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Research Article

Critical Analysis and Performance Optimization of Waste Management Facilities in Pontianak City

Maulana Nur[1*], Syafrial Nur[2] dan Nawawi[3]

[1]Master of Environmental Science, Postgraduate Program, Tanjungpura University, Pontianak
[2]Master of Social Sciences Education, FIPPS, PGRI Pontianak University, Pontianak
[3]Biology Education Study Program, FMIPATEK, PGRI Pontianak University, Pontianak
** corresponding author: Mnur5713@gmail.com*

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ABSTRACT

The rapid population and economic growth in Pontianak City have significantly increased waste generation, yet the capacity of existing waste management infrastructure remains insufficient. This study evaluates the facility requirements necessary for achieving the national waste reduction target of 30% by 2025, as stipulated in Presidential Decree No. 97 of 2017. A quantitative descriptive method was applied, utilizing secondary data from the National Waste Management Information System (SIPSN), the Environmental and Forestry Office of Pontianak City, and the Central Statistics Agency (BPS). Data were analyzed using descriptive statistics to assess facility development and simple linear regression with SPSS version 22 to project waste generation from 2023–2025. The results indicate a strong correlation between population growth and waste generation ($R^2 = 0.914$), with projected waste reaching 134,606 tons by 2025. A 30% reduction would require the diversion of 40,381 tons. Simulation analysis highlights the need for expanding TPS3R and Waste Bank Units, as well as optimizing current facility capacity. This study recommends strategic investment in infrastructure and operational fleets to ensure the achievement of the 2025 waste reduction target.

Keywords: Waste Management; TPS3R; Waste Bank; Waste Projection; Urban Sustainability

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INTRODUCTION

The increase in the number of population, accompanied by the development of economic activities in cities, has an impact on the environment, one of which is the emergence of environmental problems related to waste (Al-Shetwi, 2022). Meanwhile, the lifestyle and consumption of residents who lack knowledge about the process of reducing, sorting, and reusing waste can result in an increase in the amount, type, and diversity of waste characteristics (Pierini et al., 2021). Meanwhile, It is time for the management of "gathering-transporting-disposing" waste to be abandoned. The final handling model to the landfill is an old pattern that is outdated (Kamaruddin et al., 2021). Currently, the perspective of waste has been changed in accordance with Law No. 18 of 2008 that the waste produced is a resource that has economic value and is utilized (Andeobu et al., 2021). Waste according to the law can be reprocessed as a source of energy (Seif et al., 2024), compost (Rashid & Shahzad, 2021), raw

materials for industry and buildings and other benefits. So that in the end the final product of the waste that goes to the final disposal is no longer utilized and has no economic value.

Waste management can be carried out from the time the product has not become waste (from upstream) until after the product is finished being used and becomes waste. Waste management can be carried out from the time the product has not become waste (from upstream) until after the product is finished being used and becomes waste. In this study, the scope of the researcher is Pontianak City. Pontianak City is the administrative area with the largest population density in West Kalimantan (5,661 people/km2) (Kamaruddin et al., 2021). The total population of Pontianak City is 669,795 people with a total waste production in Pontianak City in 2022 of 396.30 tons/day. In accordance with Presidential Regulation (Perpres) Number 97 of 2017 concerning Government Policies and Strategies in terms of Waste Management both for Household Waste and Waste Similar to Household Waste, Pontianak City targets to reduce waste generation by 30 percent by 2025. To achieve this target, it is necessary to evaluate and plan waste management in Pontianak City so that waste in Pontianak City can be managed properly and optimally.

The purpose of the study is to analyze the needs of waste management facilities in Pontianak City based on the existing conditions of waste management and the target of achieving waste management performance using Presidential Decree of the Republic of Indonesia No. 97 of 2017 in Pontianak City. The purpose of the study is to get an overview of the condition of waste management and the level of achievement of waste management performance, analyze the needs of waste management facilities in Pontianak City in 2019-2025, and formulate strategies that need to be carried out by the Pontianak City Government so that the reduction target and aspects of waste management in Pontianak City can be achieved in 2025.

