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Financial Feasibility and Investment Risk Analysis for the High-Voltage Connection Project of PT Mitra Murni Perkasa (MMP) in Balikpapan

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Abstract
This research aims to analyze the financial feasibility and investment risk of PT Mitra Murni Perkasa's (MMP) high-voltage connection project in Balikpapan. The project entails the construction of a 4.68 km, 150 kV High-Voltage Overhead Transmission Line (SUTT) supported by nine towers, designed to supply 140 MVA of electricity in accordance with the 2022 Power Purchase Agreement (SPJBTL). The analysis employed both deterministic and Monte Carlo simulation approaches to account for uncertainties in input variables, such as investment costs (including construction labor), operations and maintenance (O&M) labor costs, non-labor operating costs, effective electricity tariffs, and the discount rate. Deterministic analysis results indicate a total investment of IDR 59.9 billion, a positive NPV of IDR 36.3 billion, an IRR of 19.4% (exceeding the WACC of 10.5%), a payback period of 4.9 years, and a Benefit-Cost Ratio (BCR) of 1.61. Monte Carlo simulations (10,000 iterations) yielded mean values of IDR 108.3 billion for NPV, 33.7% for IRR, 3.0 years for the payback period, and 2.8 for the BCR. The probabilities of NPV > 0, IRR > WACC, payback period < 15 years, and BCR > 1 all reached 100%, demonstrating a very high level of confidence in the project's feasibility. WACC, effective electricity tariffs, and load factor were identified as key risk factors, with Spearman correlation coefficients of -0.71, 0.45, and 0.39, respectively; conversely, labor costs (construction and O&M) had a relatively minor impact, with correlation coefficients below 0.1.

INTRODUCTION

Electricity demand in East Kalimantan continues to rise alongside the growth of the downstream industry, particularly the nickel smelting sector. PT Mitra Murni Perkasa (MMP), located in Kariangau, West Balikpapan, East Kalimantan, is a key player in this ecosystem. MMP produces nickel matte a crucial raw material for electric vehicle batteries with a total production capacity of 27,800 tons per year across two production lines (marketeers.com, 2022). As a nickel smelting company operating in Balikpapan, it requires a substantial electricity supply of 140 MVA, in accordance with the 2022 Electricity Sale and Purchase Agreement (SPJBTL) concluded with PT PLN (Persero) (Frasa.id, 2025).

To meet this demand, PT PLN (Persero)'s East Kalimantan Development Unit (PLN UIP KLT) constructed electrical infrastructure in the form of a 150 kV High-Voltage Overhead Transmission Line (SUTT) connecting the Tempadung Substation (GI) to MMP's High-Voltage Consumer (KTT) Substation. The project involved the construction of nine towers spanning a total route length of 4.68 circuit-kilometers (kms). The project was successfully completed and energized in September 2024.

Investment in electrical infrastructure projects is a long-term undertaking that entails significant costs and involves various uncertainties. Consequently, a comprehensive financial feasibility analysis that accounts for risk is crucial. Financial feasibility analysis is a critical step in infrastructure project evaluation, conducted after initial studies confirm sufficient demand and technical viability. This analysis determines the required funds for establishment, operation, management, and obligations, while assessing whether the project can provide adequate returns to stakeholders (Ssegawa & Muzinda, 2021). The feasibility is assessed through several key indicators: Net Present Value (NPV), which measures the difference between the present value of cash inflows and outflows, with projects considered feasible when NPV > 0 (Sun, 2023); Internal Rate of Return (IRR), where feasibility requires IRR > Weighted Average Cost of Capital (WACC); Benefit-Cost Ratio (BCR), requiring BCR > 1; and Payback Period (PP), where shorter payback periods indicate more attractive projects (Sinaga et al., 2023). Prior studies on 150 kV overhead transmission line (SUTT) projects in Indonesia have employed various approaches, including ranking procedures and financial assessments based on cost estimation, though most have relied on deterministic methods without fully accounting for input uncertainty (Alkahtani et al., 2025; Cáceres et al., 2025; Markovic et al., 2025; Raja et al., 2026; Watkiss et al., 2015).

