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# A Decision Support Model for Optimizing Capital Structure in the Jayapura–Wamena Trans-Papua Road Public–Private Partnership (PPP) Project: The Mamberamo–Elelim Segmen

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**Abstract**

*Infrastructure development through Public–Private Partnerships (PPP) has become a key strategy for addressing infrastructure financing constraints. Successful PPP implementation depends not only on selecting an appropriate partnership scheme but also on designing an optimal capital structure that ensures financial feasibility and resilience. This study develops a Decision Support Model (DSM) that integrates PPP scheme evaluation, capital structure formulation, financial performance assessment, and sensitivity analysis. A quantitative approach was applied through several stages, including evaluation of PPP scheme alternatives, Life Cycle Cost (LCC) analysis, identification of capital structure determinants, development of leverage-based financing alternatives, financial feasibility assessment, and sensitivity analysis. The results show that three PPP schemes—Design–Build–Finance–Maintain–Operate (DBFMO), Design–Build–Finance–Maintain (DBFM), and Operation and Maintenance (O&M)—met the criteria for further evaluation. Among nine combinations of PPP schemes and capital structures, only the DBFMO scheme with Debt-to-Equity ratios of 80:20 and 75:25 satisfied the financial feasibility criteria based on Weighted Average Cost of Capital (WACC), Internal Rate of Return (IRR), and Net Present Value (NPV). Sensitivity analysis identified Availability Payment as the most influential parameter affecting NPV, followed by LCC, while Cost of Debt had a relatively smaller effect. The proposed DSM provides a systematic framework for evaluating financing alternatives and supporting capital structure decisions in PPP infrastructure projects.*

## Introduction

Infrastructure development plays a fundamental role as a strategic instrument for promoting economic growth, enhancing regional connectivity, and reducing development disparities. Infrastructure serves not only as a physical facility that supports the movement of people and the distribution of goods but also as a catalyst for economic activity by improving productivity, logistics efficiency, and national competitiveness (Todaro & Smith, 2021; World Bank, 2017). In Indonesia, an archipelagic country characterized by complex geographical conditions, the provision of transportation infrastructure faces significant challenges due to its vast territory, diverse topography, and the existence of many areas with limited accessibility (Utomo et al., 205; Fauzi et al., 2026; Narotama, 2022; Krisnanta et al., 202; Napitupulu et al., 2024). These challenges are particularly evident in the development of the Jayapura–Wamena Trans Papua Road, Mamberamo–Elelim Segment, which requires advanced construction technology, extensive logistical support, and substantially higher



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investment costs than road projects located in regions with less challenging geographical conditions (Law of the Republic of Indonesia No. 2 of 2022 concerning the Second Amendment to Law No. 38 of 2004 on Roads, 2022; Borowski, 2025; Qin et al., 2024; Berhanu et al., 2023; Lindvall, 2023; Agoundedemba et al., 2023).

The growing demand for national infrastructure development has led to a substantial increase in investment requirements. According to Indonesia's National Medium-Term Development Plan (RPJMN) 2025–2029, total infrastructure investment needs are projected to exceed IDR 10,303 trillion, while government financing capacity through the State Budget (APBN) and Regional Budgets (APBD) remains insufficient to meet these requirements. This financing shortfall has created a significant infrastructure financing gap, prompting the government to promote Public–Private Partnerships (PPPs) as an alternative financing mechanism to increase private sector participation in infrastructure provision (Coordinating Ministry for Economic Affairs of the Republic of Indonesia, 2025; Akpor et al., 2025; Alamu et al., 2024; Mawejje, 2024; Casalini et al., 2025; Hernandez, 2026).

