



Optimization Strategies for TPS3R in the Circular Economy: A Comparative Study between East Java and Saga Japan

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Abstract. The Indonesian government has made significant efforts to address the waste management crisis, mainly through adopting the 3R (Reduce, Reuse, Recycle) framework outlined in Law Number 18 of 2008. However, challenges persist, especially in regions like East Java, where food waste constitutes 57.03% of total waste generation. This study compares waste management practices in three cities in East Java, Blitar, Kediri, and Tulungagung, with successful models in Japan, specifically in Saga and Omuta. Japan's 3R-based system has successfully integrated waste management into daily life. By comparing the local TPS3R in East Java with Japan's waste management systems, the study aims to provide insights into best practices that can be adopted to improve the effectiveness of TPS3R in Indonesia. The research employs a qualitative descriptive method with SWOT analysis, using interviews, observations, and documentation to analyze existing challenges and propose recommendations for optimizing TPS3R to support the circular economy. Ultimately, the study aims to offer evidence-based policy recommendations and practical strategies to enhance sustainable waste management at the village level, contributing to long-term environmental and economic benefits aligned with the Sustainable Development Goals (SDGs).

Keywords: Waste Management, Circular Economy, Sustainable Development Goals, TPS3R.

1 Introduction

Waste management has become one of the biggest concerns of the twenty-first century due to the growth in garbage output during the twentieth century. Trade has become a cheap management strategy for countries that are overburdened with the duty of controlling the waste they produce [1]–[4]. This has had a huge impact on the global waste management system, pushing many countries' domestic recycling facilities close to collapse and altering the direction of international waste flows, since most countries' response is still to look for alternative dumping places instead of improving their waste management systems [3]. The Ministry of Industry continues to encourage industry to

transition towards sustainable development. One of these strategic steps is implementing the green industry concept, prioritizing efficient, environmentally friendly, reusable, and sustainable resource utilization while utilizing waste as an alternative energy source. The waste problem is a global problem that needs serious attention. The worldwide quantities of household waste have continued to rise. The Indonesian government issued Law Number 18 of 2008 concerning Waste Management at the national level. This law clarifies the roles and responsibilities of the national government, regional governments, the business community, and local governments [5]–[8]. The 3Rs Reduce: waste reduction, Reuse: pile disposal, and Recycle: recycling and waste utilization are the components of the waste management method used by the policy. Additionally, the Indonesian government has released several derivative rules to mainstream the paradigm shift in waste management required by the law above and released several regulations about derivatives.

The National Waste Management Information System (SIPSN) of the Ministry of Environment and Forestry (KLHK) stated that Indonesia generated 14.91 million tons of waste during 2023. D.K.I. Jakarta contributed the most by dumping 3.14 million tons of waste, followed by Central Java (2.74 million tons) and East Java (2.38 million tons). In East Java, 57.03% of waste generation was dominated by food waste, followed by 14.88% plastic and 10.4% paper waste. Food waste is still a major problem in this case, considering its lack of economic value compared to plastic and paper waste [9].

In East Java, further analysis of SIPSN. data shows that 57.03% of total waste generation was dominated by food waste. This is a significant problem because of food waste. However, it has the potential to be composted or processed into biogas, which often has no direct economic value compared to other types of waste, such as plastic and paper. Plastic, which accounts for 14.88% of waste generation in East Java, is known for its long-term environmental impacts, mainly due to its difficult-to-decompose nature. On the other hand, paper waste reaches 10.4% and has economic potential through a more developed recycling process [9]. The Indonesian government is strengthening its commitment to achieving the Sustainable Development Goals (SDGs) and reducing greenhouse gas (GHG) emissions while addressing economic, social, and environmental challenges [10]. For example, the Ministry of Industry (Kemenperin) is actively working to improve industrial efficiency and resource sustainability [11]. In addition, the main initiative that supports this commitment is the economic transformation towards a more sustainable "green" model, known as the circular economy [12].