A deterministic approach relying solely on "best estimate" values without considering the uncertainty inherent in each input variable is considered insufficient to realistically depict investment risks. Investment risks have become increasingly significant and concerning for investors; erroneous investment decisions characterized by irreversibility and uncertainty often entail long-term consequences, such as substantial financial losses and reputational damage (Alkaraan, 2015). Consequently, conducting a detailed risk assessment when making such investment decisions is crucial (Virlics, 2013).

Risk assessment is a systematic, evidence-based approach to evaluating future events characterized by uncertainty or risk. Uncertainty refers to a condition where a precise numerical value cannot be assigned to an activity due to potential value variations arising from unpredictable circumstances; conversely, a risk event is defined by the probability of an occurrence and the consideration of its impact on relevant objectives should it take place (Liu et al., 2017).

Monte Carlo simulation has emerged as a robust probabilistic method for analyzing uncertainty in infrastructure investment decisions by generating probability distributions of output variables from uncertain inputs (Li, 2025). This approach enables analysts to move beyond simple "best case/worst case" scenarios and gain a deeper understanding of the full spectrum of possible outcomes. In the context of Indonesian energy infrastructure, Monte Carlo simulation has been effectively applied to assess the financial feasibility of mini-hydro power plants (Suandi & Chayati, 2018), solar PV systems, and transmission interconnection projects, with findings indicating that probabilistic methods provide more realistic risk profiles than deterministic approaches, often yielding differences of up to 11% in key indicators such as IRR, NPV, and Payback Period (Nizar et al., 2025). Studies on the Sumatra–Java Interconnection project and geothermal energy investments further confirm that Monte Carlo simulation enables more informed investment decision-making by quantifying the influence of critical uncertain variables such as investment costs, electricity tariffs, and discount rates on project feasibility, thereby supporting more robust risk management strategies (Ramadyanto, 2019; Setiawan et al., 2026; Sudarmadi et al., 2025; Tanoto, 2021).

The values of the uncertain parameters involved fluctuate in conjunction with the occurrence of risk events. This implies that risk events, rather than the uncertain parameters themselves, are the primary drivers of variation in investment decision variables. However, traditional quantitative risk assessment models fail to account for the influence of risk events on decision variables; consequently, no targeted measures are developed to prevent potential future losses.

This research aims to: (1) analyze the financial feasibility of PT MMP's high-voltage connection project using deterministic methods (NPV, IRR, Payback Period); and (2) identify key variables characterized by uncertainty that influence project feasibility. (3) applying Monte Carlo simulation to analyze the probabilistic distribution of financial feasibility indicators; and (4) providing investment decision-making recommendations based on risk analysis.

The findings of this study are expected to provide both practical and methodological benefits. Practically, the results serve as a decision-support tool for PT MMP's management, PLN, and other stakeholders in evaluating the financial viability of the high-voltage connection project and in formulating effective risk mitigation strategies. For investors and financial institutions, this research offers a comprehensive risk profile that can inform financing decisions and reduce uncertainty in capital allocation. Methodologically, the integration of deterministic and Monte Carlo simulation approaches provides a more robust analytical framework for power infrastructure project evaluation, which can be replicated in similar projects across Indonesia. Furthermore, the findings contribute to the broader literature on infrastructure investment risk analysis by identifying the key drivers of financial feasibility particularly WACC, electricity tariff, and load factor which can serve as a reference for policymakers and project developers in designing more resilient and bankable power infrastructure projects in the future.

METHOD

Project Description

The PT MMP high-voltage connection project consists of 150 kV overhead transmission line (SUTT) infrastructure connecting the Tempadung Substation to the MMP KTT Substation in Balikpapan. The project's technical specifications are presented in Table 1.