Under the PPP framework, the Project Company (Special Purpose Vehicle/SPV) is responsible for securing project financing, which typically consists of a combination of debt and equity. Determining the appropriate capital structure is a strategic decision because it directly affects the Weighted Average Cost of Capital (WACC), financial risk, and the overall financial feasibility of the project (Brealey et al., 2023; Brigham & Ehrhardt, 2023; Finnerty, 2013). For capital-intensive road infrastructure projects with long concession periods, an optimal capital structure is essential to minimize financing costs while ensuring sustainable project cash flows throughout the operational period (Grigg, 1987; Surbakti & Asyriana, 2025). Furthermore, the application of the Life Cycle Cost (LCC) approach enables project companies to manage investment, operation, maintenance, and rehabilitation costs in an integrated manner, thereby improving cost efficiency throughout the asset's service life (Federal Highway Administration [FHWA], 2002; International Organization for Standardization [ISO], 2017).

Previous studies on PPP project financing have primarily focused on capital structure optimization or financial feasibility assessment. However, most existing research examines only a single PPP scheme or evaluates capital structure without considering the characteristics of different PPP contractual arrangements (World Bank, 2017; Yescombe, 2011). In practice, PPP schemes such as Design Build Finance Maintain Operate (DBFMO), Design Build Finance Maintain (DBFM), and Operation and Maintenance (O&M) differ substantially in terms of risk allocation, responsibilities, investment requirements, and life-cycle costs. These differences may lead to varying optimal capital structures and financial feasibility outcomes, highlighting the need for a decision-support framework that integrates PPP scheme selection with capital structure optimization (Guo et al., 2024; Della Spina, 2026; Zhao et al., 2026; Zekri et al., 2026).

Based on this research gap, the present study aims to develop a Decision Support Model (DSM) for selecting the optimal capital structure for the Jayapura–Wamena Trans Papua Road PPP Project, Mamberamo–Elelim Segment. The proposed model integrates expert judgment, Life Cycle Cost (LCC) analysis, and financial feasibility evaluation using the Weighted Average Cost of Capital (WACC), Net Present Value (NPV), and Internal Rate of Return (IRR) indicators. This integrated framework is expected to generate financing strategies that provide the best value for money, improve resource allocation efficiency, and serve as a practical reference for both government agencies and private partners in making financing decisions for PPP infrastructure projects.


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## Methods

### Research Approach and Design

This study is classified as applied research employing a descriptive quantitative approach with a case study design. The primary objective is to develop a Decision Support Model (DSM) for selecting an appropriate Public–Private Partnership (PPP) scheme and evaluating alternative capital structures for road infrastructure projects.

### Research Object

The research focuses on the Jayapura–Wamena Trans Papua Road PPP Project, Mamberamo–Elelim Segment, located in the Highland Papua Province, Indonesia. The project spans a total length of 48.8 km, divided into five construction zones, with a 15-year concession period consisting of 2 years of construction and 13 years of operation and maintenance. The project adopts an Availability Payment (AP) mechanism as the revenue model.

### Data Collection and Research Instruments

The study utilizes both primary and secondary data sources. Primary data were collected through expert interviews and expert judgment using a Likert-scale questionnaire. Respondents were selected using purposive sampling and consisted of specialists in PPP implementation, infrastructure finance, and construction project management. Secondary data were obtained from project feasibility studies, cost estimation reports, government regulations related to PPP implementation, and relevant academic literature.

### Data Analysis Procedure

The research methodology was implemented through a systematic framework consisting of three main phases:

#### *Phase I: Research Preparation*

This phase involved identifying the research problem, conducting a comprehensive literature review, defining the research variables, and collecting both primary and secondary data.

#### *Phase II: PPP Scheme Selection*

Expert evaluations were analyzed using the weighted scoring method to identify the three highest-ranked PPP schemes. These selected alternatives were subsequently subjected to financial evaluation.

#### *Phase III: Capital Structure and Financial Evaluation*

The selected PPP schemes were evaluated using the Life Cycle Cost (LCC) approach to formulate alternative capital structures for each scheme. Each alternative was then assessed using the Weighted Average Cost of Capital (WACC), Internal Rate of Return (IRR), Net Present Value (NPV), and sensitivity analysis. The evaluation results were integrated into the proposed Decision Support Model, providing comprehensive information to support decision-making in selecting the most appropriate financing alternative.

