

## Economic Feasibility Study of the Multi-Utility Tunnel (MUT) Project in the New Capital City of Nusantara (IKN) During the Budget Efficiency Period

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### Keywords

budget efficiency; multi utility tunnel; life cycle cost; net present value; sensitivity; social; environment

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### Abstract

The development of Ibu Kota Nusantara (IKN) has faced considerable uncertainty following the implementation of government budget efficiency policies in 2025, which may affect the feasibility of key infrastructure, including the Multi-Utility Tunnel (MUT). This study aims to evaluate the feasibility of MUT development under budget efficiency conditions by analyzing its economic, social, and environmental dimensions to support informed decision-making by relevant stakeholders. The Life Cycle Cost (LCC) method is applied using structural design data and applicable regulations, while project implementation is assessed through scenario-based simulation and forecasting. Economic feasibility is analyzed using Net Present Value (NPV) and sensitivity analysis, whereas social and environmental impacts are evaluated through systematic observation. The analysis identifies three possible development scenarios: optimistic, moderate, and pessimistic. The moderate scenario exhibits the highest initial and operational costs when cash inflows are excluded. To achieve economic feasibility at an NPV of zero, the pessimistic scenario requires the highest total cash inflow, amounting to IDR 1.074 trillion during the operational phase. Among the three variables analyzed, initial cost is the most sensitive parameter, recording the highest sensitivity value of 24.34 under both the pessimistic and moderate scenarios. In contrast, the discount rate is the least sensitive variable, with a sensitivity value of -9.00 across all scenarios. In terms of social impact, budget efficiency may affect public trust in the project, while environmentally, it may reduce immediate adverse impacts but risk prolonging long-term environmental effects.

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### INTRODUCTION

The Government of Indonesia plans to build the Capital City of the Archipelago (IKN) with the concept of Smart City and Forest City to improve the quality of life and support sustainable development (Rifaid, Abdurrahman, et al., 2023). One of the main supporting infrastructures for the Smart City concept is the Multi Utility Tunnel (MUT), which is an underground tunnel system for structuring utility networks such as water pipes, power cables, and fiber optics (Alaghbandrad, 2020; Bergman et al., 2022). This infrastructure has been widely applied in developed countries and has been proven to improve the efficiency of utility management, reduce service interruptions, reduce water pipe leaks, and minimize visual pollution. However, since MUT is a new infrastructure in Indonesia, a comprehensive feasibility study is required before implementation (Hermawati et al., 2023; Paradongan et al., 2024; Wirabumi & Anas, n.d.).

This study uses the Life Cycle Cost (LCC) approach, Net Present Value (NPV) method, and sensitivity analysis to assess the economic feasibility of MUT development in IKN. The LCC approach was chosen because it is able to thoroughly evaluate construction, operational,

and maintenance costs over the service life of the infrastructure (Altaf et al., 2023; Frangopol & Liu, 2019; Xie et al., 2018). In contrast to previous research that analyzed economic feasibility under normal conditions, this study specifically examines the economic feasibility of MUT development in the context of government budget efficiency as stipulated in Presidential Instruction Number 1 of 2025. This study fills the gap of previous studies by considering construction and operational delays due to fiscal limitations. In addition to assessing the feasibility of the project based on the NPV value, this study emphasizes the minimum amount of cash inflow needed to achieve break even point (BEP) conditions under strict fiscal conditions, thus making a methodological and practical contribution to MUT development planning in Indonesia (Gnap & Pitera, 2023; Jayantara, 2025; Mellichamp, 2019).

Based on this background, the objective of this study is to evaluate the feasibility of the Multi Utility Tunnel (MUT) project in the IKN area during the budget efficiency period by analyzing economic, social, and environmental aspects, as well as identifying key variables that influence project viability under different development scenarios. This study is expected to provide several important benefits. Theoretically, it contributes to the development of infrastructure feasibility studies by incorporating budget efficiency considerations into economic analysis models. Practically, the findings can serve as a reference for project owners, planners, and policymakers in determining appropriate strategies for continuing, delaying, or modifying MUT development under fiscal constraints (Baskent, 2024; Okei, 2025). From a policy perspective, this research offers evidence-based insights to support decision-making related to infrastructure investment prioritization and financing schemes (Marcelo et al., 2016; Nandy, 2025; Organization, 2026). Furthermore, for stakeholders and the broader community, this study enhances understanding of the importance of cost control, risk management, and sustainable planning in ensuring the success of large-scale infrastructure projects.

