Strategy for Improving the Quality of Slum Settlements Through Environmental Infrastructure Enhancement

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Abstract
Slum settlements are one of the major urban issues in many Indonesian cities, including in Tegal Sari Subdistrict, Kisaran City. This study aims to analyze strategies for improving the quality of slum areas through the enhancement of environmental infrastructure using SWOT analysis. Data were collected through surveys of 150 respondents, in-depth interviews, and field observations. The results indicate that the quality of environmental infrastructure in Tegal Sari is still poor, particularly in terms of drainage systems, sanitation, and access to clean water. Community participation in environmental planning and maintenance remains low, while government policies have had limited impact due to minimal citizen involvement and a lack of program sustainability. The SWOT analysis identifies significant opportunities to improve slum areas through collaboration among government, communities, and the private sector. Strategic recommendations proposed in this study include the implementation of eco-drainage systems based on green technology, the use of blockchain for transparent distribution of housing improvement aid, and participation-based incentives for community-led infrastructure maintenance. These innovations are expected to provide sustainable solutions for enhancing environmental quality and improving the well-being of residents in slum settlements.

Keywords: Slum Settlements, Environmental Infrastructure, Community Participation, SWOT.

Introduction

Slum settlements remain one of the major challenges faced by many cities in Indonesia, including Kisaran City in Asahan Regency. These areas are characterized by high building density, inadequate infrastructure, and poor sanitation, all of which contribute to a lower quality of life for residents. In recent years, despite efforts to address these issues, the quality of environmental infrastructure in several areas still falls short of the expected standards (Nuraini, 2019, 2024). Problems such as inadequate drainage systems, limited access to clean water, and substandard sanitation facilities remain persistent challenges (Hidayat et al., 2023; Meka Hasianta & Sugiarto, 2024). These conditions not only affect public health but also have wider social and economic implications.

Previous research has highlighted the importance of improving environmental infrastructure as a key strategy in addressing slum conditions. For example, a study by Yunus and Muvidayanti (2019) emphasized that population growth due to urbanization contributes to the expansion of slum areas, thereby requiring a comprehensive management strategy. Furthermore, research by Maulana (2020) demonstrated that community participation and collaboration with various stakeholders are crucial to the success of slum settlement improvement programs.

In the specific context of Kisaran City, particularly in Tegal Sari Subdistrict, these issues are especially critical. A preliminary survey conducted by the researcher in 2024 revealed that approximately 60% of households in the area lack access to safe and adequate clean water, and more than 70% of drainage systems are non-functional, resulting in frequent flooding during the rainy season. Additionally, the available public sanitation facilities do not meet health standards, increasing the risk of disease outbreaks. Therefore, this study focuses on developing strategies to improve the quality of slum settlements through the enhancement of environmental infrastructure in Tegal Sari. It is hoped that this research will make a tangible contribution to improving the quality of life for local residents.

Literature Review

A. Definition of Slum Settlements

Slum settlements are residential areas deemed uninhabitable due to poor physical and environmental conditions. According to UN-HABITAT (2007 in Sugiarto & Kustiah Ramadania, 2024), a slum household is defined as a group of individuals living under one roof in an urban area that lacks one or more of the following indicators:

1. Durable Housing: Structures that can protect occupants from extreme weather conditions.
2. Sufficient Living Space: Ideally, no more than three people should share one room to ensure comfort and health.
3. Access to Safe Drinking Water: Availability of safe and affordable drinking water.
4. Access to Adequate Sanitation: Proper sanitation facilities for the disposal of human waste.
5. Security of Tenure: Legal protection against forced eviction or uncertainty in land ownership.

In addition, Law No. 1 of 2011 on Housing and Settlements in Indonesia defines slum settlements as areas that are unfit for habitation due to irregular building arrangements, high building density, and inadequate quality of housing and infrastructure.

B. Characteristics of Slum Settlements

Slum settlements have several defining features that distinguish them from livable residential areas. According to Milasari et al. (2021), these characteristics include:

1. Building Density: Closely packed buildings with minimal spacing and often lacking proper urban planning.
2. Building Quality: Use of temporary or low-quality materials, such as wood or salvaged items, making structures vulnerable to damage.
3. Infrastructure Availability: Limited access to basic facilities such as clean water, sanitation, drainage, and waste management.
4. Socioeconomic Conditions: Most residents work in the informal sector with low incomes, limited education, and poor access to healthcare services.
5. Land Tenure Security: Many slum settlements are built on land without clear legal ownership, such as state land or disputed areas.

