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Improvement of Environmental Road Facilities and Infrastructure as a Recommendation for the Ternate City Slum Settlement Arrangement Project

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ABSTRACT:
Ternate City, located on a volcanic island in North Maluku, faces significant challenges in managing slum settlements due to its unique topography and coastal characteristics. Despite efforts like the KOTAKU program (2015–2023), slums still cover 268.5 hectares, classified as light to moderate. This study aims to analyze the role of road infrastructure improvements in slum upgrading, focusing on accessibility, fire protection, waste management, and drainage systems. Using a mixed-method approach, the research combines quantitative data from slum assessments, stakeholder questionnaires, and Difference-in-Differences (DiD) analysis to evaluate the impact of road construction in East Makassar Village. Findings reveal that environmental roads reduce slum levels by 2.87%, addressing key issues like fire safety and waste transport. However, budget constraints, particularly land acquisition costs (76–78% of total expenses), pose challenges. The study concludes that targeted infrastructure investments, prioritized based on local needs, can significantly enhance slum conditions. Recommendations include alternative road designs to optimize costs and community engagement to ensure sustainable outcomes.

Keywords: Neighborhood Roads; Accessibility; Slum Criteria; Slum Baseline; Ternate City; Slum Settlement Management

INTRODUCTION

Ternate City is located on the island of *Ternate*, which is one of the volcanic islands in the province of North Maluku. Morphologically, the island of *Ternate* has an active volcanic mountain situated in the middle of the island. The topography of *Ternate* island generally consists of slopes descending toward the coast. Conditions like these make the development of residential areas challenging. The coastal area of *Ternate* island serves as the center for settlements, industrial areas, and public facilities. Population density is highest in the central, southern, and northern parts of *Ternate* (Kusrini et al., 2023).

Figure 1. Typical of the Ternate city settlement

Ternate City is an archipelago city with a total area of 574.736 km², consisting of a land area of 162.03 km² and a water area of 5,547.55 km². It comprises eight islands, three of which are uninhabited (Umanailo et al., 2017). The urban area on *Pulau Ternate* itself covers a total area of 80.17 km², of which 22.26 km² are designated as residential areas (Sarihi et al., 2020). A more complete overview of the Ternate City area is shown in the following image:

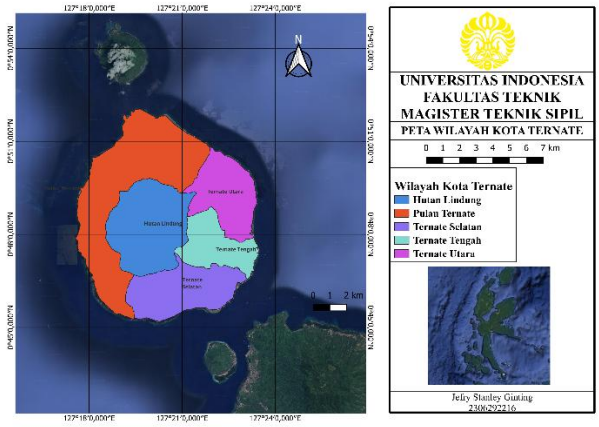

Figure 2. Ternate City Area
Source: (Naufal Alfiandra, 2024), has been reprocessed

The land use of Ternate City can be grouped as shown in the table below:

Table 1. Land Use of Ternate City

No	Land Use	Area: (Ha)	Percentage
1	Bakau	1,73	0,02%
2	Lake	54,87	0,68%
3	Forest	762,89	9,52%
4	Airport Area	16,87	0,21%
5	Vacant Land	32,52	0,41%
6	Settlements	2226,72	27,77%
7	Perkebunan	4829,93	60,24%
8	Bushes	92,22	1,15%
Total		**8017,75**	**100%**

Source: (Sarihi et al., 2020)

Minister of Public Works and Public Housing Regulation Number 13.1 of 2015 concerning the Strategic Plan of the Ministry of Public Works and Public Housing for 2015–2019 outlines strategic steps in the implementation of development in the public works and public housing sectors. These steps are directed to support the provision of quality and adequate basic infrastructure. The main goal is to improve the quality of life of the Indonesian people. This policy aligns with the principle of *"infrastruktur untuk semua"* (*infrastructure for all*), which emphasizes the importance of ensuring equitable access to infrastructure for all groups of people. In its implementation, efforts to foster and develop residential infrastructure focus on alleviating slum areas, with the expectation of creating a livable and healthy living environment for all residents. This regulation serves as the main guideline in directing inclusive and sustainable infrastructure development during the period by:

1. Improving environmental quality in slum areas, which has been carried out in areas totaling 38,431 hectares;
2. Developing settlements in rural areas, covering as many as 5,238 locations spread across various regions; and

3. Carrying out development in border areas and outermost small islands in 86 locations, while similar activities in disaster-prone or post-disaster areas have been conducted in 63 locations, aiming to support recovery and strengthen infrastructure in these areas.

The Ministry of PUPR, through Minister of PUPR Regulation Number 26/PRT/M/2017, aims to realize the Vision of Indonesia 2045. The Ministry of PUPR's vision until 2030 for *Cipta Karya* includes a budget of 170 trillion Rupiah, targeting 100% access to drinking water, 0 hectares of slums, and 100% proper sanitation. To implement this program, the *KOTAKU* (*Kota Tanpa Kumuh* or *City Without Slums*) program was formed by the Directorate General of *Cipta Karya* through Circular Letter number: 40/SE/DC of 2016. The *KOTAKU* program, developed in collaboration with local governments as the main leaders in the initiative to create livable settlements, aims to accelerate efforts to address and reduce slum areas. Its primary focus is on improving environmental quality, settlement management, and preventing future slum formation. This is implemented through cross-sectoral and interdisciplinary collaboration at the village and urban levels, engaging various entities and other relevant stakeholders to ensure a comprehensive and sustainable approach (Amiroh et al., 2021). The *KOTAKU* program includes:

1. Improving the ability to plan and implement slum management at the district/city level comprehensively, considering the strategic role of local governments in providing infrastructure and public services that support slum management efforts.
2. Preparing plans to address slums, including investment plans involving various funding sources, to ensure sustainability and sufficient funds for settlement improvement and quality enhancement programs.
3. Increasing repair, operation, and maintenance activities of urban infrastructure related to slum handling to ensure existing infrastructure functions optimally and supports the improvement of residents' quality of life.
4. Providing technical assistance focused on strengthening information systems, monitoring, and evaluation of land problem solutions, which is crucial to support data-based decision-making and effective policy formulation in handling slums.

In Ternate City itself, the *KOTAKU* program has been running from 2015 to 2023 through the North Maluku Regional Settlement Infrastructure Center (*Balai Prasarana Permukiman Wilayah* or *BPPW*) of the Directorate General of *Cipta Karya* under the Ministry of PUPR. In 2024, the *KOTAKU* program will no longer be implemented, and the Ternate City government will face the challenge of managing the existing slum areas.

