

SWOT Analysis of Financing and Operational Sustainability of Domestic Wastewater Management in Deli Serdang Regency, North Sumatra Province

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Abstract

Sustainable domestic wastewater management is a crucial aspect in maintaining environmental quality and improving public health. This study aims to analyze the existing conditions of domestic wastewater management and identify strengths, weaknesses, opportunities, and threats (SWOT) factors in its financing and operational systems, as well as formulate sustainable management strategies. The research method used is a qualitative descriptive approach with data collection techniques through observation, interviews, and documentation, which is analyzed using the SWOT approach. The results of the study show that domestic wastewater management in Deli Serdang Regency is still not optimal, characterized by the dominance of on-call-based service systems, the availability of infrastructure such as IPLT that is adequate but has a transport fleet, and low service coverage. From the financing aspect, services still depend on the local government budget with an ineffective levy system, so it has not yet achieved *cost recovery*. In addition, operational sustainability is also affected by limited institutional capacity, low community participation, and suboptimal implementation of regulations. The SWOT analysis shows that despite strengths in the form of policy support and development opportunities through partnerships and national programs, internal weaknesses are still the dominant factors that hinder service development. Therefore, the recommended strategies include strengthening institutional capacity, developing innovative financing schemes such as PPP and cross-subsidies, improving infrastructure and operational systems, and strengthening community participation. Thus, an integrated approach between technical, institutional, and financing aspects is the key to realizing effective and sustainable domestic wastewater management in Deli Serdang Regency.

Keywords: SWOT, Financing, Domestic Wastewater, Sustainability, LLTT

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Introduction

Sanitation is an inseparable element of residential architecture, the basic concept of residential architecture involves a thorough understanding of human needs, relationships with the natural and social environment and the creation of functional, aesthetic and sustainable spaces (Nuraini Cut, 2024). Sustainable sanitation management is an important indicator in regional development and improving the quality of life of the community (Belinda et al., 2024). Efforts to develop sanitation systems that are not only effective in treating waste, but also environmentally friendly, are a very urgent need (Ginting A.D. et al., 2024). Access to safe sanitation services, including fecal sludge management, is still a challenge in various regions in Indonesia, especially in urban and peri-urban areas. Inadequate management systems can lead to environmental pollution, reduce the quality of public health, and hinder the achievement of sustainable development targets, especially the 6th goal related to clean water and decent sanitation (Word Bank, 2021).

One of the approaches developed by the Indonesian government is the Scheduled Fecal Sludge Service (LLTT), which is a fecal sludge management system that is carried out regularly and systematically without waiting for the septic tank to be full (Ministry of Health of the Republic of Indonesia, 2022) LLTT aims to minimize the risk of environmental pollution and improve the efficiency of sanitation services.

However, the implementation of LLTT still faces various obstacles, including limited institutional capacity, low public awareness, and not optimal financing system. Financing schemes are a crucial aspect because the sustainability of services is highly dependent on the ability of local governments to manage funding sources, both from the Regional Revenue and Expenditure Budget (APBD), service levies, and partnerships with the private sector (Asian Development Bank, 2020).

Deli Serdang Regency as one of the strategic areas in North Sumatra Province has a fairly rapid regional development dynamic. This has an impact on the increasing need for adequate sanitation services, including fecal sludge management. However, the existing management still faces various challenges such as limited infrastructure and low service coverage (Ministry of Public Works and Housing, 2021).

In this context, SWOT analysis is important to identify internal and external conditions in supporting the development of financing strategies and operational sustainability of domestic wastewater management.

Problem Identification

Based on the formulation of the problems that have been described, several problems in domestic wastewater management in Deli Serdang Regency can be identified as follows:

1. The existing conditions of domestic wastewater management are not optimal, which is characterized by low service coverage, limited fecal truck fleets and dominance of on-call-based service systems compared to scheduled systems.
2. Internal and external factors that affect the success of domestic wastewater management have not been comprehensively identified, both in terms of strengths, weaknesses, opportunities, and threats.
3. The weak financing system for domestic wastewater services is still weak, which is characterized by dependence on the local government budget, the suboptimal levy system, and limited private sector involvement.
4. There is no integrated and sustainable strategy in domestic wastewater management, especially in combining financing and operational aspects based on SWOT analysis.
5. Low operational effectiveness of services, which includes limited institutional capacity, suboptimal management systems, and low community participation in supporting service sustainability.