### Research Framework

The overall research methodology is presented in a research flowchart that illustrates the sequential and integrated stages of the study. The flowchart begins with the identification of key variables and decision criteria relevant to PPP scheme selection and capital structure formulation. This stage is followed by data collection from primary and secondary sources to obtain the information required for subsequent analyses. The collected data are then processed using a weighted scoring approach to evaluate and rank the available PPP scheme alternatives based on predetermined criteria. The selected PPP schemes are subsequently analyzed using



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the Life Cycle Cost (LCC) approach to estimate the total costs incurred throughout the project life cycle, including investment, operation, maintenance, and other relevant expenditures. Based on the results of the PPP scheme evaluation and LCC analysis, several capital structure alternatives are developed by varying the proportion of debt and equity financing. Each alternative is then assessed through financial feasibility analysis using indicators such as the Weighted Average Cost of Capital (WACC), Internal Rate of Return (IRR), and Net Present Value (NPV). The final stage involves comparing the financial performance of the proposed alternatives and conducting sensitivity analysis to examine the robustness of the results under changes in key financial and project parameters. Through this integrated process, the research flowchart provides a systematic representation of how each analytical stage contributes to the development of the Decision Support Model for determining the most appropriate PPP scheme and capital structure.

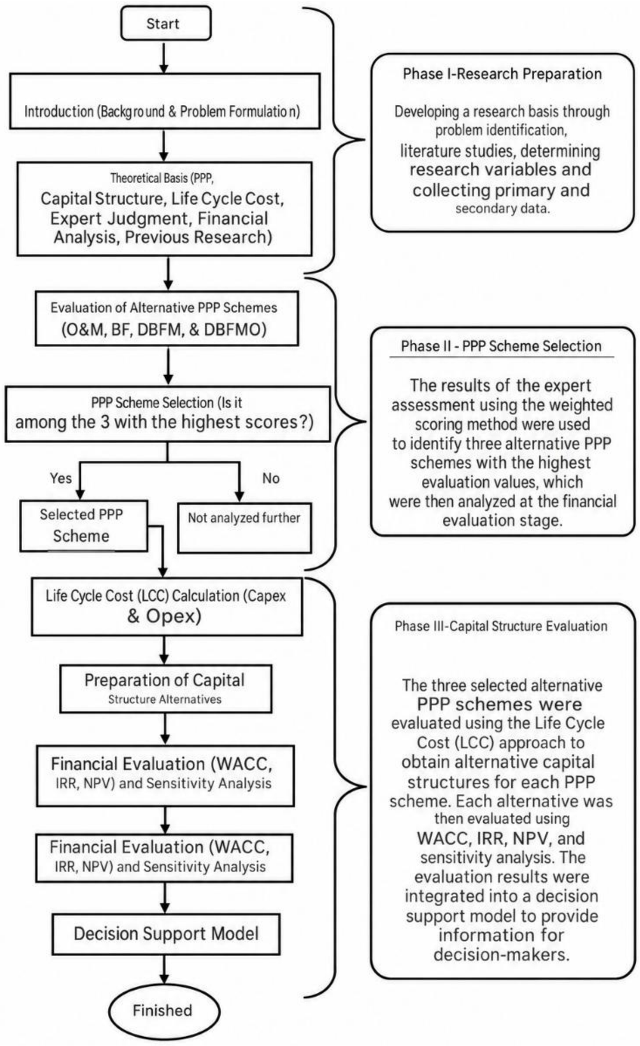


*Figure 1. Research Framework.*

## Results and Discussion

### Respondent Profile

The respondents in this study consisted of professionals with extensive experience and expertise in the implementation of Public–Private Partnership (PPP) projects, particularly in the areas of investment, project finance, procurement, and infrastructure project management. All respondents were affiliated with the Project Company (Special Purpose Vehicle/SPV) or companies directly involved in the development and execution of PPP projects. Therefore, they were considered to possess sufficient knowledge and practical experience to evaluate the



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research variables. The respondents were categorized according to their organization, functional division, and job position. This profile provides an overview of their professional backgrounds and demonstrates that the research data were collected from individuals with substantial experience and responsibilities in infrastructure investment decision-making. The detailed respondent characteristics are presented in Table 1.