## **METHOD**

### **Development Prediction and Simulation in the Budget Efficiency Period**

Prediction is the process of forecasting future events based on available data, trends, and information, while simulation is a modeling method to represent real system behavior to evaluate system performance under various conditions. In the context of budget efficiency policies in the Ministry of PUPR, the impact on the implementation of infrastructure projects can be described through three scenarios, namely:

1. postponement of secondary projects with the continuation of core projects as planned;
2. project sustainability by adjusting the construction period through extension of time according to budget limitations;
3. postponement of new projects as well as optimization of ongoing projects to achieve key functions within available budgets.

### **Life Cycle Cost**

LCC is a concept in modeling cost calculations from the initial stage to the dismantling of assets from a project. This concept is used as a tool in decision-making, as well as in the analysis and calculation of total costs that occur during the life cycle of the asset (Rosita et al., 2023). According to Puhessti, the LCC analysis formula is as follows:

$$LCC = IC + MC + OC - CI - SV \text{ (Puhessti, 2021)} \quad (1)$$

Remarks:

- a. IC = Initial Cost
- b. MC= Maintenance Cost
- c. OC= Operation Cost
- d. CI = Cash Inflow (revenue during the operating life)
- e. SV = Salvage Value

**Net Present Value**

Net present value (NPV) is a common and appropriate approach to assessing LCC. Discounted cash flow is used in the calculation of LCC (Puhessti, 2021). The formula for calculating NPV is as follows:

$$\sum_{t=1}^n \frac{CF_t}{(1+r)^t} - C_0 \tag{2}$$

Remarks:

- a. CF<sub>t</sub> = Cash flow in the year to
- b. C<sub>0</sub> = Initial investment (project cost)
- c. r = Discount rate
- d. t = Year t (in units of years)
- e. n = Project life (number of years)

**Project Feasibility Study**

In this scientific paper, the aspect that will be discussed is the economic aspect. Here the important role of NPV is used to assess the economic benefits of a project and provide a measure of whether a project will result in profits or losses in the long run. The interpretation of NPV in the feasibility study is as follows:

- a) NPV > 0, meaning that the project is feasible because it generates positive economic value;
- b) NPV = 0, meaning that break-even projects can be considered further;
- c) NPV < 0, meaning the project is not financially viable.

In addition, social and environmental aspects will also be discussed slightly due to the impact of budget efficiency on the development of MUT. The method used is through observation and evaluation. To find out the positive impact, negative impact, and mitigation to reduce the negative impact that will occur.

**Sensitivity**

In feasibility studies, sensitivity is an analysis that measures the impact of changes in certain variables on the final outcome of a project's feasibility. Sensitivity analysis is carried out by changing the value of a parameter at a certain time to see how it affects the acceptability of an investment alternative (Sufa, 2007). According to Siti Aisyah (Aisyah & Fachrizal, 2020) to measure the rate of sensitivity can be calculated with the formula:

