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Original Research

TPS3R MOJO MAKMUR WASTE PROCESSING FACILITY IN SUSTAINABLE WASTE MANAGEMENT

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ABSTRACT

Effectiveness of the TPS3R Mojo Makmur Waste Processing Facility in Sustainable Waste Management. *This study analyzes household waste generation and the sustainability of the TPS3R Mojo Makmur waste management system in the City of Surakarta in response to increasing urban waste problems. The results show that household waste generation is still dominated by organic waste, while inorganic waste is relatively lower. Socioeconomic factors such as age, education level, and income do not significantly affect the total amount of waste generated but do influence waste composition. Multidimensional sustainability assessment indicates that TPS3R Mojo Makmur falls into the moderately sustainable category, with ecological and technological dimensions as its main strengths, particularly in waste reduction and the application of basic processing technologies. In contrast, the economic and socio-cultural dimensions remain challenging, especially in terms of limited economic value creation and suboptimal community participation. These findings highlight the need for policies that strengthen TPS3R institutional capacity, promote community-based circular economy development, and enhance public education and engagement. Support from local governments in the form of regulations, funding, and technological innovation is essential to improve the sustainability of integrated household waste management.*

INTRODUCTION

Waste is defined as the residual output of human activities and/or natural processes in solid form, which has the potential to cause environmental, health, and socio-economic impacts if not properly managed. Household waste remains the primary contributor to the national waste stream in Indonesia, in line with increasing population, urbanization rates, and shifts in consumption patterns. Data from the Ministry of Environment and Forestry indicate that the total national waste generation in 2023 reached 41.29 million tons, showing a year-on-year increasing trend(1). This fact suggests that the national waste management system still requires substantial strengthening, particularly in aspects of reduction and treatment at the source level.

Current dominant waste management practices still rely on the collect–transport–dispose approach, in which waste is gathered at Temporary Disposal Sites (TPS) and subsequently disposed of at Final Disposal Sites (TPA). Several TPAs in Indonesia continue to employ open dumping or controlled landfill methods, which pose risks of leachate contamination, odor

nuisances, and greenhouse gas emissions[2,3]. Efforts toward modernization through the development of waste-to-energy facilities (PLTSa) have been undertaken; however, their processing capacity has not kept pace with the daily increase in waste generation. This situation highlights the increasing relevance of source reduction strategies and the strengthening of community-based processing facilities within the context of sustainable development.

Surakarta City is one of the urban areas with the highest population density in Central Java Province. In 2023, the population was recorded at 526,870, with a density of 11,277 people per km^2[4]. Putri Cempo TPA received approximately 336,764 tons of waste throughout 2023, with an average generation of 1.75 kg per person per day, exceeding the national average[5]. The predominance of household waste in this composition indicates that interventions at the household level occupy a strategic position in reducing the burden on TPAs and enhancing the effectiveness of urban waste management systems.

Strengthening community-based waste management through Reduce–Reuse–Recycle Waste Processing Facilities (TPS3R) aligns with the principles of the circular economy and the waste management hierarchy[6,7]. Several studies suggest that TPS3R has significant potential to reduce waste flows to TPAs and increase citizen participation[8,9]. Nevertheless, various investigations also indicate that TPS3R implementation often encounters technical, social, and economic challenges, resulting in outcomes that do not always match ideal planning[10,11]. The Mojo Makmur TPS3R in Surakarta City illustrates the complexity of community-based waste management dynamics. Research by Chia et al. emphasizes that the consistency and quality of organic waste inputs are critical determinants of successful composting and bioconversion, as contaminated or unstable feedstock can reduce productivity and disrupt production cycles[12].

The low level of waste segregation at the source demonstrates that behavioral change does not occur automatically, even when processing facilities are available. Ajzen explains that environmental behavior is influenced by attitudes, subjective norms, and perceived behavioral control; thus, without educational interventions and adequate incentive schemes, community participation tends to be unsustainable[13]. These findings align with the study by Wilson et al., which underscores that the success of community-based waste management heavily depends on active citizen engagement and consistent social system support[14].