Table 1. Respondent Profile

| No. | Characteristic | Description | Number of Respondents |
|---|---|---|---|
| 1 | **Organization** | PT Hutama Karya (Persero) | 1 |
| | | PT HMTP | 3 |
| | | PT HPSL | 1 |
| 2 | **Division** | Investment Development Division | 1 |
| | | Management | 1 |
| | | Procurement | 1 |
| | | Finance, Risk Management, and Human Capital | 2 |
| 3 | **Position** | PPP Expert | 1 |
| | | Director | 1 |
| | | Procurement Expert | 1 |
| | | General Manager (GM) | 2 |

As shown in Table 1, this study involved five respondents representing three organizations directly engaged in PPP project implementation. The majority of respondents (60%) were from PT HMTP, while one respondent each (20%) came from PT Hutama Karya (Persero) and PT HPSL. In terms of functional divisions, the respondents represented Investment Development, Management, Procurement, and Finance, Risk Management, and Human Capital, providing comprehensive perspectives on investment planning, risk management, procurement, and project financing. Based on their positions, the respondents consisted of one PPP Expert, one Director, one Procurement Expert, and two General Managers (GMs). This composition indicates that all respondents were either decision-makers or senior professionals with substantial experience in PPP-based infrastructure projects, thereby enhancing the credibility and validity of the expert assessments used in this study.

**Selection of PPP Scheme Alternatives**

The first stage of the selection process was conducted to identify the Public Private Partnership (PPP) scheme that best matches the characteristics of the Trans Papua Road Project based on expert judgment. Five key selection criteria were evaluated, and the average weighted scores and rankings for each PPP scheme alternative are presented in Table 2.

Table 2. Weighted Scores and Ranking of PPP Scheme Alternatives

| PPP Scheme | Return Mechanism | Construction Period | Concession Period | Capital Expenditure | Operating Expenditure | Total Weighted Score | Average Score | Rank |
|---|---|---|---|---|---|---|---|---|
| O&M | – | – | – | – | – | 73 | 2.92 | 3 |
| BF | – | – | – | – | – | 63 | 2.52 | 4 |
| DBFM | – | – | – | – | – | 75 | 3.00 | 2 |
| DBFMO | – | – | – | – | – | 115 | 4.60 | 1 |

The weighting results indicate that the Design–Build–Finance–Maintain–Operate (DBFMO) scheme achieved the highest average score (4.60), ranking first among the evaluated alternatives. This finding suggests that the DBFMO scheme is considered the most suitable for accommodating the characteristics of the project, which is capital-intensive, involves a


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long concession period, and requires integrated operation and maintenance throughout the asset life cycle. Following the research methodology, the three highest-ranked PPP schemes DBFMO, Design–Build–Finance–Maintain (DBFM), and Operation and Maintenance (O&M) were selected for further analysis. These alternatives were subsequently evaluated through Life Cycle Cost (LCC) analysis and comprehensive financial feasibility assessment to determine the most appropriate financing structure for the project.

**Life Cycle Cost (LCC) Analysis Results**

The Life Cycle Cost (LCC) analysis was conducted to estimate the total funding requirements of the project throughout the concession period, including both the initial investment costs and the operational expenditures. The summary of the LCC components for the case study project is presented in Table 3.

