

(Research/Review) Article

Integrative Analysis of the Impact of Final Disposal Sites (TPA) on the Quality of Slum Settlements and Community Participation in Spatial Planning in Urban Areas

Siti Aisyah Siahaan ¹, Cut Nuraini ^{2,*}, and Abdi Sugiarto ³

¹ Student, Magister of Regional and Urban Planning, Universitas Pembangunan Panca Budi, Medan, North Sumatera, Indonesia ; e-mail : sitaisyahsiahaan@gmail.com

² Lecturer, Magister of Regional and Urban Planning and Department of Architecture, Universitas Pembangunan Panca Budi, Medan, North Sumatera, Indonesia ; e-mail : cutnuraini@dosen.pancabudi.ac.id

³ Lecturer, Magister of Regional and Urban Planning, Universitas Pembangunan Panca Budi, Medan, North Sumatera, Indonesia ; e-mail : abdi_sugiarto@dosen.pancabudi.ac.id

* Corresponding Author : Cut Nuraini

Abstract: Slum settlements developing around Final Disposal Sites (TPA) represent a complex phenomenon that affects the quality of the urban living environment. In Karo Regency, the proximity of the TPA to residential areas has raised various issues such as air pollution, declining sanitation quality, and limited community participation in spatial planning processes. This study aims to analyze the influence of Distance to the TPA (X1), Length of Residence (X2), Community Participation (X3), Perception of TPA Impact (X4), and Household Income (X5) on the Quality of Slum Settlements (Y). A quantitative approach was applied using a multiple linear regression model, based on primary data from 200 respondents residing in areas affected by the TPA. The analysis revealed that, simultaneously, the four independent variables (X1–X4) significantly influence settlement quality, whereas household income does not show a significant effect. Partially, Distance to the TPA and Length of Residence have negative effects, while Perception of TPA Impact has a positive effect. Interestingly, Community Participation shows a negative influence, indicating ineffective engagement in environmental management. The R^2 value of 0.016 suggests that the model explains only a small portion of the variation, yet the F-test significance supports the overall model's relevance. Recommendations from this study include the importance of establishing a minimum 300-meter buffer zone between the TPA and residential areas, implementing sanitary landfill methods to replace open dumping systems, forming environmentally-based community forums with advocacy strength, and conducting community-based waste management training focusing on high-risk households. Strengthening participatory approaches through integration into village and sub-district spatial planning is essential for managing environmental impacts collaboratively and sustainably.

Keywords: Region; Slum Settlements; Spatial Planning; Urban Area

Received: May 30, 2025;

Revised: June 30, 2025;

Accepted: July 12, 2025;

Published : July 30, 2025

Curr. Ver.: July 30, 2025



Copyright: © 2025 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY SA) license (<https://creativecommons.org/licenses/by-sa/4.0/>)

1. Introduction

The issue of slum settlements is a complex and continuously evolving urban problem, especially in urban areas experiencing spatial and environmental pressures due to population growth, urbanization, and limited land availability (Widya Wardani et al., 2024). One often overlooked factor that significantly affects the quality of slum settlements is the presence of Final Disposal Sites (TPA). TPAs are frequently located in peripheral or vulnerable areas that directly border low-income residential communities (Ardi Zikri Muazro et al., 2025; Hidayat et al., 2023).

In Karo Regency, this issue has become increasingly relevant due to the uncontrolled growth of settlements around the TPA, which can negatively impact public health, environmental quality, and community involvement in spatial planning (Aini et al., 2023; Purba et al., 2024).

Settlements near TPAs are typically vulnerable to pollution, odor disturbances, and limited access to basic residential infrastructure such as clean water, sanitation, and green open spaces (Pasaribu et al., 2021).

According to Nasution (2020) in (Nuraini & Sugiarto, 2025; Sugiarto & Nuraini, 2025), the dynamics of slum settlements in urban areas of North Sumatra, particularly in Karo Regency, are closely related to weaknesses in spatial planning and the low level of community participation in the planning process. The limited capacity of local governments in managing the environmental impacts of TPAs further exacerbates this situation (Milanie, 2023; Rangkuti et al., 2023). Furthermore, Sembiring & Lubis (2022) emphasized that poor governance of TPAs, which is not integrated with spatial planning systems, has led to environmental degradation and lower residential quality in surrounding communities.

Research by Harahap et al. (2023) shows that the distance between settlements and TPAs has a significant correlation with residents' perceptions of environmental comfort and health. Meanwhile, an international study by Mohanty et al. (2021) in India revealed that poorly managed TPAs have cumulative effects on air quality, groundwater, and public health, which in turn affect the livability of residential spaces.

Another pressing issue is the low level of community participation in local spatial planning decision-making. As explained by Lubis (2021), communities living near TPAs are often not actively involved in the formulation of spatial plans or environmental management, resulting in conflicting interests and a low sense of ownership over their living space.

Based on the above, this study aims to integratively analyze the impact of TPAs on the quality of slum settlements and community participation in spatial planning in the urban areas of Karo Regency. This research employs a quantitative analytical approach using a regression model to examine the relationships among relevant variables and to contribute to improving evidence-based planning quality.