METHODS

This study uses quantitative data analyzed with the help of Microsoft Excel software for descriptive analysis and SPSS version 22 to calculate the projected waste generation from 2023 to 2025. The data used is secondary data sourced from the National Waste Management Information System (SIPSN), the Pontianak City Environment and Forestry Service, the Central Statistics Agency, and other supporting sources. The analysis method in this study is divided into two main parts, namely descriptive analysis and regression analysis. Descriptive analysis is used to describe in general the condition of waste generation per facility in Pontianak City. The variables analyzed include the development of the number of waste management facilities from 2019 to 2022, the rate of waste generation in 2019–2022, waste generation per capita in 2019–2022, The analysis method in this study is divided into two main parts, namely descriptive analysis and regression analysis. Descriptive analysis is used to describe in general the condition of waste generation per facility in Pontianak City. The variables analyzed include the development of the number of waste management facilities from 2019 to 2022, the rate of waste generation in 2019–2022, waste generation per capita in 2019–2022, the number of units, the amount of waste managed, and the average per unit based on the type of waste management facilities, as well as the distribution of waste management facilities per sub-district.

Meanwhile, regression analysis is used to project waste generation in 2023–2025. In this case, the number of population is used as an independent variable (X), while the amount of waste generation is a dependent variable (Y). The data used is the number of residents and waste generation in West Kalimantan Regency from 2019 to 2022. Before conducting regression analysis, classical assumption testing is carried out to ensure that the regression model used meets the criteria of estimation accuracy, unbiased, and consistent. The assumptions tested include normality, homoscedasticity, non-autocorrelation, non-multicollinearity, and linearity. The normality test uses the Kolmogorov-Smirnov method to compare the data distribution with the standard normal distribution. The hypothesis tested was H0: Normally distributed residuals, and Ha: Normally distributed non-normally distributed residuals. If the significance value (p-value) < 0.05, then H0 is rejected, meaning that the data is not normally distributed.

Furthermore, the determination coefficient (R^2) is used to measure how much the independent variable (population number) affects the dependent variable (waste generation). The R^2 value is categorized as strong if > 0.67, moderate if 0.33–0.67, and weak if 0.19–0.33. Linear regression tests were carried out to determine the influence of population on waste generation. Furthermore, the determination coefficient (R^2) is used to measure how much the independent variable (population number) affects the dependent variable (waste generation). The R^2 value is categorized as strong if > 0.67, moderate if 0.33–0.67, and weak if 0.19–0.33. Linear regression tests were carried out to determine the influence of population on waste generation. The hypothesis tested is H0: There is no effect of population on waste generation, and Ha: There is an influence of population on waste generation. If

the significance value (p-value) < 0.05, then H0 is rejected, meaning that there is a significant influence between the population and waste generation. The linear regression model used is $Y = \beta 0 + \beta 1X + \varepsilon$, where Y is the generation of garbage (dependent variable), X is the number of population (independent variable), β0 is the constant, β1 is the regression coefficient, and ε is the error term. With this method, this study aims to predict waste generation in Pontianak City until 2025 and provide recommendations based on the results of the analysis obtained.

RESULTS AND DISCUSSION

The development of waste management facilities available in Pontianak City from 2019 to 2022 has experienced a significant increase (Table 1). Although in 2019 to 2020 there was a stagnation in the number of management facilities, in 2021 there was a drastic increase with a total addition of 59 units or a three-fold increase compared to 2019. In 2022, there will be another increase in the number of waste management facilities with a total of 84 waste management units consisting of waste banks, composting houses, organic processing centers, TPS3R, TPST, PDU, and other units (collectors).

When observed from the average amount of managed waste per unit per facility, collectors have the largest average managed waste with a total of 762 tons per unit in 2022, followed by TPST with 301 tons per unit and Main Waste Bank with 281 tons per unit. The smallest average of managed waste in 2022 is at the Unit Waste Bank with 11 tons per unit.

The increase in the number of waste management facilities in Pontianak City from 2019 to 2022 reflects progressive steps in responding to the urgency of source-based waste management. The sharp spike in 2021 and 2022—with the addition of a total of 143 units marked an important turning point in the development of the city's waste infrastructure. However, the dynamics of each unit's capacity show a structural imbalance: the collection unit dominates with an average management of 762 tons per year, far exceeding the Unit Waste Bank which manages only 11 tons. This inequality indicates that the increase in quantity has not been fully offset by the improvement in the quality and efficiency of management. So, going forward, an approach that not only emphasizes expanding numbers, but also revitalizing technical and social capacities—especially in small units such as the Unit Waste Bank will be key to ensuring an equitable and maximum contribution to the achievement of the 2025 waste reduction target.