Table 3. Life Cycle Cost (LCC) of the Project

| No. | Description | Value (IDR) |
|---|---|---|
| 1 | Total Capital Expenditure (CAPEX) | 3,398,274,458,895 |
| 2 | Total Operational Expenditure (OPEX) | 1,022,704,699,321 |
| 3 | Residual Value (RV) | 0 |
| | Total Life Cycle Cost (LCC) | **4,420,979,158,216** |

The total Life Cycle Cost (LCC) of the Jayapura–Wamena Trans Papua Road Project was estimated at IDR 4.42 trillion. The results indicate that Capital Expenditure (CAPEX) constitutes the largest component of the project cost, contributing significantly more than the operational expenditure (OPEX). The substantial CAPEX reflects the project's challenging geographical conditions, including rugged terrain, remote locations, and complex logistics in the Papua region. Consequently, the project can be classified as a capital-intensive infrastructure project, requiring considerable upfront investment to ensure successful implementation and long-term operational performance.

**Capital Structure Alternative Determination**

The debt-to-equity composition was determined by calculating the Leverage Score (LS) based on the combined assessment of the company's internal and external factors affecting financing capacity. The evaluation results identified the following capital structure alternatives.

Table 4. Selected Capital Structure Alternatives

| No. | Capital Structure Alternative | Debt (%) | Equity (%) |
|---|---|---|---|
| 1 | Alternative 1 | 80 | 20 |
| 2 | Alternative 2 | 75 | 25 |
| 3 | Alternative 3 | 70 | 30 |

The analysis produced a Leverage Score (LS) of 4.28, which falls within the Very High category. According to the established decision criteria, a very high leverage capacity indicates that the project is capable of supporting a capital structure predominantly financed through debt. Based on this result, three alternative debt-to-equity ratios were selected for subsequent financial evaluation: 80:20, 75:25, and 70:30. These alternatives represent varying levels of financial leverage and were further assessed to determine the most financially feasible capital structure for the proposed PPP project.

**Comparison of the Financial Performance of PPP Schemes and Capital Structure Alternatives**

This stage compares the financial performance of each combination of PPP scheme and capital structure alternative using three key financial indicators: Weighted Average Cost of



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Capital (WACC), Internal Rate of Return (IRR), and Net Present Value (NPV). The comparative results are presented in Table 5.

Table 5. Comparison of Financial Evaluation Results for PPP Schemes and Capital Structure Alternatives

| Selected PPP Scheme | Debt (%) | Equity (%) | WACC (%) | IRR (%) | NPV (IDR Billion) | Financial Feasibility |
|---|---|---|---|---|---|---|
| **DBFMO** | 80 | 20 | 9.13 | 9.62 | 81.20 | Feasible |
| | 75 | 25 | 9.51 | 9.61 | 15.53 | Feasible |
| | 70 | 30 | 9.89 | 9.60 | -46.84 | Not Feasible |
| **DBFM** | 80 | 20 | 9.13 | 9.02 | -18.66 | Not Feasible |
| | 75 | 25 | 9.51 | 8.94 | -91.23 | Not Feasible |
| | 70 | 30 | 9.89 | 8.86 | -160.23 | Not Feasible |
| **O&M** | 80 | 20 | 9.13 | 16.18 | -15.95 | Not Feasible |
| | 75 | 25 | 9.51 | 16.91 | -16.29 | Not Feasible |
| | 70 | 30 | 9.89 | 17.65 | -16.61 | Not Feasible |