Table 1. Technical Specifications of the PT MMP 150 kV Overhead Transmission Line Project

Parameter	**Value**
Voltage	150 kV
Route length	4.68 km circuit (kms)
Number of towers	9 unit
Power capacity	140 MVA
Type	SUTT 150 kV Incomer Double Phi
Construction year	2025
Operation year	2026–2056 (30 years)

Source: PT PLN (Persero) East Kalimantan Development Unit (UIP KLT) project document, 2025

Basic Assumptions and Input Variables

Investment Costs

Based on references from similar projects, the construction cost for a 150 kV high-voltage transmission line (SUTT) is estimated to range from IDR 2.5 billion to IDR 4.5 billion per km, depending on geographical conditions and technical specifications. For this project, which spans 4.68 km and involves nine towers, the estimated total investment cost is presented in Table 2.

Table 2. Estimated Project Investment Cost

Cost Component	Estimate (IDR Billion)
Tower and SUTT construction	18.72–21.06
Substation and equipment	25.00–35.00
Engineering and management costs	5.00–8.00
Licensing and administrative costs	2.00–4.00
Total Non-Labor Investment	50.72–68.06
Construction Labor Cost	2.50–3.50
Total Overall Investment	53.22–71.56

Source: Author's estimation based on references from similar 150 kV SUTT projects, 2025

Revenue

Project revenue is derived from electricity sales based on the Electricity Sale and Purchase Agreement (SPJBTL) between PLN and PT MMP. This analysis utilizes an effective rate (wheeling tariff) of Rp25.00 per kWh, reflecting the cost of utilizing the transmission network. Based on a power requirement of 140 MVA and a load factor of 75%, the estimated annual revenue is calculated as follows: connected power of 140 MVA × 0.75 = 105 MW; annual energy of 105 MW × 8,760 hours × 0.85 (availability) = 782,730 MWh; and annual revenue of 782,730 MWh × Rp25,000/MWh = Rp19.6 billion.

Labor Costs

Labor costs for this project comprise two main components:

Construction Labor Costs

Based on data from similar 150 kV high-voltage transmission line (SUTT) projects, estimated construction labor costs are approximately Rp2.94 billion, equivalent to 4–5% of the total investment cost.

Operations and Maintenance (O&M) Labor Costs

For the operational phase, the 150 kV SUTT project requires personnel for routine maintenance, inspections, and fault handling, with estimated costs of approximately Rp0.77 billion per year.

Operations and Maintenance (O&M) Costs

Total O&M costs (including labor) are estimated as follows:

1. Labor component: Rp0.77 billion/year
2. Non-labor component (materials, equipment): 1.5% of investment per year
3. Total O&M: approximately Rp1.6–2.5 billion/year

The annual escalation rate for O&M costs is estimated at 4% per year (Syifai et al., 2024).

Income Tax

This model assumes a corporate income tax rate of 25%, in accordance with Indonesian tax regulations.

Discount Rate (WACC)

The Weighted Average Cost of Capital (WACC) for electricity infrastructure projects in Indonesia ranges from 8% to 12%. This study uses a WACC of 13.69% as the baseline.

Uncertainty Variables

Uncertainty variables were identified based on a literature review and project characteristics. Table 3 presents the key variables and their respective probability distributions.

Table 3. Uncertainty Variables and Probability Distributions

Variable	Distribution	Parameter
Non-labor investment cost (IDR Billion)	Triangular	Min: 50.72; Likely: 57.00; Max: 68.06
Construction labor cost (IDR Billion)	Triangular	Min: 2.50; Likely: 2.94; Max: 3.50
Effective electricity tariff (IDR/kWh)	Normal	Mean: 25.00; Std Dev: 2.0
Load factor	Triangular	Min: 0.65; Likely: 0.75; Max: 0.85
Non-labor O&M cost (% of investment)	Triangular	Min: 1.0%; Likely: 1.5%; Max: 2.5%
O&M labor cost (IDR Billion/year)	Triangular	Min: 0.65; Likely: 0.77; Max: 0.95
O&M escalation	Normal	Mean: 4.0%; Std Dev: 1.0%
Availability	Triangular	Min: 0.80; Likely: 0.85; Max: 0.92
WACC	Normal	Mean: 10.5%; Std Dev: 1.5%
Project life	Fixed	30 years
Non-labor investment cost (IDR Billion)	Triangular	Min: 50.72; Likely: 57.00; Max: 68.06