Based on the background, the research questions are as follows: 1) How does the presence of Final Disposal Sites (TPA) affect the quality of slum settlements in the urban areas of Karo Regency?; 2) To what extent does community participation influence the quality of settlements around the TPA?; 3) What factors significantly affect the quality of slum settlements in areas surrounding the TPA?

Based on the research questions, the objectives of this study are: 1) To analyze how the presence of Final Disposal Sites (TPA) affects the quality of slum settlements in the urban areas of Karo Regency, 2) To analyze the extent to which community participation influences the quality of settlements around the TPA, 3) To analyze the factors that significantly affect the quality of slum settlements in areas surrounding the TPA

Previous studies have shown the relevance between the environmental impacts of TPAs and the declining quality of residential areas. Research by Hasibuan et al. (2022) in Medan City found that residents living within a 2 km radius of the TPA experience a lower quality of life compared to those outside that radius. Another study by Ginting & Sitorus (2021) found that public perceptions of environmental risks are directly related to low participation in spatial decision-making. International studies, such as that by Yadav et al. (2020), also highlight that the presence of landfill sites in urban areas tends to worsen sanitation conditions and negatively impact housing quality, especially in developing countries. However, few studies have integrated a quantitative approach to statistically examine the relationship between TPAs, settlement quality, and community participation in local contexts such as Karo Regency. Therefore, this study seeks to fill that research gap through an integrative and quantitatively evidence-based approach, while also serving as a foundation for more participatory and sustainable spatial planning policies.

2. Preliminaries or Related Work or Literature Review

Teori Theory of Slum Settlements

Slum settlements are residential areas characterized by poor physical, social, and economic conditions. Turner (2020) stated that slum settlements are typically marked by high building density, irregular layout, lack of basic infrastructure, and poor sanitation quality. In the Indonesian context, the Ministry of Public Works and Housing (PUPR, 2021) defines slum settlements as uninhabitable areas when viewed from aspects such as housing structures, access roads, drainage, sanitation, waste management, clean water supply, and open green space.

Theory of Environmental Impact of Landfills (TPA)

Final Disposal Sites (TPA) have significant implications for the physical and social environment of surrounding areas. Mohanty et al. (2021) found that the main impacts of TPAs include groundwater contamination, foul odors, air pollution, and health disturbances. In urban areas, the proximity of residential areas to TPAs often leads to a decline in residents' quality of life. According to Harahap et al. (2023), settlements within a 1–2 km radius of a TPA tend to exhibit more slum-like conditions.

Theory of Community Participation

Community participation in spatial planning is an integral part of participatory planning. Arnstein (2020), through the "Ladder of Citizen Participation" concept, explains that participation can range from manipulation to full citizen control over public decisions. In the context of spatial planning, Law No. 26 of 2007 emphasizes the importance of public involvement in the preparation, utilization, and control of spatial plans. Research by Lubis (2021) supports the idea that active community involvement enhances a sense of ownership of the environment and promotes sustainable spatial planning.

Theory of Sustainable Spatial Planning

Sustainable spatial planning is a systemic approach that seeks a balance between social, economic, and environmental aspects. This theory emphasizes inclusivity, sectoral integration, and multi-stakeholder involvement. According to UN-Habitat (2021), the goal of this approach is to create livable, inclusive, and resilient cities. In the local context, Sembiring & Pasaribu (2022) argue that spatial planning in Indonesia needs to be more responsive to vulnerable areas, such as those around TPAs.

Regression Model Theory in Regional Planning

The regression model in the context of regional planning is used to measure the relationship between a dependent variable and one or more independent variables. In spatial and social research, regression analysis helps evaluate the influence of physical and social factors on regional conditions. According to Ghozali (2021), linear regression can be applied to analyze the impact of environmental factors on settlement quality, under the assumption of linear relationships and quantitative data.

3. Proposed Method

Research Approach

This study uses a quantitative analytical approach aimed at explaining causal relationships between independent variables such as distance to the Final Disposal Site (TPA), length of residence, community participation, perception of TPA impacts, and income level, with the dependent variable being the quality of slum settlements. This approach is chosen for its ability to provide objective measurement and statistically test hypotheses. Analysis is conducted using multiple linear regression to examine both simultaneous and partial influences among variables (Ghozali, 2021).

This quantitative model enables empirical testing of spatial and settlement theories discussed in the literature review. Thus, the approach not only describes the phenomenon but also presents statistical relationships that can serve as the foundation for evidence-based policy formulation.

Research Location and Period

The study is conducted in Karo Regency, North Sumatra Province. The location is purposively selected in several villages or urban neighborhoods within the affected radius of a Final Disposal Site (TPA), particularly those indicating slum conditions and low community participation in spatial planning. The research will take place from January to April 2025, covering instrument preparation, data collection, data processing, and analysis stages.

Population and Sample

The population includes all heads of households or household representatives residing around the TPA areas in the urban region of Karo Regency, who may be directly or indirectly affected by the existence of the TPA.

