Risk Analysis in Capital Budgeting Decisions: Sensitivity and Scenario Analysis Approach

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Kata Kunci	Abstrak
Penganggaran Modal; Analisis Risiko; Analisis Sensitivitas; Analisis Skenario; Keputusan Investasi.	Keputusan penganggaran modal secara inheren rentan terhadap ketidakpastian karena kondisi ekonomi yang berfluktuasi dan proyeksi arus kas yang tidak sempurna. Evaluasi investasi yang tidak akurat dapat menyebabkan kerugian finansial yang signifikan dan alokasi sumber daya organisasi yang tidak efisien. Studi ini bertujuan untuk menganalisis peran penilaian risiko dalam keputusan penganggaran modal dengan menerapkan analisis sensitivitas dan analisis skenario sebagai alat evaluasi yang saling melengkapi. Dengan menggunakan pendekatan deskriptif-analitis yang didukung oleh ilustrasi numerik, studi ini meneliti bagaimana perubahan variabel keuangan utama seperti harga jual, volume penjualan, biaya produksi, dan tingkat diskonto memengaruhi indikator kelayakan proyek, khususnya Nilai Sekarang Bersih (NPV). Temuan menunjukkan bahwa analisis sensitivitas efektif dalam mengidentifikasi variabel kritis dengan dampak tertinggi pada hasil proyek, sementara analisis skenario memberikan pandangan yang lebih komprehensif tentang ketahanan proyek dalam berbagai kondisi ekonomi. Studi ini menyimpulkan bahwa mengintegrasikan kedua metode tersebut meningkatkan kualitas keputusan, mendukung manajemen risiko proaktif, dan meningkatkan keberlanjutan investasi jangka panjang.

Keyword	Abstract
Capital Budgeting; Risk Analysis Keyword; Sensitivity Analysis; Scenario Analysis; Investment Decision.	*Capital budgeting decisions are inherently exposed to uncertainty due to fluctuating economic conditions and imperfect cash flow projections. Inaccurate investment evaluation may lead to significant financial losses and inefficient allocation of organizational resources. This study aims to analyze the role of risk assessment in capital budgeting decisions by applying sensitivity analysis and scenario analysis as complementary evaluation tools. Using a descriptive-analytical approach supported by numerical illustrations, this study examines how changes in key financial variables such as selling price, sales volume, production costs, and discount rates affect project feasibility indicators, particularly Net Present Value (NPV). The findings demonstrate that sensitivity analysis is effective in identifying critical variables with the highest impact on project outcomes, while scenario analysis provides a more comprehensive view of project resilience under varying economic conditions. The study concludes that integrating both methods enhances decision quality, supports proactive risk management, and improves long-term investment sustainability.*

INTRODUCTION

Investment decisions constitute one of the most critical and strategic responsibilities in financial management, primarily because they involve substantial capital expenditures, long planning horizons, and irreversible commitments (Hossain, 2025). Once an investment decision is implemented, the organization is often locked into a particular course of action, making errors in project evaluation potentially costly and difficult to reverse. As a result, the effectiveness of capital allocation decisions plays a decisive role in determining a firm's long-term financial performance, competitiveness, and sustainability (Lintang & Suherlan, 2024).

Capital budgeting serves as the primary analytical framework through which investment projects are evaluated and selected. By systematically comparing expected future cash inflows with initial capital outlays, capital budgeting techniques aim to assess whether a proposed investment is capable of generating value for the firm (Amburgey et al., 2025). Among the most widely used methods are Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period, and Profitability Index. In particular, NPV has been widely endorsed in financial theory as the most reliable criterion because it incorporates the time value of money and directly measures value creation. However, despite their theoretical rigor, these traditional techniques are fundamentally based on forecasts that are inherently uncertain (Mehdiyev et al., 2024).

In practice, projected cash flows depend on numerous assumptions related to internal operational performance and external economic conditions. Variables such as selling price, sales volume, production costs, inflation rates, interest rates, and regulatory policies are subject to continuous change over time. Economic volatility, intensified market competition, technological disruption, and shifting consumer preferences further exacerbate uncertainty in investment outcomes (Nguyen et al., 2023). Consequently, even projects that appear financially attractive under baseline assumptions may become unviable when adverse conditions materialize. This reality highlights a critical limitation of conventional capital budgeting approaches: their tendency to rely on single-point estimates that may mask underlying risk exposure (Arimond et al., 2025).

The absence of explicit risk analysis in capital budgeting can lead to overly optimistic projections and biased decision-making. Managers may underestimate downside risk, overestimate expected returns, or fail to recognize the vulnerability of projects to unfavorable changes in key variables. Such shortcomings can result in inefficient capital allocation, financial distress, or the erosion of firm value (Ch Caterina Cruciani Graduand Luca Romanazzi, 2025). Therefore, integrating risk assessment into the capital budgeting process is not merely an analytical enhancement, but a managerial necessity in modern financial decision-making (K et al., 2025).

