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Waste Management System to Achieve a Clean and Beautiful City in Teminabuan District, South Sorong Regency

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A B S T R A C T

An effective waste management system is essential for creating a clean and beautiful city. This study aims to describe the waste governance system in Teminabuan District, South Sorong Regency; identify internal factors (strengths and weaknesses) and external factors (opportunities and threats); provide strategic recommendations based on SWOT analysis; and propose policy revisions for sustainable waste management. The study uses a descriptive quantitative and qualitative approach with SWOT analysis. Data were collected through interviews, field observations, documentation, and questionnaire distribution. The results show that the waste management system in Teminabuan District still faces several challenges, including limited infrastructure capacity, low community participation, and suboptimal operational efficiency. SWOT analysis places the strategy in quadrant III, which focuses on leveraging external opportunities to address internal weaknesses. The study concludes that waste management in the area still faces multiple barriers, such as the absence of temporary waste disposal sites (TPS), the need for landfill (TPA) upgrades, strengthening of waste transport systems, and public education. Internally, there is support from local government regulations on waste management; externally, there are national programs aimed at improving waste governance and revising policies that encourage active participation and stricter enforcement against illegal dumping. By implementing these strategies, waste governance in Teminabuan District is expected to become more effective, efficient, and sustainable, supporting the realization of a clean and beautiful environment

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INTRODUCTION

A clean and beautiful city reflects well-organized and effective environmental management (Costa, 2018). One of the most crucial components to achieve this goal is the implementation of an effective and sustainable waste governance system (Thamrin et al., 2022). Today, waste has become a global issue due to its increasing volume and its alarming state, as the quantity of unmanaged waste continues to grow (Sa'diyah et al., 2020). According to a World Bank report (2018), the world generates approximately 2.01 billion tons of waste annually, and this number is projected to rise to 3.4 billion tons by 2050 unless significant changes are made in waste management practices.

Data from Indonesia's Ministry of Environment and Forestry (2021) indicates that the national waste generation reached 67.8 million tons per year, of which 15.3% consisted of plastic waste—materials that can take hundreds of years to decompose naturally. In Teminabuan, the increasing volume of waste without adequate governance systems has resulted in various environmental problems. One of the primary challenges is the absence of official temporary waste collection points (TPS) and the limited availability of operational facilities.

Although the Regent Regulation No. 7 of 2021 concerning policies and strategies for household and household-like waste management has been enacted, the effectiveness of its implementation remains low. In addition to infrastructure problems, the waste collection system in Teminabuan has not operated optimally. Sanitation workers frequently face delays in waste collection services due to the limited number of vehicles and insufficient operational support. If such conditions persist, waste accumulation—accompanied by unpleasant odors—may lead to more severe environmental pollution.

Based on this situation, the main research problem can be formulated as follows: How is the waste governance system implemented in Teminabuan, in terms of both policy and practical application? Therefore, the objectives of this study are to describe the current waste management system, identify internal and external influencing factors, formulate management strategies based on SWOT analysis, and provide strategic policy recommendations for improving waste governance in the area.

LITERATURE REVIEW

According to Nugraha (2022), managing waste allows communities to collaborate in activities to solve waste problems. This shows that the community is highly concerned about waste issues and acts based on shared interests. According to Indriani, Heny, and Santoso (2021), the integrated waste management system implemented in Talang Village, Talang Subdistrict, Tegal Regency is the 3R system (Reduce, Reuse, Recycle). This integrated waste management has many effects, including a clean and healthy environment, improved socio-economic conditions of the community around the waste management site, and a reduction in the volume of waste disposed of (Mahyudin, 2014).

Sembiring (2022) stated that efforts to make Kediri City a smart environment depend on the interests of the actors involved, the strength of those actors, and how the system used to protect the environment is adapted to the

problems faced. It also depends on the expectations of the actors regarding their environment and the presence of external interventions.

According to Mirnawati (2018), the waste management by the City Sanitation Technical Implementation Unit (UPT) in Metro City is quite good, as evidenced by the cleanliness of the main roads and various achievements, including receiving the Adipura award as a Clean City. The increase in the original regional sanitation retribution revenue (PAD) in Metro City is not fully accessible due to a lack of labor and inadequate facilities and infrastructure for applying Good Governance principles.

In waste management, several cities around the world have succeeded by implementing various technologies and policies. For example, the technology-based waste management system in Surabaya has high community participation, allowing more than 70% of waste to be recycled (Wijaya et al., 2024). In Singapore, an effective waste management system using incinerators and other waste processing technologies has significantly reduced the amount of waste sent to landfills.

METHODOLOGY

Study Site and Duration

This research was conducted in the Teminabuan District, South Sorong Regency, over a period of four months, from October to January 2025. The study location map is presented in Figure 1.

