SUDEIJ
Sustainable Urban Development and Environmental Impact
SUDEIJ 2(2): 137–152
ISSN 3062-8997

Institute for Advanced Science, Social and Sustainable Future
MORALITY BEFORE KNOWLEDGE

# Identifying basic infrastructure priorities for slum management through analytical hierarchy process (AHP): A local government perspective

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Received Date: June 18, 2025 Revised Date: July 20, 2025 Accepted Date: August 31, 2025

## ABSTRACT
**Background**: Padang, as a national activity center, continues to face serious challenges related to urban slum settlements, primarily due to the limited provision of basic infrastructure. While infrastructure provision is considered one of the most effective strategies to address these issues, its implementation remains difficult due to the varying perceptions among government stakeholders responsible for infrastructure development. In this context, identifying priority infrastructure becomes crucial. **Methods:** This study aims to identify infrastructure priorities for slum upgrading using a mixed-methods approach. The analysis incorporates the perceptions of seven key stakeholders from the local government, employing the Analytical Hierarchy Process (AHP) alongside qualitative descriptive methods based on interviews and field observations. **Findings:** The results reveal that the prioritized infrastructure components, in order of importance, are drainage, clean water, wastewater management, solid waste management, neighborhood road improvement, and fire protection. These priorities may serve as a guideline for the Padang City Government in realizing a city that is progressive, safe, clean, orderly, inclusive, and respectful of local wisdom. **Novelty/Originality of this article:** This research offers a unique contribution by presenting infrastructure provision priorities from the perspective of local government—an aspect that remains underexplored in slum settlement studies.

**KEYWORDS**: basic infrastructure; slum settlements; infrastructure provision priority.

## 1. Introduction

Uncontrolled urbanization is frequently associated with the emergence of slum settlements (Cohen, 2006; Nursyahbani & Pigawati, 2015). These areas, often characterized by inadequate basic infrastructure (Kusumawardhani et al., 2016), continue to expand and create various urban challenges, including the deterioration of city aesthetics and image. The presence of slums also serves as a critical indicator of a city's capacity to ensure the well-being of its residents often reflecting fundamental failures in urban governance and service delivery (Choguill, 1996; Minnery et al., 2013). In this context, addressing slum settlements through adequate infrastructure provision becomes a critical pathway toward achieving equitable and sustainable urban growth (Parikh et al., 2013). Strengthening infrastructure systems not only supports the physical transformation of slum areas but also promotes social inclusion and environmental sustainability, crucially enhancing climate resilience, in line with global development commitments (Soyinka & Siu, 2017). Slum

**Cite This Article:**
Putri, H. T., & Salsabila, N. (2025). Identifying basic infrastructure priorities for slum management through analytical hierarchy process (AHP): A local government perspective. *Sustainable Urban Development and Environmental Impact Journal, 2*(2), 137-152. https://doi.org/10.61511/sudeij.v2i2.2025.2165

settlements are commonly found in major Indonesian cities, including Padang, which functions as a National Activity Center and the capital of West Sumatra Province.

Padang ranks 11th among Indonesian cities with the largest slum areas, with slums distributed across eight districts as designated in Padang Mayor's Decree No. 519 concerning the Determination of Housing and Slum Settlement Locations. These areas are generally classified as having mild to moderate slum conditions, primarily due to limited access to basic infrastructure. According to the Ministerial Regulation of Public Works and Public Housing No. 14 of 2018 on the Prevention and Quality Improvement of Slum Housing and Settlements, the key indicators of slum conditions include inadequate access to neighborhood roads, clean water, environmental drainage, wastewater treatment, solid waste management, and fire protection systems. These indicators highlight the urgent need for improved infrastructure provision in Padang's slum areas.

Previous studies support this finding that Asmariati et al. (2021) and Risna et al. (2022) identified poor waste management and malfunctioning drainage systems as major contributors to slum conditions in Padang. Putri & Ardiningrum (2025) highlighted the persistent lack of adequate sanitation and clean water facilities, while Alfian et al. (2024) also emphasized the urgency of providing clean water in the city's slum settlements. Aziz et al. (2019) further demonstrated the generally low environmental quality in Padang's slum areas. Collectively, these findings underscore the need for enhanced infrastructure services to improve quality of life, environmental health, and urban resilience in Padang's slum settlements.

At the global level, the urgency of addressing basic infrastructure gaps in slum settlements aligns with Sustainable Development Goal (SDG) 11, which calls for inclusive, safe, resilient, and sustainable urban development. Adequate infrastructure provision is widely recognized as a critical pathway for improving slum living conditions and achieving equitable urban growth (Trindade et al., 2021; UN-Habitat, 2012). International experiences also show consistent priorities in slum upgrading, particularly improving housing quality, strengthening connectivity, and enhancing environmental resilience. Secure housing, improved accessibility, and the integration of green–blue infrastructure serve as core foundations for slum area transformation (Collado & Wang, 2020).

Similarly, studies in Bangladesh, Brazil, Kenya, and Thailand emphasize the need for basic infrastructure such as clean water, sanitation, drainage, and adequate housing, with effectiveness often determined by the inclusiveness of planning processes and alignment with residents' socio-economic needs (Degert et al., 2016; Mukeku, 2018; Uddin, 2018; Yeboah et al., 2021). Community-based programs such as Baan Mankong in Thailand have shown greater adaptability compared with top-down initiatives in Brazil and Kenya, highlighting the significance of participatory and context-sensitive planning (Yeboah et al., 2021). These global insights indicate a shift toward integrated approaches that combine physical, social, and environmental dimensions in slum infrastructure development—an approach increasingly relevant for Indonesian cities, including Padang.

Managing and improving slum areas is consistent with the second mission of the Mayor of Padang, which aims to create a city that is excellent, safe, orderly, friendly, and respectful of local wisdom. Enhancing basic infrastructure is a key strategy to improve environmental quality in these areas. However, implementation efforts often face practical challenges, particularly budget constraints and differing priorities among infrastructure stakeholders at the local government level. Identifying and prioritizing infrastructure needs therefore becomes essential. Without clear prioritization, interventions risk being inefficient, unfocused, or even exacerbating existing problems.