C. Causes of Slum Formation

Several factors contribute to the formation of slum areas, including:

1. Uncontrolled Urbanization: Migration from rural to urban areas without adequate housing provision leads to the development of informal settlements.
2. Poverty: Economic hardship forces people to live in low-cost areas despite poor living conditions.
3. Limited Land Availability: High urban land prices drive low-income populations to settle in undesirable areas such as riverbanks or near railway tracks.
4. Poor Urban Planning: Inadequate city planning that overlooks the housing needs of low-income populations contributes to slum development.
5. Lack of Law Enforcement: Weak monitoring and enforcement of land use regulations and building codes allow slums to proliferate.

D. Impacts of Slum Settlements

The presence of slum settlements has various negative impacts on both residents and the surrounding environment, such as:

1. Health: Poor sanitation increases the risk of infectious diseases such as diarrhea, dengue fever, and respiratory infections.
2. Environment: Improper waste disposal causes land and water pollution.
3. Social Issues: High population density and inadequate living conditions can trigger social conflict, crime, and other security issues.
4. Economic: Poor health conditions and lack of access to education and decent employment reduce productivity and economic potential.

E. Strategies to Improve Slum Settlement Quality Through Environmental Infrastructure Enhancement

Improving the quality of slum settlements requires a comprehensive approach involving various aspects, particularly environmental infrastructure. Key strategies include:

1. Provision of Clean Water: Developing or upgrading water distribution systems to ensure that every household has access to potable water.
2. Improvement of Sanitation Systems: Constructing adequate sanitation facilities such as hygienic public toilets and effective waste treatment systems to prevent environmental pollution.
3. Drainage Upgrades: Building or improving drainage systems to prevent waterlogging and flooding, which are potential sources of disease.
4. Waste Management: Providing efficient waste disposal facilities, such as temporary collection points and regular waste transport systems, while encouraging community participation in recycling programs.

Conceptual Framework

The conceptual framework of this study illustrates the relationship among the research variables and the analytical process conducted. The following is a flowchart representing the conceptual framework of the study:

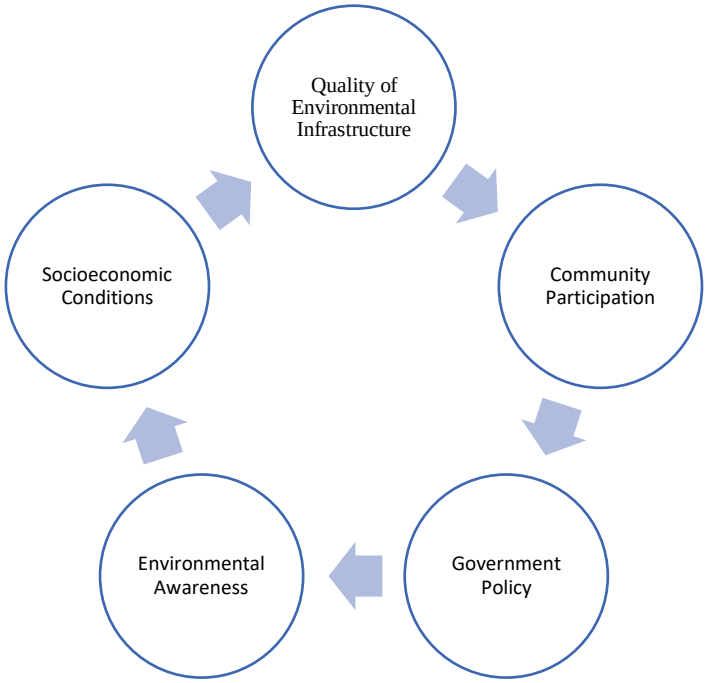

Figure 1. Conceptual Framework of the Study
Source: Author's Compilation, 2025

The flowchart above illustrates the research process, starting from the identification of slum settlements, data collection based on the research variables, SWOT analysis, and ending with the formulation of strategies to improve the quality of slum settlements through the enhancement of environmental infrastructure.

Results nd Discussion

A. Current Conditions of Slum Settlements in Tegal Sari Subdistrict

Tegal Sari Subdistrict, located in Kisaran City, Asahan Regency, North Sumatra, is one of the areas facing significant slum settlement issues. Based on field observations conducted in June 2024, the following current conditions were identified:

1. Building Density: The buildings in this area are extremely close to each other, with distances of less than one meter between them. This results in poor air circulation and limited access to natural lighting.
2. Building Quality: Most of the houses are constructed from semi-permanent materials such as wood and used zinc sheets, which are prone to damage and not durable.
3. Environmental Infrastructure:
    a. Roads: Most roads in the settlement are unpaved and become muddy during the rainy season, hindering residents' mobility.
    b. Drainage: The drainage system is not functioning properly, leading to standing water and an increased risk of disease.
    c. Sanitation: Public sanitation facilities are limited and do not meet health standards, with many households disposing of domestic waste directly into the environment without treatment.