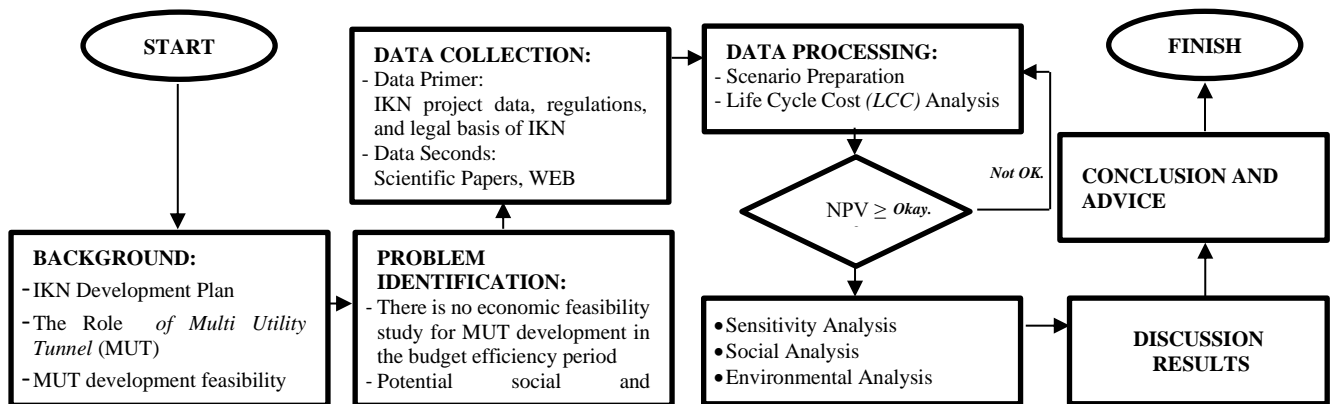
$$\frac{\frac{X_1 - X_0}{X} \times 100\%}{\frac{Y_1 - Y_0}{Y} \times 100\%} \tag{3}$$

Remarks:

- a) X<sub>1</sub> = NPV/IRR/Net B/C ratio after change
- b) X<sub>0</sub> = NPV/IRR/Net B/C ratio before change
- c) X = Average change in NPV/IRR/Net B/C ratio
- d) Y<sub>1</sub> = Variable value after change
- e) Y<sub>0</sub> = Value of the variable before the change
- f) Y = Average change of variable

## RESULT AND DISCUSSION

### A. Research Flowchart



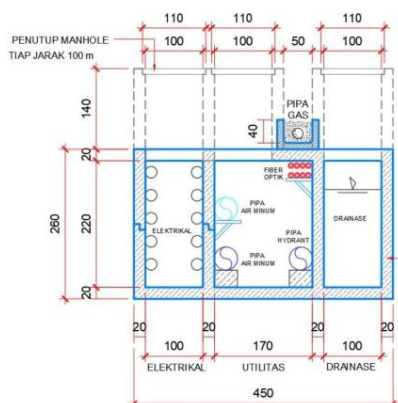
### B. Data Multi Utility Tunnel (MUT)

The MUT that will be analyzed is part of the work package Road Development Within KIPP: Road Improvement in the Core Precinct and Tripraja Axis Areas. The general data of the structure of the MUT is as follows:

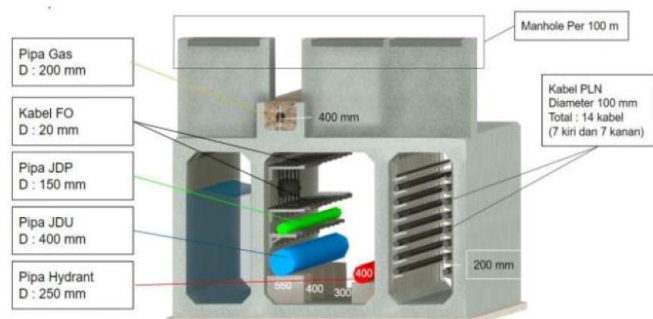


**Figure 1. Track of Handling MUT in 2024 at KIPP IKN**

Source: Project planning document of MUT development at KIPP IKN, processed by the authors (2026)



**Figure 2. Type 1 MUT 2D Cross-Section**



**Figure 3. Apparent Isometric MUT Type 1**

Source: MUT structural design document, processed by the authors (2026)

a) Types of structures	= Reinforced concrete	g) Handling length	= 3,875 meters
b) Mutu concrete structure	= Fc' 30 Mpa	h) System bemisting	= Conventional
c) Quality of concrete working floor	= Fc' 10 Mpa	i) Building age plan	= 50 years
d) Iron quality	= BJTS 420B	j) Construction period	= 15/8/2024 n.d. 7/12/2025
e) Surface finishing	= <i>Waterproofing &amp; Epoxy</i>	k) Project type	= Main (Ring 1)
f) Method of implementation	= <i>Cast in situ</i>		