The circular economy is an economic system that aims to eliminate waste and use resources sustainably [13] and designed to replace the linear economic model [14]. By promoting a circular economy, TPS3R can contribute to the achievement of several Sustainable Development Goals (SDGs), especially SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). Through effective waste management, TPS3R helps maintain environmental cleanliness and creates jobs and economic opportunities for local communities. Several TPS3Rs have been built in various villages in East Java as part of the local government's efforts to improve waste management. However, implementing TPS3R still needs to improve due to a lack of community participation, limited funds, and in-

adequate infrastructure. At the local level, there are diversities regarding the implementation of waste management policy due to the availability of infrastructure, human resources, and economic growth rate varying from one place to another. Based on the facts, this is study for a local level in Blitar, Kediri, Tulungagung, East Java, Indonesia, as a research object to gain more specific understanding. As it is known currently, local governments have a pivotal role in raising sustainable development programs.

Japan one of the countries that has succeeded in implementing a 3R-based waste management system. Japan's experience in managing waste can be an essential reference for Indonesia. In Japan especially Saga and Omuta, people are accustomed to strict waste sorting, and local governments have well-integrated waste management systems. A comparative study between TPS3R in East Java Blitar, Kediri, Tulungagung and Saga and Omuta Japan can provide new insights into strategies and best practices that can be adopted to improve the effectiveness of TPS3R in Indonesia. Meanwhile, Japan is known as a country that is successful in waste management with a 3R system that has been well integrated into the daily lives of its people. A comparative study between TPS3R in East Java and Japan is expected to provide new insights for optimizing the TPS3R system in Indonesia.

This research is essential to understand how TPS3R in East Java can be optimized to support a circular economy and achieve SDGs. By identifying existing challenges and comparing them with best practices in Japan, it is hoped that appropriate solutions can be found to improve TPS3R performance. The results of this study are expected to provide evidence-based policy recommendations and practical implementation strategies for waste management at the village level to provide long-term benefits for the environment and society.

2 Literature Review

2.1 Economy Circular

A circular economy (CE) is defined as an economic model that targets the efficient use of resources through waste utilization, producing products in the long term, and aims to increase socio-economic benefits that are environmentally friendly [15]. The CE. model is one of the models that supports the SDGs to increase zero waste by 2030. The circular economy is an alternative to the traditional economy, where economic activities are carried out by maintaining resources for as long as possible, maintaining their value when used, and reusing them to produce new products at the end of their useful life [16]. Then according to [17] the circular economy is a system that aims to maximize the product life cycle from resource selection, production, and consumption to disposal by encouraging practices such as zero waste design, reuse, repair, and resource-sharing.

2.2 Waste Management Analysis at TPS3R

According to Government Regulation Number 81 of 2012 concerning managing household waste and household-like waste with the 3R program (Reduce, Reuse, Recycle)

[18]. 3R waste management is a concept that reduces, reuses and recycles waste starting from its source. Through 3R, it is hoped that the community will not depend on waste services from the local government so that the local government is no longer the leading actor in waste management. The urban waste management policy implemented by the Ministry of Public Works and Public Housing in Indonesia aligns with the SNI. 3242:2008 standard concerning Waste Management in Residential Areas states that city waste management consists of five sub-system components [7]. These sub-systems include institutional aspects, financing, regulation (law), community participation, and operational techniques.

2.3 SWOT Analysis

SWOT analysis is a comprehensive tool that aids in the evaluation of both internal and external factors in qualitative research. It helps to identify strengths, weaknesses, opportunities, and threats that affect a particular subject or system [19]. In qualitative research, SWOT gathers in-depth descriptions rather than numerical ones. The strengths provide advantages and contribute positively to the subject being analyzed. The weaknesses provide the challenges or limitations that could restrict the subject's advancement. Opportunities could provide the project's growth, improvement, and success; the threats could be the risks or obstacles to the subject's success or stability.