Problem Formulation

Based on the background of the problem that has been described, the formulation of the problem can be formulated as follows:

1. What are the existing conditions of domestic wastewater management in Deli Serdang Regency?
2. What are the strengths, weaknesses, opportunities, and threats factors in service financing and operations?
3. What is the right strategy to improve the sustainability of domestic wastewater management financing and operations?

Based on the formulation of the problem that has been described, the objectives of this research are as follows:

1. Analyzing the existing conditions of domestic wastewater management in Deli Serdang Regency.
2. Identify and analyze strengths, weaknesses, opportunities, and threats (SWOT) factors in the financing and operation of domestic wastewater services.
3. Formulate the right strategy to improve the sustainability of domestic wastewater management financing and operations in Deli Serdang Regency.

Literature Review

Domestic Wastewater

Domestic wastewater is liquid waste derived from household activities such as bathing, washing, cooking, and defecating (*blackwater and greywater*). Domestic wastewater management aims to prevent environmental pollution and maintain public health through a safe and sustainable treatment system.

According to Word Bank, (2021) domestic wastewater management covers the entire service chain (*Sanitation Service Chain*), namely collection, transportation, processing, and safe final disposal. If not managed properly, domestic wastewater can pollute water sources, cause environmental-based diseases, and reduce people's quality of life.

In the context of this study, the domestic wastewater variable is focused on fecal sludge management systems as part of integrated sanitation services, particularly through the domestic waste management services approach.

Domestic Wastewater Management Financing

Financing domestic wastewater management is an important aspect in ensuring the sustainability of sanitation services. Financing covers all funding sources and mechanisms used for the construction, operation, and maintenance of wastewater management systems.

According to the World Bank (2021), sanitation financing consists of two main components, namely:

1. Capital Expenditure (*CapEx*): initial investment costs such as infrastructure development (IPLT, fleet, network)
2. Operational Expenditure (*OpEx*): operational costs and maintenance of services

Sources of financing can come from the government (APBN/APBD), service tariffs or levies, partnerships with the private sector (PPP), and assistance from donor institutions (Asian Development Bank, 2020)

In this study, financing variables were analyzed to see the effectiveness, efficiency, and sustainability of the financing scheme in supporting domestic wastewater management operations.

Operational Sustainability of Domestic Wastewater Management

Operational sustainability is the ability of domestic wastewater management systems to continue to run effectively, efficiently, and sustainably in the long term. According to

Ramdhan et al., (2025) Operational sustainability is influenced by several key factors, including:

1. Institutional: the organizational capacity of the service management organization
2. Operational technical: availability of facilities and infrastructure (fleet, IPLT)
3. Financing: the adequacy of funds for operations
4. Community participation: level of awareness and compliance of service users
5. Regulation: support for local policies and regulations

According to UNICEF & WHO, (2023) The sustainability of sanitation services is determined not only by technical aspects, but also by social, economic, and institutional aspects.

In this study, operational sustainability is an important variable to assess the extent to which the domestic wastewater management system in Deli Serdang Regency can run consistently and sustainably.

SWOT Analysis

SWOT analysis is a strategic analysis method used to identify internal and external factors that affect a system or organization (Zianah Safitri et al., 2024). SWOT consists of:

1. Strengths: internal factors that become an advantage
2. Weaknesses: internal factors that become limitations
3. Opportunities: external factors that can be leveraged
4. Threats: external factors that have the potential to hinder

According to Azandi Wilasto & Wening, (2025) SWOT analysis is used to formulate strategies by maximizing strengths and opportunities and minimizing weaknesses and threats.

