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Analysis of the Operational Value Needs of the Rapak Drainage System in Samarinda City

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Abstract

This study aims to evaluate the operational needs and cost requirements for improving the drainage system along *Jalan Rapak Dalam* in Samarinda City, where frequent waterlogging and infrastructure damage occur due to inadequate drainage performance. Using a mixed-method approach, the research combines field surveys, hydrological data analysis, and stakeholder interviews to assess current conditions and calculate the budget needed for optimal system operation. The results reveal that an annual operational cost of Rp 262,300,000 is necessary to cover personnel incentives, equipment maintenance, and routine channel upkeep, while an additional Rp 1,056,970,651 is required for structural repairs and sediment management. These investments are critical to enhancing drainage efficiency, reducing flood risks, and ensuring long-term infrastructure sustainability. The findings provide actionable insights for local authorities in budget planning and maintenance prioritization, emphasizing the importance of proactive drainage management in flood-prone urban areas. Furthermore, this study contributes to broader discussions on sustainable urban water management by demonstrating the cost-benefit relationship between systematic maintenance and flood mitigation. Future research could expand on hydrodynamic modeling and climate-resilient drainage design to further optimize flood control strategies.

Keywords: Drainage Infrastructure; flood mitigation; urban infrastructure; Maintenance

INTRODUCTION

Road drainage is an important element of urban infrastructure that serves to drain rainwater and prevent inundation and flooding. An efficient drainage system is necessary to ensure the comfort and safety of road users while protecting road structures from water damage. The city of Samarinda, as the capital of East Kalimantan Province, faces high rainfall and flood-prone geographical conditions. Therefore, an effective drainage system is essential to address these challenges.

However, it is often observed that the water sewerage system in various areas of Samarinda, including along *Jalan Rapak Dalam*, faces several problems. In addition to road damage caused by poor drainage systems, frequent waterlogging during heavy rains indicates that the existing system is not functioning properly. This suggests that the current drainage systems should be evaluated and improved to enhance their performance. Studies such as "Evaluation of Drainage Systems in Urban Areas in Semarang City" by Basuki and Haryanto (2018) and "Performance Analysis of Urban Drainage Systems in the City of Surabaya" by Prasetyo and Hartono (2019) highlight the importance of regular evaluations to identify issues related to maintenance and repair of drainage systems.

One of the key factors affecting the performance of drainage systems is the operation and maintenance activities conducted (Belete, 2011; Mukherjee, 2014; Rizal et al., 2023; Ruwali & Ghimire, 2022; Zhu et al., 2016). Inadequate operation and maintenance can result in reduced drainage capacity, sediment buildup, and damage to drainage components (Ghosh & Mistri, 2020; Mowla & Islam, 2013; Van Loon et al., 2015; Yusnita et al., 2025). For example, the journal articles by Suryani and Gunawan (2020), "The Role of Maintenance in Increasing the Effectiveness of Drainage Systems in the City of Bandung," and by Wibowo and Putra (2017), "Drainage Operation and Maintenance Management in Urban Areas," illustrate how good operation and maintenance practices can improve drainage effectiveness. Therefore, assessing drainage operation and maintenance activities is critical to ensuring the system functions optimally and sustainably.

This study aims to evaluate the operation and maintenance of drainage infrastructure along *Jalan Rapak Dalam*, Samarinda City. This evaluation includes identifying existing problems, assessing the function of the current drainage system, and calculating the values required for optimal operation and maintenance. The article "The Influence of Operations and Maintenance on Drainage Performance in Medan City" by Yuliana and Akbar (2021) and the book *Urban Drainage* by Butler and Davies (2011) provide valuable guidance on cost analysis and budget planning for drainage maintenance. Thus, this study's results are expected to offer appropriate recommendations to enhance the drainage system's performance.

Using both quantitative and qualitative approaches, this study will collect data from various sources to present a comprehensive picture of the condition and requirements of the drainage system on *Jalan Rapak Dalam*. Quantitative data will be collected through direct field measurements and hydrological analysis, while qualitative data will be gathered via interviews with relevant stakeholders and literature reviews. The international journal article by Fletcher et al. (2015), "SUDS, LID, BMPs, WSUD and more – The evolution and application of terminology surrounding urban drainage," provides perspectives on terminology and approaches in sustainable drainage management. This research aims to contribute to minimizing inundation and flooding problems in the *Jalan Rapak Dalam* area, thereby creating a more comfortable, safe, and sustainable environment for the residents of Samarinda City.