3 Research Method

This study uses a descriptive research method with a SWOT analysis approach by taking several steps, namely searching, describing, and analyzing objects regarding the current conditions of waste management in 3 cities in East Java, namely Blitar, Kediri, and Tulungagung. This study focuses on a) The current conditions of waste management in cities in East Java, namely Blitar, Kediri, and Tulungagung, including the implementation of TPS3R; and (b) Recommendations for sustainable waste management development strategies in 3 cities in East Java, namely Blitar, Kediri and Tulungagung. This research conducted in cities in East Java, namely Blitar, Kediri, and Tulungagung. The selection of this research location took into account the local government's efforts to prepare Blitar, Kediri, and Tulungagung to become smart cities. Smart city is a program designed by the government to improve the quality of life of people in urban areas by considering six indicators: intelligent life, innovative environment, smart utilities, smart economy, smart mobility, and intelligent society. In this case, good waste management is part of realizing a "smart environment [20]." This study uses data collection techniques consisting of three techniques: a) Interviews with local government officials, b) Documentation, and c) Observation, a technique carried out by observing directly and making field notes on the implementation of waste management. This method will enrich the research findings, interviews, and documentation.

4 Result and Discussion

4.1 Current Waste Management Situation at TPS3R

Guyub Rukun Waste is a community initiative in Gedok Village, Blitar, that aims to overcome waste problems while providing economic benefits to the local community. Established as part of an effort to support community-based waste management programs, Guyub Rukun Waste Bank operates with the 3R principle (Reduce, Reuse, Recycle), an essential part of a sustainable waste management strategy. Guyub Rukun Waste Bank operates with an efficient process. Members deposit their types of waste (e.g., plastic, paper, metal), which are then recorded in a book or digital system by officers. Members receive points or credits based on the weight and type of waste deposited. The collected waste is then sorted and recycled. The sale proceeds used to incentivize members or manage the waste bank, thus creating a sustainable and profitable system for all involved.

Kediri Reuse, Reduce, Recycle Waste Processing Site (TPS3R) is in Jongbiru Village of Kediri Regency, East Java. TPS3R was developed to offer a way of handling waste that incorporates the support of the people in the village. This program is conducive to a principle of the circular economy, a tactic designed to minimize waste's environmental effects while utilizing essential waste. The goal of TPS3R is to educate the community in the 3R waste management, enhance and improve the way waste management is carried out so that less waste goes to TPA, establish a market for the collected waste, and train and counsel community members on handling the waste. Waste is gathered from the people's homes, offices, schools, and other institutions in Jongbiru Village. Then, the waste is segregated according to the material it is made of, such as organic waste, plastics, papers, or metals, which are then disposed to TPS3R.

KMP Sumber Selamat is a KMP Community Management Group established in Samar Village Tulungagung Regency East Java. As is the case with many other villages in Indonesia, Samar Village experiences significant issues in the disposal of its wastes. The growing amounts of waste produced, the absence of an efficient waste management system and clean technologies, in combination with the lack of public awareness of the impact of inefficient waste management on the environment and the population's health, have led to the deterioration of the environmental and public health conditions. There is an urgent need for Samar Village to manage household and other waste efficiently with the increasing population. This is because when wastes are not properly disposed of, they may spread in the open or even pollute the environment, harming human health. In order to tackle these problems, there is a need to develop a community-based solution that is more extensive in its approach, and thus, KMP Sumber Selamat was formed. KMP Sumber Benefit is implemented to help manage waste in a circular economy in Samar Village. The main objective of implementing this KMP is Environmental / Social Responsibility: It is believed that its adverse effects on the environment, for instance, contamination of soil, air, and water by wastes, will be minimized by proper management.

4.2 Saga and Omuta City, Japan Waste Management

The observation visits at TPS3R at Saga Eco Plaza, Saga, Japan, will seek to identify and study how waste management technology and methods are practiced in developed countries and learn best practices for sustainable waste management. It also seeks to identify applicable practices that may be adopted or practiced, especially in Indonesia, to enhance the efficiency of waste management and address the principle of circular economy.