Source: Author's identification based on literature review and project characteristics, 2025

Monte Carlo Simulation Steps

The Monte Carlo simulation is conducted using the following steps (Syifai et al., 2024): (1) identification of input variables containing uncertainty; (2) determination of probability distributions for each variable based on historical data and expert judgment; (3) generation of random numbers for each variable according to its distribution over 10,000 iterations; (4) calculation of NPV, IRR, and Payback Period for each iteration; (5) statistical analysis of the resulting output distribution; and (6) interpretation of results in terms of feasibility probability and Value at Risk (VaR).

Cash Flow Model

The project cash flow model is developed using the following equation:

Annual Revenue (R_t):

$$R_t = \text{Daya (MVA)} \times \text{Load Factor} \times 8.760 \times \text{Availability} \times \text{Tarif Efektif}$$

Annual O&M Cost (OM_t):

$$OM\_none_t = \text{Non-TK Investment} \times (\%\ \text{O\&M Non-TK}) \times (1 + \text{Eskalasi O\&M})^{t}$$

Annual O&M Labor Cost (OM_labor_t):

$$OM\_labor_t = \text{Initial O \& M Costs} \times (1 + \text{Eskalasi O\&M})^{t}$$

Annual Net Cash Flow (CF_t):

$$CF_t = R_t - \text{Total } OM_t - \text{Tax}$$

NPV = Σ(CF_t / (1 + WACC)^t) − Total Initial Investment

$$NPV = \Sigma(CF_t / (1 + WACC)^t) - \text{Total Initial Investment}$$

Benefit-Cost Ratio (BCR):

$$BCR = \Sigma(CF_t / (1 + WACC)^t) / \text{Total Initial Investment}$$

RESULTS AND DISCUSSION

Deterministic Analysis

Deterministic analysis, which applies the best-estimate value for each input variable, produces the feasibility indicators presented in Table 4. The results show that the project is financially feasible, with a positive NPV of IDR 36.3 billion, an IRR of 19.4% that exceeds the WACC of 10.5%, a Payback Period of 4.9 years, and a BCR of 1.61 indicating that every IDR 1 invested generates more than IDR 1.6 in benefits.

Table 4. Results of Deterministic Analysis

Indicator	Value	Feasibility Criterion	Status
NPV (30 years)	IDR 36.3 billion	NPV > 0	Feasible
IRR	19.4%	IRR > WACC (13.69%)	Feasible
Payback Period	4.9 years	< 30 years	Feasible
Benefit-Cost Ratio	1.61	BCR > 1	Feasible

Source: Results of deterministic financial analysis, 2025

Monte Carlo Simulation Results

A Monte Carlo simulation was carried out using 10,000 iterations through risk-analysis software, with the resulting statistics summarized in Table 5. The simulation shows a mean NPV of IDR 108.3 billion, considerably higher than the deterministic result of IDR 36.3 billion. This gap arises because, within the Monte Carlo simulation, favorable variables such as tariff and load factor can take values above their best estimates, which pushes the average simulated outcome above the deterministic value. The mean IRR reaches 33.7% with a standard deviation of 3.6%, reflecting very strong financial performance, while the mean Payback Period is only 3.0 years and the mean BCR is 2.8, both comfortably above the feasibility threshold.

Table 5. Monte Carlo Simulation Statistics (10,000 Iterations)

Indicator	Mean	Median	Std Dev	P5	P95
NPV (IDR billion)	108.3	106.7	23.1	73.1	149.2
IRR (%)	33.7	33.6	3.6	27.9	40.0
Payback Period (years)	3.0	3.0	0.3	2.5	3.5
BCR	2.8	2.7	0.4	2.2	3.5

Source: Monte Carlo simulation output (10,000 iterations), 2025

Feasibility Probability Analysis

Feasibility probability analysis is a critical step in investment risk evaluation, as it provides a quantitative measure of confidence that the project will meet its financial feasibility criteria across a range of uncertainty scenarios. Unlike deterministic analysis, which yields only a single value based on best-estimate assumptions, probability analysis draws on the distribution of Monte Carlo simulation outcomes to calculate the relative frequency of scenarios that satisfy the established feasibility criteria. This approach allows decision-makers to understand not only whether the project is feasible, but also how confident they can be in that feasibility bridging the gap between the optimistic outlook of the deterministic approach and the uncertainty inherent in power infrastructure projects.