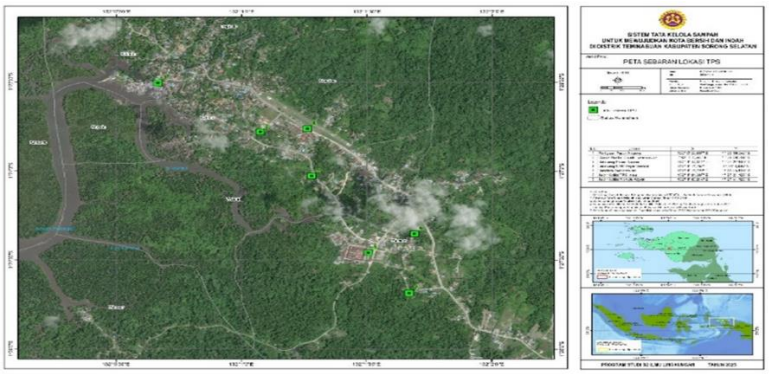

Figure 1. Study Area Map

Research Instruments and Materials

The tools used in this study included writing materials, interview instruments (such as audio recorders), cameras, and a laptop. The main material used was a questionnaire or structured list of questions. The variables in this study included; policies and regulations, Waste management infrastructure and systems, Community participation, and Environmental impacts.

Data Collection Techniques

Data were collected through interviews, questionnaire distribution, documentation, and direct observation. The study population comprised local residents and business actors (including markets, shops, and food vendors) within the vicinity of the temporary waste disposal site (TPS), as well as

government institutions such as the Environmental Agency (DLH) and sanitation workers. The total population is approximately 1,000 households (HHs) living near the TPS, with fairly even distribution across urban villages and hamlets. However, 100 households are located within a ±100 meter radius of the TPS or illegal dumping sites.

Sampling Technique

This research employed a descriptive quantitative approach to assess the level of policy implementation and community participation in waste management. Data were collected through structured interviews and analyzed using technical ratio analysis (Wawanudin, 2017). Additionally, the study incorporated qualitative elements through SWOT analysis to identify strengths, weaknesses, opportunities, and threats associated with the implementation of waste management policies. Therefore, a mixed methods approach was adopted, with a primary emphasis on descriptive quantitative analysis.

To obtain a representative sample that reflects the main characteristics of waste sources, purposive sampling was used. Respondents were deliberately selected based on their knowledge and understanding of the waste management situation in the study area (Prima & Putra, 2018). The sample size was determined using the Slovin formula (Sugiyono, 2020): The sample size was calculated using the Slovin formula, defined as follows: $\mathbf{n}=\frac{\sum Respondent\ score}{Total\ Rerspondent}$, where, n = sample size, N = population size, and e = margin of error (10%).

With a total population of 100 households (HHs) located within a ±100 meter radius of the temporary waste disposal site (TPS), a sample of 50 respondents was deemed sufficient. This is due to the relatively homogeneous social and environmental characteristics of the population and their direct exposure to waste-related impacts (Darmawan, 2014). The selected respondents—who were directly affected and engaged in in-depth exploration—were considered contextually representative and relevant for supporting the validity of the collected data (Widi Hartanto, 2009). According to data from the South Sorong Statistics Agency (BPS) in 2020, the population of Teminabuan District was recorded at 14,095 people. Teminabuan falls into the classification of a small to medium-sized city based on the Small City Index (IKK). Therefore, a sample of 50 households was considered proportionate and appropriate to reflect the characteristics of the area, as presented in Table 1.

Tabel 1. Respondent Sampling

No.	City	Population	Total Sample	Total Households
1	Metropolitan	1.000.000 – 2.500.000	1.000 – 1.500	200 – 300
2	Besar	500.000 – 1.000.000	700 – 1.000	140 – 200
3	Sedang, Kecil, IKK	3.000 – 500.000	150 - 350	30 - 70

Source: SNI-19-3964-1994

A total of 50 respondents were proportionally distributed across the study area within Teminabuan District. As Teminabuan is classified as a small city

based on the Small City Index (IKK), the respondents were allocated evenly to represent key zones within the district. The distribution of respondents is presented in Table 2 below.

Table 2. Distribution of Respondents by Area within Teminabuan District

No.	Respondent Category	Number of Respondents	Percentage (%)	Sampling Method
1	Community near illegal dump sites	30	60%	Purposive Sampling
2	Sanitation workers	10	20%	Purposive Sampling
3	Government (Environmental Agency / DLH)	5	10%	Purposive Sampling
4	Local business operators (market, shops, food stalls)	5	10%	Purposive Sampling
Total		50	100%	

Source: SNI-19-3964-1994

Analisis Deskriptif Kuantitatif

Evaluasi tingkat implementasi is calculated using formuale of Tingkat implementasi = $\frac{\sum Respondent\ score}{Total\ Rerspondent}$. The level of policy implementation, based on low, medium, and high categories, is generally regulated under the national standard SNI 19-2451-2002 concerning procedures for calculating the Cleanliness Index of Cities. However, for a broader measurement of policy implementation levels, the approach used follows SNI 7703:2011, which outlines procedures for evaluating the performance of waste management. The total score is obtained by summing the scores from each category based on the number of respondents who selected each respective category. This allows for the identification of how respondents assess the level of policy implementation.