In the context of this study, SWOT analysis is used to:

1. Identify internal conditions (institutional, operational, financing)
2. Analyze external factors (policy, socio-economic, environmental)
3. Formulating financing and operational sustainability strategies for domestic wastewater management

The results of the SWOT analysis will be the basis for the preparation of a more effective, efficient, and sustainable management strategy in Deli Serdang Regency.

Frame of Mind

This framework of thinking is a logical flow of research that begins by reviewing the existing conditions of domestic wastewater management in Deli Serdang Regency which currently still faces obstacles of low service coverage and infrastructure limitations.

The data is then processed using SWOT Analysis to dissect internal variables (related to strengths and weaknesses in financing/operational aspects) and external variables (related to policy opportunities and environmental threats). The results of the synthesis of these factors will formulate a Sustainability Strategy that includes financing innovations and strengthening operational systems to achieve the target of safe and sustainable sanitation services in the future. The following is a picture of the thinking framework of this research:

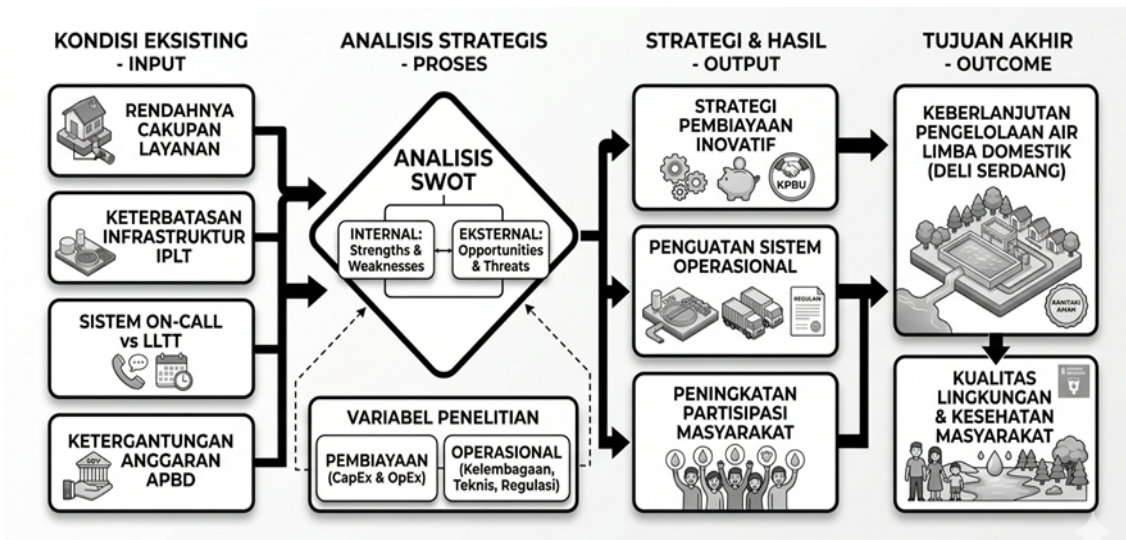


Figure 1. Frame of Mind

Research Methodology

Types of Research

This study uses a qualitative descriptive approach with a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis method. A qualitative descriptive approach was used to systematically describe the existing conditions of domestic wastewater management in Deli Serdang Regency and analyze the financing and sustainability aspects of service operations.

This approach allows researchers to understand the phenomenon in depth through empirical data in the field, especially related to the implementation of sanitation services such as Domestic Waste Management, institutional capacity, and the financing system implemented. SWOT analysis is used as a tool to identify internal and external factors that affect the sustainability of domestic wastewater management and formulate appropriate strategies (Sugiarto et al., 2024).

Research Location

This research was carried out in Deli Serdang Regency, North Sumatra Province. The selection of the location is based on the consideration that this region has rapid development dynamics and faces various problems in domestic wastewater management, such as limited infrastructure, low service coverage, and suboptimal financing system.

In addition, Deli Serdang Regency is also an area that has begun to develop the LLTT system, so it is relevant to be analyzed in the context of operational sustainability and sanitation service financing strategies.