Sensitivity analysis and scenario analysis have emerged as two of the most widely applied tools for incorporating risk considerations into investment evaluation. Sensitivity analysis focuses on examining how changes in a single key variable such as price, volume, or cost affect project outcomes, while holding other variables constant (Settembre-Blundo et al., 2021). This approach enables decision-makers to identify critical assumptions and assess which variables exert the greatest influence on project feasibility. In contrast, scenario analysis evaluates the combined effects of simultaneous changes in multiple variables under different economic conditions, typically categorized as optimistic, most-likely, and pessimistic scenarios. By doing so, scenario analysis provides a broader and more realistic perspective on potential investment outcomes (Gressler et al., 2024).

Despite their conceptual simplicity and practical relevance, sensitivity analysis and scenario analysis are often applied in a fragmented or unsystematic manner. In

many cases, investment decisions continue to rely heavily on base-case projections without sufficiently exploring the implications of uncertainty (Asgarpour et al., 2023). Moreover, some managers treat risk analysis as a supplementary exercise rather than an integral component of capital budgeting. This gap between theory and practice underscores the need for a clearer understanding of how these analytical tools can be effectively employed to improve decision quality (Hasan et al., 2022).

Against this background, this study aims to analyze the application of sensitivity analysis and scenario analysis in capital budgeting decisions and to demonstrate their contribution to enhancing investment evaluation accuracy and managerial judgment (Kuronen, 2023). By examining how variations in key financial variables influence project feasibility indicators particularly Net Present Value this study seeks to highlight the strategic value of risk-based capital budgeting. Ultimately, the findings are expected to provide insights for managers and decision-makers in designing more robust, informed, and resilient investment strategies in the face of uncertainty.

RESEARCH METHODS

This study employs a descriptive-analytical research design to examine the role of sensitivity analysis and scenario analysis in capital budgeting decision-making (Kuronen, 2023). The research focuses on evaluating how changes in key financial variables influence investment feasibility indicators, particularly Net Present Value (NPV). Secondary data are used, derived from established financial management literature, textbooks, and empirical studies related to capital budgeting and risk analysis (Nair, 2025).

The analytical procedure begins with the development of a base-case investment scenario using standard capital budgeting assumptions, including initial investment, projected cash flows, project lifespan, and discount rate. Sensitivity analysis is then conducted by varying one key variable at a time such as selling price, sales volume, and production costs while holding other variables constant. Subsequently, scenario analysis is applied by simultaneously adjusting multiple variables under optimistic, most-likely, and pessimistic conditions (Yemets & Rubin, 2021). The resulting NPV values are compared across scenarios to assess project resilience and risk exposure. This methodological approach enables a systematic evaluation of investment risk and supports more informed managerial decision-making.

RESULTS AND DISCUSSION

The results of this study are derived from the application of sensitivity analysis and scenario analysis to a hypothetical investment project evaluated using the Net Present Value (NPV) method (Kamel et al., 2023). The base-case scenario assumes an initial investment of Rp1,000,000,000, annual net cash inflows of Rp300,000,000 over five years, and a discount rate of 10%. Under these assumptions, the project generates a positive NPV of Rp137,000,000, indicating that the investment is financially feasible. To assess risk exposure, sensitivity analysis was conducted by varying key financial variables by ±10%, while holding other variables constant. The results are presented in Table 1.

Table 1. Results of Sensitivity Analysis

Variable	Change (%)	NPV (Rp)	Impact on Feasibility
Selling Price	+10%	300,000,000	Strongly Improved
Selling Price	−10%	(25,000,000)	Not Feasible
Sales Volume	+10%	250,000,000	Improved

Sales Volume	−10%	20,000,000	Marginal
Production Cost	+10%	70,000,000	Weakened
Production Cost	−10%	210,000,000	Improved

The findings indicate that selling price is the most sensitive variable affecting NPV, followed by sales volume and production cost. A 10% decrease in selling price results in a negative NPV, rendering the project financially unviable. Scenario analysis was then applied to evaluate the combined effects of multiple variable changes under different economic conditions. The results are summarized in Table 2.

Table 2. Results of Scenario Analysis

Scenario	Selling Price	Sales Volume	Production Cost	NPV (Rp)	Decision
Optimistic	+10%	+5%	−5%	350,000,000	Feasible
Moderate	0%	0%	0%	150,000,000	Feasible
Pessimistic	−10%	−5%	+5%	30,000,000	Marginally Feasible

The results of the sensitivity analysis demonstrate that revenue-related variables, particularly selling price and sales volume, exert the greatest influence on project feasibility. This finding reinforces the argument that uncertainty on the revenue side represents a dominant source of investment risk compared to cost-related factors. In competitive and volatile markets, firms often face limited control over pricing power and demand stability, making projected revenues more susceptible to external shocks. Consequently, even relatively small deviations in market conditions can lead to disproportionate changes in Net Present Value (NPV), potentially altering the overall feasibility of an investment project (Espinoza et al., 2023).