The economic sustainability of TPS3R is determined by the managing unit's ability to develop a viable business model. Limited market access, low product market value, and the absence of quality certification hinder the achievement of financial independence for many TPS3Rs. Parodi et al. argue that failure to integrate resource efficiency principles and value-creation strategies into the business model is a major reason for the discontinuity of community-based waste management initiatives[15].

This study aims to comprehensively evaluate the effectiveness of TPS3R Mojo Makmur management by examining technical, social, and economic aspects as an integrated system. The findings are expected to provide a scientific basis for formulating adaptive, sustainable TPS3R strengthening strategies oriented toward community welfare, as well as a reference for developing community-based waste management in other urban areas.

MATERIALS AND RESEARCH METHODS

This study was designed through a structured methodological framework to comprehensively evaluate the effectiveness of waste management at the Mojo Makmur TPS3R. A quantitative approach with a quasi-experimental design was employed, allowing the examination of cause–effect relationships through intervention implementation without full randomization of subjects[16]. This design was selected based on the characteristics of the ongoing community-based waste management program, which involves naturally

formed social groups. The study location encompassed RW 21 and RW 22 in Jebres Subdistrict, Jebres District, Surakarta City, with a population of 749 households.
Sample determination was conducted using a proportionate stratified random sampling technique based on RT (neighborhood unit) areas, as well as respondents' age, education level, and income characteristics, resulting in 157 respondents representing the socio-economic conditions of the community. Data collection included primary data, such as household waste generation measurements and structured questionnaires, as well as secondary data sourced from official documents, local policies, and scientific publications.
Data analysis involved assessing waste generation, conducting statistical tests on socio-economic variables, and evaluating management effectiveness through a sustainability index across institutional, economic, social, technological, ecological, and socio-cultural dimensions. The final stage of the study applied SWOT analysis as a basis for formulating strategies to enhance the sustainable effectiveness of Mojo Makmur TPS3R management.

Tabel 1. Karakteristik Responden Penelitian

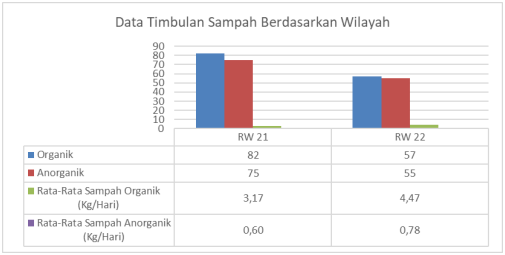
Characteristic	Category	Number (n)	Percentage (%)
Area	RW 21	78	49,7
	RW 22	79	50,3
Age (years)	< 30	18	11,5
	31–40	32	20,4
	41–50	41	26,1
	51–60	36	22,9
	> 60	30	19,1
Highest Education Level	No formal education/Elementary School	29	18,5
	Junior High School	38	24,2
	Senior High School/Vocational School	57	36,3
	Diploma/Bachelor	33	21,0
Monthly Income	< Rp2.000.000	52	33,1
	Rp2.000.000–Rp4.000.000	63	40,1
	> Rp4.000.000	42	26,8
Total Respondents		157	100,0

Source: Data processed by the researchers (2026).

RESEARCH RESULTS AND DISCUSSION

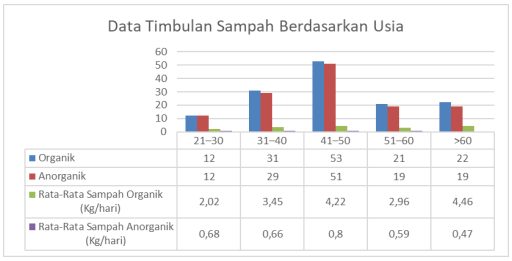
Waste Generation Analysis

The validity of the questionnaire instrument was tested using the Pearson Product Moment correlation at a significance level of 0.05. The results indicated that all questionnaire items had r-values ranging from 0.412 to 0.781, which are higher than the critical r-value of 0.156 (n = 157). Therefore, all statement items were considered valid and capable of accurately measuring the research variables.
The reliability of the instrument was assessed using Cronbach's Alpha coefficient. The results showed a Cronbach's Alpha value of 0.823, exceeding the minimum threshold of 0.70, indicating that the questionnaire was reliable. This value demonstrates that the questionnaire possesses a good level of internal consistency and can be used dependably to collect research data.