Population and Sample

The population in this study includes all parties related to domestic wastewater management in Deli Serdang Regency, including:

1. Local government agencies (related agencies in charge of sanitation, namely the Deli Serdang Regency Cipta Karya and Spatial Planning Office)
2. Fecal sludge service manager (Domestic Limbag Water Management Unit of Deli Serdang Regency)
3. Community of service users
4. Private parties or partners involved in sanitation management

The sampling technique uses purposive sampling, which is the deliberate selection of respondents based on certain criteria relevant to the research objectives (Kusumastuti et al., 2025). Research samples include:

1. Local government officials involved in sanitation policies
2. LLTT service operations manager
3. Community of users of sanitation services
4. Stakeholders related to financing and management

Data Collection Techniques

The data collection technique in this study is carried out through several methods, namely (Sugiarto et al., 2024):

1. Observation

Conducting direct observation of the existing conditions of domestic wastewater management, including infrastructure such as IPLT, transport fleets, and service operational systems.

2. Interviews

Interviews are conducted *in-depth interviews* with related parties to obtain information about the financing system, operational constraints, and public perception of sanitation services.

3. Documentation

Collect secondary data in the form of planning documents, local government reports, regulations, and statistical data related to domestic wastewater management.

Data Analysis Techniques

Data analysis was carried out using qualitative descriptive analysis techniques combined with SWOT analysis (Rangkuti et al., 2023). The stages of analysis include:

1. Data Reduction

Screening and selecting data relevant to the research focus, namely financing and operational sustainability of domestic wastewater management.

2. Data Presentation

The data is presented in the form of descriptive narratives, tables, and SWOT matrices to facilitate the understanding of internal and external conditions.

3. SWOT Analysis

- a) Identify internal factors (strengths and weaknesses)
- b) Identifying external factors (opportunities and threats)
- c) Compiling a SWOT matrix (IFAS and EFAS)
- d) Formulating strategies (SO, WO, ST, WT)

4. Conclusion

Draw conclusions based on the results of the analysis to formulate an effective financing and operational sustainability strategy.

Data Validity

To ensure the validity of the data, this study uses a data triangulation technique, which is by comparing data from various sources and data collection methods (observation, interviews, and documentation).

In addition, a member check is also carried out, which is to reconfirm the results of the interview with the respondents to ensure the suitability of the data with the actual conditions in the field (Arianto, 2024)

Results

Results

1. Existing Conditions of Domestic Wastewater Management in Deli Serdang Regency

Based on the results of field observations, interviews with related agencies, and document analysis, it is known that domestic wastewater management in Deli Serdang Regency is still in the development stage and is not fully optimal. The dominant system used by the community is still an on-call service, namely fecal sludge suction is carried out only when the septic tank is full.

In terms of infrastructure, the existence of the Fecal Sludge Treatment Plant (IPLT) already has 2 (two) units but it is still not seen in terms of capacity and service coverage. The fecal sludge transport fleet, which is 3 (three) units, is also not enough to serve the entire region, especially peri-urban and rural areas. This has an impact on the low coverage of safe fecal sludge management services.

The results of the interviews show that some people do not have adequate awareness regarding the importance of scheduled fecal sludge management. This can be seen from the low level of community participation in scheduled service programs such as LLTT. In addition, there are still practices of disposing of fecal sludge that are not up to standard, which has the potential to pollute the environment.

From an institutional perspective, the management of sanitation services still faces obstacles in coordination between agencies, limited human resources, and an inoptimal operational management system. This condition shows that domestic wastewater management in Deli Serdang Regency still needs to be strengthened in various aspects, both technical, institutional, and social.

2. Analysis of Domestic Wastewater Management Financing

The results of the study show that the domestic wastewater management financing system in Deli Serdang Regency is still highly dependent on the local government budget (APBD). The available budget allocation is generally focused on the development of basic infrastructure and minimum operational services.

From the results of interviews with the management, it is known that the service levy system has not run optimally. The existing service tariff is in accordance with Deli Serdang Regency Regional Regulation Number 1 of 2024, which is a general amount of Rp 400,000 (four hundred thousand rupiah) and has not been able to cover the full operational costs (*cost recovery*), so sanitation services still require subsidies from the government. This shows that the financing model currently applied is still in the category of partial subsidies.