Saga Eco Plaza is an innovative source created in Saga, Japan's leading waste disposal solution aimed at promoting efficiency in the utilization of waste. The establishment of it is to enhance people's understanding of the circular economy and green management of 3R (reduce, reuse, recycle). Saga Eco Plaza is designed to contain and demonstrate fundamental practice ideas concerning waste management and disposal. Saga prefecture is working hard to make it a pilot region in Japan and the international market. Saga Eco Plaza has various necessary waste management and sustainability facilities and structures. The primary building of the Saga Eco Plaza is a waste treatment plant that employs the latest methods for separating, reusing, and treating different kinds of waste. These include sorting facilities for consumer goods, an experienced plastic and paper sorting line, and technologies for sorting compost and biogas from organic waste. There is also a provision for extending knowledge and capacity-building programs for communities, schools, and other institutions to manage waste and enhance sustainability. There is an exhibition area in Saga Eco Plaza where one can examine modern waste treatment and recycling methods and learn what products can be made from recycled materials. This is done to prove that waste management can achieve the set goals and standards. From the visit, some key findings and learnings included: The automated sorting and waste processing technology utilized at Saga Eco Plaza enhances the recycling ratios and lessens the waste disposed of into landfills.

The purpose of the observation visit to recycle plaza in Omuta, Japan, was to gain insight into effective waste management policies/campaigns that will be addressed under Japan's TPS3R: Reuse, Reduce, and Recycling system. The tour was to learn about the processing of wastes, effective technologies utilized, and measures put in place to promote a circular economy and environmental conservation. Omuta City Recycle Plaza is an IMS-type waste management center at Omuta, Fukuoka Prefecture, in Japan. Operated within the framework of the city's campaign to manage waste and popularize the concept of circular economy, Recycle Plaza is focused on experiments in recycling operations. Due to development and concerns over environmental and sustainability issues, Omuta City Recycle Plaza aims to minimize the effects of waste and increase people's awareness of proper waste disposal.

Omuta City Recycle Plaza consists of several vital facilities and infrastructure that support the goals of waste management and sustainability. The main facility at Omuta City Recycle Plaza is a waste processing center equipped with modern technology to sort, recycle, and process various types of waste. These include automated sorting systems, facilities for recycling plastic, paper, and metal, and technologies for processing organic waste into compost and biogas. Observation visits to TPS3R in Saga Eco Plaza and Omuta City Recycle Plaza provided valuable insights into more advanced waste

management practices and adaptable technologies. Meanwhile, observations at TPS3R Blitar, Jongbiru Village, and Saman Village demonstrated local efforts to manage waste with more limited resources. This comparison identified opportunities for improving technology and education in Indonesia by leveraging best practices from Japan while considering local contexts and specific needs. Observation visits to TPS3R in Saga Eco Plaza and Omuta City Recycle Plaza, Japan, and TPS3R in Blitar, Jongbiru Village, and Saman Village, aimed to Understand the methods and technologies applied in waste management in Japan and Indonesia and how these practices support the principles of Reduce, Reuse, Recycle (3R) and the circular economy. Assess the effectiveness of waste management systems at various locations, including how they manage different types of waste and contribute to environmental sustainability. Comparing waste management approaches in Japan and Indonesia to identify strengths, weaknesses, and opportunities for improvement and adaptation.

Differences between the two countries include Technology and Infrastructure. Japanese waste management systems use more sophisticated and automated technology, such as automated sorting systems and more modern recycling facilities. In Indonesia, especially in rural waste management systems, technology is often simpler and focuses on manual methods and primary education. In Japan, community education is more integrated into waste management systems, often with more systematic and planned programs. In Indonesia, education programs are generally more community-based and often require additional support to increase community engagement. Similarities include the 3R Principle: In both Japan and Indonesia, all waste management systems adopt the principles of Reduce, Reuse, and Recycle as the basis for waste management. Focus on Organic Waste Processing: In both countries, organic waste processing, either for composting or biogas, is emphasized as part of efforts to reduce waste sent to landfills.