Slums remain a significant challenge for district/city governments, although they also serve as a pillar of the city's economy. Based on the Decree of the Mayor of Ternate Number 137/II.4/KT/2022, the slum area in Ternate City covers 268.5 hectares, with 160.92 hectares on *Pulau Ternate* classified as light slums. Although this area is not large, it accounts for 2.01% of the total area of Ternate City, which is only 80.18 km². The distribution of slum locations includes several urban villages, such as North Sangaji (14 ha), Kasturian (9.82 ha), Salero (2.9 ha), and others, with varying slum statuses. The Ternate City Government needs to organize the 160.92 hectares of slum area, so an analysis of slum facilities is necessary to overcome existing risks. To understand accessibility and its relation to slum planning, an analysis of relevant previous research is conducted, which will be summarized in the *State of the Art* table, including the title of the study, author, year of publication, method, scope, and conclusions.

To gain an overview of research on improving accessibility facilities as part of slum arrangement, several previous studies have been reviewed. There are four articles related to the concept of slum arrangement (Aziz & Shawket, 2011; El-Anwar & Aziz, 2014; Kenney & Kenney, 2016), thirteen articles related to slum management in Indonesia, including Jakarta (Abidin et al., 2015), East Java (Amiroh et al., 2021; Sardjito et al., 2018; Wijaya, 2016), South Sulawesi (Arifin et al., 2022), South Kalimantan (Michiani & Asano, 2019), North Sulawesi (Mononimbar, 2018), East Kalimantan (Surya, 2015), West Java (Tasya Salsha Safarina & Verry Damayanti, 2023; Winarso, 2021), and various provinces (Pramantha et al., 2021; Zubaidah et al., 2023). Additionally, three articles discuss slum restructuring in other countries, including Nigeria (Adama, 2020), the Philippines (Hwang & Feng, 2020), and South Africa.

Based on the *state of the art* table in Appendix 1, it can be concluded that improving basic infrastructure such as road access, sanitation, clean water, drainage, electricity, and street lighting is a fundamental step in slum restructuring efforts. Adequate infrastructure not only improves quality of life but also reduces health risks and enhances environmental safety. The city of Ternate urgently needs to improve accessibility infrastructure, including the quality of environmental roads, drainage, sidewalks, and street lighting, to increase the mobility and accessibility of people living in slums. Geographical factors, such as soft soil conditions, must be considered in road construction to ensure that the infrastructure built is durable and efficient. However, budget limitations, especially dependence on the *Dana Alokasi Khusus* (*DAK* or Special Allocation Fund), are the main obstacles in implementing the slum restructuring program. In addition, effective socialization to the community regarding relocation and settlement rearrangement programs is essential to avoid social conflicts that often arise during the process.

This study reviewed eight criteria for slums based on the Minister of Public Works and Housing Regulation Number 14 of 2018 concerning Prevention and Quality Improvement of Slums. Seven of these criteria were then analyzed using Ternate City *KOTAKU* data to identify the basic infrastructure recommendations needed in the slums of Ternate City.

The lack of research specifically discussing accessibility facilities and infrastructure in the arrangement of urban slums in Indonesia is a strong reason to conduct this research. To analyze infrastructure needs in slum areas and determine accessibility facilities and infrastructure according to proper specifications, valid data and careful planning are required. The implementation of slum management through improving accessibility facilities and infrastructure is expected to significantly reduce the level and extent of slum areas in Ternate City. An analysis of the construction of environmental roads in the slums of East Makassar, Ternate City, was also conducted in 2022 to examine the impact of road construction on the development of settlement quality in the East Makassar sub-district until 2024.

The city of Ternate is experiencing rapid population and economic growth, driving increased urbanization and urban development. This requires appropriate development to meet the needs for land, policies, and budget allocation. However, the geographical location of Ternate City—situated around the peak of an active volcano and surrounded by the sea—poses challenges for spatial planning. Along with population growth, the settlement pattern in Ternate City has undergone significant changes, reflecting the dynamics of the city's development.

The Central Statistics Agency (*Badan Pusat Statistik* or *BPS*) of North Maluku Province recorded the percentage increase in the population of Ternate City from 2011 to 2022 (BPS North Maluku Province, 2024). With the population growth in Ternate City year by year, the need for settlement facilities has also increased. The total population of Ternate City in 2023 is projected to reach 199,600 people (Mayor of Ternate, 2023), with a total residential land area of 2,226.72 hectares. The calculation of the Carrying Capacity of Residential Land (*Daya Dukung Pemukiman* or *DDPm*) shows a value of 3.16 m^2 per capita, indicating that the carrying capacity of residential land in the area is relatively high. Spatial analysis of the carrying capacity of residential land is essential for spatial planning and sustainable urban development and shows that available land is still sufficient to accommodate residents and support housing construction.

However, the absence of a specific policy framework for slum governance and the lack of national priority for slum management are significant obstacles. This problem is caused by a lack of coordination between sector ministries and mutual blame among them. Most programs and projects for slums are built on existing models from other programs. In Ternate City, slum restructuring programs often rely on funds from the central ministry, which makes the proposed planning unclear. The slum restructuring plan for 2024, which depends on *Dana Alokasi Khusus* (*DAK*) funds of 15 billion Rupiah and an additional 10 billion Rupiah from the Ternate City government, was rejected by the central government. As a result, the restructuring plan cannot be implemented. In addition, the arrangement of slums often faces social problems due to population relocation (Ahrishar & Sulistyarso, 2019; Fakhri et al., 2023; Julianto & Jumario, 2017; Nuribadah, 2023; Widyastuty & Ramadhan, 2019), so adequate socialization and a definite source of funds are needed to ensure the success of the arrangement.

City and local governments need to prioritize infrastructure investment, especially in underserved areas such as slums and marginalized communities, as well as in the transportation system. This is important for building a resilient urban economy, creating a prosperous urban future, and increasing urban competitiveness and

productivity. UN-Habitat also emphasizes that cities in developing countries face major challenges in providing adequate infrastructure and basic services, conditions that hinder the achievement of a better urban future.

This research aims to provide relevant infrastructure analysis data for handling slums in Ternate City. The objectives include: first, to determine whether the development of road facilities and infrastructure can overcome the slum problem in Ternate City; second, to evaluate the impact of environmental road construction projects on slums; and third, to calculate the financing components of road projects based on the design that has been prepared. This research is expected to provide both academic and practical benefits. Academically, the results are expected to add insight into slum arrangement, serve as an academic document for the University of Indonesia, and be developed for further research in coastal areas of Indonesia. Practically, this research is expected to serve as evaluation material for the government in slum arrangement in Ternate City, as well as encourage the community to actively participate in overcoming the slum problem.

RESEARCH METHODS

Using a mixed-method approach, this research combines quantitative data from slum assessments, stakeholder questionnaires, and Difference-in-Differences (DiD) analysis to evaluate the impact of road construction in Desa Makassar Timur (East Makassar Village). The selection of a research strategy is an important step in answering research questions and testing the hypotheses that have been stated. According to Sugiyono, the quality of research data is influenced by two main aspects: the quality of research instruments and the quality of data collection. Data collection is divided into primary sources, which are obtained directly from respondents, and secondary sources, which are obtained through documents or other information. In this study, the author used several data collection techniques, including observation, interviews, and questionnaires. Secondary data was also used to formulate the background and understand the context of the research problem. The research strategies applied include archive analysis, documentation, and literature studies.