Table 3. Levels of Waste Management Policy Implementation Based on Weighted Scores

No	Score Interpretation (%)	Implementation Level
1	Score < 60	Low
2	Score 60–80	Medium
3	Score > 80	High

Waste Management Infrastructure

Calculate the ratio of the capacity of Temporary Disposal Sites (TPS) or Final Disposal Sites (TPA) to the daily waste volume. The Capacity is then calculated by using formulae, i.e.Capacity Ratio = $\frac{Landfill\ Capacity\ (m^3)}{Montly\ waste\ volume\ \ (m^3)}$ X 100%. Operational Waste Management System is computed by using several indicators, ie. calculation of Transport Frequency and Efficiency, i.e. transport Frequency. The formulae applied, i.e. Freqiency (%) = $\frac{\text{Number of transport day}}{Ideal\ number\ of\ transport\ days}$ X 100%.

While Transport Efficiency, i.e. Efficiency (%) = $\frac{\text{Volume of wastes transported}}{Volume\ of\ wastes\ generated}$ X 100%. Community Participation is evaluated using Evaluation of Participation Level, i.e. using the formulae of Percentage (%)= $\frac{\text{Number of households sorting wastes}}{Total\ number\ of\ households}$ X 100%.

The total score is obtained by summing the results of the multiplication between the score value of each category and the number of respondents who made the statement. The scale of community participation levels is grouped ordinally into three categories as shown in Table 4.

Table 4. Levels of Community Participation in Cleanliness Management Based on Weighted Scores

No	Score Interpretation (%)	Level of Participation
1	33.33% – 55.55%	Weak
2	55.56% – 77.78%	Moderate
3	77.79% – 100%	Very Strong

Environmental Impact

Identification of Illegal Waste Sites records the number of illegal waste locations within the study area, then evaluates the pollution impact (water, soil, air) by observing and interviewing the local community. This helps to identify the Threats, namely environmental pollution caused by poor waste management. A descriptive narrative based on field findings and interviews explains the environmental impacts.

SWOT Analysis

SWOT analysis is used to identify and evaluate the waste management conditions in Teminabuan District based on internal factors (strengths and weaknesses) and external factors (opportunities and threats). The basic assumption in SWOT analysis is the paired condition between strengths and weaknesses as well as between opportunities and threats. This paired condition occurs because it is assumed that every opportunity opened always carries a threat that must be anticipated. The stages of preparing the SWOT analysis begin with identifying internal and external factors through questionnaire distribution, followed by prioritizing and weighting the questionnaire, determining weights and scores, then conducting quadrant analysis on the X and Y axes as well as SWOT matrix analysis, and finally formulating strategic recommendations.

RESULTS

General Description of the Research Location

Teminabuan District is one of the districts administratively located in South Sorong Regency, Southwest Papua Province. The area of Teminabuan District covers 386.89 km². Teminabuan District serves as the government center or capital of South Sorong Regency (BPS 2023). Demographically, based on BPS Teminabuan District data (2023), the population totals 19,876 people, with a higher number of males compared to females. Teminabuan District consists of 2

urban villages (kelurahan) and 14 rural villages (kampung). Geographically, it is situated between 01º21' – 01º51' South Latitude and 131º53'48'' – 132º10'36'' East Longitude. The demographic condition including population size and distribution in Teminabuan District can be seen in Table 5.

Table 5. Population Size and Distribution of Teminabuan District in 2020

No	Urban village/rural village	Population (thousands)			Population growth rate per year (%)	
		2010	2018	2019	2018	2019
	(1)	(2)	(3)	(4)	(5)	(6)
1	Wersar	584	695	707	21.06	1,73
2	Seribau	200	239	243	21,50	1,67
3	Kohoin	1742	2075	2112	21,24	1,78
4	Aibobor	399	475	483	21,05	1,68
5	Wehali	115	138	140	21,74	1,45
6	Kaibus	2677	3188	3246	21,26	1,82
7	Wermit	1709	2034	2070	21,19	1,77
8	Tapiri	105	125	127	20,95	1,60
9	Tegirolo	402	479	487	21,14	1,66
10	Gorolo	252	301	306	21,43	1,66
11	Magis	137	163	166	21,17	1,84
12	Nambro	636	759	772	21,38	1,71
13	Sayolo	950	1132	1152	21,26	1,77
14	Wernas	1021	1217	1238	21,25	1,73
15	Keyen	470	559	569	21,06	1,79
16	Any	229	272	277	20,96	1,84
	Total	11627	13851	14095	21,23	1,76

Source: South Sorong Regency Statistics Agency (BPS) 2020

Table 5 illustrates that the population of Teminabuan District experienced a fairly significant increase over a period of 9 years.

General condition of respondents

The general condition of respondents based on gender, age, education, and occupation from the waste generation points in Teminabuan District.