This study is further supported by several relevant case studies. For instance, "Preliminary Modeling of Characteristics of Current and Bathymetry in the Confluence of Mahakam River and Karang Mumus River" by A. Nur et al. (2019) provides insight into the initial model of current and bathymetric characteristics at the confluence of the Mahakam and Karang Mumus Rivers. The findings reveal significant variations in depth and flow velocity at different points of the river confluence, which are relevant for understanding drainage dynamics in complex areas. Additionally, the study "Type of Mixing Confluence Between Mahakam and Karang Mumus Rivers Based on Temperature and Salinity Distribution Tidally" by A. Nur et al. (2020) discusses types of mixing in the confluence based on temperature and salinity distributions affected by tides, offering valuable insights into water mixing dynamics critical for water quality management in drainage systems.

Further research by A. Nur et al. (2020), "Preliminary Sediment Modeling at the Confluence of the Mahakam and Karang Mumus River," discusses sedimentation patterns and accumulation that can impact water quality and flow capacity. These findings are essential for managing sedimentation in the *Rapak Dalam* Road Drainage system. Moreover, "Hydrodynamic Analysis at The Confluence of The Mahakam River and The Karang Mumus Tributary" by A. Nur et al. (2021) delivers an in-depth hydrodynamic analysis of flow patterns and interactions between the main river and its tributaries, which can inform flow management and flood control strategies in the region.

Finally, the article "Hydrodynamic Modeling of the Distribution and Duration of Inundation in the Karang Mumus River" by A. Nur (2022) analyzes the spatial distribution and duration of inundation events in the *Karang Mumus* River, offering important insights for flood risk planning and management. Information from these studies will support improved assessment and planning for the drainage system on *Jalan Rapak Dalam*, helping to address existing environmental and operational challenges.

This study ultimately seeks to determine the *nilai kebutuhan* (value needs) required for the operation of the drainage system to ensure the system runs optimally and guarantees long-term functional sustainability. Beyond cost calculations, the research also highlights several key benefits, including reduced flood risks, cost-effective maintenance strategies, enhanced public safety, and durable infrastructure performance. By integrating field data, hydrological analysis, and stakeholder input, the findings will offer actionable recommendations to address Samarinda's drainage challenges and support informed policy decisions for urban water management.

METHOD

This research used a descriptive method with a quantitative approach to analyze the performance of the drainage system on *Jalan Rapak Dalam*, Samarinda City, and determine the optimal operation and maintenance requirements. Data were collected through literature study, field observation, primary data collection, and secondary data acquisition. The literature study enhanced the researchers' understanding of relevant theories, regulations, and technical standards for drainage systems. Field observations were conducted to review the physical condition of the study area and obtain preliminary information on the existing drainage system. Primary data were collected through direct surveys using the walk-through method to measure channel dimensions, record drainage conditions, and complete checklists. Secondary data included planned channel dimensions provided by the East Kalimantan Provincial Highways and rainfall data from 2013 to 2023 from the Hydrology and Water Quality Unit of BWS Kalimantan IV Samarinda.

The collected data were analyzed in stages: classification, presentation, and calculation. Data were organized into working tables for processing, and results were presented in tables, graphs, and images to visually and numerically represent existing drainage conditions. Calculations were then performed to assess drainage performance and estimate the operation and maintenance costs required. This analysis followed applicable regulations and technical standards, such as the Indonesian National Standard (SNI), to ensure the drainage system is planned, constructed, and managed safely and efficiently. The study's results are expected to provide comprehensive information regarding the costs needed for system operation and maintenance.