Infrastructure prioritization ensures that limited financial and institutional resources are allocated effectively to produce the greatest impact on community welfare and environmental improvement. It supports long-term urban sustainability by integrating spatial planning, environmental management, and social equity considerations (Rusdiyanto & Pariyanti, 2025). In slum settlements, where needs are complex and resources are scarce, prioritization enables strategic and sustainable decision-making (Saha et al., 2024; Sonda et al., 2017).

Beyond the physical improvements, the successful implementation of prioritized infrastructure components can significantly enhance public health and living conditions by reducing disease transmission risks and improving environmental quality. Such targeted improvements also support the vision of creating a safer, more resilient, and livable Padang City, enabling vulnerable communities to better cope with environmental and urban challenges. This research thus contributes to sustainable and equitable urban development by integrating infrastructure enhancement with social and environmental resilience.

From an academic perspective, this study also addresses a gap in the literature by examining stakeholder perceptions regarding basic infrastructure provision—an aspect that remains underexplored. Various studies have been conducted using the Analytical Hierarchy Process (AHP) as the primary decision-making tool, as AHP is widely considered effective in capturing stakeholder priorities in a more specific and accurate manner. Previous research by Kusumawardhani et al. (2016) highlighted the urgency of infrastructure development in slum areas, although their analysis focused mainly on general conditions.

In broader infrastructure planning contexts, AHP has been applied by Akhrouf et al. (2024) to determine effective transportation mode priorities, while Samosir et al. (2021) employed AHP to select infrastructure development projects. In the context of slum settlements, Putri & Maryati (2018) initiated discussions on the use of AHP for infrastructure prioritization, although their study was centered on formal settlement areas. Additionally, Syahputra et al. (2024). further demonstrated the applicability of AHP in identifying targeted infrastructure needs.

## 2. Methods

This study employed a deductive quantitative approach integrated within a mixed-methods design. A deductive approach is appropriate for addressing research questions guided by established concepts or theoretical frameworks (Paramita et al., 2021). Both primary and secondary data were utilized. Primary data were collected through field observations of basic infrastructure conditions in slum settlements across all districts in Padang City in 2023. Based on these observations, several sub-districts with the largest concentrations of slum areas were purposively selected to represent complex and varied settlement conditions.

Table 1. Criteria of respondents for in-depth interview

| No | Criteria | Respondent |
|---|---|---|
| 1 | Responsible for planning and formulating policies, as well as implementing programs related to slum settlement areas. | Padang City Office of Housing and Settlement Areas/*Dinas Perumahan dan kawasan Permukiman Kota Padang* |
| 2 | Coordinates planning processes and aids with monitoring and evaluation activities. | Padang City Regional Development Planning Agency/*Badan Perencanaan Pembangunan Daerah* (BAPPEDA) *Kota* Padang |
| 3 | Acts as a facilitator and capacity builder in managing slum settlement improvement programs. | City Without Slums/*Kota Bebas Kumuh* (KOTAKU) |
| 4 | Holds authority over the provision of clean water in Padang City. | Padang City Water Utility Company/*Perusahaan Daerah Air Minum (PDAM) Kota Padang* |
| 5 | Holds authority over the provision of fire protection infrastructure in Padang City. | Padang City Fire Department/*Dinas Pemadam Kebakaran Kota* Padang |
| 6 | Holds authority over the provision of clean water infrastructure in Padang City. | Padang City Public Works and Spatial Planning OfficeDinas/*Kementerian Pekerjaan Umum dan Perumahan Rakyat (PUPR) Kota Padang* |
| 7 | Holds authority over the provision of clean water infrastructure in Padang City. | Padang City Environmental Agency/*Dinas Lingkungan Hidup Kota Padang* |

To gather qualitative insights, in-depth interviews were conducted using a non-probability sampling technique, specifically purposive sampling. This approach targeted respondents with expertise and direct involvement in the provision of basic infrastructure in slum settlements (Table 1). Key informants included representatives from the Office of Housing and Settlement Areas, the Regional Development Planning Agency/*Badan Perencanaan Pembangunan Daerah* (Bappeda), the City Without Slums/*Kota Bebas Kumuh* (KOTAKU) Program, the Regional Water Utility Company/*Perusahaan Daerah Air Minum* (PDAM), the Fire Department, the Public Works and Spatial Planning Office/*Kementerian Pekerjaan Umum dan Perumahan Rakyat* (PUPR), and the Environmental Agency.

In addition to primary data, secondary data were obtained through a review of the 2021 Padang City Slum Upgrading Planning Document/*Rencana Aksi Penanganan Permukiman Kumuh Perkotaan* (RP2KPKPK). These secondary sources supported the validation and justification of findings and facilitated data triangulation. The integration of field observations, interviews, and document analysis provided a comprehensive understanding of infrastructure conditions and stakeholder perspectives. The data from these sources were first synthesized to identify key infrastructure challenges and interrelated factors affecting service provision in slum areas. These findings then served as the empirical foundation for constructing the Analytical Hierarchy Process (AHP) model, ensuring that the prioritization framework reflected real and context-specific conditions.

To determine infrastructure priorities, this study employed the Analytical Hierarchy Process (AHP). AHP is a structured decision-making method grounded in a mathematical model that facilitates the prioritization of multiple criteria by assigning subjective values to the relative importance of each variable (Putri & Maryati, 2018). The AHP model in this study was structured into three main levels: 1) The goal level, which determines the overall priority of infrastructure provision; 2) The criteria level, which represents the existing condition of infrastructure in slum settlements; and 3) The alternative level, consisting of six types of basic infrastructure—environmental drainage, clean water, wastewater management, solid waste management, neighborhood roads, and fire protection—as illustrated in Figure 1.

