

Engineering Economy Application in Investment Evaluation: A Simulation Approach

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Abstract

This study evaluates the feasibility of implementing an Enterprise Resource Planning (ERP) system in the Cosmetics and Household Needs sub-sector using engineering economics and system-dynamics simulation. The investment targets operational efficiency and the correction of transaction and inventory discrepancies. Financial viability was assessed via Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP), complemented by a multi-year Vensim simulation to capture dynamic cash-flow effects. Results indicate strong feasibility: NPV of Rp 119,654,313 over five years, IRR of 50.38% far above a 3.5% benchmark and a 7-month payback, with simulated trajectories showing increasing NPV and sustained positive cash flow under varying income, expense, and customer-growth assumptions. The ERP solution is at Technology Readiness Level (TRL) 7–8, reflecting prototype demonstration in an operational environment. The initiative aligns with institutional KPIs on digital transformation, efficiency, and financial performance, and supports SDG 9 (Industry, Innovation and Infrastructure) and SDG 12 (Responsible Consumption and Production) by promoting efficient resource management and sustainable industrial practices. Collectively, the evidence suggests ERP adoption is both financially sound and strategically beneficial for firms in this sub-sector.

Keywords: engineering economics, investment feasibility, enterprise resource planning (erp), system modeling simulation, dynamic system.

INTRODUCTION

Investment decisions in corporate sectors require thorough evaluation to ensure financial sustainability and operational efficiency. Engineering economics plays a critical role in assessing investment feasibility by applying systematic financial analysis techniques, such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP) (Park, 2015). These criteria help organizations determine whether an investment will generate positive financial returns over time (Blank & Tarquin, 2017).

In the Cosmetics and Household Needs Sub-Sector, businesses face challenges in managing inventory, transactions, and operational data efficiently. Many companies still rely on outdated or manual systems, leading to discrepancies in stock levels and transaction

records (Monk & Wagner, 2012). Enterprise Resource Planning (ERP) systems have been widely adopted as a solution to streamline operations, improve data accuracy, and enhance overall productivity (Rashid et al., 2002; Shaul & Tauber, 2013). ERP integrates various business functions into a unified system, allowing real-time data tracking and decision-making (Umble et al., 2003).

Investment feasibility studies for ERP implementation require not only financial assessment but also system modeling to predict long-term benefits. Dynamic system simulation is an effective method for analyzing the impact of ERP adoption by modeling financial indicators over time (Serman, 2000). Several studies have demonstrated that system modeling enhances investment decision-making by providing insights into future performance and potential risks (Morecroft, 2015; Akkermans & Van Oorschot, 2018). Moreover, integrating engineering economics with dynamic system simulation enables businesses to evaluate investment returns more accurately, making informed decisions on capital allocation (Abdel-Hamid & Madnick, 1991).

This study aims to analyze the feasibility of ERP investment in the Cosmetics and Household Needs Sub-Sector using an engineering economic approach. By calculating key investment criteria and utilizing system modeling simulation, this research provides a comprehensive assessment of ERP implementation and its potential impact on corporate performance.

Problem-solving approaches involve systematic methods to analyze, evaluate, and resolve issues by applying structured frameworks and logical reasoning. These approaches include identifying the problem, gathering relevant data, formulating hypotheses, and testing them through empirical analysis or modeling techniques. In scientific and engineering disciplines, hypothesis testing is essential to validate assumptions and provide evidence-based conclusions. Methods such as statistical analysis, simulation modeling, and optimization techniques are commonly used to test conjectures and ensure the reliability of proposed solutions. By integrating these approaches, decision-makers can make informed judgments, improve efficiency, and develop sustainable solutions to complex problems.

Investment feasibility studies utilizing engineering economic principles have been widely applied in corporate decision-making, particularly in evaluating capital-intensive projects such as Enterprise Resource Planning (ERP) system implementations. Engineering economics provides a structured approach to assessing financial viability by employing investment evaluation criteria such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP) (Park, 2015). However, traditional feasibility studies often focus solely on static financial calculations without considering the dynamic nature of business environments. To address this limitation, system modeling simulation has emerged as a valuable tool for enhancing investment decision-making by predicting long-term financial performance and optimizing resource allocation (Serman, 2000).

Several studies have examined the role of ERP in improving operational efficiency and corporate performance. Shaul and Tauber (2013) analyzed critical success factors in ERP implementation and emphasized the importance of integrating financial feasibility assessments into strategic planning. Similarly, Umble et al. (2003) examined ERP implementation procedures and identified financial risk assessment as a crucial factor for successful deployment. However, these studies primarily focused on qualitative assessments, leaving a gap in integrating engineering economic models with dynamic system simulations for investment decision-making.

Recent research has demonstrated the advantages of dynamic system modeling in evaluating investment feasibility. Morecroft (2015) applied system dynamics to assess long-term financial impacts and concluded that simulations provide a more comprehensive understanding of investment risks and benefits. Akkermans and Van Oorschot (2018) validated this approach by developing a balanced scorecard framework using system dynamics, highlighting its effectiveness in corporate decision-making. Additionally, Park (2015) emphasized the need for a combined approach that integrates financial analysis with simulation modeling to enhance investment feasibility studies.

