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IMPLEMENTATION OF ROAD AND DRAINAGE INFRASTRUCTURE DEVELOPMENT BY THE PUBLIC WORKS DEPARTMENT OF SIMALUNGUN REGENCY

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Abstract

Road and drainage infrastructure development is an important component in supporting community mobility, economic growth, and environmental sustainability. Simalungun Regency as a region with extensive road network coverage still faces various problems, such as high levels of road damage and suboptimal drainage system function. This study aims to analyze the implementation of road and drainage infrastructure development carried out by the Simalungun Regency Public Works Department, by reviewing factors that influence the effectiveness of its implementation, the level of development integration, and the role of community participation based on the theory of *Success Factors in Managing Wastewater Infrastructure through Community Participation* . The research method used is a descriptive qualitative approach with data collection techniques through documentation studies, observations, and interviews. The results of the study indicate that the implementation of road and drainage infrastructure development has been carried out in accordance with regional planning, but its effectiveness has not been optimal. Budget limitations, human resource capacity, weak supervision, and low community participation are the main factors inhibiting the success of development. In addition, the integration between road development and the drainage system is still low, thus affecting the sustainability of infrastructure. Therefore, it is necessary to strengthen integrated development governance, increase community participation, and optimize supervision and funding so that road and drainage infrastructure development can be sustainable and provide long-term benefits for the people of Simalungun Regency.

Keywords *: Development Implementation, Road Infrastructure, Drainage System, Community Participation and Infrastructure Sustainability*

Introduction

Road and drainage infrastructure development is a fundamental element in supporting regional economic growth, improving regional connectivity, and enhancing the quality of life for the community. Adequate road infrastructure plays a crucial role in facilitating the mobility of goods and services, expanding public access to economic, educational, and health centers, and promoting equitable development across regions. Meanwhile, a good drainage system is a key prerequisite for controlling inundation and flooding, maintaining the resilience of road infrastructure, and creating a healthy and sustainable residential environment. In Simalungun Regency, the development and maintenance of road and drainage infrastructure is the strategic responsibility of the Public Works Department, a regional agency that plays a vital role in implementing regional development policies. Simalungun Regency has diverse geographic characteristics, ranging from highland to lowland areas, with relatively high rainfall. This condition demands integrated, adaptive, and sustainability-oriented planning and implementation of road and drainage infrastructure development. However, in practice, the implementation of road and drainage infrastructure development in Simalungun Regency still faces various challenges. A number of road sections in several sub-districts have reportedly experienced damage before reaching their planned service life, such as cracks, potholes, and a decline in pavement quality. This condition is often exacerbated by a suboptimal drainage system, either due to inadequate capacity, sedimentation, or a lack of routine maintenance. As a result, waterlogging during the rainy season is a recurring problem and directly impacts the comfort and safety of road users.

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Limited regional budgets, inaccurate project prioritization, and coordination between stakeholders are factors that influence the effectiveness of infrastructure development implementation. Furthermore, oversight of construction work implementation and the quality of development results still need to be improved to ensure compliance with established technical specifications and standards. Another equally important issue is community participation and transparency in the implementation of infrastructure development. Communities as direct users of road and drainage infrastructure are often not optimally involved in the development planning and evaluation process. This condition has the potential to create a gap between the real needs of the community and the development programs implemented by the local government. It can be concluded that the implementation of road and drainage infrastructure development by the Simalungun Regency Public Works Department still faces various technical, administrative, and social challenges. Therefore, a comprehensive study is needed to analyze how the implementation of road and drainage infrastructure development is carried out, the extent of its effectiveness in achieving regional development goals, and what factors influence the success or obstacles in its implementation. The results of this study are expected to provide input for the local government in improving the quality of planning, implementation, and management of sustainable infrastructure development in Simalungun Regency.

Data from the Central Statistics Agency (BPS) shows that the total length of roads managed by the Simalungun Regency Government reached approximately 1,803.78 km by 2022. This figure illustrates the significant responsibility of the local government, particularly the Public Works Department, in ensuring the availability and quality of road infrastructure to support social and economic activities. However, the condition of existing roads presents serious challenges. Of this total length, approximately 1,005.31 km, or more than 55 percent, are in severe disrepair, while only approximately 497.81 km, or 27.6 percent, are in good condition. This disparity between adequate and inadequate roads indicates that the majority of road infrastructure in Simalungun Regency is unable to provide optimal services to the public. The predominance of roads in severe disrepair reflects the challenges faced in implementing and maintaining road infrastructure. High levels of road damage are often not solely due to technical age but are also closely related to the quality of planning, construction implementation, and suboptimal drainage systems.

Table 1.1 Length and Condition of Roads in Simalungun Regency

No	Road Conditions	Length (Km)	Percentage (%)
1	Good	497.81	±27.6%
2	Seriously Damaged	1,005.31	±55.7%
3	Other Conditions*	±300.66	±16.7%
	Total	**1,803.78**	**100%**

Source: portalsatudata.simalungunkab.go.id

Poor drainage can accelerate the degradation of road structures due to waterlogging and excessive infiltration, especially in areas with high rainfall such as Simalungun Regency. This condition is relevant to the focus of research on the implementation of road and drainage infrastructure development by the Simalungun Regency Public Works Department, because it shows a gap between infrastructure development objectives and the results achieved in the field. These data provide empirical evidence that the implementation of development has not been fully effective in improving road quality sustainably. Therefore, this study is important to examine in more depth how the process of road and drainage development is carried out, starting from the planning, budgeting, implementation, and supervision stages. In addition, this study can also identify inhibiting factors that cause high levels of road damage, so that more appropriate policy recommendations can be formulated to improve the quality of infrastructure and public services in Simalungun Regency.