The results indicate that the 80% debt and 20% equity capital structure consistently delivered the best financial performance across all evaluated PPP schemes. This financing composition produced the lowest Weighted Average Cost of Capital (WACC), thereby enhancing the present value of the project's future cash flows compared with the other capital structure alternatives. Among the evaluated PPP schemes, DBFMO demonstrated the strongest financial performance. The 80:20 debt-to-equity ratio was the only alternative that generated the highest positive Net Present Value (NPV) while simultaneously satisfying the financial feasibility criteria based on WACC, IRR, and NPV. Although the 75:25 capital structure also met the feasibility requirements, its NPV was substantially lower than that of the 80:20 alternative. In contrast, none of the capital structure alternatives under the DBFM and O&M schemes met the financial feasibility criteria, as all produced negative NPVs. Nevertheless, the 80:20 capital structure consistently yielded the highest—or least negative—NPV within these schemes, indicating relatively better financial performance than the 75:25 and 70:30 alternatives. These findings suggest that a higher proportion of debt financing is more effective in reducing the overall cost of capital for this capital-intensive infrastructure project, while the DBFMO scheme provides the most favorable financial outcomes among the evaluated PPP alternatives.

**Comparison of Sensitivity Analysis Results Across Capital Structure Alternatives**

A comparison of the sensitivity analysis results between the 80:20 and 75:25 debt-to-equity capital structure alternatives is presented in Table 6. The comparison is based on the range of changes in Net Present Value (NPV) resulting from variations in three key parameters: Availability Payment (AP), Life Cycle Cost (LCC), and Cost of Debt. A larger range of NPV variation indicates a higher level of sensitivity of the capital structure to changes in the corresponding parameter.

Table 6. Comparison of Sensitivity Analysis Results for Capital Structure Alternatives

| Parameter | NPV Variation Range (IDR Billion) | |
|---|---|---|
| | **Capital Structure 80:20** | **Capital Structure 75:25** |
| Availability Payment | 601.63 | 577.19 |
| Life Cycle Cost | 497.47 | 489.10 |
| Cost of Debt | 194.54 | 173.77 |

The sensitivity analysis demonstrates that Availability Payment (AP) is the most influential parameter affecting the project's financial performance under both capital structure


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alternatives. The 80:20 debt-to-equity ratio exhibits the largest NPV variation (IDR 601.63 billion), indicating that changes in the Availability Payment mechanism have the greatest impact on project value. This is followed by Life Cycle Cost (LCC), which also has a substantial effect on NPV, whereas Cost of Debt shows the smallest influence among the three parameters evaluated. Comparing the two alternatives, the 80:20 capital structure consistently exhibits a wider range of NPV variation than the 75:25 structure across all parameters. This suggests that although the 80:20 financing composition provides superior financial performance under the baseline scenario, it is also more responsive to changes in key project assumptions. Nevertheless, because its financial feasibility remains positive under the evaluated conditions, the 80:20 debt-to-equity ratio remains the preferred capital structure for the DBFMO scheme, offering the most favorable balance between financial performance and project resilience.

The selection of an appropriate Public–Private Partnership (PPP) scheme is a strategic stage that determines the allocation of responsibilities, risk-sharing mechanisms, financing arrangements, and ultimately the success of infrastructure project implementation. An appropriate PPP scheme creates a balance between cost efficiency, service quality, and sustainable asset management throughout the concession period (Asian Development Bank, 2020; Yescombe, 2011). The results of this study indicate that the Design–Build–Finance–Maintain–Operate (DBFMO) scheme achieved the highest suitability score (4.60), demonstrating its superior capability to integrate the entire asset life cycle from planning, design, construction, financing, operation, to maintenance. This integrated approach is particularly appropriate for the Jayapura–Wamena Trans Papua Road Project, which requires substantial capital investment, has a long concession period, and involves highly complex construction and operational challenges due to the geographical conditions of Papua (Federal Highway Administration [FHWA], 2002; World Bank, 2017).