### C. Simulation and Prediction

**Table 1.** Action Plan Scenario 1 (Optimistic)

No	Job Description	Instances	Diameter (mm)	Quantity (fruit)	Construction Period	Operating Period
1	<i>Multi Utility Tunnel</i>	Contractors	-	-	2024 – 2025	-
2	Cable Fiber Optics	Telkom, Indosat, etc.	20	16	2025 – 2029	2030 – 2073
3	JDP Pipe	In Peru	150	1	2025 – 2029	2030 – 2073
4	Pipa JDU	In Peru	400	1	2025 – 2029	2030 – 2073
5	Pipa Hydrant	Government	250	1	2025 – 2029	2030 – 2073
6	Electrical Cables	PLN	100	14	2025 – 2029	2030 – 2073

Source: Authors' simulation based on MUT development planning data (2026)

In this scenario, budget efficiency is considered to have no impact on the sustainability of the project. The construction of the MUT and utilities within the MUT is still running according to the original plan.

**Table 2.** Action Plan Scenario 2 (pessimistic)

No	Job Description	Instances	Diameter (mm)	Quantity (fruit)	Construction Period	Operating Period
1	<i>Multi Utility Tunnel</i>	Contractors	-	-	2024 – 2026	-
2	Cable Fiber Optics	Telkom, Indosat, etc.	20	16	2027 – 2032	2033 – 2073
3	JDP Pipe	In Peru	150	1	2027 – 2032	2033 – 2073
4	Pipa JDU	In Peru	400	1	2027 – 2032	2033 – 2073
5	Pipa Hydrant	Government	250	1	2027 – 2032	2033 – 2073
6	Electrical Cables	PLN	100	14	2027 – 2032	2033 – 2073

Source: Authors' simulation based on budget efficiency assumptions (2026)

The construction of the MUT, which was originally planned to be completed in 2025, in this scenario, the construction of the MUT will be completed in 2026. In addition, the procurement and installation of utilities in the MUT must also be delayed, which was previously targeted to be completed in 2029 according to *the milestone* of IKN development to be completed in 2032

**Table 3.** *Action Plan Scenario 1 (Moderate)*

No	Job Description	Instances	Diameter (mm)	Quantity (fruit)	Construction Period	Operating Period
1	Multi Utility Tunnel	Contractors	-	-	2024 – 2026	-
2	Cable Fiber Optics	Telkom, Indosat, etc.	20	16	2027 – 2031	2032 – 2073
3	JDP Pipe	In Peru	150	1	2025 – 2029	2030 – 2073
4	Pipa JDU	In Peru	400	1	2025 – 2029	2030 – 2073
5	Pipa Hydrant	Government	250	1	2026 – 2030	2031 – 2073
6	Electrical Cables	PLN	100	14	2025 – 2029	2030 – 2073

Source: Authors' simulation based on MUT development planning data and budget efficiency assumptions (2026)

In this period, the construction period of MUT is the same as a pessimistic scenario. However, the procurement and installation of utilities is carried out in parallel with the construction period of MUT. This is because to pursue utility functions in accordance with *the IKN development* milestones.

#### D. LCC Analysis

From the results of the calculation of each existing scenario, the following values are obtained:

**Table 4.** LCC Value of Three MUT Development Scenarios

No	Description	Scenario 1 (Optimistic)	Scenario 2 (Pessimistic)	Scenario 3 (Moderate)
1	Initial Cost (IC)	112.299.430.894	116.723.917.505	116.723.917.705
2	Maintenance Cost (MC)	9.456.809.897	9.456.809.897	9.456.809.897
3	Operation Cost (OC)	126.181.000.000	118.609.000.000	126.181.000.000
4	Cash Inflow (CI)	-	-	-
5	Salvage Value (SV)	5.497.581.853	5.716.921.963	5.716.921.963
<b>Total:</b>		<b>242.439.658.938</b>	<b>239.072.805.439</b>	<b>246.644.805.439</b>