Table 1.2 Actual Road Conditions in Simalungun Regency

No	Source Data	Length of Damaged Road (Km)	Total Road Length (Km)	Information
1	Media Reports	±841 km	±1,804 km	It will require a budget of more than IDR 3 trillion for a complete overhaul.
2	Alternative Media Data	±971.33 km	±1,804 km	Condition is badly damaged and relatively unchanged from the previous year.

Source: BPS data 2025

Actual road condition data in Simalungun Regency, sourced from field reports and media coverage, indicates that road infrastructure problems remain at an alarming level. Of the total road length of approximately 1,804 km, between 841 km and 971.33 km are damaged or severely damaged. This indicates that nearly half to more than half of the district's road network does not meet minimum service standards. The severity of this road damage directly impacts the significant budgetary requirements. Comprehensive repairs to the approximately 841 km of damaged roads are estimated to require more than IDR 3 trillion, a figure far exceeding the fiscal capacity of the local government. This indicates a significant gap between the actual need for infrastructure development and regional funding capabilities. In terms of budget, the Simalungun Regency Public Works and Spatial Planning Agency allocated only approximately IDR 271 billion in 2024, with a realization of approximately IDR 254 billion. Compared to the estimated budget requirement for road repairs, regional funding is only able to cover a small portion of the total requirement. This directly impacts the effectiveness of the implementation of road and drainage infrastructure development carried out by the Public Works Agency.

Table 1.3 Simalungun Regency Road Infrastructure Development Budget

No	Budget Source	Year	Budget Value
1	Regency Budget (PUTR Service)	2024	±Rp271 billion
2	PUTR Budget Realization	2024	±Rp254 billion
3	Assistance from the North Sumatra Provincial Government	2022	±Rp219.760 billion

Source: https://mistar.id/news/simalungun

Efforts to improve infrastructure quality are also supported by budget assistance from the North Sumatra Provincial Government amounting to IDR 219.760 billion in 2022. Although this assistance has made a positive contribution to accelerating road construction, this amount is still insufficient to address the accumulated road damage that has occurred over the years. Furthermore, dependence on cross-government assistance also requires effective coordination for optimal development implementation. This empirical condition is highly relevant to the focus of research on the implementation of road and drainage infrastructure development by the Simalungun Regency Public Works Agency. The high level of road damage amidst budget constraints indicates that implementation problems are not only related to funding availability, but also to aspects of planning, prioritization, construction quality, and the effectiveness of infrastructure supervision and maintenance. This research is important to analyze the extent to which road and drainage development policies and programs have been implemented effectively, as well as what factors inhibit or support their implementation. The research findings are expected to provide strategic recommendations for local governments in optimizing budget use, improving development quality, and ensuring the sustainability of road and drainage infrastructure in Simalungun Regency. Road and drainage infrastructure development is a key foundation for regional connectivity, environmental resilience, and sustainable regional development. However, empirical conditions in Simalungun Regency indicate that the implementation of road and drainage infrastructure development still faces various fundamental problems, such as high levels of road damage, suboptimal drainage function, and limited funding and management capacity. This situation emphasizes the urgency and feasibility of conducting research on the implementation of road and drainage infrastructure development by the Simalungun Regency Public Works Agency. The urgency of this research is further strengthened when linked to the theory of

Success Factors in Managing Wastewater Infrastructure through Community Participation proposed by Hidayat et al. (2023). This theory emphasizes that the success of water and drainage infrastructure management is not solely determined by technical and funding aspects, but also by community participation, institutional coordination, and post-construction management sustainability. In the context of Simalungun Regency, the problem of drainage that has not been well integrated into road construction indicates that these success factors have not been fully internalized in policy implementation practices.

Hidayat et al.'s (2023) research on wastewater infrastructure in Medan Deli District shows that community participation plays a significant role in maintaining infrastructure function and extending its service life. This is relevant to this study, as road damage in Simalungun Regency is often exacerbated by poorly maintained drainage, which ultimately reduces the overall quality of road infrastructure. Therefore, this study is important to assess the extent to which a participatory approach has been incorporated into road and drainage development and maintenance at the district level. Furthermore, Hartini et al.'s (2023) research on the characteristics and management of drainage infrastructure in Medan Sunggal District emphasizes the importance of matching regional characteristics, drainage capacity, and sustainable management patterns. These findings indicate that failure to understand local characteristics can result in drainage infrastructure not functioning optimally. In the context of Simalungun Regency, which has diverse geographic and hydrological conditions, this study is urgent to identify whether the planning and implementation of road and drainage development have comprehensively considered regional characteristics.

The urgency of this research is further reinforced by Aris et al.'s (2022) study on the direction of coastal infrastructure development in Natal District, Mandailing Natal Regency. The study shows that the success of infrastructure development is largely determined by the synchronization between regional planning, technical implementation, and local community needs. This is relevant to the conditions in Simalungun Regency, where budget constraints demand appropriate development priorities based on the community's real needs. Without systematic implementation evaluation, infrastructure development has the potential to be ineffective and unsustainable. From an institutional perspective, Milanie et al.'s (2020) study on the influence of work relationships and the work environment on employee work ethics confirms that the quality of human resources and the work ethics of civil servants also influence the performance of public organizations. In the context of the Simalungun Regency Public Works Agency, this aspect is crucial because the successful implementation of infrastructure development depends not only on policies and budgets, but also on the professionalism, commitment, and coordination of implementing officials in the field.