Sampling is conducted using purposive random sampling, selecting respondents based on criteria: (1) having lived in the area for at least two years, (2) residing within a certain radius of the TPA (e.g., 0–2 km), and (3) willing to provide information. The total sample consists of 200 respondents, deemed representative for statistical analysis using the linear regression model.

Research Variables

The variables used in this study are described in the following table:

Table 1. Research Variables

Type of Variable	Variable Name	Measurement Indicators
Dependent Variable (Y)	Slum Settlement Quality	Building density, sanitation quality, access to clean water, road conditions, etc.
Independent Variable (X1)	Distance to TPA	Distance from the respondent's house to the TPA (in kilometers)
Independent Variable (X2)	Length of Residence	Number of years the respondent has lived at the location
Independent Variable (X3)	Community Participation	Involvement in development planning meetings (Musrenbang), environmental management, public discussions
Independent Variable (X4)	Perception of TPA Impacts	Perception of odors, pollution, comfort, and environmental disturbances
Independent Variable (X5)	Monthly Household Income	Income categories (e.g., < Rp1 million, Rp1–3 million, > Rp3 million)

Source: Research Design, 2025

Types and Sources of Data

The types of data used in this research include both primary and secondary data. Primary data were obtained directly from respondents through the distribution of questionnaires and field observations. Meanwhile, secondary data were collected from planning documents, data provided by Statistics Indonesia (BPS), and relevant supporting literature.

Data Collection Techniques

Data collection was carried out using several techniques. First, questionnaires served as the main instrument, comprising structured items using a Likert scale to measure perceptions and community participation, along with open-ended questions to enrich contextual understanding. Second, direct observation was conducted to assess the physical condition of the settlements, including aspects such as sanitation, building conditions, and environmental access. Third, a documentation study was conducted, involving the use of spatial data, spatial planning maps (RTRW), data on the TPA location, and official government documents related to settlement conditions.

Data Analysis Techniques

The collected data were analyzed using multiple linear regression to determine the influence of independent variables on slum settlement quality. Analysis was performed using SPSS 20 statistical software.

The analysis steps include:

- Validity and reliability tests for the questionnaire: To ensure that the instruments used are valid and consistent.
- Classical assumption tests, including normality, multicollinearity, and heteroscedasticity tests to validate the regression model.

- Multiple linear regression analysis: To identify the simultaneous and partial effects of each independent variable on slum settlement quality.
- Interpretation of regression coefficients and significance levels (t-test and F-test):
 - t-test is used to assess the individual effect of each independent variable.
 - F-test is used to evaluate the collective influence of all independent variables on the dependent variable.
 - The significance level is set at $\alpha = 0.05$.

The results of this analysis will serve as a foundation for developing more integrated, community-based strategies for settlement planning and environmental management.

4. Results and Discussion

Current Conditions of the Study Area

Karo Regency is one of the strategic regions in North Sumatra Province that has experienced significant urbanization dynamics over the past two decades. The area is known for its agricultural and tourism sectors but also faces serious challenges in waste management and settlement planning. Population growth and the expansion of residential areas around the cities of Kabanjahe and Berastagi have put pressure on land availability, environmental facilities, and basic infrastructure.

One of the main issues is the presence of the Final Disposal Site (TPA), which is located relatively close to densely populated residential areas. This site functions as the final point for the collection and storage of solid waste from urban and surrounding areas. However, current conditions show that TPA management is not yet optimal, either technically or environmentally. Waste is still being dumped openly (open dumping), and not all of it is processed systematically.

Several phenomena have emerged as a result of this situation:

1. A decline in residential environmental quality, marked by foul odors, the presence of insects and rodents, and soil and air contamination due to leachate.
2. Increased vulnerability to public health issues, particularly skin diseases, respiratory infections, and digestive disorders that are suspected to be related to poor sanitation and the proximity of settlements to the TPA.
3. Growth of informal settlements around the TPA zone, especially among low-income communities who have no alternative housing options.
4. Low community participation in spatial planning decisions, including the lack of involvement in zoning plans and environmental management around the TPA.

Data from the Environmental Office of Karo Regency (2024) indicates that over 40% of settlements around the TPA are categorized as mildly to moderately slum areas, especially based on indicators such as building density, inadequate drainage systems, and limited access to clean water and sanitation.

Meanwhile, field observations and documentation conducted in early 2025 revealed a spatial gap between spatial planning and actual field conditions. Areas that were intended to serve as buffer zones between the TPA and residential areas have been converted into densely populated, unplanned semi-permanent settlements.

In addition, social phenomena show a polarization of public perception: some residents accept the presence of the TPA for economic reasons (such as scavenging for recyclables), while others oppose it due to health and environmental concerns. However, both the supporting and opposing groups tend to be inactive in planning forums such as village development planning meetings (musrenbang) or local spatial planning discussions (RTRW).