This research process is carried out quantitatively, starting from problem formulation, theory development, hypothesis formulation, data collection and analysis, to drawing conclusions. The research is divided into three phases: research design, theoretical framework, and data collection and presentation. The analysis was conducted using descriptive methods and Difference-in-Differences (DiD) to measure the impact of accessibility facility development interventions. The research instrument was designed to answer a wide range of research questions, with validation and reliability as the main requirements. Data collection was carried out in two stages: first, through literature study to obtain data on the identification of slum conditions; second, through interviews with stakeholders to obtain validation data. Hypothesis testing was conducted by impact analysis using the DiD method, which allowed researchers to identify the effects of the intervention more accurately. Finally, an analysis was carried out to determine budget needs based on project cost estimates prepared in accordance with applicable guidelines and regulations. With this approach, the research is expected to make a real contribution to the planning and handling of slums in Ternate City.

RESULTS AND DISCUSSION

1. Analysis of Research Question 1

The research formulation 1 uses data from the Identification of Slum Conditions of Ternate City and is supported by a questionnaire that will be distributed to previously identified stakeholders. Data on the identification of slum conditions is needed to quantitatively determine the slum conditions of Ternate City. The data taken and the analysis carried out are as follows:

1) Ternate City Slum Assessment Data Collection

The slum assessment data for Ternate City, also known as the slum baseline, is the result of identification from the KOTAKU (City Without Slums) team with funding from the State Budget managed by the Ministry of Public Works in each province. In Ternate City, the KOTAKU program has been discontinued since 2023, and the latest data

updates since 2022 are no longer available. Currently, the data can be obtained by submitting an official application letter to the North Maluku BPPW. Based on a reply letter from BPPW North Maluku, data has been obtained and will continue with analysis. The application letter and reply from the letter are as follows:

Figure 3. Request Letter and Reply to Data Request

2) Ternate City Slum Assessment Data

The Ternate City slum assessment data (Baseline) obtained reflects the condition of slums in each village that has a history of slums until 2022. This data collection is very important to display the slum assessment in each village more accurately and facilitate subsequent descriptive analysis. By using the measurement scale and instruments described in the previous chapter, the assessment of slums in Ternate City can be compiled more comprehensively. This will allow for better identification of slum patterns and trends, as well as provide a solid basis for the planning and implementation of future slum improvement programs.

Table 2. Assessment of Slums in Ternate City (Moti Island)

Yes	Category	Var		Moti Island					
				Figure	Vacation	Takofi	City	Tadenas	Tafamutu
1	Building	X.BG.1	Ideal (Unit)	111	138	135	206	95	179
			Residual (Unit)	33	48	8	3	23	0
			Weight	29,73%	34,78%	5,93%	1,46%	24,21%	0,00%
			Value	1	1	0	0	0	0
		X.BG.2	Ideal (Ha)	11,11	13,27	14,84	19,03	11,99	13,43
			Rest (Ha)	0	0	0	0	0	0
			Weight	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
			Value	0	0	0	0	0	0
		X.BG.3	Ideal (Unit)	111	138	135	206	95	179
			Residual (Unit)	60	12	42	22	15	30
			Weight	54,05%	8,70%	31,11%	10,68%	15,79%	16,76%
			Value	3	0	1	0	0	0
2	Neighborhood Roads	X.JL.1	Ideal (Meter)	4870	3210	3378	7750	4115	4070
			Residual (Meter)	1250	0	420	2070	1387	784
			Weight	25,67%	0,00%	12,43%	26,71%	33,71%	19,26%
			Value	1	0	0	1	1	0
		X.JL.2	Ideal (Meter)	4.870	3.210	3.378	7.750	4.115	4.070
			Residual (Meter)	2.820	1.700	1.283,7	4.780	1.219	2.650
			Weight	57,91%	52,96%	38,00%	61,68%	29,62%	65,11%
			Value	3	3	1	3	1	3
3	Drinking Water	X.AM.1	Ideal (KK)	141	138	146	235	118	193
			Rest (KK)	58	7	87	184	0	71
			Weight	41,13%	5,07%	59,59%	78,30%	0,00%	36,79%
			Value	1	0	3	5	0	1
		X.AM.2	Ideal (KK)	141	138	146	235	118	193

Yes	Category	Var		Moti Island					
				Figure	Vacation	Takofi	City	Tadenas	Tafamutu
			Rest (KK)	51	5	0	223	118	0
			Weight	36,17%	3,62%	0,00%	94,89%	100,00%	0,00%
			Value	1	0	0	5	5	0
4	Environmental Drainage	X.DL.1	Ideal (Ha)	11,11	13,27	14,84	19,03	11,99	13,43
			Rest (Ha)	0	0	0	0	0	0
			Weight	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
			Value	0	0	0	0	0	0
		X.DL.2	Ideal (Meter)	5.000	1.620	2.480	8.500	2.820	2.520
			Residual (Meter)	2.500	350	1.176,5	4.250	2.300	1.260
			Weight	50,00%	21,60%	47,44%	50,00%	81,56%	50,00%
			Value	1	0	1	1	5	1
		X.DL.3	Ideal (Meter)	5.000	1.620	2.480	8.500	2.820	2.520
			Residual (Meter)	1.250	920	664,2	2.100	370	810
			Weight	25,00%	56,79%	26,78%	24,71%	13,12%	32,14%
			Value	1	3	1	0	0	1
5	Wastewater Management	X.AL.1	Ideal (KK)	141	138	146	235	118	193
			Rest (KK)	24	8	23	3	10	8
			Weight	17,02%	5,80%	15,75%	1,28%	8,47%	4,15%
			Value	0	0	0	0	0	0
		X.AL.2	Ideal (KK)	141	138	146	235	118	193
			Rest (KK)	28	8	30	1	6	3
			Weight	19,86%	5,80%	20,55%	0,43%	5,08%	1,55%
			Value	0	0	0	0	0	0
6	Waste Management	X.PS.1	Ideal (KK)	141	138	146	235	118	193
			Rest (KK)	141	138	146	235	118	193
			Weight	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
			Value	5	5	5	5	5	5
		X.PS.2	Ideal (KK)	141	138	146	235	118	193
			Rest (KK)	141	138	146	235	118	193
			Weight	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
			Value	5	5	5	5	5	5
7	Fire Protection	X.KB.1	Ideal (Unit)	111	138	135	206	95	179
			Residual (Unit)	0	62	0	0	0	0
			Weight	0,00%	44,93%	0,00%	0,00%	0,00%	0,00%
			Value	0	1	0	0	0	0
		X.KB.2	Ideal (Unit)	111	138	135	206	95	179
			Residual (Unit)	111	138	135	206	95	179
			Weight	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
			Value	5	5	5	5	5	5
			Total Value	27	23	22	30	27	21
			Slum Levels	Light Slums	Light Slums	Light Slums	Light Slums	Light Slums	Light Slums