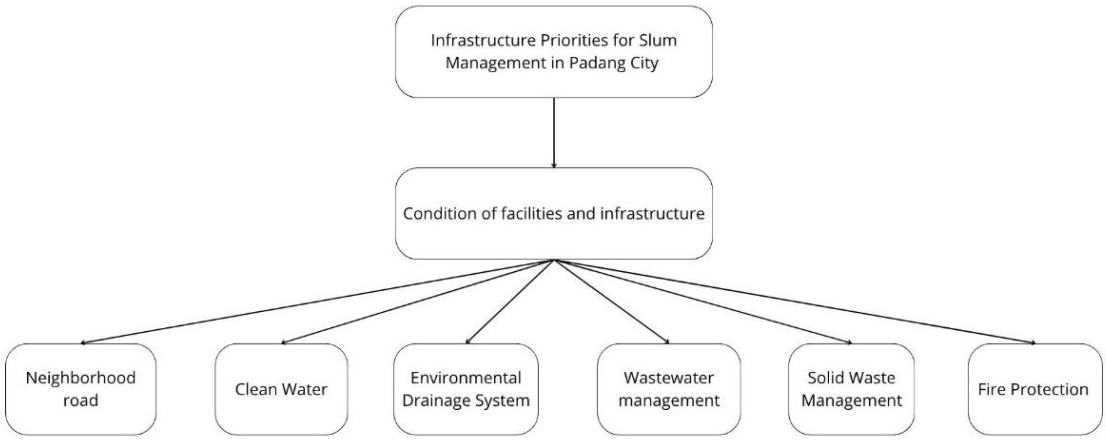



Fig. 1. AHP tree model implemented in the study

AHP data were collected through a pairwise comparison questionnaire based on the 1–9 scale developed by Saaty (1987), as presented in Table 2. Each respondent was asked to assess the relative importance of each criterion and alternative according to their perception of the existing condition and the urgency of infrastructure provision in slum areas. The results of the analysis provided an aggregated assessment of stakeholder perceptions, enabling the identification of the most prioritized components of basic infrastructure in slum settlements.

The respondents in this study were key stakeholders with authority and technical expertise in urban infrastructure provision in Padang City, namely representatives from the Department of Housing and Settlements, the Regional Development Planning, Research, and

Development Agency and the City Without Slums/*Kota Bebas Kumuh* (KOTAKU) Program. These three respondents were considered sufficient to represent institutional perspectives in decision-making related to the planning and provision of infrastructure for slum settlements.

Table 2. AHP weighting scores for infrastructure components

| Intensity | Information |
|---|---|
| 1 | Both elements are equally important |
| 3 | One element is slightly more important than the other |
| 5 | One element is more important than the other |
| 7 | One element is clearly more strongly important than the other |
| 9 | One element is absolutely more important than the other |
| 2,4,6,8 | Intermediate values between two adjacent judgments |

(Saaty, 1998)

To ensure the reliability and validity of the data, each pairwise comparison matrix was tested for its Consistency in the pairwise comparisons was ensured by calculating the Consistency Ratio (CR), a vital component of the AHP methodology. The CR is derived by comparing the Consistency Index (CI) of the judgment matrix to the Random Consistency Index (RI) obtained from Saaty (1980), using the formula CR = $\frac{CI}{RI}$. The CR value measures the level of error introduced in the formulation of judgments. To maintain a high level of relative consistency, the standard threshold for the CR was strictly applied: if the CR value is below 0.1, the responses are considered consistent and the final estimation can be accepted. Conversely, if the CR value exceeds 0.1, the judgment matrix must be re-examined and revised to eliminate sources of inconsistency until the threshold is met, thereby validating the integrity of the pairwise comparisons (Akhrouf et al., 2024).

Subsequently, all valid IC values from the informants were aggregated using the geometric mean method to derive the final priority weights of basic infrastructure needs in Padang City. This approach was adopted to maintain proportional representation of each stakeholder's assessment while minimizing individual bias, thereby producing a comprehensive and balanced evaluation of infrastructure priorities in slum settlements. The consistency of findings across primary, secondary, and analytical stages also served as a form of methodological triangulation, reinforcing the reliability and credibility of the study results.

## 3. Results and Discussion

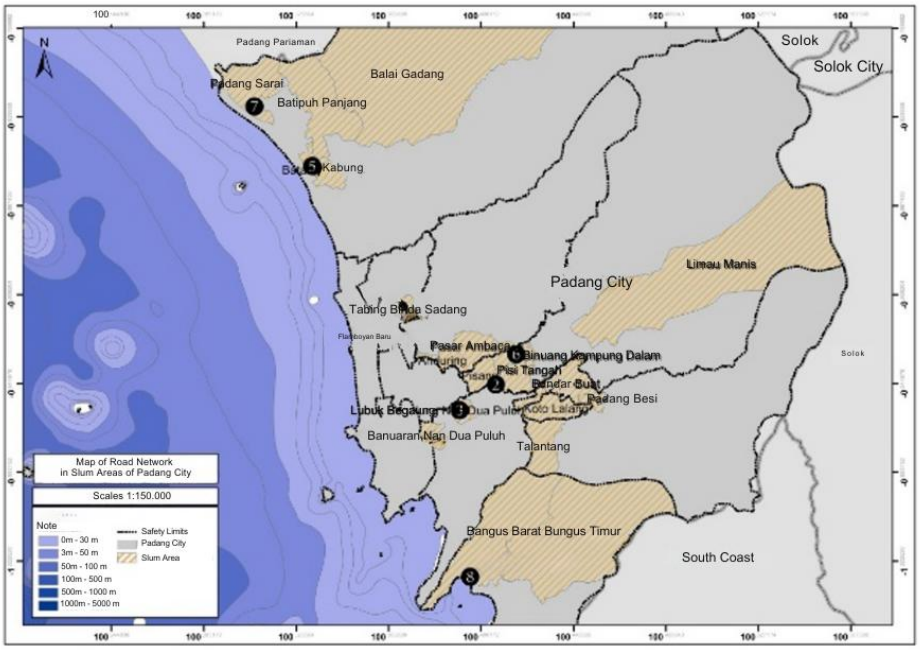
### *3.1 Basic infrastructure provision in slum areas*

#### *3.1.1 Neighborhood roads*

Based on field observations, several road segments already comply with the Indonesian National Standard (SNI) 03-1733-2004, are accessible by four-wheeled vehicles, and are in reasonably good condition. However, some roads remain in poor condition due to water pooling, unpaved surfaces, or inadequate construction. Such conditions were observed in Tabing Banda Gadang (Figure 2.1), Piai Tangah (Figure 2.2), Lubuk Begalung (Figure 2.3), and Flamboyan (Figure 2.4), where accessibility is limited, particularly for cars. In addition, poor road conditions pose both safety and public health risks for residents who rely on these routes for daily activities.