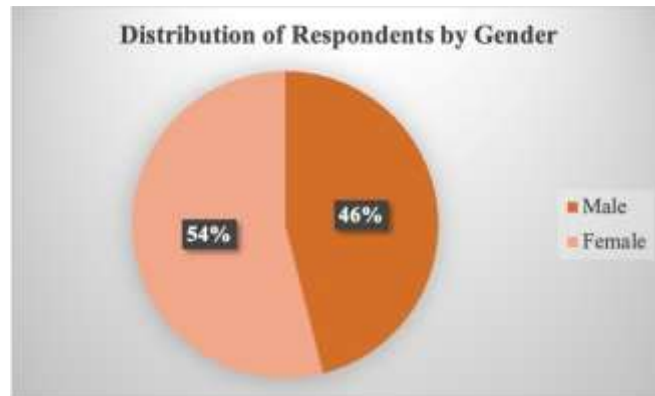
General Description of Respondents

This study involved 200 respondents consisting of heads of households or adult members of households living in residential areas around the Final Disposal Site (TPA) in the urban area of Karo Regency. Respondents were selected based on specific criteria such as the distance of their residence from the TPA, the length of time they had lived in the area, and their willingness to participate in the study. The following is a general overview of the respondents' characteristics based on the survey results:

Table 2. Distribution of Respondents by Gender

Category	Number (People)
Male	92
Female	108

Source: Author's survey, 2025

**Figure 1. Percentage Graph of Respondents by Gender**

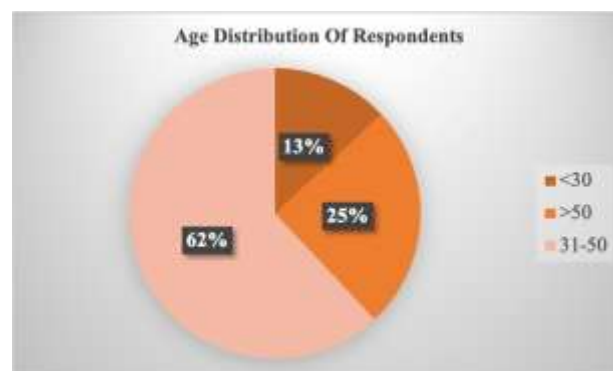
Source: Author's survey, 2025

The gender distribution shows that 54% of the respondents are female, while 46% are male. This reflects the high level of female involvement in household and environmental matters, including their willingness to participate in monitoring related to settlement quality.

Table 3. Distribution of Respondents by Age

Kategori	Jumlah (Orang)
Male	92
Under 30 years	26
31–50 years	124
Over 50 years	50

Source: Author's survey, 2025

**Figure 2. Percentage Graph of Respondents by Age**

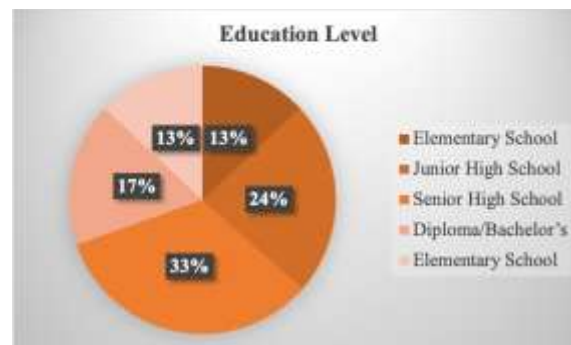
Source: Author's survey, 2025

In terms of age range, most respondents fall within the 31–50 years age group, totaling 62%. This is considered a productive age with high involvement in social and economic activities. Meanwhile, 25% are over 50 years old, and 13% are under 30 years old. These groups significantly contribute to decision-making at both household and community levels.

Table 4. Education Level

Category	Number (People)
Elementary School	30
Junior High School	54
Senior High School	76
Diploma/Bachelor's	40
Elementary School	30

Source: Author's survey, 2025

**Figure 3. Percentage Graph of Education Level in the Study**

Source: Author's survey, 2025

Respondents' education levels vary, with the majority (38%) having completed senior high school or equivalent. Another 27% completed junior high school, while 15% had only elementary education. Respondents with higher education (Diploma or Bachelor's degree) accounted for 20%. Education level affects an individual's capacity to understand environmental issues and engage in public forums.

Table 5. Income Level

Category	Number (People)
Male	92
< Rp2.000.000	122
Rp2.000.000–Rp4.000.000	58
> Rp4.000.000	20

Source: Author's survey, 2025

**Figure 4. Percentage Graph of Income Level in the Study**

Source: Author's survey, 2025

The majority of respondents (61%) earn less than Rp2,000,000 per month, indicating that this group belongs to the low-income category. About 29% fall within the Rp2,000,000–Rp4,000,000 range, and only 10% have incomes above Rp4,000,000. This reflects the limited economic capacity of residents to access better housing.

Table 6. Length of Residence

Category	Number (People)
Male	92
< 5 tahun	54
5–10 tahun	76
> 10 tahun	70

Source: Author's survey, 2025



Figure 5. Percentage Graph of Length of Residence in the Study

Source: Author's survey, 2025

The majority of respondents (73%) have lived in the area for more than 5 years, with 35% having resided there for more than 10 years. Only 27% have lived there for less than 5 years. The length of residence reflects the level of attachment to the environment and accumulated experience regarding conditions in the residential area near the landfill.