Furthermore, Milanie et al.'s (2021) research on instruments for accelerating tourism village development shows that a local potential-based approach and stakeholder involvement can accelerate the achievement of development goals. These findings reinforce the urgency of research in Simalungun Regency, as effective road and drainage development can be a strategic instrument in supporting regional development, tourism, and the local economy. Sinar et al.'s (2023) research on land transportation network development in Padang Lawas Regency also confirms that the quality of the road network significantly determines regional integration and the effectiveness of the transportation system. This condition aligns with the problems in Simalungun Regency, where high levels of road damage have the potential to hamper interregional connectivity and regional economic growth.

Furthermore, Milanie's (2023) perspective on the role of regional planning in urban transformation emphasizes that infrastructure development must be implemented in a planned, integrated, and long-term manner. Without effective implementation, even good planning will not produce real change. Therefore, this research is crucial for bridging the gap between planning and implementation of road and drainage infrastructure development in Simalungun Regency. Based on the overall study, it can be concluded that the urgency of this research lies in the need to comprehensively evaluate and analyze the implementation of road and drainage infrastructure development, integrating technical, institutional, funding, and community participation aspects. This research is expected to not only provide academic contributions to the development of infrastructure development implementation theory but also provide practical recommendations for the Simalungun Regency Government in improving the effectiveness and sustainability of road and drainage infrastructure development.

Identification of problems

Based on the background, empirical data, and urgency of research regarding the implementation of road and drainage infrastructure development by the Simalungun Regency Public Works Department, several problems can be identified as follows:

1. The high level of road damage in Simalungun Regency, where more than half of the district road network is in a state of severe damage, indicates that the results of infrastructure development and maintenance are not optimal.

2. The drainage system is not functioning effectively on many road sections, causing waterlogging and accelerating damage to road construction, especially during the rainy season.
3. The gap between the real needs for road infrastructure development and repair and the budget capacity of the Simalungun Regency Government, both from the APBD and budget support from the provincial government.
4. The implementation of road and drainage infrastructure development has not been fully integrated, either at the planning, implementation or maintenance stages, thus reducing the effectiveness and sustainability of development results.
5. Weak supervision and quality control of road and drainage construction work, which has the potential to cause premature damage before the technical life of the infrastructure is reached.
6. The suboptimal involvement and participation of the community in the planning, implementation and maintenance of road and drainage infrastructure, as emphasized in the theory of successful infrastructure management based on community participation.
7. Limited human resource capacity and institutional coordination within the Simalungun Regency Public Works Department in implementing infrastructure development policies effectively and sustainably.

Formulation of the problem

Based on the identification of the problem, the formulation of the problem in this research is as follows:

1. How is the implementation of road and drainage infrastructure development carried out by the Simalungun Regency Public Works Department?
2. What factors influence the success and obstacles in implementing road and drainage infrastructure development in Simalungun Regency?
3. To what extent is the integration between road construction and drainage systems in supporting infrastructure sustainability in Simalungun Regency?
4. What is the role of budget capacity, human resources, and supervision in determining the effectiveness of implementing road and drainage infrastructure development?
5. What is the level and form of community participation in the development and maintenance of road and drainage infrastructure in Simalungun Regency?
6. How is the implementation of road and drainage infrastructure development by the Simalungun Regency Public Works Department if reviewed based on the theory of *Success Factors in Managing Wastewater Infrastructure through Community Participation* ?
7.

Literature Review

2.1 Public Policy Implementation Theory

Policy implementation is the operationalization stage of government policy aimed at realizing the objectives formulated in the policy document. According to Barus (2022), the implementation of public policy in road infrastructure development depends not only on the policy planning itself but is also influenced by several *success factors*,such as communication between implementing organizations, resource allocation, institutional characteristics, implementer attitudes, and the social and economic environment. These factors determine the extent to which the policy can be implemented effectively and achieve its stated objectives. In the context of road and drainage infrastructure development, this theory is relevant because effective implementation requires good coordination between the central government, regional governments, and technical implementing units such as the Public Works Department. An imbalance in resources or poor communication will create obstacles in the implementation process, thus hindering the achievement of quality infrastructure targets.

2.2 Success Factors for Infrastructure Implementation

In policy implementation studies, resources and bureaucratic structure are key determinants of success. Research in Kuningan Regency by Nur'aisah (2023) shows that resources, policy size and objectives, inter-organizational communication, implementer characteristics, and public involvement are key factors influencing the effectiveness of the implementation of the joint road development policy with the community (*Community Road Management Program/PJBM*). These findings reinforce the assumption that the success of road and drainage development in Simalungun Regency depends not only on physical or technical aspects, but also on institutional and social factors that support the implementation process, including the capacity of the Public Works Department, coordination between units, and stakeholder involvement.

2.3 Community Participation Theory

Community participation is a process in which citizens are actively involved in the planning, implementation, and evaluation of development programs. While not a single, formal theory like Edwards' implementation model, recent empirical research confirms the importance of the community's role in the success of infrastructure programs. In a study related to road and drainage development, research by Mia Anisa & Yuzan Noor (2025) found that community participation significantly influences the effectiveness of road and drainage development, especially in the context of the Slum-Free City (*KOTAKU*) program. The study results recorded a 26.9% contribution of community participation to development effectiveness, indicating that the level of community involvement can improve the quality of development outcomes. This theory is relevant when linked to research by Hidayat et al. (2023) on *success factors* in wastewater infrastructure management through community participation. Hidayat and colleagues demonstrated that community participation—including involvement in decision-making, implementation, utilization, and evaluation—is a key determinant of the success of sustainable infrastructure. This finding emphasizes that the success of infrastructure development is not solely due to technical factors, but also to community involvement at every stage of the process.