The provision of neighborhood road infrastructure in Padang City's slum settlements presents a complex challenge, positioning the city in a dilemma between achieving service coverage and meeting technical standards. On one hand, Padang City has demonstrated significant progress by fulfilling the service coverage indicators stipulated in the Minister of Public Works Regulation No. 14 of 2018, which ensures that all slum areas are served by a basic road network. This achievement is supported by routine rehabilitation and

maintenance programs conducted by the relevant agency and forms part of the mayor's flagship initiatives.




(a)


(b)

Fig. 2. (a) Map of Road Network in Slum Area of Padang City; (b) Condition of neighborhood roads in slum settlements of Padang City: (1) Tabing Banda Gadang, (2) Piai Tangah, (3) Lubuk Begalung, (4) Flamboyan, (5) Kabung Ganting, (6) Binuang Kampung Dalam, (7) Padang Sarai, (8) Anduring

On the other hand, efforts to improve the technical quality of these roads face substantial constraints, particularly limited land availability and high building density within the slum areas. Consequently, although most areas are served by neighborhood roads, their condition and width often do not comply with the technical standards outlined in SNI 03-1733-2004. This non-compliance results in several functional consequences, including restricted access for emergency vehicles such as fire trucks and ambulances, as well as reduced operational efficiency for waste transport services. Collectively, these limitations increase the vulnerability of slum communities and hinder broader efforts to enhance residents' quality of life.

### *3.1.2 Clean water*

According to Government Regulation No. 14 of 2010 concerning Minimum Service Standards (SPM), the minimum standard for clean water provision is 60 liters per person per day. Furthermore, the Ministerial Regulation of Public Works No. 14 of 2018 stipulates that all citizens must have access to safe drinking water that meets their daily needs. Based on interviews with the Public Works and Spatial Planning Agency/*Kementerian Pekerjaan Umum dan Perumahan Rakyat* (PUPR) of Padang City, the provision of clean water in Padang is considered relatively adequate.

Currently, the Padang City Water Utility/*Perusahaan Daerah Air Minum* (PDAM) serves approximately 64% of the city area, with most slum settlements under PDAM coverage located in the urban core. In peri-urban areas not yet covered by PDAM services, clean water supply is provided through alternative sources such as the community-based water and sanitation program/*Penyediaan Air Minum dan Sanitasi Berbasis Masyarakat* (PAMSIMAS) and household wells, including both dug and drilled wells. Therefore, clean water sources in Padang's slum areas consist of PDAM connections, individual wells, and PAMSIMAS systems. Field observations regarding clean water provision in Padang City are illustrated in Figure 3.


Fig. 3. clean water provision in slum settlements of Padang City
Photographs show the condition of clean water provision in the following sub-districts: (1) Piai Tangah-Site A, (2) Piai Tangah-Site B, (3) Anduring, (4) Pasar Ambacang, (5) Bungus Barat, (6) Batang Kabung Ganting-site A, (7) Batang Kabung Ganting-site B

The PAMSIMAS program is also referenced in the Slum Upgrading Planning Document/*Rencana Aksi Penanganan Permukiman Kumuh Perkotaan* (RP2KPKPK) document of Padang City, which lists several beneficiary subdistricts, including Limau Manis, Batipuh Panjang, Padang Besi, Tarantang, and Piai Tangah (Department of Housing and Settlements of Padang City, 2021). However, in Tarantang Subdistrict, clean water availability remains insufficient to meet the community's minimum daily needs. Therefore, special attention is required to ensure adequate clean water provision, particularly in areas that rely on PAMSIMAS, so that residents can access sufficient water for their daily use.

Overall, the clean water supply in Padang City's slum settlements can be categorized as relatively adequate. Nevertheless, the government needs to continuously monitor and strengthen the sustainability of clean water services in these areas to ensure long-term access for all communities. The analysis of clean water supply conditions in Padang City's slum areas shows that access has improved significantly; however, spatial and qualitative disparities remain. The 64% PDAM service coverage represents a notable achievement, but distribution is still concentrated in central urban areas where network infrastructure is well

established. In contrast, peripheral areas such as Bungus, Koto Tangah, and parts of Kuranji continue to face challenges due to distance, topographic conditions, and limited network capacity. This disparity indicates that while administrative service coverage targets have been met, the quality and continuity of water supply in several regions still fall short of expected standards.

Alternative water sources such as dug and drilled wells play a crucial role in meeting the water needs of residents outside PDAM coverage. However, the use of groundwater sources poses environmental and health risks, particularly in areas with inadequate sanitation systems. The proximity between wells and septic tanks, as well as the discharge of domestic wastewater into drainage channels, can degrade groundwater quality through bacterial and chemical contamination. Meanwhile, the community-based PAMSIMAS system also faces sustainability challenges, especially in operational and institutional aspects. Some areas have experienced performance declines due to limited raw water availability, high operational costs, and weak maintenance mechanisms. These challenges threaten the long-term sustainability of clean water provision unless supported by sufficient technical guidance and institutional strengthening.