Table 6. Project Feasibility Probability

Criterion	Probability
NPV > 0	100.0%
IRR > WACC (13.69%)	100.0%
Payback Period < 15 years	100.0%
Payback Period < 20 years	100.0%
BCR > 1	100.0%

Source: Monte Carlo simulation output (10,000 iterations), 2025

The probability that the project achieves a positive NPV is 100%, meaning that none of the 10,000 simulated scenarios produced a negative NPV. The probability that IRR exceeds the WACC is likewise 100%, indicating absolute certainty that the project delivers a return above its cost of capital. The probability that the Payback Period remains under 15 years and that the BCR exceeds 1 also reach 100%. These results point to an exceptionally strong financial fundamental and a negligible risk of failure.

Risk Analysis

Value at Risk (VaR)

Table 7. Value at Risk (VaR) at Various Confidence Levels

Confidence Level	VaR NPV (IDR billion)	VaR IRR (%)	VaR BCR (minimum)
90%	-57.3	29.0	2.32
95%	-73.1	27.9	2.15
99%	-99.5	25.2	1.93

Source: Monte Carlo simulation output (10,000 iterations), 2025

A 95% VaR of −IDR 73.1 billion for NPV means there is a 5% probability that the decline in NPV from the mean value exceeds IDR 73.1 billion. However, because every simulated scenario yields a positive NPV, this negative VaR figure actually reflects a potential drop from the mean rather than an absolute loss. A 95% VaR of 27.9% for IRR means there is a 5% probability that project IRR falls below 27.9% still well above the WACC. A 95% VaR of 2.15 for BCR means that, even in the worst 5% of scenarios, BCR remains above 2.15, pointing to a very large safety margin.

Sensitivity Analysis

Sensitivity analysis, based on the correlation coefficients between input variables and NPV, identifies the variables that most strongly influence project feasibility.

Table 8. Correlation Coefficients of Input Variables to NPV

Variable	Correlation Coefficient	Influence
WACC	-0.71	Very high
Electricity tariff	0.45	High
Load factor	0.39	High
Availability	0.21	Moderate
Non-labor investment	-0.15	Moderate
Non-labor O&M cost	-0.07	Low
O&M escalation	-0.05	Low
Labor O&M cost	-0.04	Low
Construction labor cost	-0.01	Low

Source: Monte Carlo simulation sensitivity analysis output (10,000 iterations), 2025

WACC is the variable with the greatest influence on NPV, with a correlation coefficient of -0.71, followed by electricity tariff (0.45) and load factor (0.39). This indicates that changes in the cost of capital (WACC) have the largest impact on the project's financial feasibility. Notably, labor costs whether during construction or operation have a relatively small effect on NPV, since their share of total cash inflow is minor: construction labor cost accounts for only about 5% of total investment, while O&M labor cost represents only around 0.09% of annual revenue.

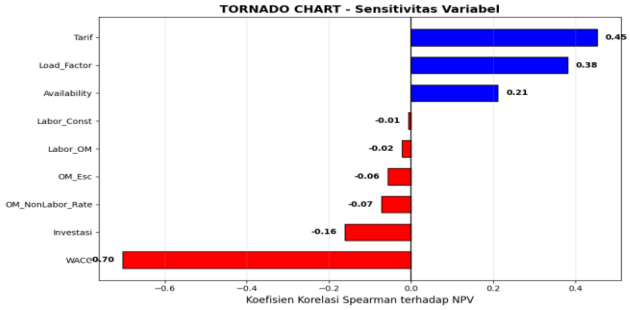

Figure 1. Tornado Chart of Input Variable Sensitivity

Source: Monte Carlo simulation sensitivity analysis output (10,000 iterations), 2025

Output Probability Distribution

NPV Distribution

The simulation results show an NPV distribution that approximates a normal distribution, with a mean of IDR 108.3 billion and a standard deviation of IDR 23.1 billion. Every scenario produced a positive NPV, with the 5th-percentile value at IDR 73.1 billion.