Source: Data processed by the researchers (2026)
Figure 1. Waste Generation Data by Area

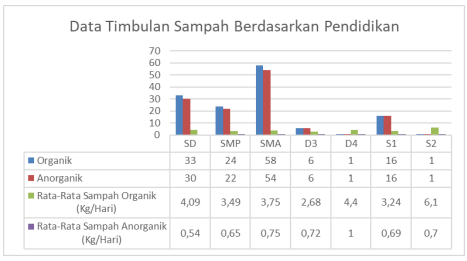
The study results indicate that RW 21 generated a higher total amount of waste compared to RW 22; however, the average daily waste generation in RW 22 was higher. This finding highlights differences in waste generation patterns between areas, which should be considered in planning community-based waste management strategies.



	21–30	31–40	41–50	51–60	>60
Organik	12	31	53	21	22
Anorganik	12	29	51	19	19
Rata-Rata Sampah Organik (Kg/hari)	2,02	3,45	4,22	2,96	4,46
Rata-Rata Sampah Anorganik (Kg/hari)	0,68	0,66	0,8	0,59	0,47

Source: Data processed by the researchers (2026)
Figure 2. Waste Generation Data by Age

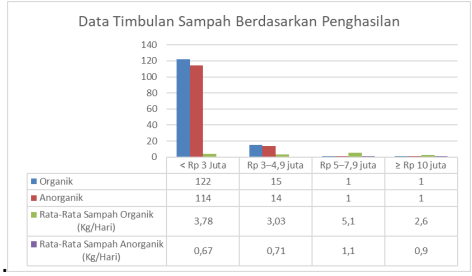
The average organic waste generation tends to increase with age, with the over-60 age group producing the highest volume. This finding indicates that age differences are associated with variations in domestic activities and household consumption patterns.



	SD	SMP	SMA	D3	D4	S1	S2
Organik	33	24	58	6	1	16	1
Anorganik	30	22	54	6	1	16	1
Rata-Rata Sampah Organik (Kg/Hari)	4,09	3,49	3,75	2,68	4,4	3,24	6,1
Rata-Rata Sampah Anorganik (Kg/Hari)	0,54	0,65	0,75	0,72	1	0,69	0,7

Source: Data processed by the researchers (2026)
Figure 3. Waste Generation Data by Education

The average waste generation was relatively similar across different education levels, for both organic and inorganic waste. This indicates that formal education level does not directly determine the volume of household waste generated



	< Rp 3 Juta	Rp 3–4,9 juta	Rp 5–7,9 juta	≥ Rp 10 juta
Organik	122	15	1	1
Anorganik	114	14	1	1
Rata-Rata Sampah Organik (Kg/Hari)	3,78	3,03	5,1	2,6
Rata-Rata Sampah Anorganik (Kg/Hari)	0,67	0,71	1,1	0,9

Source: Data processed by the researchers (2026)
Figure 4. Waste Generation Data by Income

Waste generation across all income groups showed relatively similar average values. This finding emphasizes that all economic strata contribute to waste generation and should be involved in sustainable waste management efforts.

Table 2. Results of the Kruskal–Wallis Test

	Age	Education	Income
Kruskal Wallis	4,359	4,359	7,801
df	6	6	6
Asymp. Sig	,628	,628	,253

The results of the Kruskal–Wallis test indicated that age, education, and income variables did not have a significant effect on the total household waste generation. This finding suggests that the contribution to waste generation is relatively proportional across all socio-economic groups.

Household waste in the study area was dominated by organic waste, with an average of 3.70 kg per day, while inorganic waste accounted for only 0.68 kg per day. This dominance indicates that domestic waste primarily originates from household activities, such as food preparation and maintenance of the surrounding environment. Consumption patterns that still rely on fresh food reinforce the high proportion of biodegradable organic waste. This finding aligns with studies stating that household consumption characteristics directly affect the composition of generated waste[17]. Such conditions present significant opportunities for optimizing organic waste management through composting and source-based treatment.