In addition, private sector involvement in the financing of sanitation services is still very limited. The Government and Business Entity Cooperation Scheme (PPP) has not been optimally implemented, despite having the potential to improve the efficiency and sustainability of services.

These findings suggest that key challenges in financing include:

1. Limited alternative funding sources
2. Low effectiveness of the levy system
3. The use of innovative financing schemes has not been optimal

Thus, a more comprehensive effort is needed to diversify financing sources through the use of various funding alternatives, such as increasing the optimization of service levies, strengthening partnership schemes with the private sector (PPP), and access to donor institutional support or grant-based financing. In addition, improving the efficiency of financial management is also crucial, which can be done through improving the financial management system, budget transparency and accountability, and effective control of operational costs. These steps are expected to be able to create a more sustainable, independent, and adaptive financing system to the dynamics of service needs, so that the operational sustainability of domestic wastewater management can be guaranteed in the long term.

3 Operational Sustainability Analysis

The operational sustainability of domestic wastewater management in Deli Serdang Regency is influenced by several main factors, namely institutional, technical operations, financing, community participation, and regulations.

1. Institutional Aspects

The results of the study show that institutional capacity is still limited, especially in terms of service management, inter-agency coordination, and long-term operational planning.

2. Technical Aspects of Operations

Limited fleets, IPLT facilities that have not been biased to reach the area of Deli Serdang Regency, and service scheduling system are the main obstacles in operations. This has an impact on low service efficiency.

3. Financing Aspects

Dependence on the APBD makes it difficult for services to develop independently. Limited funds also affect operational quality.

4. Aspects of Community Participation

The level of public awareness is still low, so participation in scheduled sanitation services is not optimal.

5. Regulatory Aspects

Although there has been a policy related to sanitation, there is no Regional Regulation on Domestic Waste Management so it is not optimal for its enforcement.

Overall, operational sustainability still faces various interrelated challenges, requiring an integrated approach.

4. SWOT Analysis

Based on the results of the data analysis, the following SWOT factors were obtained:

1. Strengths

- a. There is support for government policies related to sanitation
- b. The availability of 2 (two) basic infrastructure units such as IPLT
- c. Local government commitment to service development

2. Weaknesses

- a. Limited institutional capacity
- b. Inadequate infrastructure and fleet
- c. Unsustainable financing system
- d. Low community participation

3. Opportunities

- a. Support of national and international programs in the field of sanitation
- b. Potential cooperation with the private sector (PPP)
- c. Increasing public awareness of sanitation

4. Threats

- a. Population growth that increases service load
- b. Environmental pollution risk
- c. Local government fiscal limitations
- d. Inconsistent policy changes

Based on the results of the identification of internal and external factors, the SWOT analysis is then poured into the SWOT matrix as a tool to formulate the right management strategy. This matrix integrates strengths and weaknesses (internal factors) with opportunities and threats (external factors) to produce alternative strategies that include the SO strategy (utilizing strengths to take opportunities), WO strategies (minimizing weaknesses by taking advantage of opportunities), ST strategies (using strengths to overcome threats), and WT strategies (minimizing weaknesses and avoiding threats). Thus, the SWOT matrix not only serves as an analysis tool, but also as a basis for the preparation of financing and operational sustainability strategies for domestic wastewater management that are more effective, directed, and sustainable in Deli Serdang Regency. Here's a picture