2.4 Synergy of Policy Implementation Theory and Community Participation

This research's theoretical framework combines public policy implementation theory with community participation theory as a key factor in successful infrastructure management. This combination of thinking is necessary because road and drainage development is a program that involves many actors, including local government bureaucracies and the community as beneficiaries. Barus (2022) emphasizes internal institutional factors such as resources, communication, and implementer characteristics as determining the success of policy implementation, while Hidayat et al. (2023) emphasize the role of community participation as a *success factor* . These two perspectives complement each other: institutional aspects provide the framework for technical implementation, while community participation ensures sustainability and links development to the community's social needs.

Research Methodology

3.1 Research Approach

This study uses a descriptive qualitative approach to gain an in-depth understanding of the road and drainage infrastructure development implementation process carried out by the Simalungun Regency Public Works Department, including supporting and inhibiting factors. A qualitative approach allows researchers to holistically explore social phenomena, public policies, bureaucratic practices, and interactions between the actors involved (Creswell & Poth, 2018). According to Moleong (2020), qualitative research is suitable for studying phenomena occurring in natural contexts, where the researcher is the key instrument in data collection, and the data collected is verbal and narrative. This research aims to uncover the implementation process and dynamics of road and drainage infrastructure development, rather than simply measuring numbers or statistics.

3.2 Location and Time of Research

The research was conducted in Simalungun Regency, North Sumatra, specifically in areas focused on road and drainage infrastructure development. This location was selected based on the empirical evidence that most of the district's roads are in severe disrepair and face recurring drainage problems, necessitating an in-depth study of the implementation process. The research was conducted in the period January–May 2026. This timing was adjusted to the stages of the ongoing infrastructure development program so that researchers could observe the implementation conditions directly and up to date.

3.3 Research Informants and Sampling Techniques

This study used key informants selected using purposive sampling based on their relevant roles and insights into road and drainage infrastructure development programs. According to Sugiyono (2021), purposive sampling is a sampling technique with specific considerations relevant to the research objectives, particularly when researchers want to understand a specific phenomenon based on specific criteria.

Informants in this study include:

1. Officials from the Simalungun Regency Public Works Department who are directly involved in the planning and implementation of the program.
2. Technical implementers in the field such as project supervisors and contractors.
3. Community leaders or residents living around the road and drainage project.
4. Representatives of non-governmental organizations or road user groups.

With this variety of informants, the research will gain a comprehensive perspective on the implementation process, obstacles, and community perceptions of infrastructure development.

3.4 Data Collection Techniques

Data collection in this study was carried out using several techniques as follows:

3.4.1 In-Depth Interview

Interviews are used to obtain direct information from informants regarding their experiences, perspectives, and interpretations of the development implementation process. According to Kvale & Brinkmann (2020), in-depth interviews allow researchers to access the informants' internal perspectives, including motivations, barriers, and social interpretations of the observed phenomena.

3.4.2 Participatory Observation

Researchers observed the infrastructure development process in the field, including construction activities, interactions between implementers, and community responses to ongoing projects. Miles, Huberman, & Saldaña (2019) stated that participant observation provides contextual data that enriches understanding of actual practices in the field.

3.5 Research Instruments

The primary instrument in this research is the researcher themselves, who serve as the primary tool for data collection and analysis. Moleong (2020) explains that in a qualitative approach, the researcher, as the primary instrument, must be sensitive to the social context and research ethics when interacting with informants. In addition, a list of interview questions, observation guidelines, and documentation checklists were also used to ensure that the data obtained was consistent and systematic.

3.6 Data Analysis Techniques

Data analysis was carried out qualitatively descriptively through several stages:

1. Collection of primary and secondary data through interviews, observation, and documentation.
2. Data reduction to focus on data that is relevant to the problem formulation.
3. Presentation of data in narrative form or comparative tables to show the relationship between categories.
4. Verification and drawing conclusions to answer research questions.

Miles, Huberman, & Saldaña (2019) stated that qualitative data analysis is cyclical and iterative so that researchers need to evaluate and verify temporary hypotheses throughout the process to achieve in-depth understanding.

Results

Implementation of road and drainage infrastructure development carried out by the Public Works Department of Simalungun Regency

The implementation of road and drainage infrastructure development is an important indicator in assessing the success of regional development. In Simalungun Regency, the Public Works Department plays a strategic role in planning, implementing, and supervising the development of road and drainage infrastructure to support community mobility, economic growth, and improving the quality of residential environments. Based on research results, the implementation of road and drainage infrastructure development by the Simalungun Regency Public Works Department has been carried out through the stages of planning, budgeting, technical implementation, and supervision. At the planning stage, the Public Works Department prepares a development program based on regional planning documents, such as the Regional Medium-Term Development Plan (RPJMD) and the Regional Government Work Plan (RKPD). This planning aims to determine the priority of road and drainage development that is considered the most urgent based on the level of damage, economic interests, and community needs.

However, the implementation of road and drainage infrastructure development still faces various challenges. One major issue is the limited budget available compared to the area and length of roads required. This situation means that not all damaged roads and problematic drainage systems can be completely repaired within a single budget year. As a result, construction is carried out in stages and in parts, which in some cases has not significantly improved the overall quality of the infrastructure. In terms of technical implementation, road and drainage construction has followed established standards and technical specifications. However, research results indicate that the quality of construction on the ground is not yet fully optimal. Several repaired road sections still experience damage within a relatively short time. This indicates problems with material quality, construction implementation, and technical

supervision during the construction process. Furthermore, the implementation of road and drainage development has not been fully integrated. In some locations, road construction has not been accompanied by the construction or repair of adequate drainage systems. This condition causes water to pool on the road surface, especially during the rainy season, which ultimately accelerates road damage. The lack of integration between road and drainage development indicates that technical coordination in planning and implementation still needs to be improved. Supervision is also a crucial factor in infrastructure development implementation. Supervision carried out by the Public Works Department aims to ensure that work is carried out in accordance with plans and technical specifications. However, research results indicate that field supervision still faces obstacles, both in terms of the limited number of supervisors and suboptimal supervision intensity. This condition has the potential to lead to deviations in work quality, which impact infrastructure durability.

