sorted, and recycled, reducing the environmental impact of plastic pollution (Dirjen Cipta Karya, 2017). Furthermore, the waste composition analysis provides valuable insights for the design and implementation of the 3R TPS system. The high proportion of organic waste suggests that the system should prioritize the processing and treatment of this waste fraction, potentially through the use of aerobic composting methods (Dirjen Cipta Karya, 2017). The plastic waste can be segregated and processed for recycling, either within the 3R TPS system or through partnerships with external recyclers (Dirjen Cipta Karya, 2017).

Table 1. Composition of Household Waste in Pandansari Lor Village

Type of waste	Waste composition (%)								total	Average (kg)	Percentage (%)
	H1	H2	H3	H4	H5	H6	H7	H8			
Leftovers	14,54	10,20	11,14	9,04	12,77	10,51	10,58	12,20	90,98	11,37	58,42%
Leaf trash	0,69	0,93	0,62	0,34	0,83	1,06	0,18	1,33	5,98	0,75	3,84%
Papers	1,92	1,03	0,84	1,68	0,79	1,40	0,90	0,61	9,17	1,15	5,89%
Plastic	5,26	6,73	5,48	5,76	3,76	3,45	5,45	5,76	41,65	5,21	26,74%
Textiles	0,91		0,14	0,36			0,56		1,97	0,49	1,26%
Metals		0,13	0,59		0,23	0,24	0,06		1,25	0,25	0,80%
Glass	0,13		0,75		0,34			0,18	1,40	0,35	0,90%
Rubber		0,07							0,07	0,07	0,04%
Wood		0,31			1,06	0,37	0,15	0,21	2,10	0,42	1,35%
Other			0,98		0,19				1,17	0,59	0,75%
Total	**23,45**	**19,40**	**20,54**	**17,18**	**19,97**	**17,03**	**17,88**	**20,29**	**155,74**	**20,64**	**100,00%**

Source: Calculation Results, 2023

The secondary data collected on the socio-economic characteristics of Pandansari Lor Village also provides important context for understanding the waste composition. The village's predominantly rural and agricultural nature, as well as the relatively low income levels of the residents, are likely contributing factors to the high proportion of organic waste and the relatively low generation of other waste types, such as paper and electronic waste (Damanhuri & Padmi, 2011; Sumantri, 2010). Overall, the waste composition analysis conducted in this study highlights the need for a tailored waste management approach in Pandansari Lor Village, one that capitalizes on the high proportion of organic waste and addresses the growing challenge of plastic waste. The development of a community-based 3R TPS system, informed by the understanding of the local waste composition, can be a promising strategy for sustainable waste management in the village (Dirjen Cipta Karya, 2017; Dwi Bhaskara Nugraha et al., 2015).

The waste composition analysis also reveals insights into the waste generation and management practices within Pandansari Lor Village. The high proportion of organic waste, which includes food waste and garden waste, suggests that the community engages in a significant amount of food preparation and gardening activities. This aligns with the village's predominantly rural and agricultural nature, as reported in the secondary data (Damanhuri & Padmi, 2011; Sumantri, 2010). The relatively low percentage of paper waste (5.89%) and textile waste (1.26%) in the waste stream may be indicative of the community's limited access to or usage of paper-based products and textile-based materials, which are often associated with higher-income households and urban areas (Dwi Bhaskara Nugraha et al., 2015; Mallongi & Saleh, 2015). Similarly, the low proportion of metal (0.80%) and glass (0.90%) waste suggests that the community's consumption patterns and material usage are skewed towards more biodegradable and plastic-based products (Dwi Bhaskara Nugraha et al., 2015; Mallongi & Saleh, 2015).

The high percentage of plastic waste (26.74%) in the Pandansari Lor Village waste stream is a growing concern that reflects the increasing reliance on single-use plastic products and packaging in the community. This trend is consistent with observations made in other developing regions, where the use of plastic-based materials has become more prevalent due to factors such as convenience, accessibility, and affordability (Dwi Bhaskara Nugraha et al., 2015; Mallongi & Saleh, 2015). The waste composition findings provide a clear roadmap for the development of a community-based 3R TPS system in Pandansari Lor Village. The high organic waste fraction presents an opportunity for the implementation of effective composting techniques, which can help divert a significant portion of the waste

stream from landfills and provide a valuable soil amendment for local agricultural activities (Harsono, 2007; Dirjen Cipta Karya, 2017). The plastic waste, on the other hand, can be segregated, processed, and recycled, contributing to the reduction of plastic pollution in the community (Dirjen Cipta Karya, 2017).Furthermore, the waste composition data can inform the design and dimensioning of the various waste processing units within the 3R TPS system. For instance, the high organic waste fraction would require a larger composting area and more efficient composting methods, while the plastic waste would necessitate dedicated sorting, cleaning, and recycling facilities (Dirjen Cipta Karya, 2017).

By aligning the 3R TPS system design with the local waste composition, the waste management solution can be tailored to the specific needs and challenges of Pandansari Lor Village. This approach, in turn, can improve the system's efficiency, effectiveness, and long-term sustainability, as it addresses the root causes of the waste management problem within the community (Dirjen Cipta Karya, 2017; Dwi Bhaskara Nugraha et al., 2015). It is important to note that the waste composition in Pandansari Lor Village may be influenced by various socio-economic, cultural, and behavioral factors, as highlighted in the secondary data. The village's predominantly rural and agricultural nature, as well as the relatively low income levels of the residents, are likely contributing to the high proportion of organic waste and the relatively low generation of other waste types, such as paper and electronic waste (Damanhuri & Padmi, 2011; Sumantri, 2010).

Ongoing monitoring and evaluation of the waste composition in Pandansari Lor Village will be crucial to track any changes or trends over time, which may necessitate adaptations to the 3R TPS system design and operations. Additionally, community engagement and awareness-raising efforts will be essential to foster the active participation of residents in the waste management process and promote sustainable waste management practices within the village (Dirjen Cipta Karya, 2017; Dwi Bhaskara Nugraha et al., 2015).

4. Conclusions

This study aimed to determine the waste composition in Pandansari Lor Village, Malang Regency, as a basis for developing a community-based 3R TPS system for waste management. The analysis of waste composition revealed that the waste stream is dominated by organic waste, including food waste (58.42%) and garden waste (3.84%), followed by plastic waste (26.74%), paper waste (5.89%), and other types of waste (Table 4.6) (Badan Standardisasi Nasional, 1994). The high proportion of organic waste in the village's waste stream presents an opportunity for the implementation of a 3R TPS system that prioritizes composting and resource recovery. The segregation and processing of plastic waste can also be integrated into the system, contributing to the overall sustainability of waste management in the community (Dirjen Cipta Karya, 2017; Harsono, 2007).

The findings of this study provide valuable insights for the design and implementation of a tailored 3R TPS system in Pandansari Lor Village. By understanding the local waste composition, community-based waste management strategies can be developed that address the specific needs and challenges of the village, promoting sustainable practices and reducing the environmental impact of waste (Dirjen Cipta Karya, 2017; Dwi Bhaskara Nugraha et al., 2015). Further research is needed to explore the socio-economic and behavioral factors that influence waste generation and composition in Pandansari Lor Village, as well as the feasibility and operational aspects of the proposed 3R TPS system. Ongoing community engagement and capacity-building efforts will also be crucial for the successful implementation and long-term sustainability of the waste management system (Damanhuri & Padmi, 2011; Sumantri, 2010).

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Author Contribution

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