From a managerial standpoint, this result underscores the strategic importance of market-oriented decision-making in capital budgeting. Accurate demand forecasting, rigorous market research, and flexible pricing strategies become critical risk mitigation instruments. Managers should not merely rely on optimistic sales assumptions but must continuously monitor market signals and competitive dynamics throughout the project lifecycle. Failure to do so may expose the firm to downside risks that are not immediately apparent in base-case financial projections (Clere, 2025).

Furthermore, the scenario analysis provides a more comprehensive and realistic understanding of project resilience under varying economic conditions. While the investment remains feasible across optimistic, moderate, and pessimistic scenarios, the sharp decline in NPV under the pessimistic scenario reveals a limited margin of safety. This finding suggests that although the project can absorb moderate adverse shocks, its financial performance becomes increasingly vulnerable as unfavorable conditions intensify. Such vulnerability highlights the importance of stress-testing investment projects beyond average expectations, particularly in environments characterized by macroeconomic instability or regulatory uncertainty.

Importantly, scenario analysis contributes not only to numerical evaluation but also to strategic foresight. By

explicitly considering worst-case outcomes, managers can establish risk tolerance thresholds and prepare contingency plans before adverse conditions occur. This proactive orientation aligns capital budgeting decisions with broader enterprise risk management principles, transforming investment evaluation from a static calculation into a dynamic strategic process.

The combined application of sensitivity and scenario analysis enhances decision-making quality by addressing both individual risk drivers and systemic uncertainty. Sensitivity analysis offers precision by identifying which assumptions require the greatest managerial attention, whereas scenario analysis provides breadth by capturing the interactive effects of multiple variables. Together, these methods enable a more balanced assessment of expected returns and downside risks, thereby reducing reliance on overly simplistic or deterministic investment models (Ndikum & Ndikum, 2024).

Overall, the findings confirm that incorporating structured risk analysis into capital budgeting significantly improves the reliability and robustness of investment evaluations. By integrating sensitivity and scenario analysis, firms are better equipped to allocate capital efficiently, anticipate potential losses, and support long-term sustainability objectives. In an increasingly uncertain business environment, risk-aware capital budgeting should be regarded not as an optional analytical extension, but as a fundamental component of sound financial management practice.

CONCLUSION

This study examines the role of risk analysis in capital budgeting decisions by applying sensitivity analysis and scenario analysis as complementary evaluation tools. The findings demonstrate that investment feasibility is highly influenced by uncertainty in key financial variables, particularly those related to revenue, such as selling price and sales volume. Sensitivity analysis proves effective in identifying critical assumptions that have the greatest impact on Net Present Value (NPV), thereby enabling managers to focus their attention on the most significant sources of risk.

Furthermore, the application of scenario analysis provides a broader and more realistic assessment of project performance under varying economic conditions. The results indicate that although the evaluated investment remains financially feasible across optimistic, moderate, and pessimistic scenarios, its resilience weakens significantly under adverse conditions, as reflected in the sharp decline in NPV. This highlights the importance of assessing downside risk and defining acceptable risk thresholds before committing capital to long-term projects.

Overall, the study confirms that integrating sensitivity analysis and scenario analysis into capital budgeting enhances the accuracy, reliability, and robustness of investment evaluations. The combined use of these methods supports more informed managerial judgment, improves risk awareness, and reduces the likelihood of suboptimal capital allocation. Consequently, risk-based capital budgeting should be regarded as an essential component of effective financial management, particularly in environments characterized by high uncertainty and volatility. Future research is encouraged to extend this approach through empirical applications or advanced probabilistic techniques to further strengthen investment decision-making frameworks.

BIBLIOGRAPHY

Amburgey, A. J., Birinci, S., Christiano, L., Eichenbaum, M., Gosselin, J., Känzig,

D., Lara, J. L., Mccracken, M., Mokyr, J., Primiceri, G., & Raghavan, R. (2025). *How Election Shocks Impact Markets: Evidence from Sectoral Stock Prices*. https://arxiv.org/pdf/2504.02731

Arimond, A., Borth, D. S., Garcia-Vega, S., Harjoto, M., Hoepner, A. G. F., Klawunn, M., & Weisheit, S. (2025). Neural Networks and Value at Risk in Asset Management. *Review of Quantitative Finance and Accounting 2025*, 1–40. https://doi.org/10.1007/S11156-025-01460-Y

Asgarpour, S., Hartmann, A., & Gkiotsalitis, K. (2023). Infrastructure investment planning through scenario-based system-of-systems modelling. *Transportation Planning and Technology*, *46*(5), 527–572. https://doi.org/10.1080/03081060.2023.2196987