From a policy perspective, PDAM service coverage approaching two-thirds of the city indicates that Padang is on a positive path toward meeting national clean water standards. However, to ensure equitable access, strategies are needed to expand PDAM networks into priority areas and remap potential water sources based on local geohydrological conditions. Collaborative efforts among local governments, PDAM, and communities are essential to ensure system sustainability across technical, social, and institutional dimensions. With strengthened governance and continuous monitoring, the provision of clean water in Padang City is expected to meet minimum service standards while supporting improved living conditions in slum settlements sustainably.

### *3.1.3 Environmental drainage system*

According to the Ministerial Regulation of Public Works No. 14 of 2018, drainage systems must be available at the neighborhood scale to ensure that water accumulation does not exceed 30 cm for more than two hours. In practice, several areas in Padang City—particularly within slum settlements—are still not served by proper drainage infrastructure. This lack of coverage often results in water pooling during rainfall events. The following are the results of field observations on environmental drainage conditions in slum settlements of Padang City.

Based on field observations (Figure 4), many environmental drainage systems in Padang City's slum settlements are in poor condition—damaged, clogged with waste, or obstructed by sediment and vegetation—thereby preventing proper water flow. This situation often leads to standing water, which poses risks to both public health and the surrounding environment. According to the Department of Housing and Settlements of Padang City (2021), only a portion of slum areas are currently served by environmental drainage systems. In many locations, drainage channels are disconnected and not integrated into the broader drainage hierarchy. As a result, heavy rainfall frequently causes localized flooding and prolonged waterlogging. This finding is consistent with interviews conducted with the Regional Development Planning Agency of Padang City, which reported that many existing drainage systems are damaged or disconnected.

The provision of technically compliant drainage systems is a crucial infrastructure component that significantly influences environmental quality and public health, particularly in slum settlements. However, current conditions in Padang City reveal that several neighborhood drainage systems in slum areas experience functional malfunction because they are also used as non-sewage wastewater (greywater) discharge channels. This dual function, combined with limited network coverage and poor physical conditions such as damage or sedimentation, collectively increases environmental risk. Polluted and clogged channels not only cause surface water contamination but also contribute to local ponding and flooding during the rainy season. These stagnant conditions create ideal

habitats for disease vectors, directly threatening community health. Therefore, ensuring the availability of adequate drainage systems that effectively manage stormwater and remain physically separate from wastewater flow is critically important. This should be a key priority for realizing healthier, safer, and more sustainable slum settlements.

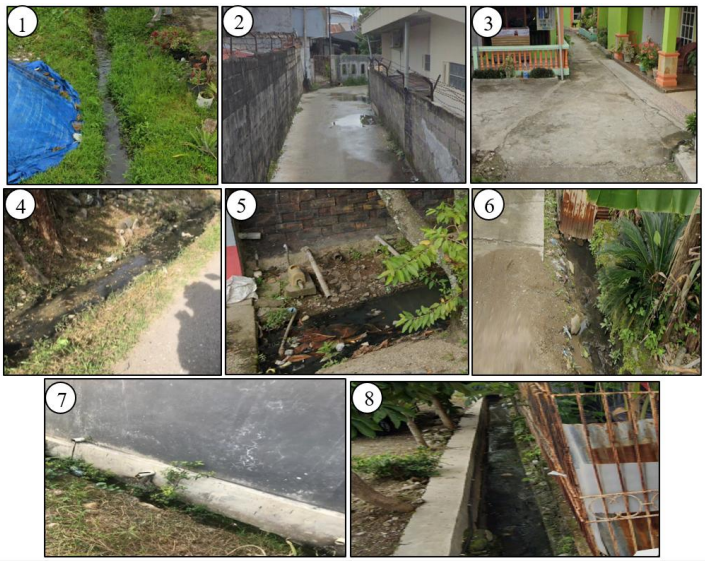



Fig. 4. Environmental drainage in slum settlements of Padang City

To address this issue, the Padang City Housing and Settlement Office conducts regular construction, maintenance, and operational repairs of environmental drainage systems each year. Nevertheless, the current state of drainage infrastructure in slum areas still does not fully meet the standards set by the Ministerial Regulation of Public Works No. 14 of 2018. This underscores the need for increased attention and investment to improve drainage services in these areas.

### *3.1.4 Wastewater management*

According to the Ministerial Regulation of Public Works No. 10 of 2018, adequate wastewater treatment systems must be available along with supporting infrastructure, whether individual or communal. The following are the results of field observations conducted in several slum sub-districts of Padang City.


Fig. 5. Wastewater management conditions in slum settlements of Padang City

As shown in Figure 5, several sub-districts already have wastewater management systems in place, with households connected to individual septic tanks. In areas such as Pisang (Figure 5.1), Bungus Barat (Figure 5.3), and Batang Kabung Ganting (Figure 5.4), residents generally have access to toilets connected to individual septic tanks. However, the management of greywater remains problematic, as large quantities are still discharged directly into drainage channels, particularly in sub-districts such as Padang Sarai, Anduring, Pasar Ambacang, and Tabing Banda Gadang.

Nearly all slum settlements in Padang City are served by individual wastewater treatment systems. Only a few areas, including Bungus Timur, Koto Lalang, Tarantang, and Limau Manis, remain largely underserved (Department of Housing and Settlements of Padang City, 2021). In terms of infrastructure provision, there are currently no communal wastewater treatment plants/*Instalasi Pengolahan Air Limbah Komunal (IPAL Komunal)* in the slum settlements of Padang City, mainly due to natural and geographic constraints. To address this limitation, the city government provides individual septic tanks for each household.

These individual septic tanks now serve nearly all residential areas in Padang City, including slum settlements. Only a few slum areas, such as Limau Manis and Tabing Banda Gadang, remain without adequate service (Department of Housing and Settlements of Padang City, 2021). Therefore, the provision of wastewater treatment systems in Padang City has nearly met the indicators outlined in the Ministerial Regulation of Public Works No. 10 of 2018. Nevertheless, while individual household systems are present in many slum areas, not all of them comply with the required technical standards.

### *3.1.5 Solid waste management*

According to the Ministerial Regulation of Public Works No. 10 of 2018, a solid waste management system must include proper facilities such as waste containers, collection points, and a system for handling waste from collection to transportation. Based on field observations conducted in several sub-districts, the following findings describe the condition of solid waste management in slum settlements of Padang City (Figure 6).