Table 1. Number of Units, Number of Managed Waste, and Average per Unit Based on the Type of Waste Management Facilities in Pontianak City in 2022.

No	Waste Management Facilities	Unit Quantity		Total Waste Managed (Tonnes)		Average per Unit (Tonnes)	
		Local Government	NGO	Local Government	NGO	Local Government	NGO
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Waste Bank Unit	-	18	-	194,28	-	10,79
2	Main Waste Bank	1	-	281,05	-	281,05	-
3	Compost House	1	-	108,98	-	108,98	-
4	RTRW Composting	-	1	-	21,90	-	21,90
5	POO	-	19	-	629,26	-	33,12
6	TPS3R	2	1	27,38	130,349	13,69	130,35
7	TPST	1	-	301,12	-	301,12	-
8	PDU	1	-	122,38	-	122,38	-
9	Collectors	-	39	-	29.721,95	-	762,10
	SUMMARY	6	78	840,91	30.697,74	140,15	393,56

Furthermore, the calculation of waste generation projections for 2025 was carried out. The results of the Kolmogorov Smirnov normality test obtained a significant value of 0.200. Reject H0 if the significant value < 0.05. H0 is accepted, meaning that the residual normality requirement for linear regression is met. In addition, the value of the determination coefficient (R2) was obtained by 0.914, meaning that 91.4 percent of the waste generation variables were explained by the population variable (independent variable), while 8.6 percent were explained by other factors. Meanwhile, the results for the ANOVA table have a significant value of 0.000 < 0.05, meaning that each treatment has a different effect. Meanwhile, from the coefficient table, the value of sig. The value of both the constant and the population is < 0.05. This means that there is an influence of the population variable on the waste generation variable. Because all conditions are met, the following model is obtained: Waste generation = -26,135.84 + (0.233 x population).

So that a projected waste generation for 2025 is obtained of 134,606 tons, and a 30 percent waste reduction target of 40,381 tons. Furthermore, a comparison was made with three districts that in 2022 have succeeded in achieving the target of 30 percent waste management, namely Pamekasan, Ciamis, and Banyumas Regencies. The results of the comparison of the three districts, including in terms of completeness of the types of facilities, show that Pontianak City is still more complete than the three districts with a total of nine types of facilities, while the three districts only have six types. However, in terms of the number of operational fleets and the management capacity per facility type, it is still necessary to maximize and optimize existing infrastructure. Similar findings were reported by (Budihardjo et al., 2023) in Semarang City, where the improvement of decentralized facility performance and fleet optimization were prioritized to achieve effective municipal solid waste management (MSWM). Moreover, (Harfadli et al., 2025) emphasized that sustainable waste management requires balancing environmental, social, and technical capacities through scenario prioritization that integrates local socioeconomic conditions. In addition, (Wibisono et al., 2020) highlighted that metropolitan cities such as Pontianak, which experience rapid urbanization, tend to face more complex waste challenges that demand higher investment in infrastructure and human resource capacity.

Table 2. Amount of Waste Managed and Percentage of Waste Management Achievement in Four Regencies in 2022

Unit Type	Amount of Waste Managed				Achievements in Waste Generation (%)			
	Banyumas	Pamekasan	Ciamis	Pontianak	Banyumas	Pamekasan	Ciamis	Pontianak
Waste Bank Unit	1,548	122,49364	2095,488	194,284	0,001	0,121	0,999	0,133
Main Waste Bank	-	309,36	1255,6	281,05	0,000	0,306	0,599	0,192
Compost House	-	85,7	-	108,98	-	0,085	-	0,074
RTRW Composting	-	50,98	-	21,9	-	0,050	-	0,015
POO	-	-	26765,2	629,26	-	-	12,760	0,429
TPS3R	6562,36	2220,03	3.336,10	157,724	3,359	2,195	1,590	0,108
TPST	13065,01	-	29720,53	301,125	6,688	-	14,169	0,205
PDU	10721,16	-	-	122,38	5,488	-	-	0,084
Collectors	0	28568,97	89148,38	29721,95	0,000	28,247	42,500	20,280