Source: (BPPW North Maluku, 2022), has been reprocessed

Table 3. Assessment of Slums in Ternate City (Pulau Hiri)

No	Category	Variable		Hiri Island					
				Dorari Isa	Togolobe	Tafraka	Mado	Tomajiko	Faudu
1	Building	X.BG.1	Ideal (Unit)	93	92	95	62	71	94
			Residual (Unit)	0	1	0	0	0	18
			Weight	0,00%	1,09%	0,00%	0,00%	0,00%	19,15%
			Value	0	0	0	0	0	0
		X.BG.2	Ideal (Ha)	5,28	10,02	6,01	10,56	6,67	7,63
			Rest (Ha)	0	0	0	0	0	0
			Weight	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
			Value	0	0	0	0	0	0
		X.BG.3	Ideal (Unit)	93	92	95	62	71	94
			Residual (Unit)	2	9	3	22	13	36
			Weight	2,15%	9,78%	3,16%	35,48%	18,31%	38,30%
			Value	0	0	0	1	0	1
2	Neighborhood Roads	X.JL.1	Ideal (Meter)	3.946	2.110	2.687	3.611	5.021	6.431
			Residual (Meter)	1.340	99	78	821	430	409
			Weight	33,96%	4,69%	2,90%	22,74%	8,56%	6,36%
			Value	1	0	0	0	0	0
		X.JL.2	Ideal (Meter)	3.946	2.110	2.687	3.611	5.021	6.431
			Residual (Meter)	994	948	600	1.377	1.978	3.289
			Weight	25,19%	44,93%	22,33%	38,13%	39,39%	51,14%
			Value	1	1	0	1	1	3

No	Category	Variable		Hiri Island					
				Dorari Isa	Togolobe	Tafraka	Mado	Tomajiko	Faudu
3	Drinking Water	X.AM.1	Ideal (KK)	123	116	117	62	86	116
			Rest (KK)	0	0	0	0	0	0
			Weight	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
			Value	0	0	0	0	0	0
		X.AM.2	Ideal (KK)	123	116	117	62	86	116
			Rest (KK)	123	116	117	61	86	116
			Weight	100,00%	100,00%	100,00%	98,39%	100,00%	100,00%
			Value	5	5	5	5	5	5
4	Environmental Drainage	X.DL.1	Ideal (Ha)	5,28	10,02	6,01	10,56	6,67	7,63
			Rest (Ha)	0	0	0	0	0	0
			Weight	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
			Value	0	0	0	0	0	0
		X.DL.2	Ideal (Meter)	1.820	1.774	1.225	2.135	4.799	6.591
			Residual (Meter)	850	790	400	1.600	2.763	3.473
			Weight	46,70%	44,53%	32,65%	74,94%	57,57%	52,69%
			Value	1	1	1	3	3	3
		X.DL.3	Ideal (Meter)	1.820	1.774	1.225	2.135	4.799	6.591
			Residual (Meter)	200	0	0	0	1.136	1.618
			Weight	10,99%	0,00%	0,00%	0,00%	23,67%	24,55%
			Value	0	0	0	0	0	0
5	Wastewater Management	X.AL.1	Ideal (KK)	123	116	117	62	86	116
			Rest (KK)	0	22	0	18	11	31
			Weight	0,00%	18,97%	0,00%	29,03%	12,79%	26,72%
			Value	0	0	0	1	0	1
		X.AL.2	Ideal (KK)	123	116	117	62	86	116
			Rest (KK)	2	36	0	19	2	17
			Weight	1,63%	31,03%	0,00%	30,65%	2,33%	14,66%
			Value	0	1	0	1	0	0
6	Waste Management	X.PS.1	Ideal (KK)	123	116	117	62	86	116
			Rest (KK)	123	116	117	62	86	116
			Weight	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
			Value	5	5	5	5	5	5
		X.PS.2	Ideal (KK)	123	116	117	62	86	116
			Rest (KK)	123	116	117	62	86	116
			Weight	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
			Value	5	5	5	5	5	5
7	Fire Protection	X.KB.1	Ideal (Unit)	93	92	95	62	71	94
			Residual (Unit)	0	0	22	0	0	0
			Weight	0,00%	0,00%	23,16%	0,00%	0,00%	0,00%
			Value	0	0	0	0	0	0
		X.KB.2	Ideal (Unit)	93	92	95	62	71	94
			Residual (Unit)	93	92	95	62	71	94
			Weight	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
			Value	5	5	5	5	5	5
			Total Value	23	23	21	27	24	28
			Slum Levels	Light Slums	Light Slums	Light Slums	Light Slums	Light Slums	Light Slums

Source: (BPPW North Maluku, 2022), has been reprocessed

3) Descriptive Analysis of Ternate City Slum Assessment

Based on the slum assessment data (Baseline) of Ternate City which reflects the condition of the slums in each village, it can be known the condition of the slums of Ternate City as a whole. This assessment is based on seven research variables that cover various aspects of slums. Thus, this data provides a comprehensive picture of the level of slums in each village, which in turn allows the analysis of the slum condition of Ternate City as a whole based on the seven research variables that are the slum aspect.

Table 4. Results of Identification of Overall Ternate City Slum Assessment

No	Category	Variable	Unit	Ideal	Remnant	Percentage	Value
1	Building	X.BG.1	Unit	4.253	839	19,73	0
		X.BG.2	Has	291,05	0	0,00	0
		X.BG.3	Unit	4.253	641	15,07	0
2	Neighborhood Roads	X.JL.1	Meter	118.695	28.375,80	23,91	0

		X.JL.2	Meter	118.695	54.061	45,55	1
3	Drinking Water	X.AM.1	MONTHS	4.984	632	12,68	0
		X.AM.2	MONTHS	4.984	2.157	43,28	1
4	Environmental Drainage	X.DL.1	Has	291,05	4,34	1,49	0
		X.DL.2	Meter	94.931,40	48.758,20	51,36	3
		X.DL.3	Meter	94.931,40	29.700,90	31,29	1
5	Wastewater Management	X.AL.1	MONTHS	4.984	267	5,36	0
		X.AL.2	MONTHS	4.984	561	11,26	0
6	Waste Management	X.PS.1	MONTHS	4.984	3.672	73,68	3
		X.PS.2	MONTHS	4.984	3.140	63,00	3
7	Fire Protection	X.KB.1	Unit	4.253	2.368	55,68	3
		X.KB.2	Unit	4.253	3.655	85,94	5
Slum Value							**20**
Classification of Slums							**Light**
Average Slum							**33,77%**