Table 6. Distribution of Respondents Based on Age, Gender, Occupation, and Education

No	Categorical Respondent	Total Respondent	Percentage (%)
1	Sex ration		
	➢ Man	24	48
	➢ Women	26	52
		50	100
2	Ages		
	➢ 18 – 25 yr	3	6
	➢ 26 – 35 yr	15	30

	➢ 36 – 45 yr	17	34
	➢ 46 – 55 yr	9	18
	➢ 55 - up	6	12
		50	100
3	Education		
	➢ Basic/Junior high	3	6
	➢ Senior High/	19	38
	➢ Bachelor	27	54
	➢ Magister	1	2
		50	100
4	Work		
	➢ Private sector	7	14
	➢ State officers	21	42
	➢ Bussiness	17	34
	➢ Other	5	10
		50	100

The community selected as respondents in this study are residents domiciled in the waste management service areas, namely Kaibus Village, Kohoin Village, and Wernas Hamlet. Observations show that the population of Teminabuan District is dominated by the productive age group (34%), and most of the residents work as Civil Servants (42%) and Entrepreneurs (34%).

General Condition of the Sample

The number of sample locations based on waste sources in Teminabuan District and their coordinate points are summarized in Table 7.

Table 7. Sample Locations Based on Waste Sources

No	Wastes source categorial	Sampling location	Coordinate point	
			X	Y
1	Housing wastes and commercial (mix)	- Pertigaan pasar Ampera	132° 0′ 39,857″ E	1° 26′ 30,349″ S
		- Depan Kantor Distrik	132° 1′ 4, 382″ E	1° 26′ 46,798″ S
		- Pasar Kajase	132° 1′ 30, 311″ E	1° 27′ 27,7561″ S
		- Jl Sengget	132° 1′ 16, 767″ E	1° 27′ 1, 685″ S
		- Depan Bandara	132° 1′ 15, 722″ E	1° 26′ 45,804″ S
		- Kaliat Wernas bekas TPA lama	132° 1′ 41, 387″ E	1° 26′ 21,126″ S
		- Jl Kaliat lama	132° 1′ 40, 214″ E	1° 27′ 41,123″ S

Waste Management Conditions in Teminabuan District

Teminabuan District has various sources of waste originating from household activities, markets, shops, and public facilities. The research results show that waste management in Teminabuan District is still conducted conventionally, meaning waste is collected, transported, and dumped in the landfill (TPA). Even temporary waste disposal sites (TPS) that accommodate residents' waste have not yet been established, so the process of waste reduction from the source to the TPS has not occurred. Law No. 18 of 2008 concerning waste management states that waste reduction can occur if it is done from the source by involving community participation. Waste management in Teminabuan District is carried out by the South Sorong Regency Government through the Environmental Service of Sorong Regency.

Waste accumulation is often found on the roadside in areas without temporary waste disposal sites (TPS). In addition, community habits of littering and the limited number of transport vehicles worsen the situation. This condition causes a decline in environmental aesthetics, increases the risk of disease, and adds to the environmental pollution burden. Waste management in Teminabuan District can be reviewed from policies and regulations, waste management infrastructure, operational systems, community participation, and environmental impact. The evaluation results of each variable are described as follows:

Policies and Regulations

Research results on waste governance in Teminabuan District show that the community generally knows about the waste levy regulations, but almost all respondents are not aware of the waste management regulations. There are four criteria that became the focus of questions to respondents. Based on the research results, the level of policy implementation can be seen in the following table.

Table 8. Community Response to Policies and Level of Implementation

Assessed aspect	Achievement Actualization				
	Category				
	Score	%	Low	Medium	High
Regional government policy related to waste management to create a clean and beautiful environment	36	72		√	
Strictness in enforcing existing waste management regulations	32	64	√		
Policies or regional regulations encourage community participation in waste management	34	68	√		
Existence of regional regulation on waste service retribution	45	90			√

Waste management should have improved to support sustainable development by referring to Law Number 18 of 2008 concerning Waste

Management. This waste regulation has been further reinforced by Government Regulation No. 81 of 2012 concerning Household Waste and Household-Like Waste Management, which mandates that waste producers must reduce and manage waste starting from the source (Mildayanti, 2021). The waste management policy in Teminabuan District has not been optimally implemented. This aligns with research by Nurufitriza (2013), which states that regulations that are not well enforced tend not to change community behavior. Consequently, the regulations must be strengthened, including stricter law enforcement and incentives for community participation. This indicates that policies or regulations on waste management at the district level are not yet fully known, understood, or optimally implemented by the community or relevant stakeholders.

The low knowledge and implementation of policies are caused by several main factors, including minimal dissemination of regulations, which corresponds with Fitri et al. (2020) who argue that waste management policies will only succeed if accompanied by continuous information dissemination and training to the community. According to Mayangkara et al. (2016), if there is no adequate budget allocation and supporting facilities, waste management policies will be difficult to implement. Based on interviews with the head of the environmental capacity building section, "Waste management policies, including levies, already exist but have not been well communicated through socialization or campaigns, so the implementation of waste governance remains very low and there has been no revision of policies or local regulations (PERDA)."

Waste Management Infrastructure

Based on research results in Teminabuan District, the variable of waste management infrastructure is analyzed through several indicators. The observation results are summarized in the following table 9.