Lubis's (2023) research on *the Clean Water Provision Governance Model as a Sustainable Urban Facility Plan in Medan City* emphasizes the importance of integrated governance between planning, institutions, and infrastructure sustainability. This finding is relevant to drainage development in Simalungun Regency, where drainage is part of the basic infrastructure system directly related to environmental quality and public health. The lack of integration between road and drainage development in Simalungun indicates that the principles of sustainable governance as proposed by Lubis (2023) have not been fully implemented optimally. Furthermore, Lubis and Siregar (2024) in their research on *the Role of Geographic Information Systems (GIS) in Sustainable Urban Transportation Infrastructure Development* emphasized that the use of GIS can improve the accuracy of planning, damage mapping, and prioritizing infrastructure development. This condition is particularly relevant to Simalungun Regency, which has an extensive road network with a high level of damage. The minimal use of GIS technology in planning and monitoring road and drainage development has the potential to lead to development that is partial and poorly targeted.

Regional government policy is also a determining factor in the success of infrastructure development. This is in line with research by Nasution, Sugiarto, and Lubis (2024), which evaluated regional government policies in the management of the Tavip Market in Binjai City. The study showed that budget constraints, weak inter-agency coordination, and poor oversight impacted the effectiveness of policy implementation. Similar conditions were found in the implementation of road and drainage infrastructure development in Simalungun Regency, where limited fiscal capacity and oversight impacted the quality of development outcomes. Furthermore, community participation in the construction and maintenance of road and drainage infrastructure remains relatively limited.

Communities generally act as beneficiaries, but have not been fully involved in the planning and oversight of development. However, community involvement can help local governments identify real needs on the ground and ensure the sustainability of development outcomes through collaborative maintenance. Overall, the implementation of road and drainage infrastructure development by the Simalungun Regency Public Works Department has been carried out in accordance with applicable policy and regulatory frameworks, but its effectiveness still needs to be improved. Budget limitations, suboptimal implementation quality, lack of integration between road and drainage development, and weak oversight and community participation are factors that influence development outcomes. Therefore, continuous improvement efforts are needed through enhanced integrated planning, strengthened oversight, optimized budget utilization, and active community involvement so that road and drainage infrastructure development can provide maximum and sustainable benefits to the people of Simalungun Regency.

What factors influence the success and obstacles in implementing road and drainage infrastructure development in Simalungun Regency?

The successful implementation of road and drainage infrastructure development is not solely determined by budget availability, but is also influenced by various technical, institutional, policy, and social factors. In the context of Simalungun Regency, the implementation of road and drainage infrastructure development by the Public Works Department is influenced by interrelated supporting and inhibiting factors.

1. Policy and Planning Factors

Policy and planning factors are the primary foundation for successful infrastructure development. The existence of regional planning documents such as the RPJMD (Regional Medium-Term Development Plan) and RKPD (Regional Work Plan) is a supporting factor because it provides direction and priorities for road and drainage development. Clear planning allows the Public Works Department to determine which road and drainage sections are most in need of attention. However, obstacles arise when planning is not fully based on real-world conditions. The lack of updated road and drainage condition data results in reactive development that fails to fully address issues. Furthermore, the suboptimal integration between road and drainage development planning leads to waterlogging on roads, accelerating infrastructure damage.

2. Budget Factors and Funding Capacity

Budget availability is a crucial factor in determining the success of development implementation. Budget support from the Simalungun Regency Regional Budget (APBD) and assistance from the provincial government are supporting factors that enable annual road and drainage construction. However, the vast area of Simalungun Regency and the length of its road network, which reaches over 1,800 km, pose challenges. The available budget is not commensurate with the actual need for road and drainage repairs. As a result, construction is carried out in stages, with some damaged road sections remaining unaddressed. These budget constraints also impact the quality of the work, as limited funds often influence the choice of materials and construction methods.

3. Human Resources and Institutional Factors

Competent human resources (HR) within the Public Works Department are a crucial supporting factor in infrastructure development. The presence of technical personnel and field supervisors enables construction activities to proceed according to technical specifications. However, obstacles arise due to the limited number of technical personnel and supervisors compared to the size of the work area. This prevents intensive supervision across all project sites. Weak supervision has the potential to lead to mismatches between planning and implementation in the field, impacting the quality and durability of road and drainage infrastructure.

4. Technical Factors and Geographical Conditions

Technical factors and geographic conditions are highly influential in road and drainage construction in Simalungun Regency. The region's diverse topography, relatively high rainfall, and soil conditions in some areas present challenges in infrastructure development and maintenance. On the one hand, the implementation of technical construction standards and work specifications contributes to successful construction. However, on the other hand, the lack of adaptation of technical designs to local environmental conditions poses a barrier. Drainage systems that are unable to accommodate rainwater discharge cause localized pooling and flooding, ultimately damaging the road surface.

5. Monitoring and Evaluation Factors

Supervision and evaluation are crucial factors in ensuring the successful implementation of infrastructure development. Continuous supervision can ensure that road and drainage construction is carried out in accordance with established plans and quality standards. However, research shows that supervision and evaluation have not been carried out optimally. Limited time, supervisory personnel, and supporting facilities have led to weak quality control in the field. Post-construction evaluations have also not been fully utilized as a basis for improving planning in the following year.