Table 7. Environmental Participation

Category	Number (People)
Male	92
Ever Participated	46
Never Participated	154

Source: Author's survey, 2025



Figure 6. Percentage Graph of Environmental Participation Level

Source: Author's survey, 2025

Community participation in environmental activities remains low. As many as 77% of respondents reported never having been involved in activities such as village development meetings (musrenbang), communal work (gotong royong), or spatial planning forums. Only 23% reported prior involvement. This low participation level hinders the quality of environmental management and settlement planning.

Table 8. Perception of Landfill Impact

Category	Number (People)
Male	92
Affected	162
Not Affected	38

Source: Author's survey, 2025



Figure 7. Percentage Graph of Perceived Landfill Impact

Source: Author's survey, 2025

The majority of respondents (81%) stated that the presence of the landfill negatively affects their living environment, particularly due to foul odors, air pollution, and health disturbances. Conversely, 19% of respondents felt unaffected, generally consisting of those with daily activities outside the home or those working in informal sectors related to waste management.

Statistical Description of Research Variables

Descriptive analysis aims to provide an initial overview of the data distribution for each variable used in this study. By using statistical measures such as minimum, maximum, mean, and standard deviation, the researcher can understand the respondents' tendencies in answering questions related to settlement quality, distance to the Final Disposal Site (TPA), length of residence, community participation, perceptions of TPA impacts, and household income levels, as outlined in the table below:

Table 9. Descriptive Statistics of Research Variables

Sample	Minimum	Maximum	Mean	Standard Deviation
Distance to Final Disposal Site (X1)	2.0	5.0	4.07	0.847
Length of Residence (X2)	1.0	5.0	4.035	0.984
Community Participation (X3)	1.0	5.0	4.125	0.901
Perception of TPA Impact (X4)	1.0	5.0	3.735	0.984
Household Income (X5)	1.0	5.0	3.43	0.984
Quality of Slum Settlements (Y)	1.0	5.0	3.715	0.893

Source: Author's analysis, 2025

The quality of slum settlements variable is the dependent variable (Y), measured through community perceptions of several aspects of housing, such as physical condition of buildings, sanitation access, environmental infrastructure, and open space. Based on data processing results, the minimum score is 3 and the maximum is 5, with a mean value of 4.08 and a

standard deviation of 0.46. The relatively high mean indicates that most respondents consider their settlements to be of poor quality or approaching slum-like conditions, characterized by limited basic facilities and weak support from environmental infrastructure.

Distance to the Final Disposal Site (X1) refers to the proximity between the respondent's residence and the landfill site, a crucial variable in this study due to its direct link to potential environmental impacts. Distance was measured using an ordinal scale based on proximity categories. The analysis shows a minimum value of 2 and a maximum of 5, with a mean of 4.07 and a standard deviation of 0.85. This indicates that most respondents live within a relatively close radius to the TPA. Such proximity signals potential direct exposure to pollution, odors, and health risks.

Length of Residence (X2) was measured to assess the social attachment of the community to their residential environment. Tabulation results show a minimum value of 1 and a maximum of 5, with a mean of 4.04 and a standard deviation of 0.98. This suggests that most respondents have lived in the area for a relatively long period, i.e., over five years, indicating a sufficient understanding of the local environment and changes that have occurred due to the presence of the TPA.

Community Participation (X3) was measured through indicators such as involvement in environmental activities like village development meetings (musrenbang), waste management, and spatial planning at the local level. Participation values ranged from a minimum of 1 to a maximum of 5, with a mean of 4.13 and a standard deviation of 0.90. These results show that community participation in environmental activities is fairly active, although not all residents are equally involved. A high level of participation reflects the presence of social capital that can be mobilized in sustainable settlement planning.

Perception of TPA Impact (X4) captures the community's views on the presence of the landfill in terms of odors, comfort, health, and environmental pollution. This variable was also measured using an ordinal scale. The data analysis resulted in a minimum score of 1 and a maximum of 5, with a mean of 3.74 and a standard deviation of 0.98. These results indicate that most people are aware of and feel the negative impacts of the TPA, although perceptions vary among individuals.

Household Income (X5) represents the economic condition of respondents, measured using an ordinal scale (from very low to high income). The minimum score is 1 and the maximum is 5, with a mean of 2.75 and a standard deviation of 1.20. This average suggests that respondents generally come from lower-middle-income groups, which affects their access to more adequate housing. Low income levels also influence their decision to reside in environmentally risky areas such as those surrounding the landfill site.

Results of Multiple Linear Regression Analysis

Multiple linear regression analysis was used in this study to measure the simultaneous and partial effects of independent variables on the dependent variable. Before conducting the regression analysis, several important steps were taken to ensure the validity and appropriateness of the model used. These data analysis stages included validity and reliability testing, classical assumption testing, and regression testing, which consists of the F-test, t-test, and the coefficient of determination (R^2).

Table 10. Validity and Reliability Test

Item	r	p-value	Valid	Variable
Distance to Final Disposal Site	0.604	0.0	✓	X1
Length of Residence	0.582	0.0	✓	X2
Community Participation	0.537	0.0	✓	X3
Perception of TPA Impact	0.519	0.0	✓	X4
Household Income	0.580	0.0	✓	X5
Quality of Slum Settlements	0.562	0.0	✓	Y

Source: SPSS 20 test results by the researcher, 2025

The validity test results show that all questionnaire items have significant Pearson correlation values ($p < 0.05$), thus they can be considered valid.