Spatial analysis by area (RW) revealed variations in waste generation between RW 21 and RW 22, both in total volume and average waste per household. RW 21 had a higher total waste volume, whereas RW 22 exhibited a higher average daily generation per household. These differences reflect variations in consumption intensity, population density, and household waste management effectiveness across areas. This finding is consistent with studies emphasizing the importance of spatial and socio-economic factors in influencing household waste generation[18,19]. Therefore, community-based waste management approaches need to be adapted to the local characteristics of each area.

Age was clearly associated with both the volume and composition of waste, particularly in the organic category. Older age groups tended to generate more organic waste due to more intensive domestic activities and home cooking habits. Conversely, the productive-age groups contributed more to inorganic waste, arising from packaged products and mobility-related consumption. This pattern reinforces previous findings that the age of the household head influences the type and quantity of waste generated[20,21]. Considering age is therefore crucial in designing targeted waste management policies and educational programs.

Individuals with higher education and income levels tend to have more complex consumption patterns, increasing the proportion of inorganic waste. Conversely, lower-income groups produce more organic waste due to fresh-food-based consumption. This finding aligns with environmental economic theory, which states that economic capacity affects the type of waste rather than merely the quantity[22,23]. The statistically insignificant Kruskal–Wallis test results emphasize that waste management should focus on controlling composition and behavior, rather than solely reducing total volume[24].

The quasi-experimental design employed in this study has limitations, as it did not involve randomization of respondents, making selection bias and confounding variables across areas possible. Differences in household characteristics and measurements conducted over a limited period mean that the results do not fully represent long-term variations in behavior and waste generation. Additionally, the use of observational data and questionnaires may introduce measurement bias. Therefore, the findings should be interpreted cautiously, and follow-up studies with experimental or longitudinal designs are recommended to improve validity and causal inference strength.

SWOT Analysis of Internal and External Factors

The SWOT analysis consists of internal and external factors. Internal factors include Strengths and Weaknesses, while external factors encompass Opportunities and Threats.

These factors yield positive impacts from Strengths and Opportunities, and negative impacts from Weaknesses and Threats.

Table 3. Internal and External Factors of the Mojo Makmur Reduce–Reuse–Recycle Waste Processing Facility (TPS3R) Management

No.	Strengths	No.	Weaknesses
1	Public awareness regarding waste management and environmental sustainability is relatively high	1	Institutional reporting and documentation are not yet optimal
2	Community participation in waste management activities is relatively good	2	Maintenance of equipment and infrastructure is limited
3	Reduction of organic waste through composting activities has been implemented	3	Waste segregation by the community is not yet uniform
4	Waste segregation by a portion of the community has been carried out	4	Financial independence of the TPS3R is still low
No.	**Opportunities**	**No.**	**Threats**
1	Development of waste-based economic enterprises	1	Decline in community participation
2	Support through multiparty guidance and collaboration	2	Damage to waste processing equipment
3	Enhancement of environmental education and outreach	3	Uncertainty of sustainable funding
4	Innovation and digitalization of waste management	4	Weak support from local regulations

The utilization of primary and secondary data indicates that the sustainability of Mojo Makmur TPS3R management is influenced by internal factors, including public awareness and participation, implementation of waste segregation and organic composting, availability of facilities and infrastructure, institutional capacity, and funding support.

From a strengths perspective, Mojo Makmur TPS3R benefits from relatively high environmental awareness among the community, citizen participation in waste segregation, and the implementation of composting activities that reduce the volume of waste sent to the final disposal site. These conditions constitute a crucial foundation for developing more sustainable community-based waste management.

However, internal weaknesses hinder the optimization of TPS3R performance, including suboptimal institutional reporting and documentation, irregular maintenance of facilities and infrastructure, and uneven implementation of household waste segregation practices. Limited financial independence also constrains program development and capacity-building for facility managers. Therefore, strengthening institutional governance, enhancing education and consistency in waste segregation, ensuring sustainable technical maintenance, and diversifying funding sources are necessary to support the long-term sustainability of Mojo Makmur TPS3R.