6. Public Participation and Awareness Factors

Community participation is a supporting factor that has the potential to increase the success of infrastructure development. Public involvement in providing information on road and drainage conditions and maintaining development outcomes can assist local governments in creating sustainable infrastructure. However, low public awareness of road and drainage maintenance poses a serious obstacle. The practice of dumping trash into drainage channels and using roads beyond their capacity accelerates infrastructure damage. A lack of public outreach and education contributes to this worsening situation.

Milanie et al.'s (2024) study on *the SWOT Analysis of Village Road Infrastructure Planning* emphasizes the importance of strategic analysis in road infrastructure planning, particularly in areas with high density and economic activity. This finding is relevant to the conditions in Simalungun Regency, which has a vast area and diverse geographic characteristics. Without a comprehensive strategic analysis, road and drainage development risks failing to address key issues such as local congestion, waterlogging, and accelerated road deterioration. In addition to planning and policy aspects, the dimensions of community participation and the use of appropriate technology are also important concerns. Lubis et al. (2024) in their study on *Education and Assistance in the Utilization of Smart Water Filter Appropriate Technology* showed that community involvement in infrastructure management improves the sustainability and effectiveness of facility utilization. In the context of Simalungun Regency, low community participation in drainage and road maintenance contributes to the decline in infrastructure quality, primarily due to blocked drainage channels and inappropriate road use.

Furthermore, Sirait, Lubis, and Hidayat (2025) and Lumbangaol, Lubis, and Hidayat (2025) emphasized that the use of GIS in regional and urban planning, both through participatory approaches and technical management, can improve the quality of development decision-making. These studies strengthen the argument that the implementation of road and drainage development in Simalungun Regency requires a spatial data-based approach, stakeholder participation, and cross-sector coordination for more effective and sustainable development. Based on the correlation with previous research, it can be concluded that the implementation of road and drainage infrastructure development by the Simalungun Regency Public Works Department still requires strengthening in aspects of governance,

technology utilization, strategic planning, and community participation. By adopting approaches proven effective in various previous studies, infrastructure development in Simalungun Regency is expected to provide long-term benefits to the community and support sustainable regional development.

To what extent is the integration between road construction and drainage systems in supporting infrastructure sustainability in Simalungun Regency?

Integration between road construction and drainage systems is a key prerequisite for achieving sustainable infrastructure. Roads built without adequate drainage systems are susceptible to damage due to waterlogging, while drainage systems not integrated with the road network have the potential to function less than optimally. In the context of Simalungun Regency, the integration of these two types of infrastructure is a critical issue given the high level of road damage and inadequate drainage conditions. Research shows that the integration between road construction and drainage systems in Simalungun Regency is still suboptimal. At the planning stage, road and drainage construction are designed within a single regional planning framework through the RPJMD (Regional Medium-Term Development Plan) and RKPD (Regional Work Plan). However, in practice, implementation on the ground shows that road construction is often carried out without concurrent construction or repair of drainage systems. This condition results in rainwater not being properly collected and flooding the road surface, especially in areas with high rainfall and certain topographical conditions.

Budget constraints are a major factor contributing to this low level of integration. Given the extensive road network and significant drainage repair needs, the Simalungun Regency Public Works Department must prioritize development. Consequently, road construction is often prioritized because its impact is more directly felt by the community, while drainage construction tends to be delayed or implemented partially. This imbalance impacts infrastructure sustainability, as repaired roads quickly deteriorate due to suboptimal drainage systems. From a technical perspective, road and drainage designs in several locations have not fully considered local environmental characteristics. The drainage systems constructed are often unable to accommodate high rainfall volumes, resulting in runoff onto the roadway. This situation indicates that the integration of technical planning between roads and drainage still needs to be improved to support long-term infrastructure resilience.

Furthermore, institutional coordination also influences the level of development integration. Although structurally, road and drainage construction falls under the authority of the Public Works Department, its implementation requires coordination with other regional agencies, such as the planning and environmental departments. Research shows that cross-sector coordination has not been optimal, resulting in road and drainage construction often being carried out based on individual programs without adequate synchronization of time and location. Maintenance is also a crucial factor in assessing development integration. Roads equipped with a good drainage system should have a longer service life. However, low public awareness of maintaining the cleanliness of drainage channels, such as the habit of throwing trash into water channels, causes drainage to not function properly. As a result, the integration that was planned from the start becomes unsustainable during the utilization stage.

Overall, the integration between road development and drainage systems in Simalungun Regency remains suboptimal. Although a planning framework aimed at integration exists, implementation on the ground demonstrates a gap between planning and implementation. To support infrastructure sustainability, efforts are needed to improve integration through integrated planning, balanced budgeting, technical design that adapts to environmental conditions, stronger cross-sector coordination, and community involvement in infrastructure maintenance. With these steps, road development and drainage systems in Simalungun Regency are expected to support each other and provide long-term benefits to the community.

The role of budget capacity, human resources, and supervision in determining the effectiveness of implementing road and drainage infrastructure development

The effectiveness of road and drainage infrastructure development is greatly influenced by budget capacity, human resource quality, and the monitoring system in place. These three aspects are interrelated and form a unified whole that determines the success of infrastructure development, both in terms of the quality of the results and the sustainability of its benefits to the community.

1. **The Role of Budget Capacity**

   Budget capacity is a fundamental factor in implementing road and drainage infrastructure development. Adequate budget availability allows local governments to implement development comprehensively, from the planning stage through physical implementation and post-construction maintenance. In the context of road and drainage construction, a sufficient budget is essential to ensure material quality, the application of appropriate technical specifications, and equitable development coverage. However, limited budget capacity

is often a major obstacle to achieving effective development. When budgets are not commensurate with actual needs on the ground, development tends to be carried out in stages and in sections. This situation impacts infrastructure resilience, as the roads and drainage systems constructed are unable to function optimally in the long term. Therefore, adequate budget capacity and efficient financial management are key prerequisites for increasing the effectiveness of infrastructure development implementation.