In contrast, the Build–Finance (BF) scheme obtained the lowest score (2.52) because the private partner's responsibilities are limited to construction and financing without including operation and maintenance activities. Consequently, the private sector has limited incentives to optimize costs throughout the asset's service life. According to the Life Cycle Cost Analysis (LCCA) approach, integrating design, construction, operation, and maintenance functions leads to greater long-term cost efficiency because technical decisions are based on total life-cycle costs rather than solely on initial investment expenditures (Federal Highway Administration [FHWA], 2002; International Organization for Standardization [ISO], 2017; Altaf et al., 2023; Hromada et al., 2024; Rostamiasl & Jrade, 2024; Felicioni et al., 2025; Altaf et al., 2025). These findings are consistent with PPP implementation guidelines, which emphasize the importance of integrating private-sector responsibilities to maximize value for money in infrastructure projects (Asian Development Bank, 2020; Presidential Regulation of the Republic of Indonesia No. 38 of 2015).

The capital structure determination in this study was based on the assessment of factors influencing financial leverage, resulting in an overall Leverage Score (LS) of 4.28, which falls within the Very High category. The most influential factors were profitability (4.80) and firm size (4.60), indicating that the project company possesses sufficient financial capacity to utilize debt financing extensively. This finding supports the Trade-off Theory, which argues that firms achieve an optimal capital structure by balancing the tax advantages of debt financing against the risks of financial distress and agency costs (Brealey et al., 2023; Brigham & Ehrhardt, 2023; Ross et al., 2024). Furthermore, PPP projects employing the Availability Payment (AP) mechanism generate relatively stable cash flows because payments are made by the government based on service availability, thereby improving the project's ability to meet debt obligations (Asian Development Bank, 2020; Yescombe, 2011; Guo et al., 2024;



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Vajdic et al., 2023; Olando et al., 2025). Accordingly, this study identified three debt-dominated capital structure alternatives, namely 80:20, 75:25, and 70:30 debt-to-equity ratios.

The financial evaluation demonstrates that capital structure has a direct impact on both the Weighted Average Cost of Capital (WACC) and the Net Present Value (NPV) of the project (Wang, 2026; Rodríguez, 2024). Increasing the equity proportion from 20% to 30% resulted in a gradual increase in WACC from 9.13% to 9.89%. This outcome reflects the significantly higher cost of equity (15.23%) compared with the after-tax cost of debt (7.61%), implying that a higher equity proportion increases the firm's average financing cost (Brealey et al., 2023; Brigham & Ehrhardt, 2023; Damodaran, 2015).

Among the evaluated PPP schemes, only the DBFMO scheme with 80% debt–20% equity and 75% debt–25% equity generated positive NPVs of IDR 81.20 billion and IDR 15.53 billion, respectively. In contrast, the 70% debt–30% equity alternative produced a negative NPV because the higher financing cost caused the project's Internal Rate of Return (IRR) (9.595%) to fall below the corresponding WACC. These findings indicate that debt-dominated financing provides greater financial benefits than increasing the proportion of equity for long-term, capital-intensive road infrastructure projects. The results therefore support the principles of capital structure optimization in project finance, where appropriate leverage can enhance project value while maintaining financial feasibility (Finnerty, 2013; Yescombe, 2011).

The sensitivity analysis of the two financially feasible capital structure alternatives (80:20 and 75:25) revealed a consistent pattern. Availability Payment (AP) was identified as the most influential parameter affecting NPV, followed by Life Cycle Cost (LCC), whereas Cost of Debt had the smallest impact. These findings indicate that the sustainability of project revenues and effective life-cycle cost management are more critical to financial viability than moderate changes in financing costs. This observation is consistent with the characteristics of Availability Payment-based PPP projects, in which stable government payments constitute the primary source of project revenue and are essential for maintaining the project's financial sustainability (Asian Development Bank, 2020; Ministry of National Development Planning/Bappenas Regulation No. 9 of 2025).

A comparison of the two feasible capital structure alternatives further shows that the 80:20 debt-to-equity ratio exhibits a slightly wider NPV variation than the 75:25 alternative under all sensitivity scenarios. Specifically, the NPV variation attributable to changes in Availability Payment reached IDR 601.63 billion for the 80:20 structure and IDR 577.19 billion for the 75:25 structure. Similarly, variations due to Life Cycle Cost amounted to IDR 497.47 billion and IDR 489.10 billion, respectively, while changes associated with Cost of Debt were IDR 194.54 billion and IDR 173.77 billion.