RESULTS AND DISCUSSION

Operating Cost Budget Plan

Table 1. Drainage Channel Operation Cost

No.	Operating Cost	Volume	Frequency	Unit	Unit Price (Rp.)	Total Price (Rp.)	Remarks
I	**INCENTIVES**						
	- Observer	1	12	Person	3,500,000	42,000,000	
	- Irrigation Officer	1	12	Person	3,300,000	39,600,000	
	- Observation Staff	1	12	Person	3,000,000	36,000,000	
	Sub Total					**117,600,000**	
II	**OFFICIAL TRAVEL OF OBSERVER & IRRIGATION OFFICER**						
a.	**Monitoring**						
	- Observer	1	12	Person	800,000	9,600,000	
	- Officer	1	12	Person	800,000	9,600,000	
	Sub Total					**19,200,000**	
b.	**Meetings (to regency/city/province/BWS)**						
	- Observer	1	6	Person	2,500,000	15,000,000	
	- Coordination in Jakarta	1	4	Person	5,000,000	20,000,000	
	- Training in Jakarta	1	2	Person	5,000,000	10,000,000	
	- Monitoring in Jakarta	1	2	Person	5,000,000	10,000,000	
	- Monitoring in Regency	1	12	Person	1,000,000	12,000,000	
	- Officer	1	12	Person	1,000,000	12,000,000	
	Sub Total					**67,000,000**	
III	**OFFICE OPERATIONS**						
	- Electricity	12	Month		-	-	
	- Telephone	12	Month		200,000	2,400,000	
	- Water	12	Month		-	-	
	- Stationery (ATK)	12	Month		100,000	1,200,000	
	- Work Clothes	3	Person		300,000	900,000	
	- Survey Materials	12	Month		-	-	
	Sub Total					**15,300,000**	
IV	**EQUIPMENT OPERATIONS**						
	- Boat	1	12	Unit/Month	-	10,200,000	

No.	Operating Cost	Volume	Frequency	Unit	Unit Price (Rp.)	Total Price (Rp.)	Remarks
	- Generator	1	12	Unit/Month	850,000	10,200,000	
	- Grass Cutter Machine	1	12	Unit/Month	550,000	6,600,000	
	- Hoe, Shovel	1	12	Set/Month	350,000	4,200,000	
	- Safety Helmet, Safety Shoes, Gloves	1	12	Set/Month	750,000	9,000,000	
	Sub Total					**43,200,000**	
	TOTAL (I + II + III + IV)					**262,300,000**	

Source: Operational cost analysis

I. Incentives

- **Observer**: There is an incentive fee for an observer with a monthly payment frequency. The annual total is RP. 42,000,000.
- **Irrigator**: The monthly incentive fee for an irrigator is RP. 39,600,000 per year.
- **Observer Staff**: Incentives are provided with an annual total of RP. 36,000,000.
- **Sub Total Incentive**: The overall total for the incentive is RP. 117,600,000.

II. Trip of the Observer and Irrigation Officer Service

- **Observers and Interpreters**: Official travel expenses for observers and irrigators, with a monthly frequency, each of RP. 9,600,000 per year.
- **Meetings (Regency/City/Province/BWS):** Fees for meetings at various levels, with a total annual fee of RP. 67,000,000.
- **Sub Total Official Trip**: The total cost of the official trip is RP. 67,000,000.

III. Office Operations

- **Electricity, Telephone, Water, ATK, Survey Materials**: The operating costs of the office include utilities and supplies with an annual total of RP. 15,300,000.
- **Sub Total Office Operations**: The total cost for office operations is RP. 15,300,000.

IV. Equipment Operations

- **Equipment**: Includes costs for generators, lawn mowers, and safety equipment with a total annual RP. 43,200,000.
- **Sub Total Equipment Operation**: The total operational cost of equipment is RP. 43,200,000.

Overall Total Amount

- **Grand Total**: The total sum of all categories is RP. 243,100,000.

The summary of this table shows a fairly detailed allocation of operational costs for incentives, official travel, office operations, and equipment. It provides a clear overview of the distribution of costs in support of operations and maintenance within a predefined scope.

1.1 Routine Maintenance Costs

Table 2. Cost of Drainage Channels (Water Plants)

No.	Channel Segment	p (m')	l (m')	k (m²)	f	u (Rp)	Psal
1	*2*	*3*	*4*	*5*		*6*	*7*

1	Open Channels	1300	2.5	50	2	IDR150,000	IDR19,500,000

Source: Calculation of open channel maintenance costs

1. The Open Channel is 1300 meters long and 2.5 meters wide, with a cross-sectional area of 50 square meters.
2. The maintenance fee per square meter is IDR 150,000.
3. The total maintenance cost for this line is IDR 19,500,000.

From this data, we can conclude that the cost required for the maintenance of an open channel has been calculated based on the cross-sectional area of the channel and the cost per square meter. The total cost generated gives an idea of the budget required to keep this channel in good condition.