Source: Authors' calculation using the Life Cycle Cost method (2026)

Based on LCC values, the pessimistic scenario is the most viable alternative because it has the lowest lifecycle costs. The optimistic and moderate scenarios show that LCC is higher, mainly influenced by the large cost of operations, making it less economically efficient. In terms of risk, high operating costs and upfront costs increase the potential for long-term financial risks if utilization levels are not optimal. The implications of decision-making confirm that the selection of MUT development scenarios should focus on life-cycle cost efficiency, with the Pessimistic Scenario as a priority option. With the note, further analysis of *cash inflows*

is needed, due to the low value of *operation costs* due to a shorter operational period than other scenarios.

### E. NPV Analysis

Before calculating the NPV value, a fair portion of utility rental cost sharing is first calculated. The results of the calculation of the cost *sharing* portion are as follows:

**Table 5.** Cost Sharing Percentage Calculation Matrix

Criteria	Description			
	Cable FO	Clean Water Pipe	Pipa Hydrant	Electrical Cables
<b>Space used (cross-sectional area)</b>	5.0265,55 mm <sup>2</sup>	143.335,16 mm <sup>2</sup>	49.087,39 mm <sup>2</sup>	109.955,74 mm <sup>2</sup>
<b>Shoes (1-4)</b>	1	4	2	3
<b>Maintenance Frequency</b>	- OTDR Loss Measurement = 1 x per year - Thorough audit = 1 x per year - Corrective fixes = when a disturbance occurs	- Flushing = 1-2 x per year - Pressure test = 1 x per year - Pigging = every 2-5 years - Incidental repairs = according to needs	- Static & dynamic pressure test = 1 x per year - Flushing = 1 x per year - Valve inspection = 2 x per year - Nozzle testing = 1 x per year - System test = weekly/monthly - Thorough audit = once every 1-2 years	- Isolation test = 1 x per year - Temperature measurement = 1 x per year Faul locator = as needed
<b>Score (1-4)</b>	2	3	4	1
<b>Profit Projection</b>	The need for the internet is very high, the income from retail and corporate subscriptions	Government-manageable (PDAM) / Private and recurring revenue nature every month	It is a public facility, not for direct commercial	The profit potential is high but very regulative and dominated by SOEs (PLN)
Criteria	Description			
	Cable FO	Clean Water Pipe	Pipa Hydrant	Electrical Cables
<b>Score (1-4)</b>	4	3	1	2
<b>Risk of Damage</b>	Cable is flexible and easy to break, complete internet break	Corrosion and leaky connections, supply disruptions	Rarely used, no damage detected, malfunction in an emergency	Overload and mechanical disturbances, short circuits and power outages
<b>Score (1-4)</b>	4	2	1	3
<b>Potential future conflicts</b>	Competition between ISPs, shared ducting, and service disruptions	Water crisis and uneven distribution	Minimal conflict, except in times of disaster or malfunction	Energy transition and distribution monopoly

<b>Shoes (1-4)</b>	4	2	1	3
<b>Total Point:</b>	<b>15</b>	<b>14</b>	<b>9</b>	<b>12</b>
<b>Percentage:</b>	<b>30%</b>	<b>28%</b>	<b>18%</b>	<b>24%</b>

Source: Authors' calculation based on utility space, maintenance frequency, profit projection, damage risk, and potential conflict criteria (2026)

In accordance with the three existing scenarios, the NPV calculation will use a 10% discount value. This is in accordance with the recommendations of Bappenas in *the Public Procurement Partnership* (PPP) guidelines where the discount range is 8-12% for the evaluation of the economic feasibility of government projects, so that the value of 10% is seen as moderate and conservative to reflect the risk of MUT development in the IKN amid uncertainty due to budget efficiency policies.