Table 9. Waste Management Infrastructure Variable Indicators

Infrastructure Indicator	**Findings**	**Remarks**
Availability of TPS (Temporary Waste Storage)	7 active TPS found	2 are official TPS and 5 are unofficial or illegal dumping sites.
Availability of TPA (Final Disposal Site)	1 existing TPA	The existing TPA does not meet modern management standards. There is no waste sorting or further processing (e.g., recycling or composting).
Waste transport fleet	3 units available	2 of them are old vehicles and often break down.
Supporting facilities and infrastructure	No trash bins or waste carts available	Lack of budget for providing supporting tools and facilities.

The limited number of official Temporary Disposal Sites (TPS) causes residents to dispose of waste indiscriminately at illegal locations or create illegal TPS. According to a report by the Ministry of Environment and Forestry (KLHK, 2023), poor infrastructure is one of the main obstacles in waste management in many regions of Indonesia. Lack of investment in the development and maintenance of waste management facilities worsens the situation. Temporary disposal sites intended to hold communal waste have not yet been established, meaning that waste reduction from its source to the TPS has not occurred.

Based on direct observations and measurements, the volume and characteristics of waste in Teminabuan District from 7 waste disposal points amounted to 4,247 m^3 in December. With a landfill (TPA) capacity of 80,000 m^3, the landfill capacity ratio is 188%. This means the landfill capacity can accommodate the daily, monthly, and even yearly waste volume from Teminabuan District. The landfill capacity ratio is sufficient to hold the waste, so there should be no more waste piles at disposal points or roadside, and no pollution from waste buildup if all infrastructure, including facilities and equipment, operates effectively and efficiently. According to guidelines from the Ministry of Environment and Forestry, landfill capacity should be >100% of the total daily waste volume to accommodate population growth and economic activities.

Three aspects evaluated from the questionnaire distribution fall into the high category, as shown in Table 10 below.

Table 10. Community Response to Waste Management Infrastructure

Accessed Aspect	Achievement Actualization				
			Categoty		
	Score	%	Low	Middle	High
Limited waste collection facilities (TPS, containers)	48	96			√
Complete waste management facilities (disposal sites, cleaning tools)	41	82			√
Adequate facilities provided by the government	41	82			√

According to an interview with one of the sanitation workers, "The lack of garbage containers causes waste to always be scattered, which makes it difficult for us during collection. There is also no adequate waste disposal site available. As a result, unpleasant odors are noticeable in public places such as this market. We receive many complaints from the vendors who are directly facing the waste buildup."

Waste Management Operational System

Based on the research conducted in December, the actual number of collection days by the Environmental Service, specifically the sanitation workers, was 18 days in December. Given that the ideal daily frequency is 30 days per

month, the collection frequency is 60%, indicating that waste is not collected every day as per the ideal schedule. Consequently, waste piles up at disposal points, especially on days without collection, increasing the risk of environmental pollution. According to Nugraha (2022), the efficiency of waste collection depends on the availability of collection vehicles, consistent operational schedules, and the distance between Temporary Disposal Sites (TPS) and the Landfill (TPA). The problem is caused by a limited number of collection vehicles and suboptimal operational schedules. In an interview, a sanitation worker said, "The collection vehicles often break down due to their old age, and the operation, especially the fuel supply, is inadequate, which causes waste not to be collected." Meanwhile, the efficiency of waste collected was 3,162 m^3, while the volume of waste generated was 4,247 m^3. The waste data are as follows:

Table 11. Waste Data for December from Research Locations

No	Sumber sampah	Volume sampah Bulan (Desember (m^3/hari)	Volume sampah Bulan (Desember m^3)	Total terlayani	% terlayani
1	Pasar Kajase	68,89	1240	930	75
2	Pasar Ampera	55,11	992	775	78,12
3	Kelurahan Kaibus	51,67	930	620	66,67
4	Wernas	62,28	1085	837	77,14
	Total	237,95	4247	3.162	

Waste collection efficiency reaches 74.45%, which means that most of the generated waste is successfully transported to the landfill (TPA), but there is still 25.55% of waste that is not collected. Inefficient waste collection is due to insufficient transport fleet capacity to handle the daily waste volume and the distance between disposal points and the landfill being too far, reducing collection efficiency.

To achieve the goal of creating a beautiful and clean city, the current waste management operational system does not meet the requirements to realize such a city (Mah & Ibrahim, 2022). Improvements are needed to reduce waste accumulation at disposal points and increase the efficiency of waste transport to the landfill.

Community Participation

Community participation in waste management reflects the involvement or active role of the public in managing their waste independently. Community participation in waste management is dominated by passive participation (only disposing of waste to temporary disposal sites, TPS) without active participation such as waste sorting, managing waste independently, or innovating in waste reduction. According to a resident interviewed, "We who live near the roadside waste disposal area feel uneasy because we often reprimand people who litter. Actually, most of the waste dumped by the roadside is not from our residents.

Some residents do participate in waste sorting, but when the waste is dumped together by sanitation workers, this shows weakness due to limited facilities, education, and program implementation."

Based on research results from questionnaires and direct observation, community participation in waste management is generally still low or not optimal. The level of community participation can be seen in the weighted score table based on its assessment aspects below.