2. **The Role of Human Resources**
   In addition to the budget, human resources (HR) play a crucial role in determining the quality and effectiveness of infrastructure development. Competent HR, in planning, technical implementation, and supervision, will be able to translate development policies and plans into quality physical results. The presence of technical personnel with expertise and experience in road and drainage construction is a key factor supporting successful implementation. However, limited human resources often hinder development implementation. High workloads and extensive supervision areas prevent optimal quality control of work in the field. Furthermore, a lack of training and competency development of HR has the potential to reduce the ability of officials to adopt more effective and efficient construction technologies and methods. Therefore, increasing the capacity and professionalism of HR is a key factor in supporting the effectiveness of road and drainage infrastructure development.
3. **Supervisory Role**
   Supervision is a crucial tool for ensuring that infrastructure development is carried out in accordance with plans, technical specifications, and applicable regulations. Effective supervision serves as a quality control mechanism that can prevent deviations during construction. Through intensive and continuous oversight, the potential for technical errors and reduced construction quality can be minimized. However, a weak oversight system is often the primary cause of the low effectiveness of infrastructure development. A limited number of supervisors, inadequate supporting facilities, and a lack of post-implementation evaluations result in suboptimal oversight. Consequently, road and drainage construction results do not always meet expected standards, accelerating deterioration and reducing the service life of the infrastructure. Therefore, strengthening the oversight system is a strategic step in improving the effectiveness of development implementation.
4. **Synergy of the Three Factors**
   Budget capacity, human resources, and oversight are inseparable in determining the effectiveness of road and drainage infrastructure development. An adequate budget without competent human resources and strong oversight can potentially result in substandard development. Conversely, qualified human resources and strong oversight will also be suboptimal without sufficient budget support. Thus, effective road and drainage infrastructure development can only be achieved through synergy between these three factors. Regional governments need to ensure a balance between budget allocation, strengthening human resource capacity, and implementing an effective monitoring system to ensure infrastructure development can achieve its intended purpose.

Level and form of community participation in the development and maintenance of road and drainage infrastructure in Simalungun Regency

Community participation is a crucial element in sustainable infrastructure development, including the construction and maintenance of roads and drainage systems. Community involvement not only strengthens the legitimacy of development policies but also contributes to the effectiveness of their implementation and the sustainability of development outcomes. In the context of Simalungun Regency, the level and form of community participation vary, influenced by social and institutional factors, as well as the level of public awareness of the importance of infrastructure. Research shows that the level of community participation in road and drainage infrastructure development in Simalungun Regency remains moderate to low. Community participation is more prevalent in the early stages of development, particularly in the form of conveying aspirations and proposing infrastructure needs through planning forums such as the village and sub-district development planning meetings (Musrenbang). At this stage, the community plays a role in identifying damaged roads and drainage channels in need of repair, thus contributing to determining development priorities. However, community involvement in the implementation phase of development remains limited. Road and drainage construction is generally carried out by contractors under the supervision of local governments, leaving the community as beneficiaries. Participation in the form of local labor occurs only in certain activities, particularly small-scale or self-managed projects. This limitation indicates that the community has not been fully involved as an active partner in the development process. In terms of infrastructure maintenance, community participation tends to be lower than in the planning phase. Ideally, the

community plays a crucial role in keeping drainage channels clean and maintaining roads to ensure they remain functional. However, research shows that public awareness of infrastructure maintenance still needs to be improved. The practice of dumping garbage into drainage channels and using roads beyond their capacity are factors that accelerate infrastructure damage. This situation indicates that community participation in maintenance is not yet optimal. The forms of community participation found in this study can be classified into several forms, namely participation in decision-making, participation in implementation, and participation in maintenance. Participation in decision-making is relatively better than other forms of participation, due to the existence of formal mechanisms that facilitate community involvement. In contrast, participation in implementation and maintenance remains passive and not well-structured. The low level of community participation in the development and maintenance of road and drainage infrastructure in Simalungun Regency is influenced by several factors, including minimal socialization of development programs, limited public understanding of the importance of infrastructure maintenance, and the assumption that development responsibility lies entirely with the government. Furthermore, the lack of a clear mechanism for sustainable community involvement in monitoring and maintenance also weakens the community's role.

Nevertheless, community participation has significant potential to be enhanced as part of a sustainable infrastructure development strategy. Through increased outreach, education, and community empowerment, community involvement can be expanded beyond the planning stage to include infrastructure monitoring and maintenance. Therefore, road and drainage development in Simalungun Regency relies not only on the local government but also on shared awareness and responsibility between the government and the community. Overall, the level and form of community participation in the development and maintenance of road and drainage infrastructure in Simalungun Regency still needs to be improved to support infrastructure sustainability. More active and structured community involvement is expected to help maintain infrastructure quality, extend its service life, and increase development benefits for the wider community.

Implementation of road and drainage infrastructure development by the Public Works Department of Simalungun Regency when reviewed based on the theory of *Success Factors in Managing Wastewater Infrastructure through Community Participation*

The theory of *Success Factors in Managing Wastewater Infrastructure through Community Participation* emphasizes that the success of wastewater and drainage infrastructure management is determined not only by technical aspects, but also by community involvement, institutional governance, funding sustainability, and management capacity. Although this theory was specifically developed in the context of wastewater infrastructure, its principles are relevant to analyzing the implementation of drainage and road infrastructure development, as both are interrelated in supporting environmental functions and infrastructure sustainability. When viewed from the perspective of community participation factors, the implementation of road and drainage infrastructure development in Simalungun Regency shows that community involvement is still limited. Communities are generally involved at the planning stage through the Musrenbang forum, where they convey aspirations regarding damaged roads and non-functioning drainage. However, based on the theory of *success factors* , effective participation should not stop at the planning stage, but continue through the implementation, monitoring, and maintenance stages. In practice, communities in Simalungun Regency still play more of a beneficiary role than an active partner, so that community participation factors do not fully support the successful implementation of sustainable drainage and road development.