The determination of *cash inflow* is carried out through a *trial-and-error approach* to achieve the NPV condition  $\geq 0$ . The value of *cash inflow* to be calculated is not a projection of actual income, but the minimum value of *income* needed to achieve BEP. So that the calculation results are obtained according to the following table:

**Table 6.** NPV Values of Three MUT Development Scenarios

Description	Scenario 1 (Optimistic)	Scenario 2 (Pessimistic)	Scenario 3 (Moderate)
<i>Cash Inflow (expected)</i>	865.263.252.2567,84	1.074.456.566.893,40	943.918.191.881,79
<i>Net Cash Flow</i>	735.123.024.212,79	952.107.678.959,20	813.997.303.947,59
<i>Present Value</i>	112.299.430.894,13	116.723.917.505,24	116.723.917.505,24
<i>Net Present Value</i>	0,00	0,00	0,00
<b>Description:</b>	<b>BEP</b>	<b>BEP</b>	<b>BEP</b>

Source: Authors' calculation using the Net Present Value method (2026)

The NPV results show that all scenarios are in BEP conditions, which confirms that the *calculated cash inflow* value is the *minimum level* that must be achieved so that the project does not suffer losses. If the realization of *cash inflow* is lower than this value, then the NPV will be negative and the project is considered financially unfeasible. This condition shows a high risk of uncertainty in the use of MUT, so decision-making must emphasize ensuring the achievement of minimum *cash inflows* through cost control, certainty of occupancy levels, and operational policy support.

## F. Sensitivity Analysis

Based on the existing factors, sensitivity analysis will be focused on the most influential and most uncertain factors (*high impact – high uncertainty*). So that the following variables are obtained:

**Table 7.** Variables of Sensitivity Analysis Change

No.	Variable	Schema of Change	Remarks
1	Cash Inflow	- Operational 2 years back from the initial scenario plan - In the first 3 years of operation, there was no inflow	This is due to the delay in scanning ASN to the IKN and the low utilization of buildings. As well as an indication of the utilization fee of 0 rupiah to attract investors.

2	<i>Initial Cost</i>	Cost increase of 10 billion from the initial cost	Due to the extension of the time of the implementation of the work and the escalation of material costs
3	Discount	Down 2%	Consequences of economic stability and fiscal support

Source: Authors' scenario assumptions for sensitivity analysis (2026)

From table 7 above, in each scenario, sensitivity analysis will be carried out to determine the rate of sensitivity to variable changes.

**Table 8.** Calculation of Sensitivity Rate Scenario 1 (Optimistic)

Description	X1	X0	X	Y1	Y0	And	Sensitivity Rate
<i>Cash Inflow</i>	- 47,52	0	- 23,76	766,94	865,26	816,10	- 16.60
<i>Initial Cost</i>	- 10,00	0	- 5,00	122,30	112,30	117,30	23.46
Discount	35,76	0	17,88	8.0%	10.0%	9.0%	- 9.00

\*Remarks= In Billion Rupiah

Source: Authors' sensitivity analysis calculation (2026)

**Table 9.** Calculation of Sensitivity Rate Scenario 2 (Pessimistic)

Description	X1	X0	X	Y1	Y0	And	Sensitivity Rate
<i>Cash Inflow</i>	- 48,40	0	- 24,20	943,43	1.074.46	1.008,94	- 15.40
<i>Initial Cost</i>	- 10,00	0	- 5,00	126,72	116,72	121,72	24.34
Discount	45,27	0	22,64	8.0%	10.0%	9.0%	- 9.00

\*Remarks= In Billion Rupiah

Source: Authors' sensitivity analysis calculation (2026)

**Table 10.** Calculation of Sensitivity Rate Scenario 3 (Moderate)

Description	X1	X0	X	Y1	Y0	And	Sensitivity Rate
<i>Cash Inflow</i>	- 48,40	0	- 24,20	943,43	1.074.46	1.008,94	- 15.40
<i>Initial Cost</i>	- 10,00	0	- 5,00	126,72	116,72	121,72	24.34
<b>Discount</b>	45,27	0	22,64	8.0%	10.0%	9.0%	- 9.00

\*Remarks = In Billion Rupiah

Source: Authors' sensitivity analysis calculation (2026)

Sensitivity analysis shows that changes in the value and timing of *cash inflow*, *initial cost*, and discount rates have a significant impact on NPV. A high sensitivity rate value indicates that the project is highly sensitive to changes in those variables. Therefore, the certainty of revenue realization, investment cost control, and the determination of the right discount rate are the main factors in maintaining the economic feasibility of MUT development in IKN.