Table 12. Levels of Community Participation in Cleanliness Management Based on Weighted Scores

Accessed aspect	Achievement Actualization				
			Category		
	Score	%	Low	Midle	High
Lack of community participation in waste sorting	47	94			√
Community participation in waste collection from neighborhood units (RT) to the waste bank	11	22	√		
Lack of community participation in environmental cleanliness programs	48	96			√
Existence of mutual cooperation (gotong royong) behavior by the community	25	50	√		

Based on the range of percentage scores from respondent answers, community participation in waste management is considered weak. This weak participation is evident in the provision of facilities, environmental cleanliness (mutual cooperation), and the implementation of the 3R concept (Reduce, Reuse, Recycle). This phenomenon aligns with research conducted by (Wijaya et al., 2024), which states that lack of education and economic incentives are two factors that often cause low public awareness.

Mixed waste entering the landfill (TPA) accelerates accumulation and shortens the landfill's lifespan. The available trash bins are provided by the local government. Since there are no investors who can absorb recyclable waste for sale, the 3R concept is considered unimportant, and the community is reluctant to implement it. One factor causing low participation is poor education (Abdussamad et al., 2022). Additionally, people are not motivated to sort waste if there are no incentives. This poses a major challenge to achieving an effective and sustainable waste management system.

Environmental Impact

Based on observations and interviews with the head of the environmental service section and the community, there are 7 illegal waste sites scattered in several locations:

Table 13. Locations of Unofficial Waste Disposal Sites or Without Official TPS

Location Point	Environmental Condition	Environmental Impact Occurred
Ampera Market Intersection	Accumulated trash with a strong odor	Air pollution (unpleasant odor), disturbed city aesthetics, and potential disease source.
In front of Teminabuan District Office (Kaibus Village)	Trash scattered on the roadside	Reduces city beauty, breeding ground for flies, and disease factor.
Kajase Market	Accumulated trash with a strong odor	Air pollution (unpleasant odor), disturbed city aesthetics, and potential disease source.
Sengget Street (Kaibus Village)	Trash left accumulating	Disturbed aesthetics, potential odor disrupting comfort.
In front of the Airport	Trash piling up in place	Reduces city beauty as it is in front of a public facility.
Old Landfill Riverbank (Wernas)	Trash scattered and left piling up	Strong odor, decreased city aesthetics, and air pollution.
Riverbank towards Keyen (Wernas)	Trash scattered on the roadside	Unpleasant odor and disease factor.

In Teminabuan District, there are six illegal waste disposal sites causing contamination of soil, water, and air. According to a local resident who runs a kiosk at the market, "waste from the market and from everywhere is piled up, sometimes it is not collected for a week, it smells very bad, there are many flies. We have reported it to the village head but no action has been taken yet." Community habits are one of the reasons for the still low awareness of disposing of waste in designated places. In addition, there is no effective supervision system to stop illegal dumping. The environmental impact of these illegal waste sites includes a decline in city aesthetics due to waste accumulation, creating the impression of a slum environment. Disease vectors are also a consequence of illegal waste due to the proliferation of pests such as flies and rats (Surjandari et al., 2009).

Impact of waste on water, air, and soil pollution: Soil pollution requires laboratory testing of groundwater quality to detect BOD and COD levels in accordance with the thresholds set by the Ministry of Environment (Sari et al., 2023). However, in South Sorong Regency, there is no laboratory or clean water testing center, so there is no data on groundwater pollution. Air pollution is characterized by a foul odor from decomposing organic waste at illegal sites, especially during hot weather. There have been complaints from residents reporting respiratory irritation caused by illegal waste burning and decomposing organic waste (Sari et al., 2023). Soil pollution observations show that plastic residues and heavy metals are present in the soil around illegal dumping sites, which can damage soil structure.

The effects of pollution on water, soil, and air worsen environmental conditions and hinder efforts to achieve sustainable waste management. Improvements in the waste management system in Teminabuan District are needed because of these six illegal waste sites and their effects on water, soil, and air. To reduce environmental impact, methods such as improving TPS facilities, strict supervision, and community training must be implemented. These efforts can achieve the research objective of a clean and beautiful city.

SWOT Analysis

The results of the SWOT analysis based on the summary of the waste management system questionnaire in Teminabuan District can be seen in the table below:

Table 14. Internal Factors (IFAS)

No.		Importance	Weight	Urgency	
	Internal Factors	(1-5)	(0-1)	(1-4)	(Rel. Weight × Rating)
	Strengths	Weight	Relative Weight	Rating	Total Score
1	Complete waste management facilities (disposal sites, cleaning tools)	5	0.27027027	4	1.081081081
2	Adequate support from local government in providing facilities and resources for waste management	4.5	0.103828306	4	0.415313225
3	Waste collectors regularly transport garbage	3	0.162162162	2	0.324324324
4	Public awareness of the importance of waste management	2	0.108108108	3	0.324324324
5	Existence of a Regional Regulation (Perda) on waste service retribution	4	0.216216216	4	0.864864865
	Total	18.5	1.000		3.00990782
No.	Weaknesses	Weight	Relative Weight	Rating	Total Score (Rel. Weight × Rating)
1	Waste accumulation frequently occurs due to	3	0.181818182	4	0.727272727

	limited waste management facilities				
2	Weak enforcement of regulations and sanctions for waste governance violators	3.5	0.212121212	2	0.424242424
3	Lack of waste management planning systems, including a waste database	5	0.303030303	4	1.212121212
4	Waste collection fleet mixes all types of waste	3	0.181818182	3	0.545454545
5	Waste management development is not yet a regional priority	2	0.121212121	2	0.242424242
	Total	16.5	1.000		3.15151515