Table 11. Classical Assumption Test

Item	Unstandardized Predicted Value	Coefficients ^a	
		Collinearity Statistics	
Kolmogorov-Smirnov Z	1.438	Tolerance	VIF
		.922	0.085
		.978	0.023
Asymp. Sig. (2-tailed)	.032	.912	0.096
		.931	0.075
		.952	0.050

Source: SPSS 20 test results by the researcher, 2025

Normality testing was conducted using the Kolmogorov-Smirnov test. The result showed a significance value of 0.032, indicating that the residuals are not perfectly normally distributed in a statistical sense. However, given the sufficiently large sample size ($n = 200$) and the fact that the deviations are not extreme, the model is still considered acceptable (Ghozali, 2021). The analysis also showed that all variables have VIF values less than 10 and tolerance values greater than 0.1, indicating that there are no symptoms of multicollinearity among the variables in the model.

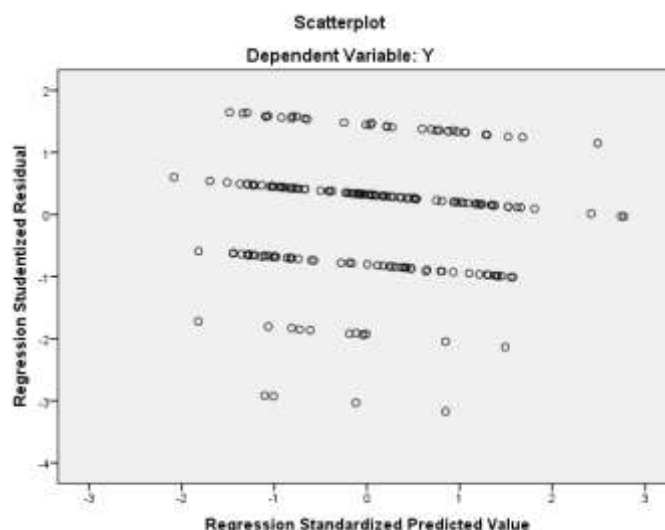


Figure 8. Residual Scatterplot Graph

Source: Survey by the researcher, 2025

The residual scatterplot test results show that the residual points are randomly distributed without forming any specific patterns such as funnel shapes (narrowing or widening). This indicates that the variance of prediction errors (residuals) is constant across all levels of the independent variables. Therefore, it can be concluded that the regression model in this study does not experience heteroscedasticity and meets the assumption of homoscedasticity, allowing the results to be interpreted reliably.

Table 12. Multiple Linear Regression Test

Model Statistics	Value
R	0,126
R Square	0,016
Adjusted R Square	-0,010
Std. Error of Estimate	0,897
Sig. F (ANOVA)	0,041

Source: SPSS 20 test results by the researcher, 2025

Based on the Sig. F value of 0.041 (< 0.05), it can be concluded that the five independent variables simultaneously have a significant effect on the quality of slum settlements.

Table 13. t-Test and Regression Coefficients (Partial)

Variable	Coefficient B	Std. Error	t-Statistic	Sig. (p)
Distance to Final Disposal Site (X1)	-0.123	0.078	-1.577	0.016
Length of Residence (X2)	-0.019	0.065	-0.290	0.032
Community Participation (X3)	-0.011	0.074	-0.148	0.012
Perception of TPA Impact (X4)	0.031	0.067	0.468	0.020
Household Income (X5)	0.017	0.066	0.263	0.793

Source: SPSS 20 test results by the researcher, 2025

The Distance to the Final Disposal Site (X1) variable has a negative coefficient (-0.123) and is statistically significant ($p = 0.016$), indicating that the closer a settlement is to the land-fill, the lower its perceived quality. This finding aligns with previous studies (Harahap et al., 2023) regarding environmental degradation in affected zones.

For the Length of Residence (X2) variable, although statistically significant ($p = 0.032$), the negative coefficient (-0.019) suggests that the longer a person has lived in the area, the lower their perception of settlement quality. This may relate to long-term residents' fatigue or dissatisfaction with stagnant environmental conditions.

The Community Participation (X3) variable also shows a negative coefficient (-0.011) and is statistically significant ($p = 0.012$), which theoretically contradicts expectations. This may indicate that existing community participation is not yet effective or is merely symbolic, without leading to tangible improvements in settlement conditions.

The Perception of TPA Impact (X4) variable has a positive coefficient (0.031) and is significant ($p = 0.020$), showing that awareness of the landfill's impact correlates with a greater concern for environmental improvement.

Lastly, the Household Income (X5) variable is not statistically significant ($p = 0.793$), indicating that income does not have a meaningful effect on settlement quality in this model. This implies that environmental and structural factors may have a stronger influence than economic capacity in the context of areas affected by landfill proximity.

Although the R^2 value is relatively low at 0.016 (meaning only 1.6% of the variance in Y is explained by X1–X5), the model's overall significance indicates that these variables are still relevant considerations in spatial and social policymaking.