Based on Table 2, it can be observed that the performance of waste management facilities varies significantly across the four regencies. Ciamis Regency shows the highest overall achievement, particularly in the Collectors and TPST units, with performance levels of 42.50% and 14.17%, respectively, indicating strong infrastructure and operational capacity. Pamekasan also demonstrates considerable progress, especially in the Collectors and Main Waste Bank units, which contribute 28.25% and 0.31% of total waste management achievements. Meanwhile, Banyumas exhibits notable efficiency in large-scale facilities such as TPST and TPS3R, yet its total achievement remains relatively modest at below 7%, suggesting a need for broader facility distribution and community involvement. In contrast, Pontianak City, despite having a wider variety of facility types, shows relatively low achievement percentages across most units, with the Collectors accounting for the highest contribution at 20.28%. This indicates that Pontianak's waste management system is still highly dependent on collection-based mechanisms, rather than source-based waste reduction initiatives such as Waste Banks or TPS3R. Strengthening the operational capacity of these community-based facilities and expanding their reach could therefore enhance Pontianak's waste reduction performance toward the 2025 national target. Findings from Bandung City similarly show that TPS3R units perform well where community groups are engaged and operational monitoring is strong (Royhan et al., 2023). Meanwhile, in Sungai Penuh

City, many TPS3R and waste bank units were found to be underutilized, and the potential waste reduction could be significantly higher if management and capacity are optimized (Rahmadhani et al., 2024). Also, evaluation of waste bank performance in East Java reveals that even where waste bank coverage is good, diversion rates and sustainability depend heavily on program effectiveness and stakeholder involvement (Burhanuddin et al., 2024).

Table 3. Simulation of Target Achievement Based on Waste Management Unit Types in Pontianak City, 2025

Jenis Unit	Before				After			
	Unit Quantity	Total waste managed	average per unit	achievement (%)	Unit Quantity	Total waste managed	average per unit	achievement (%)
Waste Bank Unit	18	194,284	10,79	0,13	29	313,01	10,79	0,23
Main Waste Bank	1	281,050	281,05	0,19	5	1405,25	281,05	1,04
Compost House	1	108,982	108,98	0,07	29	6384,64	220,16	4,74
RTRW Composting	1	21,9	21,90	0,01	29	1158,26	39,94	0,86
POO	19	629,26	33,12	0,43	19	4497,21	236,70	3,34
TPS3R	3	157,724	52,57	0,11	3	434,19	144,73	0,32
TPST	1	301,125	301,13	0,21	1	1186,00	1186,00	0,88
PDU	1	122,381	122,38	0,08	5	2352,55	470,51	1,75
Collectors	39	29721,95	762,10	20,28	39	29721,95	762,10	22,08
TOTAL	**84**	**31.538,66**	375,46	**23,43**	**159**	**47453,05**	298,45	35,25

Based on data, waste generation in 2025 is projected to reach 34,606 tons, while the reduction target reaches 40,381 tons. This represents a very ambitious target and can only be achieved with significant improvements in waste management systems, especially in the TPS3R and Waste Bank sectors. Meanwhile, (Zakianis et al., 2019) The success of TPS3R is highly dependent on location, community participation, and clarity of roles between institutions. However, based on the results of this study, TPS3R in Pontianak only exists in 3 sub-districts and is only able to manage 0.11% of the total waste. By adding units to cover all sub-districts and increasing the capacity to 289 tons/unit (national average), TPS3R's contribution can be increased by up to 0.98%. (Royhan et al., 2023) said that the performance of TPS3R's community-based facilities and service indicators (Level of Service) as well as performance monitoring are very crucial in ensuring effectiveness. Waste Banks have great potential as a form of social entrepreneurship, but the challenge is distribution and community involvement (Suci et al., 2023). Meanwhile, Unit Waste Banks in Pontianak City are only available in 18 out of 29 villages in Pontianak. The existence of Waste Bank Units spread across each sub-district can increase residents' access as waste producers. Therefore, from the results of this comparison, combined with the average national capacity, it is possible to simulate the number and capacity per unit so that the target in 2025 can be achieved.

CONCLUSION

Waste management in Pontianak City is dominated by collectors with a total achievement in 2020 of 20.28 percent. Meanwhile, the contribution of other types of facilities is still not optimal for waste management. As a result of the simulation, the strategies that need to be carried out include increasing the fleet of each waste management facility. In addition, the capacity of each unit can still be increased. If these two things can be implemented, then by 2025 the target of 30 percent can be achieved.

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