Table.15. External Factors (EFAS)

No.	External Factors	(1 - 5)	(0 - 1)	(1 - 4)	(Rel. Weight × Rating)
	Opportunities	Weight	Relative Weight	Rating	Total Score
1	Existence of national initiatives or programs that support improved waste management governance that can be adopted	3	0.142857143	3	0.428571429
2	Need for training or capacity building programs for sanitation workers and waste managers	5	0.238095238	4	0.952380952
3	Opportunity to raise public awareness on waste management through campaigns or outreach	4	0.19047619	3	0.571428571
4	Availability of new waste processing technologies that can be implemented	4	0.19047619	3	0.571428571
5	Opportunity to procure new facilities, such as temporary	5	0.238095238	4	0.952380952

	disposal sites (TPS) or waste sorting tools				
	Total	21	1.000		3.476190476

No.	Threats	Weight	Relative Weight	Rating	Total Score (Rel. Weight × Rating)
1	Risk of waste accumulation due to limited waste management facilities	4	0.228571429	3	0.685714286
2	Potential environmental pollution due to lack of waste management infrastructure	3	0.171428571	2	0.342857143
3	Irregular waste collection poses a threat to health and environmental cleanliness	4.5	0.257142857	3	0.771428571
4	Low public participation in cleanliness programs threatens success of waste solutions	4	0.228571429	3	0.685714286
5	Lack of public knowledge on environmental sanitation	2	0.114285714	2	0.228571429
	Total	17.5	1.000		2.714285715

Based on these values, the Grand Strategy Matrix is used to determine the next steps. The internal factors, or strengths and weaknesses, yielded a score of (-0.14160733), while the external factors, opportunities and threats, yielded a score of 0.761904761. Based on the weighted scores and ratings, the position of the internal and external factors in the waste management system falls into the following quadrant:

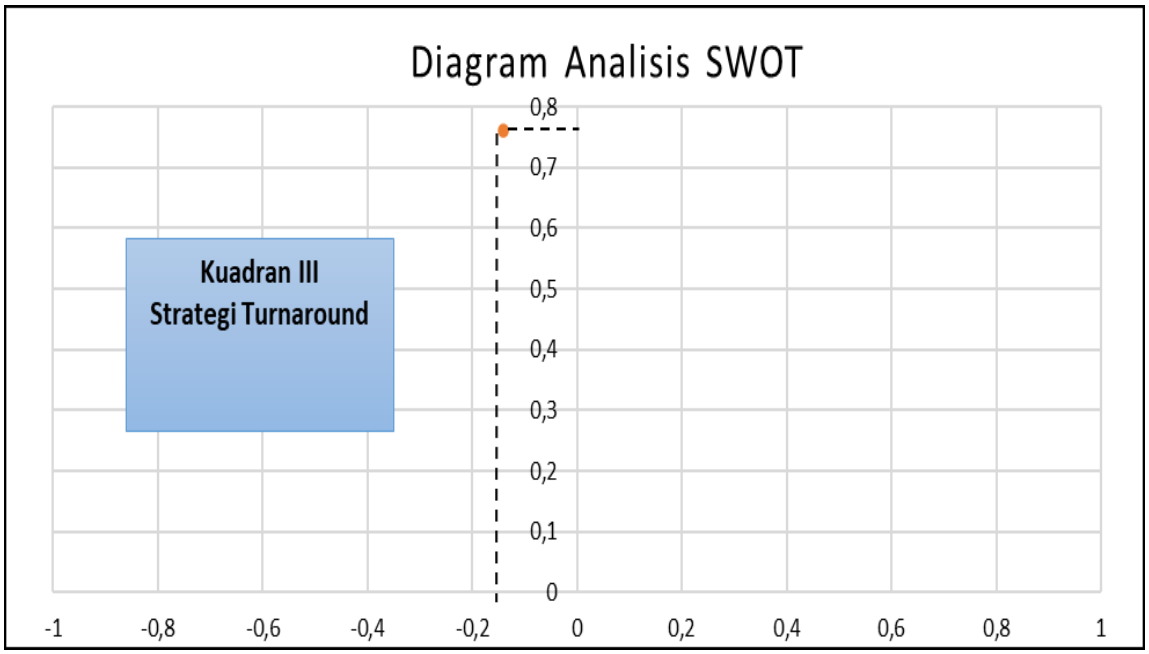

Figure 2. Matrix of Grand Strategy Result

Based on the identification of internal and external factors followed by the grand strategy, the next step is to determine the strategy using the assistance of a SWOT Matrix (Putri et al., 2023). Through matrix analysis, four strategy components will be produced as shown in the following table.