4.3 SWOT Analysis TPS3R Waste Management

The SWOT (Strengths, Weaknesses, Opportunity and Threats) analysis is a strategic analysis approach to help us evaluate the internal and external condition of an entity in company organization or project [21]. In the context of TPS3R in three cities in Indonesia and two cities in Japan the application of SWOT can provide valuable insight to improving waste management strategies. The application of SWOT analysis in the context of circular economy for TPS3R in Indonesia and recycle center in Japan can provide insight into how these organizations are contributing to the transition from linear management model to the circular economy. Based on data obtained from Blitar, Kediri, and Tulungagung, both primary and secondary data collected through observation the SWOT in the circular economy context structure can be summarized as follows:

Table 1. SWOT Analysis TPS3R Waste Management

Strengths (S)	Weaknesses (W)	Opportunity (O)	Threats (T)
Blitar, Kediri, and Tulungagung are one of the de-	Local regulations that still seem slow; Weak strategies for	Waste management is one of the leading global concerns. The	Increasing ur-banization rate, Landfill land

veloping cities with exemplary achievements in terms of providing and developing public services; The local government and the community there have a significant concern in dealing with waste problems; and the existence of a particular institution known as DLH. Three cities built TPS3R with assistance from the local government and also the local community.	sustainable long-term plans; Lack of public awareness; Lack of facilities; Lack of financial strength or development costs; Lack of operational and maintenance costs; Lack of research and development programs; and Lack of public-private partnership programs.	central government considers waste management an important issue and has issued several related laws. Some communities want to cooperate and participate in waste management activities, involve academics in finding excellent and appropriate waste management methods, and have personal involvement in waste management.	limitation, and Environmental pollution; poor organic waste management; unmanaged waste piles; air pollution from burning; TPS3R overcapacity; destruction of natural habitats
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Based on the data that obtained in Saga and Omuta Japan both primary and secondary data collected through observation, the SWOT structure can be summarized as follows:

Table 2. SWOT Analysis Saga and Omuta Japan

Strengths (S)	Weaknesses (W)	Opportunity (O)	Threats (T)
- Both Saga and Omuta have strong regulation regarding waste management. Both cities have well established waste management system that allow household and business to separate waste into many types of recycle. - Advanced technology in Japan like Saga Eco Plaza and Omuta City Recycle Plaza that enhance the efficiency which helps the process organic waste into compost and biogas. - Japan has the system which well-integrated to promote waste management and recycling at the small community levels like household. They have high level public awareness to	- Hight Cost, the operation cost for advance waste management can be expensive. The operation, investment, technology and skilled labor can be expensive to maintain. - There's a complex sorting system and the strict in the separation system into many types can be confusing.	- Both City can expand their experience to help other countries or smaller communities develop their waste management. Most of developing countries face challenge to setting up their management in TPS3R. - Saga and Omuta also can be leader in sustainable waste management to attract tourist and researchers interested in environmental practices.	- In the near future if the process of recycle is too complicated or time-consuming people may become less diligent about sorting their garbage. - Government may face budget shrink during economic recession, reducing funding in order to maintain or upgrading their system. Climate change may also introduce unpredictable

make the system and im- plementation of waste management more effec- tive.	challenges for waste man- agement.
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5 Conclusion

In conclusion, based on the analysis above, the management system in Indonesia, especially Blitar, Kediri, Tulungagung and Saga, Omuta Japan, provides valuable insights into community waste management. Both countries emphasize reduction, reuse and recycling in order to minimize environmental impact by promoting a circular economy. In Indonesia, the Guyub Rukun Bank Sampah, TPS3R Jongbiru, Kediri, and KMP Sumber Selamat Tulungagung demonstrate local efforts to handle garbage and waste with a limited resource even though they face challenges such as financial support and public awareness. However, Saga and Omuta Japan use advanced technologies and a well-integrated system, and they also have well-integrated policies to make their management efficient and easier compared to Indonesia. A comparative analysis of waste management systems between Indonesia and Japan reveals opportunities for mutual learning. Indonesia, particularly its rural regions, could adopt elements of Japan’s advanced waste management practices while tailoring them to local conditions. Ultimately, exchanging knowledge and best practices between these regions could strengthen waste management outcomes, promote sustainability, and contribute to the global advancement of the circular economy. This collaborative approach holds the potential to address pressing environmental challenges while fostering economic and social benefits across diverse communities.

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