These results suggest that although the 80:20 capital structure offers the highest financial return under the baseline scenario, it is also more sensitive to changes in key project assumptions. Conversely, the 75:25 capital structure demonstrates slightly lower sensitivity, indicating greater robustness against fluctuations in the evaluated parameters. Overall, the proposed Decision Support Model (DSM) demonstrates that integrating PPP scheme selection with capital structure optimization provides a systematic framework for identifying financing strategies that maximize value for money, improve financing efficiency, and support the long-term sustainability of public infrastructure projects (Asian Development Bank, 2020; World Bank, 2017; Yescombe, 2011).

## Conclusion

This study successfully developed a Decision Support Model (DSM) that integrates PPP scheme evaluation, Life Cycle Cost (LCC) analysis, capital structure formulation, financial



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evaluation, and sensitivity analysis to support the selection of appropriate capital structure alternatives for Public–Private Partnership (PPP) projects. The proposed model is not intended to generate decisions automatically; rather, it provides a systematic and comprehensive decision-support framework that enables decision-makers to evaluate PPP schemes and financing alternatives according to project-specific characteristics.

The financial evaluation revealed that, among the nine combinations of PPP schemes and capital structure alternatives analyzed, only the Design–Build–Finance–Maintain–Operate (DBFMO) scheme with debt-to-equity ratios of 80:20 and 75:25 satisfied the financial feasibility criteria based on the Weighted Average Cost of Capital (WACC), Internal Rate of Return (IRR), and Net Present Value (NPV). The 80:20 capital structure delivered the strongest financial performance, generating an NPV of IDR 81.20 billion, while the 75:25 alternative produced an NPV of IDR 15.53 billion. In contrast, all capital structure alternatives under the DBFM and O&M schemes resulted in negative NPVs and were therefore considered financially infeasible.

The sensitivity analysis further demonstrated that Availability Payment (AP) is the most influential factor affecting project NPV, followed by Life Cycle Cost (LCC), whereas Cost of Debt has a comparatively smaller impact. Although the 80:20 capital structure achieved the highest financial return, it also exhibited greater sensitivity to changes in key project parameters. Conversely, the 75:25 capital structure showed greater robustness, indicating a stronger ability to withstand variations in economic and operational conditions throughout the concession period. Overall, integrating financial evaluation and sensitivity analysis within the proposed Decision Support Model provides decision-makers with more comprehensive information for selecting an appropriate capital structure. The model enables financing decisions to be based not only on financial performance under the baseline scenario but also on the resilience of each alternative under changing project conditions.

From a practical perspective, the proposed Decision Support Model can serve as a valuable decision-support tool for government agencies and Project Companies (Special Purpose Vehicles/SPVs) in evaluating financing alternatives for PPP infrastructure projects, particularly road projects using the Availability Payment mechanism. For investors and financial institutions, the findings highlight that the stability of Availability Payments and effective Life Cycle Cost management are the two most critical determinants of project financial viability. Accordingly, these factors should receive primary consideration during financing arrangements and risk mitigation throughout the concession period.

Future research is recommended to extend the proposed model by incorporating additional variables affecting capital structure and financial feasibility, including inflation risk, exchange rate fluctuations, construction risk, traffic demand risk, and changes in government policy. Furthermore, the model could be enhanced by integrating Multi-Criteria Decision-Making (MCDM) techniques or probabilistic simulation methods, such as Monte Carlo Simulation, to better capture project uncertainty and improve decision robustness. Future studies may also compare different PPP payment mechanisms, including User Charge schemes or hybrid models combining Availability Payment and User Charge, to provide broader insights into financing strategies for infrastructure PPP projects.

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