Table 4. Internal Factor Evaluation (IFE) Matrix of the Mojo Makmur Reduce–Reuse–Recycle Waste Processing Facility (TPS3R) Management

No.	Internal Factor	Rating	Weight	Score
Strengths				
1	Public awareness regarding waste management and environmental sustainability is relatively high	3,00	0,14	0,42
2	Community participation in waste management activities is relatively good	3,23	0,15	0,47
3	Reduction of organic waste through composting activities has been implemented	2,77	0,10	0,28
4	Waste segregation by a portion of the community has been carried out	2,85	0,11	0,31
	Sub Total			**1,47**
Weaknesses				
1	Institutional reporting and documentation are not yet optimal	2,62	0,12	0,30
2	Maintenance of equipment and infrastructure is limited	2,77	0,14	0,38
3	Waste segregation by the community is not yet uniform	2,69	0,10	0,27
4	Financial independence of the TPS3R is still low	3,08	0,14	0,43
	Sub Total			**1,38**
	Total		**1,00**	**(Difference = 0.09)**

The external factor analysis indicates that Mojo Makmur TPS3R has strategic opportunities, such as the development of waste-based economic enterprises, including compost

production and the utilization of recycled materials, which have the potential to increase revenue and financial independence. Support through guidance and multiparty collaboration from government agencies, non-governmental organizations, and the private sector provides opportunities to enhance technical and managerial capacity, supply supporting facilities, and strengthen institutional structures. Continuous environmental education and the implementation of innovations, including digitalization of waste management, can potentially boost community participation, improve operational efficiency, and enhance TPS3R transparency and accountability.

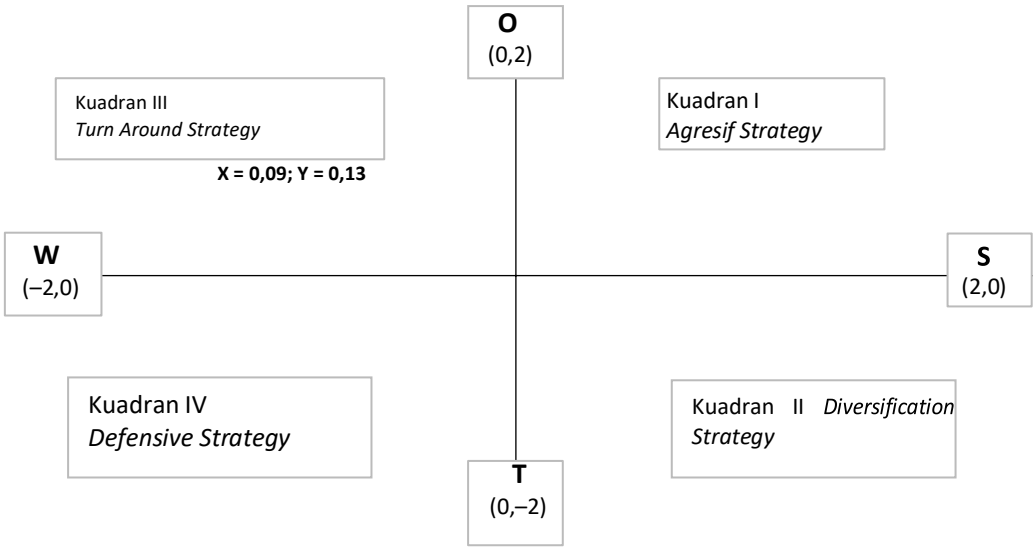
Mojo Makmur TPS3R also faces external threats, including potential declines in community participation, risks of damage to processing facilities due to limited routine maintenance, and uncertainties in sustainable funding. Dependence on limited funding sources and weak local regulatory support may hinder operations, facility maintenance, and program development. The sustainability of TPS3R is largely determined by the management's ability to leverage collaborative and innovative opportunities while mitigating social, technical, financial, and regulatory threats through adaptive and sustainable management strategies.