4. Roads: Most roads in the settlement are unpaved and become muddy during the rainy season, hindering residents' mobility.
   Drainage: The drainage system is not functioning properly, leading to standing water and an increased risk of disease.
5. Sanitation: Public sanitation facilities are limited and do not meet health standards, with many households disposing of domestic waste directly into the environment without treatment.

B. Survey Results

A survey was conducted in July 2024 involving 150 respondents who are heads of households in Tegal Sari Subdistrict. Data collection was carried out using a questionnaire covering the research variables: Quality of Environmental Infrastructure, Community Participation, Government Policy, Environmental Awareness, and Socioeconomic Conditions

C. Respondent Characteristics

The following results present the distribution of respondents based on age, gender, education level, and occupation:

Table 1. Respondent Characteristics

Category	Sub-Category	Number of Respondents	Percentage (%)
Age	18-30 years	30	20
	31-45 years	60	40
	46-60 years	45	30
	>60 years	15	10
Gender	Male	90	60
	Female	60	40
Education	Did not complete primary school	45	30
	Primary school or equivalent	60	40
	Junior high school or equivalent	30	20
	Senior high school or equivalent	15	10
	Higher education	0	0
Occupation	Daily laborer	75	50
	Small-scale trader	45	30
	Informal worker	20	13.3
	Unemployed	10	6.7

Source: Primary Data, 2025

D. Quality of Environmental Infrastructure

Respondents were asked to assess the condition of environmental infrastructure in their area. The results are shown in the following table:

Table 2. Respondents' Assessment of Environmental Infrastructure Quality

Aspect	Good (%)	Fair (%)	Poor (%)
Road Condition	10	30	60
Drainage System	5	25	70
Sanitation Facilities	8	20	72
Access to Clean Water	15	35	50

Source: Primary Data, 2025

The majority of respondents rated the environmental infrastructure in their area as poor, particularly in terms of the drainage system and sanitation facilities.

E. Community Participation

The following table presents the level of community participation in the planning, implementation, and maintenance of environmental infrastructure.

Table 3. Community Participation Level

Aspect	High (%)	Moderate (%)	Low (%)
Planning	20	30	50
Implementation	25	35	40
Maintenance	15	25	60

Source: Primary Data, 2025

Community participation was lowest in the maintenance of environmental infrastructure, with 60% of respondents reporting low levels of involvement.

F. Government Policy

Respondents were asked to assess the effectiveness of government policies in managing slum settlements. This assessment covered various programs and policy measures implemented in the study area.

Table 4. Respondents' Assessment of Government Policy

Aspect	Very Effective (%)	Fairly Effective (%)	Less Effective (%)	Not Effective (%)
Housing assistance programs	10	30	40	20
Provision of clean water	8	35	42	15
Drainage system improvement	5	25	50	20
Environmental policy outreach	7	28	45	20

Waste management	6	32	47	15

Source: Primary Data, 2025

This table illustrates how respondents evaluated the effectiveness of government policies related to improving slum settlement conditions. Key conclusions include:

a. Housing assistance programs and provision of clean water are perceived to be relatively more effective than other aspects.
b. Drainage system improvement is considered the least effective, with 50% of respondents indicating that the program has not had a significant impact.
c. Environmental policy outreach and waste management are still viewed as less effective by the majority of respondents.

SWOT Analysis

To determine strategies for improving the quality of settlements through the enhancement of environmental infrastructure, a SWOT analysis was conducted to identify internal and external factors influencing settlement improvement.

Table 5. SWOT Analysis

Factor	Identification
Strengths	Existence of environmentally-conscious community groups; some facilities already built
Weaknesses	Limited community participation; budget constraints
Opportunities	Support from central government programs; potential partnerships with private sector
Threats	Inconsistent policy changes; increasing urbanization

Source: Primary Data, 2025

The SWOT analysis in this study includes the following components:

a. Strengths: Several environmentally-conscious community groups are actively involved in improvement efforts, and some basic facilities have already been constructed.
b. Weaknesses: Community participation remains low, and budget limitations present a major challenge.
c. Opportunities: There is support from central government programs and potential for partnerships with the private sector in upgrading slum settlements.
d. Threats: Inconsistent policy changes and increasing urbanization pose significant risks, potentially leading to the expansion of slum areas.

Discussion

Based on the research findings outlined earlier, this discussion connects the results with previous studies—both those that support and those that diverge from the current findings—and includes references to relevant international journals.