Fig. 6. Solid waste management conditions in slum settlements of Padang City
Photographs show the condition of solid waste management in the following sub-districts: (1) Bungus Barat, (2) Pasar Ambacang, (3) Piai Tangah, (4) Binuang Kampung Dalam, (5) Pisang, (6) Padang Sarai

Observations reveal a significant disparity in waste infrastructure provision at the sub-district level. Sub-districts such as Bungus Barat (Figure 6.1) and Pasar Ambacang (Figure 6.2) demonstrate positive progress by having established temporary storage facilities, communal transfer stations or similar structures—that function as collection points before waste is transported to the final disposal site. The existence of these facilities reflects a growing commitment to structured waste management.

Conversely, conditions in several other sub-districts, including Piai Tangah (Figure 6.3), Binung Kampung Dalam (Figure 6.4), Pisang (Figure 6.5), and Padang Sarai (Figure 6.6), remain highly concerning. The lack of proper waste containers in these residential areas forces residents to resort to unhygienic and environmentally damaging practices. Waste is frequently burned in the open or left to accumulate in home yards and surrounding environments. Such open burning releases harmful pollutants that deteriorate air quality and pose serious respiratory health risks. Moreover, untreated waste piles create breeding grounds for disease vectors such as rats, flies, and Aedes aegypti mosquitoes, increasing the risk of communicable diseases such as dengue fever, diarrhea, and gastrointestinal infections. Consequently, the absence of adequate waste management infrastructure not only diminishes the visual quality of the settlements but also presents a serious threat to public health and safety, potentially leading to chronic health issues and epidemic outbreaks in the future.

Despite the uneven conditions across sub-districts, the Padang City Government, through the Environmental Agency, has made notable institutional efforts to support the waste management system. The agency provides facilities and equipment for waste transport and transfer, including motorized carts for neighborhood-scale collection, containers for communal storage, and roll-off trucks for transporting waste to the final disposal site. This provision signifies the city government's commitment to establishing a functioning waste management logistics chain. However, despite these efforts, the availability of solid waste infrastructure in slum areas remains inadequate (Department of Housing and Settlements of Padang City, 2021). This gap requires immediate attention, particularly considering the minimal containment facilities in several sub-districts such as Piai Tangah and Padang Sarai.

Inadequate physical infrastructure is further compounded by low public awareness and participation in waste management. Many residents do not actively engage in sorting or properly disposing of waste, which limits the effectiveness of government-provided facilities. This indifference creates a dual challenge: even when physical infrastructure exists, its impact is reduced without accompanying behavioral and educational interventions. Raising public awareness about the importance of proper household waste management is therefore critical to complement physical investments.

Furthermore, the effectiveness of the current system is hindered by a structural weakness in the waste retribution financing mechanism. The city integrates waste collection fees into the monthly billing system of the Regional Water Utility Company (PDAM) to improve payment compliance and administrative efficiency. However, this fee-bundling mechanism creates a major disconnect in the context of slum settlements. Many residents in these areas are not connected to the PDAM network due to infrastructure limitations or affordability constraints. As a result, they are automatically excluded from the waste collection fee scheme.

This exclusion significantly reduces financial coverage for waste management in slum settlements. Since retribution fees are a primary operational funding source for waste transport, the Environmental Agency faces difficulty allocating sufficient resources such as carts, containers, and transport schedules for these neighborhoods. Consequently, unserved areas tend to rely on informal disposal methods, including open burning or illegal dumping, as observed in Piai Tangah and Padang Sarai. In essence, this non-inclusive payment mechanism leaves slum environments dirty and unhealthy, disproportionately affecting low-income residents who are already the most vulnerable to environmental health risks.

### *3.1.6 Fire protection*

According to the Ministerial Regulation of Public Works No. 10 of 2018, fire protection facilities should include essential equipment such as fire extinguishers and water tank trucks. However, based on interviews conducted during this study, it was found that the Padang City Fire Department has not yet provided dedicated fire protection facilities specifically for slum settlement areas.

In terms of existing infrastructure, the Padang City Fire Department currently operates six fire stations distributed across six service areas: Pauh and its surroundings, South Padang, Koto Tangah, Kuranji, Bungus, and Pasar Raya. These stations are generally considered adequate to meet the city's overall fire protection needs. Furthermore, almost all slum settlement areas already have neighborhood roads accessible to fire trucks, allowing faster response times during emergencies.

Nevertheless, improving connectivity through the development of more adequate road networks and the establishment of additional small-scale fire posts near high-risk residential areas remain necessary. These measures are expected to enhance the efficiency of fire protection services and strengthen safety for residents living in vulnerable settlements.

While the current distribution of fire stations reflects satisfactory city-level coverage, it does not fully address the specific risks in densely populated informal settlements. High building density, narrow access roads, and the use of flammable construction materials amplify fire vulnerability in these areas. In many cases, local residents rely on informal coping mechanisms—such as manual extinguishing efforts or ad hoc water sources—due to the absence of dedicated firefighting facilities. This situation underscores the need for a more inclusive and community-oriented fire protection strategy, particularly one that integrates early warning systems, neighborhood-level firefighting tools, and basic fire safety training.

### *3.2 AHP analysis result: Priority of infrastructure provision in slum settlements*

In the provision of basic infrastructure within slum settlements, several factors must be considered when determining priorities. These include institutional authority, sources of funding, and the risk of implementation failure. However, in this study, the prioritization of infrastructure provision is primarily based on the existing conditions of basic infrastructure in the slum areas of Padang City. This approach was chosen to ensure that the analysis results accurately reflect the actual needs of the community rather than being solely influenced by top-down policies or programs. Consequently, the resulting prioritization is expected to provide a more realistic depiction of infrastructure conditions that directly support the improvement of residents' quality of life.