IRR Distribution

The IRR distribution has a mean of 33.7% with a standard deviation of 3.6%. The probability that IRR falls below the WACC (10.5%) is 0%, meaning the project is virtually certain to achieve its required return. Even in the worst-case (5th-percentile) scenario, IRR still reaches 27.9%, reflecting highly robust financial performance.

BCR Distribution

The BCR distribution has a mean of 2.8 with a standard deviation of 0.4. Every scenario produced a BCR above 1, with the 5th-percentile value at 2.2. This indicates that the project carries a very large safety margin against changes in input variables.

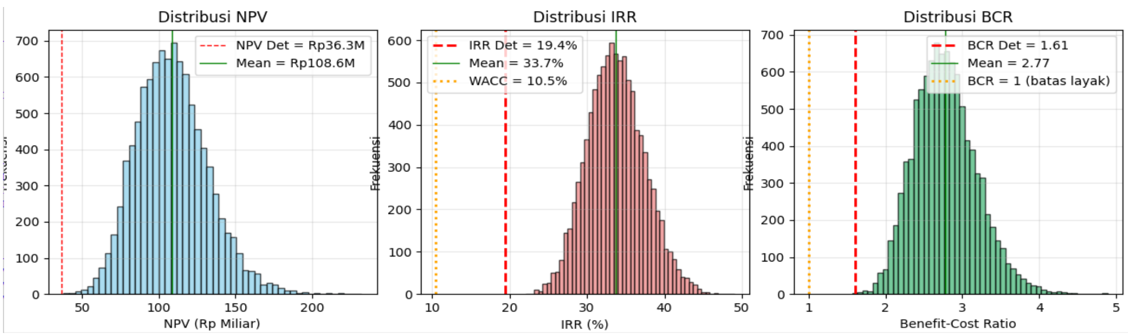

Figure 2. Probability Distribution of Monte Carlo Simulation Outputs

Source: Monte Carlo simulation sensitivity analysis output (10,000 iterations), 2025

Discussion

The analysis shows that PT MMP's high-voltage connection project is financially feasible with a very high degree of confidence, from both the deterministic and probabilistic perspectives. The Monte Carlo simulation adds valuable information in the form of an output probability distribution and a corresponding level of confidence in the project's feasibility.

The gap between the deterministic result and the Monte Carlo simulation a deterministic NPV of IDR 36.3 billion versus a mean simulated NPV of IDR 108.3 billion indicates that the deterministic approach tends to produce over-optimism, as it disregards uncertainty in the input variables (Syifai et al., 2024). The Monte Carlo simulation offers a more realistic picture by accounting for the range of scenarios that could plausibly occur.

A Payback Period of 4.9 years is a highly reasonable figure for a 150 kV high-voltage transmission line (SUTT) project. For comparison, feasibility studies of similar 150 kV SUTT projects in Indonesia report payback periods ranging from 5 to 9 years; the Seko 150 kV Substation and Incomer SUTT project in Jambi recorded a payback period of 8 years and 6 months, while another 150 kV transmission feasibility study reported 5.87 years. A payback period of 4.9 years therefore falls within a reasonable range and even outperforms the average of comparable projects.

A feasibility probability reaching 100% across all criteria indicates that the project rests on an exceptionally strong fundamental with a negligible risk of failure. This is driven by substantial annual revenue (IDR 19.6 billion per year) relative to total investment cost (IDR 59.9 billion) and relatively low O&M costs.

Labor cost components, while important for project planning, have a relatively minor influence on overall financial feasibility. Construction labor cost of IDR 2.94 billion represents only about 5% of total investment, while O&M labor cost of IDR 0.77 billion per year accounts for only about 1.3% of investment. This indicates that a small-scale power infrastructure project such as this 4.68 km, 150 kV SUTT is more sensitive to changes in revenue (tariff and load factor) and cost of capital (WACC) than to changes in labor cost.