Table 5. External Factor Evaluation (EFE) Matrix of the Mojo Makmur Reduce–Reuse–Recycle Waste Processing Facility (TPS3R) Management

No.	External Strategic Factor	Rating	Weight	Score
Opportunities				
1	Development of waste-based economic enterprises	3.38	0.18	0.62
2	Support through guidance and multiparty collaboration	3.23	0.10	0.32
3	Enhancement of environmental education and outreach	2.77	0.12	0.32
4	Innovation and digitalization of waste management	2.85	0.10	0.28
Sub Total				1.55
Threats				
1	Decline in community participation	3.23	0.13	0.42
2	Damage to waste processing equipment	2.69	0.12	0.31
3	Uncertainty of sustainable funding	2.77	0.15	0.43
4	Weak support from local regulations	2.62	0.10	0.26
Sub Total				1.42
Total		1.00		(Difference = 0.09)

The external strategic factor analysis indicates that the sustainability of Mojo Makmur TPS3R management is influenced by opportunities and threats that are relatively balanced. The subtotal score for opportunities was 1.55, slightly higher than the threats score of 1.42, with a difference of 0.13, suggesting that the external conditions remain moderately supportive but require adaptive management strategies. The primary opportunity stems from the development of waste-based economic enterprises, which scored the highest, indicating significant potential for leveraging waste as an economic resource to strengthen TPS3R financial independence. Support through guidance and multiparty collaboration, enhancement of environmental education, and opportunities for innovation and digitalization of waste management further reinforce the institutional, technical, and social capacity of TPS3R management.

The threat analysis shows that uncertainty in sustainable funding is the most significant factor, potentially hindering operations, facility maintenance, and program development. Declining community participation and risks of damage to waste processing equipment may also disrupt the effectiveness of community-based management. Limited support from local regulations weakens the long-term institutional resilience of TPS3R. These moderate external conditions necessitate strategies focused on optimizing economic and collaborative opportunities while mitigating financial, social, and policy-related risks to ensure the sustainability of Mojo Makmur TPS3R.



Source: Data processed by the researchers (2026)

Figure 5. Strategic Position of the Mojo Makmur Reduce–Reuse–Recycle Waste Processing Facility (TPS3R) Management

The SWOT analysis positions Mojo Makmur TPS3R in Quadrant I (Strengths–Opportunities), indicating a strategic position with a tendency toward implementing aggressive strategies. This condition reflects the dominance of internal strengths, including high public awareness and participation, as well as the sustained implementation of waste segregation and composting activities, supported by external opportunities such as the development of waste-based economic enterprises, multiparty collaboration, and the potential for innovation and digitalization in waste management. This position provides a strong foundation for Mojo Makmur TPS3R to optimize internal and external resources in promoting sustainable waste management while enhancing operational effectiveness and independence.

The implementation of aggressive strategies is directed at strengthening active community involvement as the management base, combined with leveraging economic opportunities and external support to reinforce institutional capacity, reporting systems, and financial independence. Strategy formulation through the SWOT Matrix allows for comprehensive integration of strengths, weaknesses, opportunities, and threats, ensuring that internal capacity building and optimization of external opportunities are addressed in a balanced manner. This strategy is expected to enhance the resilience of Mojo Makmur TPS3R and strengthen its contribution to sustainable community-based waste management at the local level.

Table 6. External Factor Evaluation (EFE) Matrix of the Mojo Makmur Reduce–Reuse–Recycle Waste Processing Facility (TPS3R) Management