## G. Social and Environmental Analysis

The indicators of social and environmental analysis of MUT development are as follows:

**Table 11.** Social Indicators

No.	Social Indicators	Focus of Impact Assessment
1	Impact on society	Levels of public acceptance, convenience, potential for social conflict
2	Absorption of local labor	Job opportunities, skills transfer, labor gap
3	Social welfare	Utility access, quality of life, local economic impact
4	Local culture and wisdom	Protection of cultural identity, participation of indigenous peoples

5	Security and order	Social risk, public safety, social environmental stability
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Source: Authors' analysis based on social impact assessment indicators (2026)

**Table 12.** Environmental Indicators

No.	Environmental Indicators	Focus of Impact Assessment
1	Land use	Space efficiency, spatial planning conflicts
2	Air quality	Emissions and dust during construction
3	Water and soil quality	Risk of contamination and runoff
4	Floar dan fauna	Habitat and biodiversity disturbances
5	Noise and vibration	Impact of construction activities
6	Waste management	Excavation waste and construction waste
7	Disaster and climate risk	Resilience to floods and climate change
8	Environmental regulatory compliance	Fulfillment of AMDAL/UKL-UPL and licensing

Source: Authors' analysis based on environmental impact assessment indicators (2026)

In the social aspect, the consequences of budget efficiency tend to cause citizens' distrust in government performance and job uncertainty. Meanwhile, in the environmental aspect, it is more about the time and scale of the damage. If the project runs normally, the damage caused is quite massive but in a short and clear period of time. Meanwhile, during the budget efficiency period, the damage caused is minimal because the work leads to priority items, but the damage can be in the long term according to the relaxation of project time due to budget efficiency.

The social and environmental analysis of MUT development plays an important role in supporting the economic feasibility of the project. Community acceptance, local labor absorption, and improved social welfare contribute to operational stability and long-term *cash inflow* certainty. In the environmental aspect, optimizing basements and increasing utility resilience to disasters has the potential to reduce maintenance costs and damage risks, thereby supporting *life cycle cost* efficiency. Conversely, suboptimal social and environmental management can increase unexpected costs and lower the economic value of the project.

## H. Results of MUT Feasibility Study

The results of the calculation analysis can be summarized and displayed in the following table:

**Table 13.** Recapitulation of MUT Feasibility Study Results

Description	Scenario 1	Scenario 2	Scenario 3
<b>Economic Aspects</b>			
<i>Initial Cost (IC)</i>	<b>112.299.430.894,13</b>	<b>116.723.917.505,24</b>	<b>116.723.917.505,24</b>
<i>Maintenance Cost (MC)</i>	<b>9.456.809.897,99</b>	<b>9.456.809.897,99</b>	<b>9.456.809.897,99</b>
<i>Operation Cost (OC)</i>	<b>126.181.000.000,00</b>	<b>118.609.000.000,00</b>	<b>126.181.000.000,00</b>
<i>Cash Inflow (CI)</i>	<b>865.263.252.256,84</b>	<b>1.074.456.566.893,40</b>	<b>943.918.191.881,79</b>
- Fiber optics	259.578.975.677,05	322.336.970.068,02	275.182.073.524,08
- Clean water pipes	242.273.710.631,91	300.847.838.730,15	269.066.916.334,65
- Pipa hydrant	155.747.385.406,23	193.402.182.040,81	169.040.416.593,36
- Electrical wiring	207.663.180.541,64	257.869.576.054,42	230.628.785.429,70
<i>Salvage Value (SV)</i>	<b>5.497.581.853,95</b>	<b>5.716.921.963,79</b>	<b>5.716.921.963,79</b>
<i>Net Cash Flow (NCF)</i>	<b>735.123.024.212,79</b>	<b>952.107.678.959,20</b>	<b>813.997.303.947,59</b>