Source: Processed Author, 2025

Table 5. Results of Identification of Slum Assessment of the Ternate Island Area

No	Category	Variable	Unit	Ideal	Remnant	Percentage	Value
1	Building	X.BG.1	Unit	2.882	705	24,46	0
		X.BG.2	Has	161,21	0	0	0
		X.BG.3	Unit	2.882	375	13,01	0
2	Neighborhood Roads	X.JL.1	Meter	67.496	19.181,8	28,42	1
		X.JL.2	Meter	67.496	30.023,3	44,48	1
3	Drinking Water	X.AM.1	MONTHS	3.393	225	6,63	0
		X.AM.2	MONTHS	3.393	1.141	33,63	1
4	Environmental Drainage	X.DL.1	Has	161,21	4,34	2,69	0
		X.DL.2	Meter	53.647,4	26.810,7	49,98	1
		X.DL.3	Meter	53.647,4	20.632,7	38,46	1
5	Wastewater Management	X.AL.1	MONTHS	3.393	109	3,21	0
		X.AL.2	MONTHS	3.393	440	12,97	0
6	Waste Management	X.PS.1	MONTHS	3.393	2.122	62,54	3
		X.PS.2	MONTHS	3.393	1.549	45,65	1
7	Fire Protection	X.KB.1	Unit	2.882	2271	78,8	5
		X.KB.2	Unit	2.882	2271	78,8	5
Slum Value							**19**
Classification of Slums							**Light**
Average Slum							**32,73%**

Source: Processed Author, 2025

Table 6. Identification Results of Slum Assessment of Hiri and Moti Island Areas

No	Category	Variable	Unit	Ideal	Remnant	Percentage	Value
1	Building	X.BG.1	Unit	1.371	134	9,77	0
		X.BG.2	Has	129,84	0	0	0
		X.BG.3	Unit	1.371	266	19,4	0
2	Neighborhood Roads	X.JL.1	Meter	51.199	9.088	17,75	0
		X.JL.2	Meter	51.199	23.847	46,58	1
3	Drinking Water	X.AM.1	MONTHS	1.591	407	25,58	1
		X.AM.2	MONTHS	1.591	1.016	63,86	3
4	Environmental Drainage	X.DL.1	Has	129,84	0	0	0
		X.DL.2	Meter	41.284	21.712,5	52,59	3
		X.DL.3	Meter	41.284	9.068	21,97	0
5	Wastewater Management	X.AL.1	MONTHS	1.591	158	9,93	0
		X.AL.2	MONTHS	1.591	152	9,55	0
6	Waste Management	X.PS.1	MONTHS	1.591	1.591	100	5
		X.PS.2	MONTHS	1.591	1.591	100	5
7	Fire Protection	X.KB.1	Unit	1.371	84	6,13	0
		X.KB.2	Unit	1.371	1.371	100	5
Slum Value							**23**
Classification of Slums							**Light**
Average Slum							**36,44%**

Based on existing data, Ternate City is at a mild slum level with a slum value of 20. To identify the most dominant variable for this slum value, it is necessary to analyze the percentage between ideal conditions and the remaining untreated conditions in each variable. This step involves measuring the ideal and actual conditions, as well as calculating the percentage difference for each variable. The results of this analysis will show the variables that need the most attention to reduce the level of slums in Ternate City.

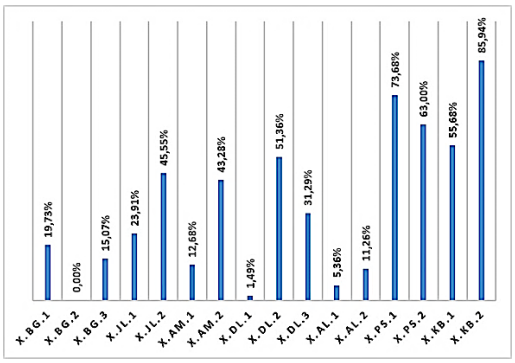

Figure 4. Dominant Slum Variables of Ternate City as a Whole

Source: Processed Author, 2025

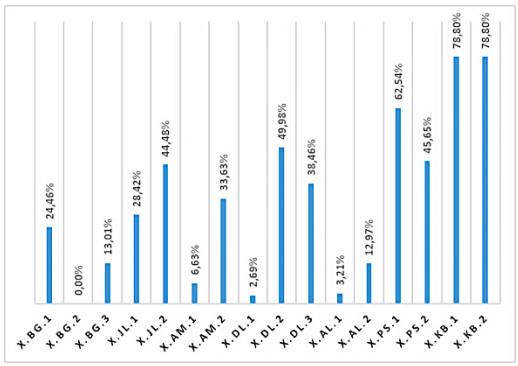

Figure 5. Dominant Slum Variable of Ternate City (Ternate Island)

Source: Processed Author, 2025

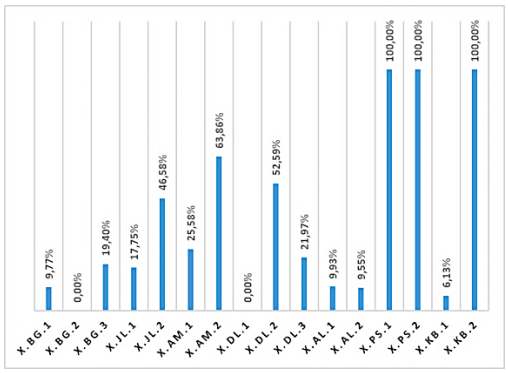

Figure 6. Dominant Slum Variables of Ternate City (Hiri and Moti Islands)

Source: Processed Author, 2025

Table 7. Explanation of Variables in RQ 1

Variable	Variable Explanation
X.BG.1	Building irregularities
X.BG.2	High Building Density
X.BG.3	Unqualified Building Quality
X.JL.1	Neighborhood Road Network Not Available
X.JL.2	Road Surface Quality Poor environment
X.AM.1	Safe Access to Drinking Water Not Available
X.AM.2	Everyone's Drinking Water Needs Are Not Met
X.DL.1	Environmental Drainage Not Available
X.DL.2	Surrounding Drainage Is Unable to Drain Rainwater Runoff
X.DL.3	Poor Environmental Drainage Construction Quality
X.AL.1	Wastewater Management System Does Not Meet Technical Requirements
X.AL.2	Wastewater Management Infrastructure and Facilities Do Not Meet Technical Requirements
X.PS.1	Waste Infrastructure and Facilities Do Not Meet Technical Requirements
X.PS.2	The waste management system does not meet the technical requirements.
X.KB.1	Fire Protection Infrastructure Not Available
X.KB.2	Fire protection facilities are not available.