Internal Factors / **External Factors**	**Strengths (S)**	**Weaknesses (W)**
	1. Public awareness regarding waste management and environmental sustainability is relatively high. 2. Community participation in waste management activities is relatively good. 3. Reduction of organic waste through composting activities has been implemented. 4. Waste segregation by a portion of the community has been carried out.	1. Institutional reporting and documentation are not yet optimal. 2. Maintenance of equipment and infrastructure is limited. 3. Waste segregation by the community is not yet uniform. 4. Financial independence of the TPS3R is still low
Opportunities (O) 1. Development of waste-based economic enterprises. 2. Support through guidance and multiparty collaboration. 3. Enhancement of environmental education and outreach. 4. Innovation and digitalization in waste management.	**(S–O) Strategies** 1. Enhance TPS3R management capacity through training and technical assistance in waste management, particularly in segregation and composting, by leveraging opportunities for improved environmental education and outreach as well as multiparty collaboration support. (S1, S2, O2, O3) 2. Optimize composting and waste segregation activities as a basis for developing waste-based economic enterprises, allowing the strength of organic waste reduction to be utilized for economic value addition. (S3, S4, O1, O4) 3. Utilize public environmental awareness to promote the adoption of simple innovations and digitalization in TPS3R management, such as recording waste volumes and processed outputs. (S1, O4)	**(W–O) Strategies** 1. Strengthen TPS3R institutional reporting and documentation through guidance from government and partner agencies, leveraging opportunities for multiparty collaboration support. (W1, O2) 2. Utilize opportunities for developing waste-based economic enterprises to enhance TPS3R financial independence, thereby reducing dependence on external funding sources. (W4, O1) 3. Continuously improve environmental education and outreach to address the uneven implementation of household waste segregation, taking advantage of opportunities to enhance environmental education programs. (W3, O3)
Threats (T) 1. Decline in community participation. 2. Damage to waste processing equipment. 3. Uncertainty of sustainable funding. 4. Weak support from local regulations.	**(S–T) Strategies** 1. Leverage ongoing composting and waste segregation activities to maintain community participation and prevent declines in citizen engagement, as a measure to address the threat of reduced participation. (S2, S3, T1) 2. Strengthen existing waste management practices to mitigate the threat of equipment damage by optimizing efficient use of tools and promoting basic maintenance using internal capabilities. (S3, S4, T2) 3. Utilize public environmental awareness to encourage compliance with existing waste management regulations, as a step to address the threat of weak local regulatory support. (S1, T4)	**(W–T) Strategies** 1. Strengthen TPS3R financial independence to mitigate the impact of uncertainty in sustainable funding through more disciplined financial management and the development of alternative revenue sources. (W4, T3) 2. Gradually improve the maintenance system for waste processing equipment and infrastructure as a mitigation measure against equipment damage that could hinder TPS3R operations. (W2, T2) 3. Develop a simpler and more adaptive internal management mechanism to anticipate weak local regulatory support, ensuring that TPS3R can continue operating consistently. (W1, T4)

The development of the Mojo Makmur TPS3R management strategy through a SWOT matrix resulted in four integrated strategic alternatives, namely S–O, W–O, S–T, and W–T strategies, designed as an adaptive framework to respond to internal and external dynamics. The S–O strategy emphasizes leveraging internal strengths, including community awareness and participation, as well as ongoing waste sorting and composting practices, to optimize external opportunities such as the development of waste-based economic ventures, multiparty support and guidance, enhanced environmental education, and innovations including digitalization of waste management. The W–O strategy is directed at addressing internal weaknesses, particularly institutional limitations, infrastructure maintenance, equitable waste sorting, and financial independence, through opportunities for collaboration, technical assistance, and strengthening of waste-based economic activities.

The S–T strategy focuses on utilizing social capital and existing management practices to confront external threats, such as declining community participation, equipment damage

risks, and weak local regulatory support, thereby ensuring operational sustainability. The W–T strategy emphasizes strengthening internal resilience by minimizing weaknesses and mitigating the impact of threats through diversified funding sources, preventive maintenance of infrastructure, and improvements in reporting systems and institutional governance. Overall, the five-dimensional sustainability analysis demonstrates that the management of Mojo Makmur TPS3R is a community-based interconnected system, where technical, institutional, socio-cultural, and economic aspects collectively determine long-term sustainability.