Table 3. Priority ranking of infrastructure components based on AHP analysis

| Priority | Infrastructure | IC Value |
|---|---|---|
| I | Drainage | 0.292 |
| II | Clean Water | 0.210 |
| III | Wastewater Management | 0.193 |
| IV | Solid Waste Management | 0.144 |
| V | Neighborhood Roads | 0.112 |
| IV | Fire Protection | 0.049 |

Based on the analysis conducted, the assessment of infrastructure priorities was carried out collaboratively by the Padang City Housing and Settlement Office, the Regional Development Planning, Regional Development Planning Agency/*Badan Perencanaan Pembangunan Daerah* (Bappeda), and the City Without Slums/*Kota Bebas Kumuh* (KOTAKU) Program, which has long served as a strategic government partner in slum area management. The involvement of these three key institutions demonstrates a multi-stakeholder approach to decision-making, in which each entity contributes technical, policy, and operational perspectives. The analysis produced an inconsistency ratio of 0.03. Since this value falls below the acceptable threshold (IC ≤ 0.10), the respondents' assessments are deemed valid (Table 3). This result indicates that the judgments provided by informants were logical and consistent across all criteria analyzed within the AHP model. Therefore, the resulting priority weights can serve as a credible foundation for formulating policy recommendations for basic infrastructure development in Padang City's slum settlements,

particularly in support of sustainable and inclusive urban environmental improvement programs.

The priority identified is environmental drainage. Ideally, drainage systems should be capable of channeling rainwater runoff effectively and preventing surface water accumulation. However, the current provision of drainage infrastructure in slum settlements remains severely lacking. A significant portion of these areas is only partially served by drainage networks, with many systems either disconnected or not integrated into broader networks. Additionally, the physical condition of existing drains is often poor, and in many cases, these systems are also used to convey greywater from households. Such practices contribute to frequent flooding and water stagnation, which pose serious public health risks and degrade the surrounding environment. These issues are particularly critical in settlements located near rivers or coastal areas, where the risk of flooding is already elevated. Given the limited-service coverage and inadequate quality of existing infrastructure, environmental drainage should be prioritized to safeguard both community health and environmental quality.

The second priority is the provision of clean water. Access to clean water is a fundamental human need that must be fulfilled for every individual. Ideally, all residents should have access to safe and sufficient clean water, whether through piped or non-piped systems. Inadequate access to clean water can have severe consequences for both public health and environmental sustainability. Based on the findings of this study and the Slum Upgrading Planning Document/*Rencana Aksi Penanganan Permukiman Kumuh Perkotaan* (RP2KPKPK) document of Padang City, the provision of clean water in slum settlements is generally adequate (Department of Housing and Settlements of Padang City, 2021). However, several sub-districts still rely heavily on community-based systems such as PAMSIMAS, and their existing supply does not yet meet the minimum daily requirements for all individuals. Therefore, the provision of clean water should remain a priority to ensure that communities have access to safe and sufficient water for healthy living.

The third priority is wastewater management. Effective wastewater treatment is essential for maintaining environmental sanitation in slum settlements. Ideally, each settlement should be equipped with a technically compliant wastewater system, including sanitation facilities (toilets) connected to septic tanks, either individually or communally. Based on existing conditions, most slum areas in Padang City are currently served by wastewater systems that meet technical standards. However, there are still several sub-districts where wastewater infrastructure does not fully comply with those standards. Therefore, it is necessary to prioritize the improvement of wastewater treatment systems to ensure proper sanitation and enhance the overall living environment in slum settlements.

Solid waste management plays a vital role in protecting public and environmental health. Ideally, the provision of solid waste infrastructure should adhere to technical standards, including proper waste storage, collection, and processing systems. Although waste management is recognized as important, it ranks as the fourth priority in this study because basic waste service infrastructure is already available in all sub-districts of Padang City. However, public awareness of proper waste management practices remains low and needs to be strengthened through education programs initiated by the Padang City Government. Resistance to the placement of waste containers has also been reported, leading to inadequate service coverage in several areas, including slum settlements. To address this, the government should implement community education programs aimed at increasing public participation and reducing the negative impacts of waste accumulation and open burning. Such initiatives are essential to ensure that effective and sustainable waste management practices are adopted, particularly in slum areas.

Neighborhood roads are essential for facilitating accessibility and mobility within residential areas. Their provision should cover all settlement zones and ensure both safety and comfort for residents. In this context, the Department of Housing and Settlements and the Public Works and Spatial Planning Office/*Kementerian Pekerjaan Umum dan Perumahan Rakyat* (PUPR) of Padang City are responsible for their development and maintenance. Although neighborhood roads rank as the fifth priority, most slum settlements in Padang

City are already served by such infrastructure. However, issues such as road damage and inconsistent road widths still need to be addressed. Therefore, while improvements are necessary, road infrastructure may be temporarily deferred in favor of more urgent needs.

The sixth priority is fire protection. Although current facilities remain inadequate, the provision of fire protection services is still essential. The Padang City Fire Department has established fire stations in various strategic locations across the city, which are expected to provide adequate coverage for slum settlements. Additionally, the existence of neighborhood roads within these areas enhances accessibility for fire trucks, facilitating faster emergency response. Despite its lower ranking, ensuring the availability of fire protection remains important for minimizing disaster risks and safeguarding residents.

The findings of this study differ from those of previous research (Putri & Maryati, 2018; Annas et al., 2018). Infrastructure provision priorities are highly dependent on the specific characteristics and current conditions of each location. Every area has unique needs and levels of urgency, making it inappropriate to apply a one-size-fits-all approach. Furthermore, infrastructure development is largely influenced by local government decisions, as authorities act as key decision-makers. Although each institution may have its own perspective, consensus can still be reached regarding shared priorities. This study thus offers a context-specific reference that enhances the understanding of infrastructure needs in the slum settlements of Padang City.