1.2 Periodic Maintenance Costs

Table 3. RAB Table Regular maintenance costs of deep Rapak Drainage channels

No	Job description	Volume		Unit price	Total price
A	**Prep Work**				
1	Mobilization and Demobilization	1	Brassiere	IDR70,000,000	IDR70,000,000
	Number of Prep Work				**IDR70,000,000**
B	**Excavation Work**				
1	Mechanical Soil Excavation	1,463	m3	IDR31,999	IDR46,798,071
	Number of Excavation Work				**IDR46,798,071**
	Total (A + B)				**IDR116,798,071**

Source: Details of periodic maintenance cost budgets, including preparatory and excavation work. Data is calculated based on the volume of work

Table 4. Total Routine Maintenance Cost: IDR 940,172,580

No.	Job Categories	Job Description	Volume	Unit	Unit Price (Rp)	Total Price (Rp)
1	Wall/Talud Work	Maintenance of the Duct wall	637.2	m3	1,097,650	699,422,580
2	Drain Cleaning	Cleaning of channels from aquatic plants and sediments	1300	m	150,000	195,000,000
3	Wooden Bridge Work	Minor inspections and repairs to wooden bridges	20	Unit	2,100,000	42,000,000
4	Concrete Bridge Work	Minor inspections and repairs to concrete bridges	5	Unit	750,000	3,750,000
	Total Routine Maintenance Costs					**940,172,580**

Source: Summary of the cost of routine maintenance of drainage channels, including wall/talud work

1. Wall/Talud Work

- **Description**: Maintenance of duct walls
- **Volume**: 637.2 m³
- **Unit Price**: Rp 1,097,650
- **Total Price**: Rp 699,422,580
- **Analysis**:
    - This is the largest cost component in RAB, which suggests that the structural maintenance of the duct wall is an important aspect and requires significant investment in materials and labor. The high cost per cubic meter indicates the complexity and quality of the materials used to ensure structural stability and safety.

2. Drain Cleaning

- **Description**: Cleaning of channels from aquatic plants and sediments
- **Volume**: 1300 m
- **Unit Price**: Rp 150,000
- **Total Price**: Rp 195,000,000
- **Analysis**:
    - Drain cleaning is an important part of regular maintenance to avoid blockages that can lead to flooding or reduced water flow efficiency. The cost per meter is relatively lower compared to wall work, describing more routine and less technical work.

3. Wooden Bridge Work

- **Description**: Minor inspection and repair on concrete bridge
- **Volume**: 5 unit
- **Unit Price**: Rp 750,000
- **Total Price**: Rp 3,750,000
- **Analysis**:
    - The budget allocated for the wooden bridge is relatively small, indicating that the work required is minor and does not require major repairs. This could include activities such as replacing damaged wooden boards or local reinforcement.

4. Concrete Bridge Work

- **Description**: Minor inspection and repair of wooden bridges
- **Volume**: 20 unit
- **Unit Price**: Rp 2,100,000
- **Total Price**: Rp 42,000,000
- **Analysis**:
    - The higher cost per unit compared to wooden bridges suggests that work on concrete bridges may be more complex or involve the use of more expensive materials. This may include work such as crack sealing, replacement of damaged concrete components, or structural reinforcement.

Cost Details from the First Table:

- **Total Amount (A + B):** IDR 116,798,071

Cost Details from the Second Table:

- **Total Routine Maintenance Cost**: IDR 940,172,580

Total Combined Cost:

To get the total combined cost of the two tables, we will add up the two totals: Total Combined Cost = IDR 116,798,071 + IDR 940,172,580 = IDR 1,056,970,651

Description of Maintenance RAB Results:

The combined RAB covers costs for work preparation, excavation work, and routine maintenance including channel walls, channel cleaning, and wood and concrete bridge repairs. The total total cost for this maintenance and preparation is **IDR 1,056,970,651.** These costs reflect significant investment in the maintenance of existing infrastructure to ensure long-term safety and operational efficiency. With this large allocation of funds, the project is expected to maintain and improve the condition of the existing infrastructure, as well as reduce the risk of further damage that may occur due to lack of adequate maintenance.

CONCLUSION

The research concluded that an annual operating cost of Rp 262,300,000 is necessary to ensure the optimal functioning of the drainage system, which is crucial for maintaining infrastructure condition, reducing flood risks, and preventing more severe damage over time. This investment supports the drainage system's capacity to operate effectively and sustainably. For future research, it is recommended to explore advanced hydrodynamic modeling for improved flood prediction, incorporate climate change projections into drainage design, assess the socio-economic benefits of enhanced drainage systems, and evaluate sustainable, cost-effective materials for maintenance. These efforts would strengthen urban water management and promote long-term resilience in flood-prone areas.

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