Source: Processed Author, 2025

In the entire area of Ternate City, the most dominant variables are fire protection, waste management, and environmental drainage. If the analysis is focused only on slums on Ternate Island, the dominant variables that will be obtained remain the same. However, if the analysis is carried out only on Moti and Hiri Islands, the results of the analysis will show different dominant variables.

a) Variables of Slum Aspect on Moti and Hiri Islands

In the Ternate City area, especially on Moti and Hiri Islands, different dominant variables were found. This shows that the infrastructure needed must include aspects of fire protection, waste management, and proper drinking water supply. This difference emphasizes the importance of baseline assessment data in determining the right infrastructure for slum arrangement in an area. Therefore, environmental roads are considered ineffective for the arrangement of slums on Moti and Hiri Islands. This difference in dominant variables is proof that each region has specific infrastructure needs and must be carefully considered in slum planning.

b) Variables of Slum Aspect on Ternate Island

The Ternate City area on Ternate Island has aspects that are the dominant variable for slum values. On Ternate Island, the most dominant variables are fire protection both in terms of facilities and infrastructure, waste and environmental drainage. These three dominant aspects can be addressed with environmental road infrastructure as follows

a. Fire Protection: Fire protection includes adequate means and infrastructure to prevent and deal with fires. In dense slums, the availability of road access that allows fire vehicles to pass is very important. Environmental road specifications should consider sufficient dimensions for fire fighting vehicles, including road width and strength. This ensures that in an emergency situation, the fire vehicle can reach the location quickly and effectively. Therefore, road infrastructure planning in slums must take into account this need to improve safety and response to fires.
b. Waste Management: Environmentally scale waste transportation in Ternate City is experiencing difficulties due to inadequate road accessibility for garbage transport vehicles. This condition causes the accumulation of waste in slums, which has a negative impact on environmental health and cleanliness. Adequate road infrastructure is essential to support effective waste management. Good road infrastructure planning will contribute significantly to slum management and sustainable waste management efforts.

c. Environmental Drainage: Based on the data of the slum assessment of Ternate City, environmental drainage in slum areas is not able to drain rainwater runoff effectively, causing inundation. In addition, the quality of environmental drainage construction is also considered poor. The construction of environmental roads equipped with a proper drainage system is very important to reduce the risk of flooding and inundation in the slums of Ternate City. With good drainage, rainwater can be drained more efficiently, thus preventing inundation that can damage infrastructure and disrupt community activities. Therefore, the planning and development of road infrastructure equipped with adequate drainage must be a priority in efforts to organize slums in Ternate City. This will improve the quality of life of the community and create a healthier and safer environment.

4) Findings on Research Question 1

In Ternate City, especially in the Ternate Island area, the dominant aspects that affect the level of slums include fire protection, waste management, and environmental drainage. These three aspects can be overcome through the development of adequate environmental road infrastructure. Environmental road access with appropriate specifications is essential to support the mobility of fire fighting vehicles in an emergency, efficient waste transportation, and the integration of effective drainage systems to prevent waterlogging and flooding. Therefore, the planning and construction of environmental roads equipped with supporting facilities is a top priority in the arrangement of slums, in order to improve the quality of life of the community and create a healthy, safe, and sustainable environment.

With the construction of environmental roads that are designed appropriately to support the needs of fire protection, waste management, and environmental drainage systems, it is expected that there will be a reduction in the slum level by 16 points from the original 19 to 3. This decrease is an indicator of an optimal improvement in the quality of settlements in slums, as shown in the following table:

Table 8. Reduction in the Value of Slums in the Ternate Island Area

No	Category	Variable	Unit	Ideal	Remnant	Percentage (%)	Value (Original)	Value (Becoming)
1	Building	X.BG.1	Unit	2.882	705	24,46	0	0
		X.BG.2	Has	161,21	0	0	0	0
		X.BG.3	Unit	2.882	375	13,01	0	0
2	Neighborhood Roads	X.JL.1	Meter	67.496	19.181,8	28,42	1	1
		X.JL.2	Meter	67.496	30.023,3	44,48	1	1
3	Drinking Water	X.AM.1	MONTHS	3.393	225	6,63	0	0
		X.AM.2	MONTHS	3.393	1.141	33,63	1	1
4	Environmental Drainage	X.DL.1	Has	161,21	4,34	2,69	0	0
		X.DL.2	Meter	53.647,4	26.810,7	49,98	1	0
		X.DL.3	Meter	53.647,4	20.632,7	38,46	1	0
5	Wastewater Management	X.AL.1	MONTHS	3.393	109	3,21	0	0
		X.AL.2	MONTHS	3.393	440	12,97	0	0
6	Waste Management	X.PS.1	MONTHS	3.393	2.122	62,54	3	0
		X.PS.2	MONTHS	3.393	1.549	45,65	1	0
7	Fire Protection	X.KB.1	Unit	2.882	2271	78,8	5	0
		X.KB.2	Unit	2.882	2271	78,8	5	0
Slum Value							**19**	**3**
Classification of Slums							**Light**	**Not Slum**

Source: Processed Author, 2025

2. Research Summary 2

The second research formulation aims to answer the second research question (RQ 2), which is to determine the impact of environmental road construction on slum areas in Ternate City. This impact analysis needs to be carried out first to provide a comprehensive evaluation of the environmental road infrastructure that has been built. This evaluation will be carried out by comparing the intervention sample and the control sample using the Difference-in-Differences (DID) analysis method.

1) Collection of Slum Assessment Data from Village Samples

The slum assessment data in Ternate City, also known as the slum baseline, is the result of identification from the KOTAKU (City Without Slums) team with funding from the State Budget managed by the Ministry of Public Works in each province. This data has been received and analyzed in the formulation of the first research. For the second study, two urban villages with slum areas were selected to analyze their impact using the Difference-in-Differences (DID) method. These two samples are then determined as control or intervention samples based on whether the village has experienced previous environmental road construction. This analysis aims to provide a more comprehensive evaluation of the impact of environmental road construction in the slums of Ternate City.

2) Determination of Control and Intervention Samples

a. Sample Intervention

East Makassar Village was chosen as an intervention sample from eleven villages in the Ternate Island area that have slum areas. This selection is based on the implementation of the East Makassar Slum Quality Improvement Work Package in Ternate City (NSUP) in 2022. One of the outputs of this work package is the development of environmental and pedestrian road infrastructure in East Makassar Village. The construction of this environmental road access aims to reduce the level of slums in the village, provide accessibility for the local community, provide an adequate drainage system, and provide access for fire fighting vehicles. In 2023, the work package for the Improvement of the Quality of East Makassar Slums in Ternate City (NSUP) has been completed, so the slum assessment of East Makassar Village has changed.

Table 9. Slum Assessment of East Makassar Village in 2023

No	Category	Variable	Unit	Ideal	Remnant	Percentage (%)	Value
1	Building	X.BG.1	Unit	399	271	67,92	3
		X.BG.2	Has	10,58	0	0	0
		X.BG.3	Unit	399	138	34,59	1
2	Neighborhood Roads	X.JL.1	Meter	5.760	1.635	28,39	1
		X.JL.2	Meter	5.760	277	4,81	0
3	Drinking Water	X.AM.1	MONTHS	505	0	0	0
		X.AM.2	MONTHS	505	322	63,76	3
4	Environmental Drainage	X.DL.1	Has	10,58	3,81	36,01	1
		X.DL.2	Meter	5.278	2.090	39,60	1
		X.DL.3	Meter	5.278	1.300	24,63	0
5	Wastewater Management	X.AL.1	MONTHS	505	0	0	0
		X.AL.2	MONTHS	505	296	58,61	3
6	Waste Management	X.PS.1	MONTHS	505	0	0	0
		X.PS.2	MONTHS	505	0	0	0
7	Fire Protection	X.KB.1	Unit	399	215	53,88	3
		X.KB.2	Unit	399	215	53,88	3
Slum Value							**19**
Classification of Slums							**Light**
Average Slums of Villages							**29,13%**

b. Control Sample

East Salero Village was chosen as a control sample from eleven villages in the Ternate Island area that have slum areas. This election is based on the similarity of location between Salero Village and East Makassar Village. In East Salero Village, the construction of an environmental road with specifications that allow firefighting vehicles to pass through has not been carried out. Control samples were taken for two periods, namely slum assessments until 2022 and 2023. The slum valuation of Salero Village until 2022 is as follows:

Table 10. Salero Village Slum Assessment 2022

No	Category	Variable	Unit	Ideal	Remnant	Percentage (%)	Value
1	Building	X.BG.1	Unit	127	49	38,58	1
		X.BG.2	Has	3,72	0	0	0

No	Category	Variable	Unit	Ideal	Remnant	Percentage (%)	Value
		X.BG.3	Unit	127	1	0,79	0
2	Neighborhood Roads	X.JL.1	Meter	2.112	549	25,99	1
		X.JL.2	Meter	2.112	0	0	0
3	Drinking Water	X.AM.1	MONTHS	167	0	0	0
		X.AM.2	MONTHS	167	0	0	0
4	Environmental Drainage	X.DL.1	Has	3,72	0	0	0
		X.DL.2	Meter	585	0	0	0
		X.DL.3	Meter	585	0	0	0
5	Wastewater Management	X.AL.1	MONTHS	167	2	1,20	0
		X.AL.2	MONTHS	157	5	2,99	0
6	Waste Management	X.PS.1	MONTHS	167	126	75,45	3
		X.PS.2	MONTHS	167	155	92,81	5
7	Fire Protection	X.KB.1	Unit	127	115	90,55	5
		X.KB.2	Unit	127	115	90,55	5
Slum Value							**20**
Classification of Slums							**Light**
Average Slums of Villages							**26,18%**

Source: (BPPW North Maluku, 2022), has been reprocessed

3) Analisis DID

Difference-in-Differences (DiD) analysis was used to answer RQ 2 because it combined before-after comparisons with treatment-control groups, allowing for more accurate identification of policy impacts. In this study, DiD was used to measure the impact of environmental road construction in the slum area of East Makassar Village, Ternate City, in 2022. By comparing the conditions of the intervention and control groups before and after development, the authors were able to estimate the impact of the intervention in depth. Based on the instruments and calculation methods in the previous chapter, the following data will be obtained:

Table 11. Average Sectoral Slum Data Intervention and Control Sample

Control Sample		Sample Intervention	
Yc,0	26,18%	yi,0	35,07%
Yc,1	23,11%	yi,1	29,13%

Source: Processed Author, 2025

The impact value resulting from the construction of environmental road accessibility facilities and infrastructure in the slums of East Makassar Village, Ternate City, in 2022 is calculated using the following DID equation:

DID=(y_(i,1)- y_(i,0))-(y_(c,1)- y_(c,0))

Equation 3.1

DID=(29.13%- 35.07%)-(23.11%- 26.18%)

DID=(-2.87%)

The impact value of the construction of environmental roads in East Makassar Village, Ternate City can be calculated by comparing with data from Salero Village with the DID method above, it was found that the impact value obtained was that there was a decrease in the average percentage of slums in East Makassar Village by 2.87%. As shown in the graph below:

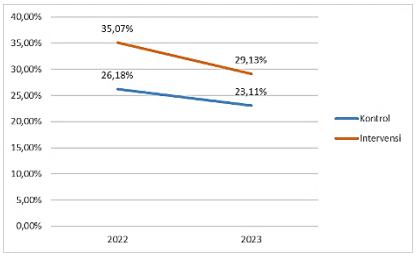

Figure 7. DID Graph of the Impact of Environmental Roads on Slums
Source: Processed Author, 2025

4) Findings on Research Question 2

By comparing two villages representing the control sample with the intervened sample and the DID method analysis was carried out, the results were obtained that the construction of environmental roads in slums in Ternate City had an impact in the form of a reduction in the average slum rate of 2.87%. The decrease in the value of the slums occurred due to the construction of an environmental road in the East Makassar district along 205 meters equipped with drainage and designed as an access for fire fighting vehicles.

3. Research Summary 3

1) Preparation of Environmental Road Design

In the previous sub-chapter, a table of environmental road specifications has been presented which is compiled based on regulations, standards, and needs to overcome slums in Ternate City. These specifications are then summarized in the following table to provide a clearer picture of the design of environmental roads in the slums of Ternate City.

In the assessment of slums in Ternate City conducted by the KTAKU team, pedestrian paths (sidewalks) are considered part of environmental roads. Consequently, the need for environmental roads in efforts to arrange slums is likely to be greater than the total length of environmental roads that currently do not meet standards. However, the existence of environmental roads equipped with sidewalks along its sides is still necessary to increase accessibility and improve the aesthetics of the area, thereby creating a more livable environment.

In this study, considering that the construction of pedestrian paths requires a large budget, two alternative environmental road designs were prepared. The first alternative is an environmental road equipped with a pedestrian path, while the second alternative is an environmental road that is only equipped with a drainage system. The design selection takes into account budget limitations while still trying to meet the needs of infrastructure that supports improving the quality of slum areas. The design is prepared as in the appendix of this study or as follows:

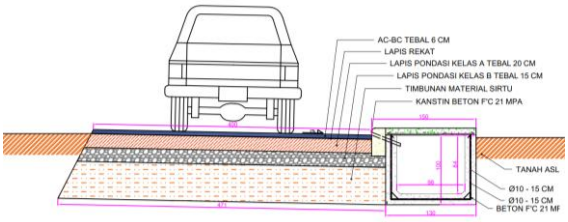

Figure 8. Neighborhood Road Design Equipped with Sidewalks (Alternative 1)
Source: Processed Author, 2025

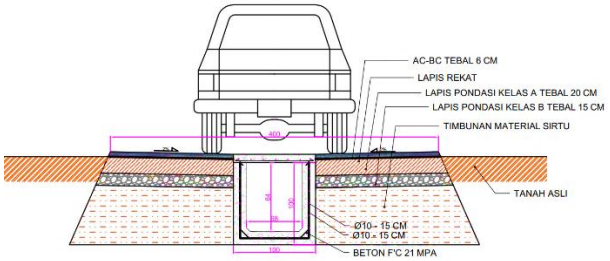

Figure 9. Neighborhood Road Design Without Sidewalks (Alternative 2)
Source: Processed Author, 2025

2) Preparation of Environmental Road WBS

To be able to compile the budget needs for the construction of environmental roads in the slums of Ternate City, based on the design that has been prepared and validated above, the scope of work (WBS) can be prepared first. The WBS that is prepared is up to the level of activity which will then be carried out a unit price analysis for each activity. So based on the two designs that have been compiled above, the WBS that has been compiled is as follows:

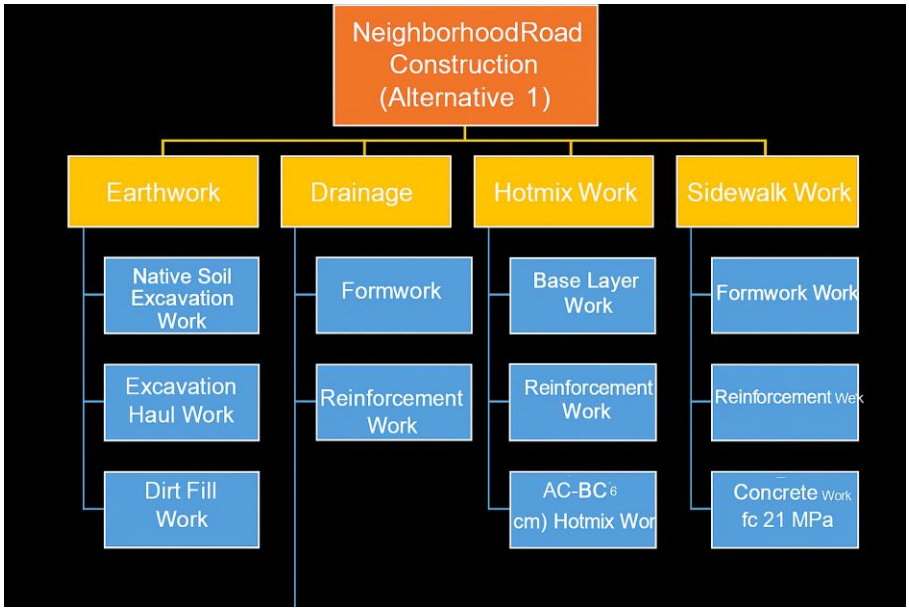

Figure 10. WBS Environmental Road Development (Alternative 1)
Source: Processed Author, 2025

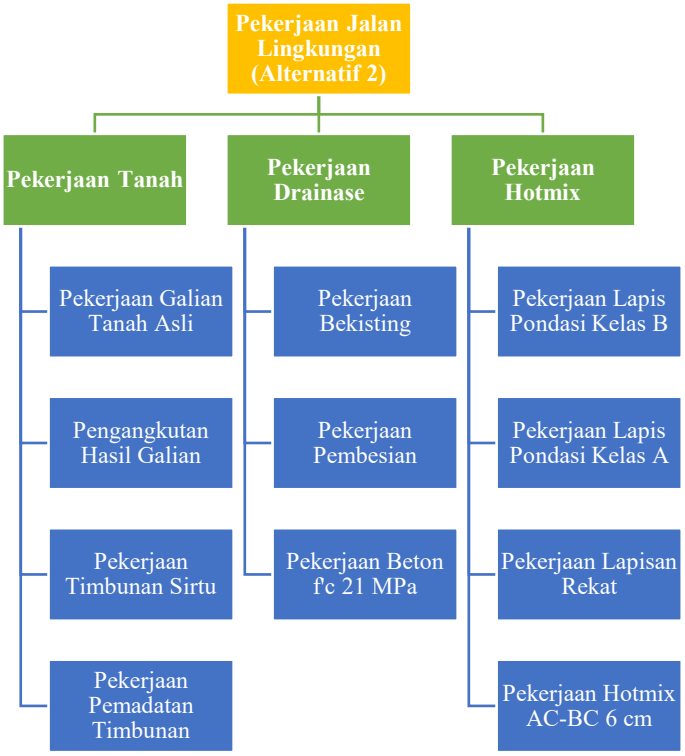

Figure 11. WBS Environmental Road Development (Alternative 2)
Source: Processed Author, 2025

3) Analysis of Unit Prices

Based on the Work Breakdown Structure (WBS) of the two design alternatives that have been prepared and validated, the preparation of the Price Analysis can refer to the Regulation of the Minister of PUPR Number 8 of 2023 and is complemented by the Circular Letter of the Directorate General of Construction Development of the Ministry of PUPR Number 73/SE/Dk/2023. The unit price standard of Ternate City, which is regulated in the Ternate Mayor Regulation Number 17.1 of 2024 and the Ternate Mayor Regulation Number 48.B of 2023, can be used as input.

Table 12. Summary of Ternate City Environmental Road Work

Yes		Work	Unit	Unit Price
A		**Earthworks**		
	1	Original Soil Excavation Work	m3	IDR 13,078
	2	Transportation of Mineral Products	m3	IDR 121,914
	3	Sirtu Stockpile Work	m3	IDR 448,380
	4	Stockpile Compaction Work	m3	IDR 9,614
B		**Concrete Works**		
	1	Formwork Work	m2	IDR 88,093
	2	Ironing Work	Kg	IDR 19,370
	3	Concrete Works f'c 21 Mpa	m3	IDR 1,556,552
C		**Hotmix Jobs**		
	1	Class B Foundation Layer Work	m3	IDR 680,537
	2	Class A Foundation Layer Work	m3	IDR 706.689
	3	Adhesive Coating Work	liter	IDR 36,933
	4	Hotmix AC-BC 6 cm Job	tone	IDR 1,560,977

Based on the table above, the unit price analysis for each type of work is as follows:

Table 13. Price Analysis of Excavation Work with Excavator

No	Description	Coefficient	Unit	Unit Price (Rp)	Total Price (Rp)
A	Tenaga				
	Worker	0,0218	OH	151.800,00	3.302,21
	Mandor	0,0109	OH	177.160,00	1.926,94
				Total Workforce	5.229,15
B	Material				
	-	-	-	-	-
				Quantity of Ingredients	-
C	Equipment				
	Excavator (0,5 m3)	0,0109	jam	612.337,00	6.660,29
				Number of Equipment	6.660,29
D	Total (A+B+C)				11.889,44
And	Overhead & Profit (10%)				1.188,94
F	**Unit Price of Work (D+E)**				**13.078,39**

CONCLUSION

In the Ternate City area on *Pulau Ternate* (Ternate Island), the level of slums is influenced by three main aspects: fire protection, waste management, and environmental drainage. All three can be addressed through the development of adequate environmental road infrastructure. Environmental roads with the right specifications play an important role in supporting access for fire engines, garbage transportation, and drainage system integration to prevent inundation and flooding. Therefore, the construction of environmental roads equipped with supporting facilities is a priority in the arrangement of slums. With the construction of environmental roads, it is hoped that the assessment of the level of slums can decrease significantly, from 19 to 3 points.

The results of the analysis using the *Difference-in-Differences* (*DiD*) method, by comparing *Desa Salero* (Salero Village) as a control sample with *Desa Makassar Timur* (East Makassar Village) as an intervention sample, showed that the construction of environmental roads in the intervention sample slums contributed to a decrease in the average slum rate by 2.87%. The intervention in question is the construction of a 205-meter-long environmental road in East Makassar Village in 2022, which is equipped with drainage and designed to support access for firefighting vehicles. The existence of environmental roads in the arrangement of slums makes pedestrian paths not a top priority, although these paths can still be used by the community to support daily activities.

However, given budget limitations, especially in the aspects of land acquisition and other financing components, a second design alternative with a more efficient budget allocation was prepared. Land acquisition remains the main problem in the arrangement of slums, particularly with the construction of environmental roads. According to the analysis of the financing components implemented in the two design alternatives, it was found that land acquisition accounts for 76.91% of the total budget needs in the first design alternative and 78.36% in the second design alternative.

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