Ch Caterina Cruciani Graduand Luca Romanazzi, S. (2025). *Exploring the Influence of Behavioral Biases on Project Evaluation and Cost Management*. https://unitesi.unive.it/handle/20.500.14247/1421

Clere, R. (2025). *Does Stock Market Performance Reflect Instability, Risk, or Uncertainty?*. https://doi.org/10.2139/SSRN.5296686

Espinoza, D., Rojo, J., Phillips, W., & Eil, A. (2023). Decoupled net present value: protecting assets against climate change risk by consistently capturing the value of resilient and adaptable investments. *Sustainable and Resilient Infrastructure*, *8*(sup1), 323–336. https://doi.org/10.1080/23789689.2022.2148453

Gressler, L. E., Marinac-Dabic, D., Resnic, F. S., Williams, S., Yang, K., Weichold, F., Avila-Tang, E., Mack, C., Coplan, P., Panagiotou, O. A., & Pappas, G. (2024). A Comprehensive Framework for Evaluating the Value Created by Real-World Evidence for Diverse Stakeholders: The Case for Coordinated Registry Networks. *Therapeutic Innovation & Regulatory Science 2024 58:6*, *58*(6), 1042–1052. https://doi.org/10.1007/S43441-024-00680-Z

Hasan, R., Akter, S., & Lead,] Marketing. (2022). Information System-Based Decision Support Tools: A Systematic Review Of Strategic Applications In Service-Oriented Enterprises. *Review of Applied Science and Technology* , *1*(04), 26–65. https://doi.org/10.63125/W3CEVZ78

Hossain, M. A. (2025). Artificial Intelligence-Driven Financial Analytics Models For Predicting Market Risk And Investment Decisions In U.S. Enterprises. *ASRC Procedia: Global Perspectives in Science and Scholarship*, *1*(01), 1066–1095. https://doi.org/10.63125/9CSEHP36

K, M. P., Gurbaxani, A., Rao, Mvks., Varun Goel, A., & Sandhad, R. (2025). Strategic Financial Management: Integrating Corporate Strategy With Financial Decision-Making. *International Journal of Applied Mathematics*, *38*(11s), 326–335. https://doi.org/10.12732/IJAM.V38I11S.1163

Kamel, A., Elwageeh, M., Bonduà, S., & Elkarmoty, M. (2023). Evaluation of mining projects subjected to economic uncertainties using the Monte Carlo simulation and the

binomial tree method: Case study in a phosphate mine in Egypt. *Resources Policy*, *80*, 103266. https://doi.org/10.1016/J.RESOURP OL.2022.103266

Kuronen, L. (2023). *The Applicability of Real Options in Strategic Capital Budgeting: An IT Industry Acquisition Case Study.* https://aaltodoc.aalto.fi/handle/123 456789/122088

Lintang, A., & Suherlan, M. (2024). Strategic Financial Management for Performance Enhancement and Sustainable Growth. *Arthatama: Journal of Business Management and Accounting*, *8*(1), 18–29. http://journal.lifescifi.com/index.ph p/art/article/view/518

Mehdiyev, N., Majlatow, M., & Fettke, P. (2024). Quantifying and explaining machine learning uncertainty in predictive process monitoring: an operations research perspective. *Annals of Operations Research 2024 347:2*, *347*(2), 991–1030. https://doi.org/10.1007/S10479-024-05943-4

Nair, G. (2025). *Data-Driven Financial Performance Analysis through Key Performance Indicators with Sensitivity and Predictive Insights: A Five-Year Study of a Public Sector IT Park.* https://doi.org/10.2139/SSRN.5839 442

Ndikum, P., & Ndikum, S. (2024). *Advancing Investment Frontiers: Industry-grade Deep Reinforcement Learning for Portfolio Optimization.* https://arxiv.org/pdf/2403.07916

Nguyen, T. T. C., Le, A. T. H., & Nguyen, C. Van. (2023). Internal factors affecting the financial performance of an organisation's business processes. *Business Process Management Journal*, *29*(5), 1408–1435. https://doi.org/10.1108/BPMJ-10-2022-0486

Settembre-Blundo, D., González-Sánchez, R., Medina-Salgado, S., & García-Muiña, F. E. (2021). Flexibility and Resilience in Corporate Decision Making: A New Sustainability-Based Risk Management System in Uncertain Times. *Global Journal of Flexible Systems Management 2021 22:2*, *22*(2), 107–132. https://doi.org/10.1007/S40171-021-00277-7

Yemets, S. Y., & Rubin, J. (2021). *Comparison of Discounted Cash Flow, Decision Analysis, and Flexibility in Design for handling uncertainty in Oil and Gas Capital Projects.* https://dspace.mit.edu/handle/1721. 1/140075