Description	Scenario 1	Scenario 2	Scenario 3
<i>Present Value (PV)</i>	112.299.430.894,13	116.723.917.505,24	116.723.917.505,24
<i>Net Present Value (NPV)</i>	0 (BEP)	0 (BEP)	0 (BEP)
<b>Sensitivity Analysis</b>			
<i>Changes in Cash Inflow Value and Time</i>			
- NPV	- 47.516.573.484,93	- 48.401.892.355,23	- 49.277.920.619,69
- Eligibility	Not Eligible	Not Eligible	Not Eligible
- Sensitivity Rate	- 16.60	- 15.40	- 16.29
<i>Change in Initial Cost Value</i>			
- NPV	- 10.000.000.000,00	- 10.000.000.000,00	- 10.000.000.000,00
- Eligibility	Not Eligible	Not Eligible	Not Eligible
- Sensitivity Rate	23.46	24.34	24.34
<i>Discount Changes</i>			
- NPV	35.764.032.248,00	45.270.659.335,09	39.387.000.700,39
- Eligibility	Worthy	Worthy	Worthy
- Sensitivity Rate	- 9.00	- 9.00	- 9.00

Source: Authors' calculation and analysis based on LCC, NPV, sensitivity, social, and environmental assessment results (2026)

In this study, *the initial cost* tends to be more sensitive than *cash inflow* and discount rates because of the characteristics of their influence in the NPV calculation. This is because in the NPV calculation, *the initial cost* has a direct impact and at the beginning of the period so it is not discounted. Every increase in *the initial cost* immediately lowers the NPV in full. Meanwhile, the decrease in *cash inflow* can be compensated by an increase in occupancy or rates in the following years. *Cash inflows* that occur in the future will decrease in current value due to discounts, so that the change in the *percentage of inflows* results in a smaller NPV impact than the change in *initial cost* of the same percentage. The sensitivity rate across all scenarios in the discount variable has identical values. This is because the calculation structure of all scenarios is identical. The sensitivity rate is calculated using the same formula and the base value of each scenario is at the condition NPV = 0. The same percentage of change in each scenario is also one of the factors that causes the value of the sensitivity rate to be identical. Thus, the implications of decision-making require strict initial cost control, strategies to accelerate the realization of *cash inflows*, and fiscal policy support or incentives to reduce risk and increase the attractiveness of investment in MUT projects.

## CONCLUSION

The results of the analysis show that in the calculation of Life Cycle Cost (LCC), the pessimistic and moderate scenarios have higher initial costs than the optimistic scenarios due to increased overhead and banking costs triggered by the extension of the project duration as a result of budget efficiency. In all scenarios, the operation cost component is the largest cash out, with the highest proportion in the optimistic scenario of 50.89%, in line with the findings of Peter Kaming. Based on Net Present Value (NPV) analysis, the pessimistic scenario has the highest target cash in value during the operational period to pursue BEP, due to greater initial costs and shorter operational life. This confirms the importance of the performance of building systems during the service life in the economic aspect as conveyed by Peter Kaming in his

research. This is also reinforced by Alaghbandrad that the principle of risk-sharing, benefit, contribution, and fair rental value sharing between utilities. Based on the results of sensitivity analysis in the three scenarios, the economic feasibility of MUT development is greatly influenced by changes in the value and timing of cash inflows as well as changes in initial cost. Changes in cash inflow and initial cost show a relatively high sensitivity rate and result in negative NPV values in all scenarios. On the other hand, changes to the discount component show a lower sensitivity rate and still produce a positive NPV. Thus, the economic success of the project is highly dependent on the ability to maintain the certainty of cash inflow realization and initial cost control, because these two variables are the most sensitive factors in determining the feasibility of MUT development. The next study is suggested to examine the variation of financing schemes, risk sharing mechanisms, projected cash inflows based on occupancy and dynamic rates, as well as the integration of social and environmental benefits in economic analysis. For practitioners, the results of this research can be the basis for controlling initial costs, operational costs, and realistic cash inflow planning. For general readers, this study reinforces the understanding that the feasibility of infrastructure projects is determined by investment, income certainty, operational efficiency, and social and environmental impact.

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