The institutional dimension shows relatively strong performance, particularly in indicators of collaboration and the existence of work programs. This condition underscores the critical role of multiparty networks in supporting TPS3R operations, including involvement from local government, community members, and external partners. The management's ability to establish partnerships has proven to expand access to technical and financial resources while accelerating knowledge transfer for more effective and sustainable waste management[25]. These networks represent valuable social capital in addressing internal limitations. Weaknesses remain evident in formal village-level policies, indicating that social strengths are not yet fully supported by adequate regulations. Strengthening local institutions through the development of village policies, standard operating procedures, and annual work plans is a fundamental requirement to ensure the long-term continuity of TPS3R management[26].

The ecological dimension demonstrates the strongest achievements compared to other dimensions, primarily through composting and source-level waste sorting practices. Community-based composting implementation has proven capable of reducing environmental pressure while generating economic benefits in the form of valuable products such as compost and organic fertilizers[27]. This success is highly influenced by the accessibility of household-level sorting systems and the consistency of ecological practices conducted by the community[28]. Recycling of inorganic waste still faces limitations due to market constraints and the absence of a stable value chain. Policy support and strengthened partnerships with the industrial sector are essential prerequisites for the further comprehensive and sustainable development of existing ecological practices[26].

The technological dimension shows relatively high achievements, supported by the availability of processing equipment and a reasonably adequate maintenance system. The use of appropriate technology, such as shredders and composters, has proven to increase processing efficiency and accelerate the implementation of the reduce, reuse, and recycle principles. The success of technology application largely depends on its suitability to local capacity and the existence of sustainable maintenance mechanisms[25]. Limitations are still apparent in management digitalization, which has not been optimally utilized to support recording, reporting, and operational transparency. The development of a simple digital system accompanied by technical guidance has the potential to enhance accountability and overall efficiency of TPS3R management[29].

The economic dimension remains the main challenge in Mojo Makmur TPS3R management, despite efforts to generate income from waste processing activities. Waste-based economic activities contribute to TPS3R independence but still face market uncertainties and relatively limited profit margins[30]. This situation affects the low incentive system for administrators, directly influencing motivation levels and operational sustainability. Literature indicates that economic sustainability requires fair compensation schemes and stable, long-term financing models[31]. Developing a circular economy through product diversification, expansion of business partnerships, and implementation of long-term purchase contracts is a critical strategy to strengthen the economic dimension of TPS3R[32].

The socio-cultural dimension shows that outreach and mentoring activities have promoted changes in waste sorting behavior among some community members. A continuous communication approach combined with practical facilitation has proven effective in establishing new household-level habits[28,33]. Weaknesses remain evident in the lack of

systematic integration of environmental education in schools and communities, risking the long-term sustainability of behavior change. Sustainable environmental education is required to build social norms and a collective sense of ownership of TPS3R as a community asset[29,33]. Overall, the analysis indicates that synergy among institutional strengthening, economic independence, technological innovation, and social participation is the key to transforming Mojo Makmur TPS3R into a more sustainable, adaptive, and resilient waste management system in the face of urban environmental challenges[34].

CONCLUSIONS AND RECOMMENDATIONS

The study results indicate that household waste generation in the research area is dominated by organic waste, reflecting a consumption pattern based on fresh food and domestic activities. Regional variations, age factors, and socio-economic background influence waste composition, although they do not significantly affect the total waste volume. This condition underscores that effective waste management should focus on controlling composition and promoting behavioral change within the community, rather than solely reducing waste quantity. The predominance of organic waste also highlights a substantial potential for optimizing source-based management through composting and community-based waste processing.

The management of Mojo Makmur TPS3R should prioritize increasing the consistency of household-level waste sorting through continuous education and community mentoring. Strengthening the capacity of managers through technical training, routine maintenance of infrastructure, and improvements in recording and reporting systems is essential to enhance operational effectiveness. The development of waste-based economic ventures, such as composting and recycling, should be encouraged to increase added value and provide incentives for both managers and the community.

Local governments need to reinforce policy support through village or sub-district regulations that mandate waste sorting, strengthen TPS3R institutional capacity, and establish sustainable funding schemes. Support in the form of market facilitation for recycled products, economic incentives, and multiparty collaboration should be enhanced to promote a community-based circular economy. Integrating TPS3R into urban waste management planning is expected to position Mojo Makmur TPS3R as a model of sustainable waste management at the local level.

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