From an institutional and governance perspective, this theory emphasizes the importance of strong, responsive management institutions capable of coordinating with various stakeholders. The Simalungun Regency Public Works Department has carried out its institutional functions through planning, implementing, and supervising infrastructure development. However, limited cross-sector coordination and the suboptimal integration between road and drainage development indicate that institutional governance still needs to be strengthened. From the perspective of *success factors theory* , weaknesses in governance can hamper the effectiveness of infrastructure management and reduce the sustainability of development outcomes. The funding capacity factor is also a key element in this theory. The successful management of drainage and wastewater infrastructure is highly dependent on the availability of adequate and sustainable funds. In the context of Simalungun Regency, budget constraints cause road and drainage development to be carried out in stages and in parts. As a result, inadequate drainage systems often accelerate the deterioration of existing roads. This indicates that funding capacity that is not yet balanced with actual needs is a factor inhibiting the successful implementation of infrastructure development when viewed from the perspective of *success factors theory* .

Furthermore, in terms of technical capacity and human resources, the *Success Factors in Managing Wastewater Infrastructure theory* emphasizes that infrastructure management requires competent human resources and adequate technical skills. The Simalungun Regency Public Works Department has technical and supervisory personnel responsible for implementing development. However, the limited number and capacity of human resources compared to the size of the work area means that supervision and maintenance of drainage and roads are not optimal. This condition indicates that technical capacity remains a challenge in achieving successful infrastructure development implementation. Sustainability and maintenance factors are also important points in this theory. Drainage and road infrastructure that is built must be supported by a maintenance system that involves the community to maintain its long-term function. In Simalungun Regency, low public awareness in maintaining the cleanliness of drainage channels, such as the habit of littering, causes drainage to function suboptimally. From the perspective of *the success factors theory* , weak community-based maintenance is one of the main causes of infrastructure sustainability failure.

Overall, when reviewed based on the theory of *Success Factors in Managing Wastewater Infrastructure through Community Participation* , the implementation of road and drainage infrastructure development by the Simalungun Regency Public Works Department has fulfilled several success factors, particularly in the formal institutional and planning aspects. However, other key factors, such as sustainable community participation, governance integration, funding capacity, and community-based maintenance, are still not optimal. Therefore, increasing community involvement, strengthening institutional governance, and more participatory drainage management are strategic steps to improve the success and sustainability of road and drainage infrastructure development in Simalungun Regency.

Conclusion

Based on the results of research and discussion regarding the implementation of road and drainage infrastructure development by the Simalungun Regency Public Works Department, several conclusions can be drawn as follows:

1. Road and drainage infrastructure development in Simalungun Regency has been implemented in accordance with regional policy and planning frameworks, such as the RPJMD (Regional Medium-Term Development Plan) and RKPD (Regional Work Plan). However, its effectiveness has not been fully optimized, particularly in addressing the high level of road damage and drainage problems that persist in various regions.
2. Integration between road construction and drainage systems remains relatively low, with road construction often not accompanied by simultaneous drainage construction or repairs. This leads to waterlogging on roads, accelerating infrastructure damage and reducing the sustainability of development outcomes.
3. Budget capacity is a major factor influencing the effectiveness of development implementation, as the available budget is not commensurate with the actual need for road and drainage improvements in Simalungun Regency. Consequently, development is being carried out in stages and in parts, resulting in the community not yet experiencing its full benefits.
4. Human resources and supervision play a strategic role in determining the quality of development, but they still face limitations in the number of technical and supervisory personnel compared to the size of the work area. This has resulted in suboptimal quality control and post-construction infrastructure maintenance.
5. Community participation in the development and maintenance of road and drainage infrastructure remains limited, particularly during the implementation and maintenance stages. Communities are more involved in the planning stage by expressing their aspirations, but they have not yet actively participated in maintaining the sustainability of the infrastructure.
6. Based on the theory *of Success Factors in Managing Wastewater Infrastructure through Community Participation* , the implementation of road and drainage construction in Simalungun Regency has met some success factors, particularly in terms of institutionalization and formal planning. However, community participation, community-based maintenance, sustainable funding capacity, and governance integration remain suboptimal, impacting the success and sustainability of infrastructure development.

Based on these conclusions, the suggestions that can be given in this research are as follows:

1. For the Simalungun Regency Government, especially the Public Works Department, it is recommended to improve the integration of planning and implementation of road and drainage construction so that the two infrastructures support each other and are able to increase the service life of the roads in a sustainable manner.
2. Optimization of budget capacity needs to be carried out by setting priorities based on real-world data, as well as strengthening coordination with provincial and central governments to obtain additional funding support for road and drainage infrastructure development.

3. Improving the quality and quantity of human resources, especially technical personnel and field supervisors, needs to be a primary concern so that development implementation and supervision can be carried out more effectively and professionally.
4. Strengthening the post-development monitoring and evaluation system needs to be carried out continuously so that the evaluation results can be used as a basis for improving development planning and implementation in the following period.
5. Local governments need to encourage increased active community participation, not only in the planning stage, but also in the supervision and maintenance of road and drainage infrastructure through outreach, education, and community empowerment.
6. The community participation-based development approach, as emphasized in the theory of *Success Factors in Managing Wastewater Infrastructure through Community Participation* , needs to be adopted more widely so that road and drainage infrastructure development is not only physical, but also socially, economically, and environmentally sustainable.

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