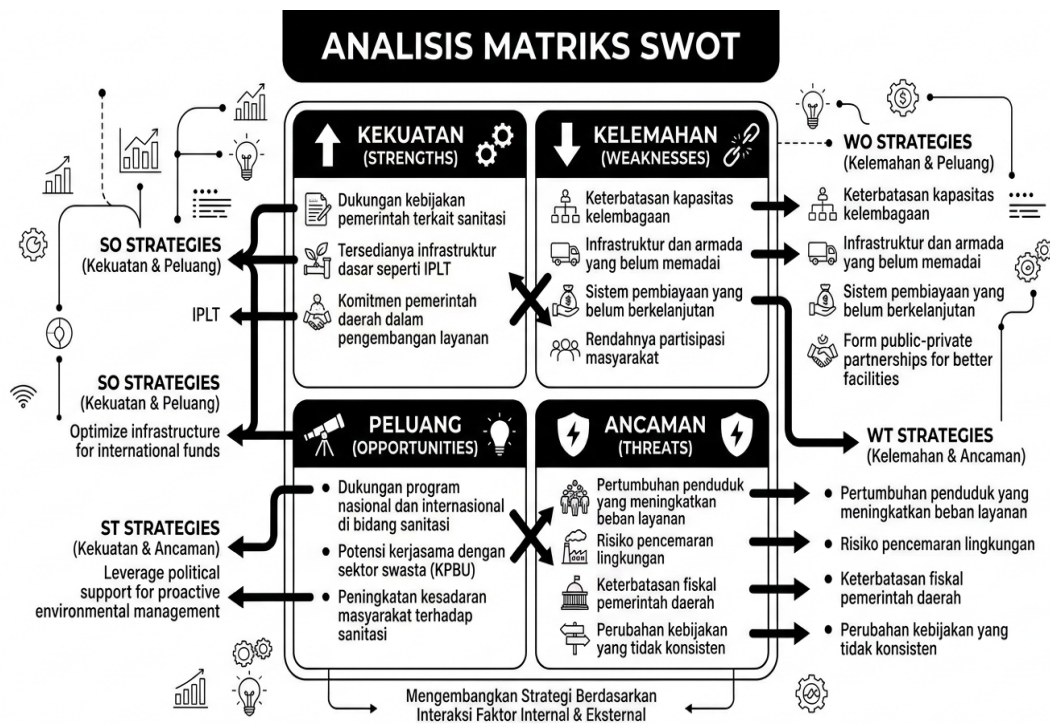


Figure 2. SWOT matrix analysis

Strategy Formulation Based on SWOT Matrix

Based on the SWOT analysis, several strategies are formulated as follows:

SO (*Strengths–Opportunities*) Strategy

1. Optimizing policy support to attract private sector investment in sanitation financing
2. Develop technology-based LLTT programs to improve service efficiency

WO Strategy (*Weaknesses–Opportunities*)

1. Increase institutional capacity through training and strengthening of management
2. Develop innovative financing schemes such as PPP and cross-subsidisation

ST Strategy (*Strengths–Threats*)

1. Leveraging government commitments to address environmental pollution risks
2. Improving the quality of regulations in the face of regional growth dynamics

WT Strategy (*Weaknesses–Threats*)

1. Improving operational efficiency to reduce dependence on the APBD
2. Improving public education to encourage active participation

Discussion

The results of the study show that domestic wastewater management in Deli Serdang Regency still faces complex challenges, especially in terms of financing and operational sustainability. These findings are in line with the theory that the sustainability of sanitation services is strongly influenced by the integration between technical, institutional, and social aspects (Rahmah et al., 2019).

These findings are also in line with the results of previous research which shows that the failure or ineffectiveness of sanitation management in various regions is generally caused by weak financing systems, limited institutional capacity, and low community participation in supporting services (Firmansyah & Widiyarta, 2025). These studies confirm that the sustainability of sanitation services depends not only on the availability of infrastructure, but also on the ability of institutions to manage resources, design adaptive financing systems, and build community awareness and engagement.

In addition, scheduled-based service approaches such as LLTT are considered more effective than demand-based systems (*On-call*), because it is able to improve operational

efficiency and reduce the risk of environmental pollution (Wardono et al., 2022). Therefore, the results of this study reinforce the importance of integration between financing innovation, institutional strengthening, and increasing community participation as the key in realizing sustainable domestic wastewater management in Deli Serdang Regency.

The SWOT analysis shows that despite considerable strengths and opportunities, internal weaknesses are still the dominant factor hindering service development. Therefore, the resulting strategy emphasizes on strengthening institutional capacity, financing innovation, and increasing community participation.

In the context of regional development, the success of domestic wastewater management not only has an impact on environmental aspects, but also on improving the quality of life of the community and regional competitiveness. Thus, the implementation of the right strategy will be the key in realizing sustainable sanitation services in Deli Serdang Regency.