A. Quality of Environmental Infrastructure

The research results show that the majority of respondents rated the environmental infrastructure in Tegal Sari Subdistrict as poor, particularly in terms of the drainage system and sanitation facilities. This finding aligns with the study by Azis and Giriwati (2024), who found that poor environmental infrastructure is one of the main indicators of slum settlements in Malang City.

Additionally, Sari and Ridlo (2021 in Nuraini, 2017, 2021) identified that the deterioration of physical environmental quality, such as damaged drainage and sanitation systems, is a hallmark of slum areas. Another study by As'ari (2018) emphasized the importance of environmentally based slum upgrading to improve community quality of life.

However, this finding contrasts with the study by Pratiwi et al. (2018), which found that some slum settlements had adequate infrastructure but were still considered slums due to socioeconomic factors. This discrepancy may be attributed to variations in local conditions and government policies.

B. Community Participation

Community participation in the planning, implementation, and maintenance of environmental infrastructure in Tegal Sari was found to be relatively low, especially in terms of maintenance. This is consistent with the findings of Azis and Giriwati (2024), who stated that community participation in improving slum settlement quality remains low.

Pratiwi et al. (2018 in Aini et al., 2023; Nuraini et al., 2023) also found that community participation in slum upgrading efforts in Parit Nenas, Siantan Hulu Subdistrict, remained low—particularly in planning and maintenance activities. Similarly, Wiarni et al. (2018) highlighted low public participation as a key obstacle in slum settlement management.

On the other hand, research by As'ari (2018) showed that with the right approach, community participation can be significantly increased in environmentally based slum settlement planning. These differences indicate that strategies and approaches used strongly influence levels of community involvement.

C. Government Policy

Respondents' assessments of government policy effectiveness in slum management indicate that housing assistance programs and clean water provision are perceived as more effective compared to drainage system improvements and waste management. These findings are in line with the study by Azis and Giriwati (2024), who noted that government programs often prioritize housing and water access, while other aspects receive less attention.

However, research by Pratiwi et al. (2018) emphasized that comprehensive policies involving community participation can significantly enhance the effectiveness of slum settlement management. This variation underscores the importance of a holistic approach to slum policy interventions.

D. SWOT Analysis

The SWOT analysis identified strengths such as the presence of environmentally-conscious community groups and some basic infrastructure already in place. Weaknesses include low community participation and budget constraints. Opportunities include support from central government programs and potential private-sector partnerships. Threats involve inconsistent policy changes and increasing urbanization. These findings align with Azis and Giriwati (2024), who emphasized the importance of collaboration between the government, community, and private sector in addressing slum settlements. However, Pratiwi et al. (2018) argued that without active community involvement, slum management efforts will not be sustainable.

Conclusion

Based on the findings of this study regarding strategies to improve the quality of slum settlements through environmental infrastructure development in Tegal Sari Subdistrict, it can be concluded that the condition of environmental infrastructure in the area remains inadequate, especially in terms of drainage systems, sanitation, and access to clean

water. Community participation in environmental improvement and maintenance efforts is still relatively low, highlighting the need for more innovative strategies to enhance citizen engagement in the management of environmental facilities. Meanwhile, government policies have shown positive impacts in certain aspects, such as housing assistance programs and clean water provision. However, weaknesses remain, particularly in the sustainability of policy implementation and the limited involvement of communities in the process. The SWOT analysis reveals a substantial potential to improve slum conditions through collaboration between the government, communities, and the private sector. Opportunities such as national program support and private-sector partnerships can be optimized, while major threats—including inconsistent policy changes and rising urbanization—must be anticipated as they pose risks to the future of slum conditions.

To accelerate slum improvement efforts, several underutilized but high-potential strategies are recommended. First, the application of eco-drainage systems using green technologies—combining biofiltration and phytoremediation—can enhance natural wastewater management and reduce flooding risks. Although successfully implemented in several European cities, this system has not been widely adopted in Indonesia. Second, the use of blockchain technology in aid distribution could ensure transparency and accountability in funding environmental improvements such as sanitation and clean water, thus increasing public trust. This approach has been piloted in some developing countries but has yet to be integrated into slum management in Indonesia. Third, the development of community-based infrastructure maintenance incentive schemes—such as utility subsidies for active residents—has proven effective in enhancing civic engagement in Latin American cities, although such models remain rare in Indonesia. Fourth, the use of digital applications for real-time waste management reporting, connected to municipal sanitation services and recycling networks, can improve waste handling efficiency and public awareness. This system has shown positive results in advanced urban settings but is still largely absent in Indonesian slums. Lastly, community empowerment through circular economy models—encouraging residents to transform plastic and organic waste into economically valuable products such as alternative building materials and organic fertilizers—can address waste issues while simultaneously enhancing the economic resilience of slum communities. Such approaches support both environmental and socioeconomic sustainability.

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