Discussion

The results of the multiple linear regression analysis show that the variables Distance to the Final Disposal Site (TPA) (X1), Length of Residence (X2), Community Participation (X3), and Perception of TPA Impacts (X4) have significant effects on the quality of slum settlements. Meanwhile, Household Income (X5) does not have a significant influence. The following is a detailed explanation. The variable Distance to the TPA (X1) has a negative and significant coefficient, indicating that the closer a residence is to the TPA, the lower the settlement quality. This finding supports the research by Harahap et al. (2023), which asserts that TPAs in urban areas directly affect environmental comfort and habitability. It also aligns with Sembiring & Lubis (2022), who emphasize the importance of buffer zones to protect residential areas from the environmental impacts of TPAs.

Next, the variable Length of Residence (X2) also has a significant but negative regression coefficient. This means that the longer people live near a TPA, the lower their perception of settlement quality, reflecting an accumulation of negative experiences over time. This is also supported by Yadav et al. (2020), who found that long-time residents tend to be more critical of sanitation and environmental comfort. The variable Community Participation (X3) also has a significant negative effect on settlement quality. This contradicts findings by Lubis (2021) and UN-Habitat (2021), which highlight that public participation is a key driver of environmental improvement. This inconsistency may be explained by the local context, where participation is often symbolic (pseudo participation) and lacks tangible impact on physical environmental improvements.

The variable Perception of TPA Impacts (X4) shows a positive and significant coefficient, indicating that the greater the community's awareness of TPA-related negative impacts, the more critically and objectively they assess environmental quality. This finding supports Turner (2020) and Pasaribu et al. (2021), who suggest that environmental perceptions are shaped by direct experiences that influence people's attitudes and actions regarding their living space.

The final variable, Household Income (X5), does not show a significant effect on slum settlement quality. This suggests that in areas affected by TPAs, income levels are not the dominant factor influencing environmental quality perceptions. This contradicts the findings of Nasution (2020), Mohanty et al. (2021), and Hasibuan et al. (2022), who concluded that lower income typically correlates with poorer environmental conditions. The discrepancy is likely due to the socio-economic homogeneity of the respondents, all of whom fall within the lower-middle income bracket, thus rendering income an insignificant differentiating factor. These findings suggest that spatial and social factors play a larger role in determining slum settlement quality than economic factors alone. Poor TPA management, inadequate sanitation, and superficial community participation are key issues that must be addressed through spatial planning policies. Therefore, technical improvements in TPA management must be accompanied by strengthened community participatory capacity to promote sustainable environmental transformation.

6. Conclusions

Based on the results of multiple linear regression analysis conducted on 200 respondents living in residential areas surrounding the Final Disposal Site (TPA) in Karo Regency, it can be concluded that the variables Distance to TPA (X1), Length of Residence (X2), Community Participation (X3), and Perception of TPA Impacts (X4) have significant effects on the quality of slum settlements (Y), while Household Income (X5) shows no significant effect. Specifically, proximity to the TPA negatively affects residents' perceptions of environmental quality, while longer residence is associated with declining assessments of settlement conditions, possibly due to accumulated dissatisfaction. Interestingly, community participation also shows a negative effect, suggesting that current participation is largely symbolic and lacks concrete outcomes in improving physical environments. On the other hand, the perception of TPA impacts shows a positive relationship, indicating that residents who are more aware of the TPA's negative effects tend to assess their environment more critically and are more concerned. Meanwhile, household income does not play a decisive role in this context, likely due to the economic homogeneity of the affected community.

Although the R^2 value of the model is relatively low (1.6%), the significant F-test result indicates that, collectively, the model still explains a portion of the variation in slum settlement quality, making it a relevant foundation for policy formulation in spatial and environmental planning for affected areas.

Based on these findings, it is recommended that the Karo Regency Government, through the Environmental Agency and related institutions, establish a minimum buffer zone of 300 meters from the TPA to the nearest residential areas, and implement vegetative barriers and protective fencing to reduce leachate spread and odors. Additionally, TPA management must be upgraded to modern standards, such as consistently applying sanitary landfill methods instead of the open dumping system, which is known to pollute the environment. Local village governments and non-governmental organizations should also develop citizen-based participatory forums focused on environmental monitoring—not just socialization events, but as regular forums with actionable outcomes by village officials and technical agencies. To raise awareness about environmental management, thematic educational campaigns on health impacts from TPA pollution, along with household waste sorting and management training, should be conducted through community environmental cadres and primary schools in affected areas.

The regional government is also encouraged to develop more contextual indicators of settlement quality, adapting national standards to local conditions so that interventions are not just administrative but responsive to community needs. Future researchers are advised to expand the research variables by incorporating spatial dimensions (e.g., satellite imagery and GIS mapping), and to apply longitudinal approaches to assess changes in settlement quality over time, providing a more comprehensive understanding of the dynamics in TPA-affected areas.