WACC was identified as the most sensitive variable, with a correlation coefficient of -0.71, indicating that even small changes in the cost of capital can significantly affect NPV. Risk management should therefore focus on controlling the cost of capital through an optimal funding structure and competitive interest-rate negotiation.

Electricity tariff and load factor also exert a high degree of influence, with correlation coefficients of 0.45 and 0.39, respectively. Although the current feasibility probability stands at 100%, potential changes in tariff policy or a decline in load factor due to consumer-side operational issues should still be anticipated through long-term contractual mechanisms.

These findings are consistent with prior research on the Sumatra–Java Interconnection project, which found that Monte Carlo simulation provides a more realistic picture of risk than the deterministic approach. The very high feasibility level found in this project suggests that power infrastructure investments serving a single (captive) consumer, such as PT MMP, carry a substantially lower risk profile than public infrastructure projects in general.

CONCLUSION

Based on the results of the financial feasibility and investment risk analysis of the PT MMP Balikpapan high-voltage connection project, it can be concluded that the deterministic analysis shows the project to be financially feasible, with a total investment of IDR 59.9 billion, an NPV of IDR 36.3 billion, an IRR of 19.4% (exceeding the WACC of 10.5%), a Payback Period of 4.9 years, and a BCR of 1.61. The Monte Carlo simulation with 10,000 iterations produced a mean NPV of IDR 108.3 billion, a mean IRR of 33.7%, a mean Payback Period of 3.0 years, and a mean BCR of 2.8, with the probabilities of NPV > 0, IRR > WACC, and BCR > 1 all reaching 100%. The project's labor costs consist of construction labor cost of approximately IDR 2.94 billion (5% of total investment) and O&M labor cost of approximately IDR 0.77 billion per year (1.3% of total investment), both of which have relatively minor influence on financial feasibility (correlation coefficients < 0.1). In contrast, the variables with the greatest influence on project feasibility are WACC (correlation coefficient of -0.71), electricity tariff (0.45), and load factor (0.39). Risk analysis using a 95% VaR indicates a potential NPV decline of IDR 73.1 billion from the mean value, with a minimum IRR of 27.9% and a minimum BCR of 2.15 under the worst 5% of scenarios both figures remaining well above the feasibility threshold. Overall, the Monte Carlo simulation provides a more realistic picture of risk than the deterministic approach and can serve as a sound basis for investment decision-making. Based on the results of the financial feasibility and investment risk analysis of the PT MMP Balikpapan high-voltage connection project, it can be concluded that the deterministic analysis shows the project to be financially feasible, with a total investment of IDR 59.9 billion, an NPV of IDR 36.3 billion, an IRR of 19.4% (exceeding the WACC of 10.5%), a Payback Period of 4.9 years, and a BCR of 1.61. The Monte Carlo simulation with 10,000 iterations produced a mean NPV of IDR 108.3 billion, a mean IRR of 33.7%, a mean Payback Period of 3.0 years, and a mean BCR of 2.8, with the probabilities of NPV > 0, IRR > WACC, and BCR > 1 all reaching 100%. The project's labor costs consist of construction labor cost of approximately IDR 2.94 billion (5% of total investment) and O&M labor cost of approximately IDR 0.77 billion per year (1.3% of total investment), both of which have relatively minor influence on financial feasibility (correlation coefficients < 0.1). In contrast, the variables with the greatest influence on project feasibility are WACC (correlation coefficient of -0.71), electricity tariff (0.45), and load factor (0.39). Risk analysis using a 95% VaR indicates a potential NPV decline of IDR 73.1 billion from the mean value, with a minimum IRR of 27.9% and a minimum BCR of 2.15 under the worst 5% of scenarios both figures remaining well above the feasibility threshold. Overall, the Monte Carlo simulation provides a more realistic picture of risk than the deterministic approach and can serve as a sound basis for investment decision-making..

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