Table 16. SWOT Matrix

EFAS / IFAS	**Opportunities (Peluang)**	**Threats (Ancaman)**
	a. There are national initiatives or programs supporting improved waste management that can be adopted. b. Need for training or capacity-building programs for sanitation and waste management personnel c. Opportunity to raise public awareness on waste management through campaigns and outreach.	a. Risk of waste accumulation due to limited waste management facilities. b. Environmental pollution potential due to limited waste processing facilities c. Irregular waste collection by sanitation workers poses health and environmental cleanliness risks d. Lack of community participation in cleanliness programs poses a

	d. Availability of new waste processing technologies that can be applied e. Opportunity to procure new facilities, such as temporary disposal sites (TPS) or waste sorting equipment	threat to the success of waste management solutions. e. . Limited public knowledge about environmental sanitation.
Strengths(Kekuatan) a. Comprehensive waste management facilities (disposal sites, cleaning equipment). b. Strong support from local government in providing resources and facilities for waste management. c. Regular waste collection by sanitation staff or waste managers d. Public awareness of the importance of waste management e. . Existence of a Perda on waste service retribution.	**Strategi SO (Strengths - Opportunities)** a. Utilize local government support to adopt national waste governance programs. b. Use the regional regulation (Perda) on waste service fees to fund staff training and procure new facilities like TPS or sorting equipment. c. Expand outreach and education campaigns on the importance of waste management using existing d. Apply appropriate new waste processing technology to improve management efficiency	**Strategi ST (Strengths - Threats)** a. Use the Perda on waste service retribution to enhance regular waste collection. b. Ensure sanitation staff consistently perform waste collection to reduce pollution risks. c. Increase public participation in cleanliness programs through community-based incentives, such as awards for neighborhoods (RT/RW) with the best waste systems d. Use available cleaning tools to clean illegal dumping sites and reduce the risk of water, soil, and air contamination

	e. Involve sanitation staff in training on new technologies to increase operational effectiveness.	
Weaknesses(Kelemahan) a. waste accumulation in the environment due to limited facilities. b. Weak enforcement of regulations and sanctions against waste governance violators c. Lack of a structured waste planning system, including a waste database d. Waste collection fleet still mixes all types of waste e. Waste management development is not a regional priority	**Strategi WO (Weaknesses - Opportunities)** a. Use national training opportunities to enhance sanitation staff skills for more efficient waste management b. Address the lack of waste facilities by procuring new TPS supported by central government programs or public-private partnerships c. Leverage campaign and outreach opportunities to increase community participation in waste sorting and support 3R programs (Reduce, Reuse, Recycle) d. Apply automated sorting technology to manage the mismatch between waste volume and processing capacity.	**Strategi WT (Weaknesses - Threats)** a. Overcome facility limitations by adding more TPS in areas prone to illegal dumping. b. Reduce the public's lack of knowledge on environmental sanitation through training programs and community-based incentives c. Engage the community in waste bank programs to reduce household waste reaching TPS or landfill d. Reschedule waste collection to be more regular and prevent accumulation that could impact environmental health

The results of the grand strategy matrix indicate that the waste management strategy uses the WO strategy, which is to increase the number and quality of temporary disposal sites (TPS) through cooperation with the private sector. Conduct regular training for sanitation workers. Encourage community participation through education, incentives, and strengthening the 3R program. Implement simple technologies such as composters and waste sorting at the household level.

CONCLUSIONS AND RECOMMENDATIONS

Based on the research conducted, it can be concluded that:

1. The description of the waste management system in Teminabuan faces many obstacles, including inadequate infrastructure capacity and the absence of representative TPS, which causes waste accumulation at several illegal points such as Kajase market, the former landfill riverbank, and the riverbank leading to Keyen. Waste is disposed of indiscriminately in empty areas, roadside, and markets due to the lack of TPS.
2. Internal factors influencing the system include local government support in waste management regulations, availability of waste management facilities though not yet optimal, and increasing community awareness. External factors influencing waste management include support from national programs to improve waste management, the presence of new waste management technologies that can be applied, and opportunities to increase public awareness through campaigns.
3. Based on the SWOT analysis, the recommendations are to increase the capacity of TPS and TPA by adding more facilities and using advanced technologies such as digital waste banks, 3R TPS, and simple sanitary landfill-based TPAs. Training sanitation workers can help improve operational efficiency by enhancing knowledge and technical skills. Campaigns and education should be conducted regularly and sustainably to raise awareness and participation in waste management, expand the Waste Bank program, and optimize waste collection schedules to support the 3R principles (Reduce, Reuse, Recycle).
4. Proposed waste management policies include increasing waste service fees through gradual and proportional tariff adjustments, digitalizing the fee system such as using QR codes, stricter enforcement of regional regulations with sanctions and fines for littering, comprehensive socialization of the regulations, and strengthening the capacity of municipal police (Satpol PP) as enforcement officers. Partnerships between local government and the private sector can be established for infrastructure procurement such as developing TPS-3R, waste bank management or third-party managed TPAs, and local recycling industry development.

FURTHER STUDY

Every research is subject to limitations; thus, you can explain them here and briefly provide suggestions to further investigations.

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