The results of this analysis are also in line with various studies Sudrajat et al., (2020) which emphasizes that the success of sanitation management, especially scheduled fecal sludge services, is highly determined by institutional strength, sustainability of the financing system, and the level of community participation. A number of studies show that regions that are able to integrate these three aspects tend to have more stable, efficient, and sustainable sanitation services in the long term.

In addition, the research Mulyani, (2021) It also revealed that innovations in financing schemes, such as the implementation of cross-subsidies and partnerships with the private sector, can increase service independence while expanding the scope of services. Therefore, the findings in this study strengthen the argument that a holistic and integrated approach is the main key in overcoming various challenges of domestic wastewater management, especially in developing areas such as Deli Serdang Regency.

Conclusion

Based on the results of the research and discussion, it can be concluded that domestic wastewater management in Deli Serdang Regency is still in the development stage and has not run optimally with the following conclusions:

1. Existing conditions show that the service system is still dominated by *an on-call service approach*, with the limitation of the carrier fleet which has an impact on low service coverage. In addition, institutional aspects and community participation are also still the main obstacles in supporting the effectiveness of sanitation service management.
2. In terms of financing, the current system still depends on the local government budget (APBD) with a low level of levy effectiveness, so it has not been able to achieve *cost recovery*. The limited sources of alternative funding and the lack of optimal use of innovative financing schemes, such as PPP, are the main challenges in realizing the independence and sustainability of services.
3. The operational sustainability of domestic wastewater management is influenced by various interrelated factors, including institutional, technical operation, financing, community participation, and regulations. Limitations in these aspects cause services to not be able to run effectively and sustainably in the long term.
4. The results of the SWOT analysis show that despite the strength of policy support and government commitment as well as opportunities from national programs and potential partnerships, internal weaknesses are still the dominant factors hindering service development. Therefore, the strategy formulated emphasizes on strengthening institutional capacity, developing innovative and sustainable financing schemes, and increasing community participation.

Overall, this study emphasizes that the success of domestic wastewater management in Deli Serdang Regency requires an integrated approach between technical, institutional, and social aspects. The implementation of the right and sustainable strategy will be the key to

improving the quality of sanitation services, protecting the environment, and supporting sustainable regional development.

Suggestions

Based on the results of the research that has been conducted, some suggestions that can be submitted academically and practically are as follows:

1. For Local Governments

The Deli Serdang Regency Government is advised to strengthen policies and institutions in domestic wastewater management, especially through increasing the capacity of sanitation service management organizations. In addition, it is necessary to optimize regulations that support the implementation of the Scheduled Fecal Sludge Service (LLTT) as a whole, including consistent enforcement of rules and supervision.

2. Strengthening the Financing System

It is necessary to diversify financing sources by developing innovative financing schemes such as Government and Business Entity Cooperation (PPP), cross-subsidies, and optimization of the service levy system. The government also needs to increase transparency and accountability in financial management to encourage efficiency and sustainability of service operations.

3. Infrastructure and Operational Improvement

It is necessary to increase the capacity of facilities and infrastructure to add a transport fleet. In addition, the development of technology-based operational systems and integrated service scheduling are indispensable to improve service efficiency and coverage.

4. Increased Public Participation and Awareness

The government and related agencies need to increase education and socialization to the public about the importance of domestic wastewater management on a scheduled basis. This effort can be carried out through sanitation campaigns, community empowerment, and community involvement in service supervision to increase compliance and active participation.

5. Collaboration with the Private Sector and Stakeholders

It is necessary to strengthen partnerships with the private sector, donor institutions, and other stakeholders in supporting the financing and management of sanitation services. This collaboration is expected to improve efficiency, innovation, and overall service quality.

6. For the Next Researcher

Further research is recommended to develop a more in-depth study using quantitative approaches or mixed methods, as well as conducting economic analysis related to the feasibility of financing and sanitation services business models. In addition, comparative research between regions can also be carried out to obtain a more effective and applicable management model.

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