The Padang's priorities are also consistent with the latest global trends toward integrated approaches, as exemplified by Baan Mankong in Thailand and studies in Kenya (Yeboah et al., 2021). The high ranking of Environmental Drainage, Wastewater, and Solid Waste (Ranks 1–4) indicates a strong focus on environmental resilience, in line with the resilience components of SDG 11. Even though Fire Protection is ranked sixth, its presence indicates concern for safety in dense settlements. Although Neighborhood Roads (Rank 5) fall below other components, their status as "adequate but in need of improvement" indicates that accessibility foundations already exist. This aligns with global findings that accessibility is a primary prerequisite. However, successful implementation will depend heavily on social aspects. The analysis shows that issues of public awareness in waste management and rejection of container placement must be addressed. In this context, Padang's program needs to adopt a more community-based and inclusive model, such as Baan Mankong, to ensure that the infrastructure built is sustainable and supported by resident participation. This becomes key to avoiding mere physical implementation failure as highlighted in studies in Brazil and Kenya.

The findings highlight the complex interrelationship between technical infrastructure conditions and broader socio-environmental factors within slum settlements. The prioritization results emphasize that infrastructure improvement should not only address the physical deficiencies of drainage, clean water, sanitation, and waste systems but also consider institutional and behavioral dimensions. Effective infrastructure development requires strong coordination among local agencies such as the Housing and Settlement Office, the Public Works and Spatial Planning Office/*Kementerian Pekerjaan Umum dan Perumahan Rakyat* (PUPR), the Environmental Agency, and community-based organizations. Overlapping authorities and limited communication between these institutions have often resulted in fragmented interventions, leaving certain areas underserved. Moreover, the sustainability of infrastructure programs depends heavily on community participation. Without adequate involvement from residents, maintenance systems tend to fail, causing newly built infrastructure to deteriorate quickly. Therefore, future slum upgrading programs in Padang must integrate participatory mechanisms that empower local communities to take an active role in planning, implementing, and maintaining infrastructure facilities.

In addition, the prioritization analysis underscores the importance of linking infrastructure development with disaster risk reduction and climate resilience strategies. Many slum settlements in Padang are located in environmentally vulnerable areas—such as low-lying coastal zones and riverbanks—that are highly exposed to flooding and erosion. Improving drainage and sanitation systems, therefore, is not only a matter of basic service

provision but also a crucial step toward enhancing adaptive capacity against climate-related hazards. Infrastructure investments should be guided by spatial risk assessments to ensure that improvements are both effective and sustainable in the long term. Furthermore, the local government needs to strengthen its policy framework by integrating slum upgrading with spatial planning, climate adaptation, and public health programs. By aligning infrastructure priorities with these broader development agendas, Padang City can move toward a more inclusive, resilient, and environmentally sustainable urban future. The outcomes of this study are expected to serve as a strategic reference for policymakers, planners, and development practitioners in designing targeted interventions that maximize both technical efficiency and social equity in slum upgrading initiatives.

The findings of this study have significant policy implications for urban governance and infrastructure planning in Padang City. To achieve equitable and sustainable improvements in slum settlements, the local government should adopt an integrated and multi-sectoral approach that combines physical infrastructure upgrading with institutional reform and community empowerment. First, infrastructure planning should be guided by data-driven prioritization to ensure that limited resources are allocated effectively to the most urgent needs, such as drainage and clean water. Second, coordination among key agencies—including the Housing and Settlement Office, the Public Works and Spatial Planning Office/*Kementerian Pekerjaan Umum dan Perumahan Rakyat* (PUPR), the Environmental Agency, and the Fire Department—must be strengthened through a unified planning framework that prevents overlap and fragmentation. Third, community-based maintenance schemes and participatory budgeting mechanisms should be institutionalized to enhance local ownership and ensure the long-term sustainability of infrastructure systems. Finally, integrating slum upgrading with broader urban resilience, climate adaptation, and public health policies will be crucial for building a safer and more inclusive city. By implementing these measures, the Padang City Government can effectively translate policy commitments into tangible outcomes that improve the well-being and resilience of its most vulnerable residents.

## 4. Conclusions

Addressing slum settlements in Padang City remains a critical challenge that requires continuous and coordinated efforts. The persistence of slums reflects spatial inequality and systemic issues in urban management, particularly the inadequate provision and maintenance of basic infrastructure. The limited capacity of existing facilities—such as drainage, clean water, sanitation, and solid waste systems—continues to affect environmental health and the quality of life of residents. The insufficient prioritization of these components has resulted in recurring problems such as flooding, water contamination, and poor sanitation, which collectively heighten the vulnerability of slum communities.

This study's findings, supported by assessments from key government stakeholders—including the Padang City Housing and Settlement Office, Regional Development Planning Agency/*Badan Perencanaan Pembangunan Daerah* (Bappeda), and the City Without Slums/*Kota Bebas Kumuh* (KOTAKU) Program—identified six infrastructure priorities: drainage, clean water, wastewater treatment, solid waste management, neighborhood roads, and fire protection. Among these, drainage emerged as the highest priority, as it directly influences environmental quality and public health. The prioritization results emphasize that infrastructure development in slum areas must be implemented through an integrated and participatory approach that links physical improvements with institutional coordination and community engagement.

In addition, the study highlights the need for strategic policy interventions. Strengthening inter-agency collaboration, promoting community-based maintenance, and aligning infrastructure investments with climate resilience and public health objectives are essential steps toward sustainable slum upgrading. Through coordinated and inclusive policy implementation, the Padang City Government can move closer to achieving its vision

of a safe, livable, and environmentally resilient city that supports equitable development for all residents.

## Acknowledgement
The authors would like to express my sincere gratitude for the opportunity and resources that have enabled the completion of this work.

## Author Contribution
Conceptulization, H.A.S.; Methodology, T.I.P.; Data Analysis, T.I.P. and H.A.S.; Writing-Original Draft, T.I.P. and H.A.S.; Writing-Review and Editing; H.A.S.

## Funding
This research did not receive funding from anywhere.

## Ethical Review Board Statement
Not available.

## Informed Consent Statement
Not available.

## Data Availability Statement
Not available.

## Conflicts of Interest
The authors declare no conflict of interest.



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