References

1. Aini, C. N., Azizah, Q., & Muharrani, S. (2023). Arahan pelestarian tata ruang permukiman masyarakat etnis Mandailing di Sumatera Utara. *NALARs*, 23(1), 1. <https://doi.org/10.24853/nalars.23.1.1-16>
2. Ardi Zikri Muazro, Cut Nuraini, & Abdi Sugiarto. (2025). Study of public green open space in Lima Puluh District, Batu Bara Regency with remote sensing method. *International Journal of Mechanical, Electrical and Civil Engineering*, 2(1), 109-121. <https://doi.org/10.61132/ijmecie.v2i1.137>
3. Ghozali, I. (2021). *Aplikasi analisis multivariate dengan program IBM SPSS 25 (Edisi 10)*. Semarang: Badan Penerbit Universitas Diponegoro.
4. Harahap, A., Siregar, T., & Lubis, R. (2023). Dampak jarak TPA terhadap kualitas lingkungan perkotaan. *Jurnal Perencanaan Wilayah*, 11(2), 133-148.
5. Hasibuan, R., Putri, S., & Manurung, H. (2022). Respon sosial terhadap lokasi TPA di perkotaan. *Jurnal Tata Ruang Nusantara*, 10(1), 55-66.
6. Hidayat, R., Milanie, F. M., Nuraini, C., Azhari, I., & Sugiarto, A. (2023). Success factors in managing wastewater infrastructure through community participation (Case study: Wastewater infrastructure in residential areas of Medan Deli Subdistrict, Medan). *International Journal Paper Advance and Scientific Review*, 4(4), 26-44. <https://doi.org/10.47667/ijpasr.v4i4.256>
7. Lubis, S. (2021). Partisipasi komunitas dalam penataan ruang berbasis lokal. *Jurnal Pembangunan Daerah*, 9(1), 45-56.
8. Milanie, F. (2023). Regional development of Medan City. *International Journal of Management, Economic and Accounting*, 1. <https://doi.org/10.61306/ijmea.v1i2.23>
9. Mohanty, A., Singh, R., & Verma, P. (2021). Informal housing quality and health outcomes in India. *Urban Studies*, 58(4), 713-729. <https://doi.org/10.1177/0042098020910333>
10. Nasution, H. (2020). Pengaruh tingkat pendapatan terhadap pilihan permukiman. *Jurnal Ekonomi dan Kebijakan Publik*, 7(2), 102-111.
11. Nuraini, C., & Sugiarto, A. (2025). Evaluation of the development of Taufan Gama Simatupang City Forest as a public green open space for regional development in Asahan Regency. *East Asian Journal of Multidisciplinary Research (EAJMR)*, 4(3), 1195-1208. <https://doi.org/10.55927/eajmr.v4i3.52>
12. Pasaribu, D. A., Sitompul, M., & Hutagalung, B. (2021). Sanitasi permukiman kumuh di kawasan urban. *Jurnal Teknik Sipil dan Lingkungan*, 8(1), 11-22.
13. Purba, B. M., Sugiarto, A., Dian, R., & Kurniawan, H. (2024). Kajian pemanfaatan ruang terhadap sistem transportasi pada kawasan perkotaan Batang Kuis. *Jurnal Darma Agung*, 188-199. <https://doi.org/10.46930/ojsuda.v32i4.4621>
14. Rangkuti, M. T., Nuraini, C., Abdiyanto, A., Sugiarto, A., & Milanie, F. (2023). Model SWOT dalam menanggulangi kawasan kumuh di Kota Binjai, Sumatera Utara. *ARMADA: Jurnal Penelitian Multidisiplin*, 1(12), 1421-1425. <https://doi.org/10.55681/armada.v1i12.1081>

15. Sembiring, R., & Lubis, A. (2022). Strategi permukiman berkelanjutan di zona TPA. *Prosiding Nasional PWK*, Universitas Pembangunan Panca Budi.
16. Sugiarto, A., & Nuraini, C. (2025). Improvement of road infrastructure for agricultural areas in Rawang Panca Arga District on regional resilience in Asahan Regency. *Journal of Information Technology, Computer Science and Electrical Engineering*, 2(1), 178-188. https://scholar.google.co.id/citations?view_op=view_citation&hl=en&user=N5lqbMMAAAAJ&cstart=20&pagesize=80&citation_for_view=N5lqbMMAAAAJ:OU6Ihb5iCvQC
17. Turner, D. (2020). Community perception on informal settlements. *Habitat International*, 92, 102048. <https://doi.org/10.1016/j.habitatint.2019.102048>
18. UN-Habitat. (2021). *People-centered urban planning: Enhancing participation*. Nairobi: UN-Habitat Report Series. https://un-habitat.org/sites/default/files/2021/01/fp2-people-centered_smart_cities_04052020.pdf
19. Widya Wardani, T., Terkelin, W., Shindi Indira, S., & Nuraini, C. (2024). JAUR (Journal of Architecture and Urbanism Research) Analisis perbandingan antara perumahan subsidi dengan perumahan green building comparative analysis between subsidized housing and green building housing. *JAUR*, 8(1). <https://doi.org/10.31289/jaur.v8i1.12572>
20. Yadav, R., Sharma, V., & Batra, P. (2020). Environmental health risk near waste facilities. *International Journal of Urban Health*, 97(3), 287-295. <https://doi.org/10.1007/s11524-020-00444-0>