The novelty of this research lies in the integration of engineering economic principles with system modeling simulation to evaluate ERP investment feasibility in the Cosmetics and Household Needs Sub-Sector. Unlike previous studies that focus on either financial analysis or system simulation in isolation, this study proposes a comprehensive framework that combines both methodologies to provide a more accurate and dynamic assessment of investment feasibility. By incorporating dynamic system simulations, this research aims to bridge the gap between static financial evaluations and real-world business dynamics, offering a more robust decision-making model for corporate investments.

METHOD

This research employs a mixed-method approach, integrating quantitative financial analysis and system modeling simulation to assess the feasibility of Enterprise Resource Planning (ERP) investments. The methodology is structured into sequential stages, ensuring a comprehensive evaluation of investment decisions from both engineering economic and dynamic system perspectives.

The study begins with data collection from primary and secondary sources. Primary data is obtained through interviews, surveys, and case studies with companies in the Cosmetics and Household Needs Sub-Sector implementing ERP systems. Secondary data includes financial reports, industry benchmarks, and academic literature related to investment feasibility, ERP implementation, and system modeling.

Engineering Economic Analysis

The financial feasibility of ERP implementation is assessed using engineering economic principles, focusing on key investment criteria:

- a. Net Present Value (NPV): Evaluates the profitability of the investment over a specified period.
- b. Internal Rate of Return (IRR): Determines the potential return rate compared to the cost of capital.
- c. Payback Period (PP): Measures the time required to recover the investment cost.

A system dynamics model is developed to simulate the long-term financial impact of ERP implementation. The model considers key variables such as operational cost reductions, efficiency improvements, and revenue growth. Using simulation software, different investment scenarios are tested over a five-year period, providing insights into risk factors and optimal investment strategies.

The simulation model is validated by comparing predicted financial outcomes with historical data and industry benchmarks. Sensitivity analysis is conducted to test how variations in key parameters (e.g., cost fluctuations, adoption rates) affect investment feasibility, ensuring robust decision-making.

Based on the analysis, the study provides practical recommendations for companies considering ERP investments, offering a decision-support framework that integrates engineering economics with system modeling. This ensures that businesses can make data-driven, financially sound investment decisions, aligning with the university's research roadmap and SDG objectives.

RESULT AND DISCUSSION

Technical Economic Analysis

In this study, the Engineering Economy method is used to analyze the feasibility of investment in the implementation of ERP by performing several calculations, namely Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP) based on the company's annual cash flow derived from its income and expenses. The following are the stages in conducting calculations using the Engineering Economy method:

Net Present Value (NPV)

This method analyzes the present value to calculate the difference between the present value of the investment and the current value of future revenues and expenses. The initial investment required to implement the ERP system is known to be Rp. 18,982,483, which is recorded as the initial investment cost in year 0. The total annual expense incurred by the company is Rp. 58,574,365. The monthly income is assumed to be consistent and projected for the whole year to assess the investment feasibility based on annual revenue. The investment period is set for 5 years with an interest rate of 3.5%. After defining these costs, a cash flow diagram is created. Based on this cash flow, the Net Present Value is calculated. The result of the NPV calculation is Rp. 119,654,313. The decision criteria are outlined in the table below:

Table 1. Net Present Value Decision Criteria

NPV Value	Meaning	Status
$NPV > 0$	Investment is feasible	Profitable
$NPV < 0$	Investment is not feasible	Unprofitable
$NPV = 0$	Investment is break-even	Neither Profitable nor Unprofitable

Based on the calculation results, the NPV value is Rp. 119,654,313. Since $NPV > 0$, this means the investment is feasible and can be considered profitable for the company as the value of Rp. 119,654,313 is greater than 0.

Internal Rate of Return (IRR)

This method calculates the interest rate of an investment and equates it with the current value of the investment. The known investment amount is Rp. 18,982,483, with a difference between annual benefits and annual costs of Rp. 30,705,144, and an investment period of 5 years. The calculated result is 0.6182. This value is then adjusted using the interest rate table. Since there is no exact match, interpolation is performed. After interpolation, the IRR value is obtained as 50.38%. Since $IRR > \text{the applied interest rate}$ ($50.38\% > 3.5\%$), this indicates that the investment is feasible and can be profitable for the company.

Payback Period (PP)

This method is used to calculate the time required for the investment to recover the initial capital. The initial investment value, denoted as P (present), is Rp. 18,982,483. In this calculation, it is necessary to find the future value (F) to determine the Equivalent Uniform Annual Benefit (EUAB). The result of the Payback Period method calculation yields a value of 7. The decision criteria are presented in the following table:

Table 2. Payback Period Decision Criteria

NPV Value	Meaning	Status
$NPV > 0$	Investment is feasible	Profitable
$NPV < 0$	Investment is not feasible	Unprofitable
$NPV = 0$	Investment is break-even	Neither Profitable nor Unprofitable

Based on the Payback Period decision criteria, the result of $PP = 7$ months is less than the investment duration of 5 years, indicating that the investment is feasible as the payback period is shorter than the investment's lifetime.

Vensim Simulation

a. Net Present Value

With the increase in company income and expenses, the Net Present Value also increases. A significant increase occurs. This can be seen in the simulation results shown in:

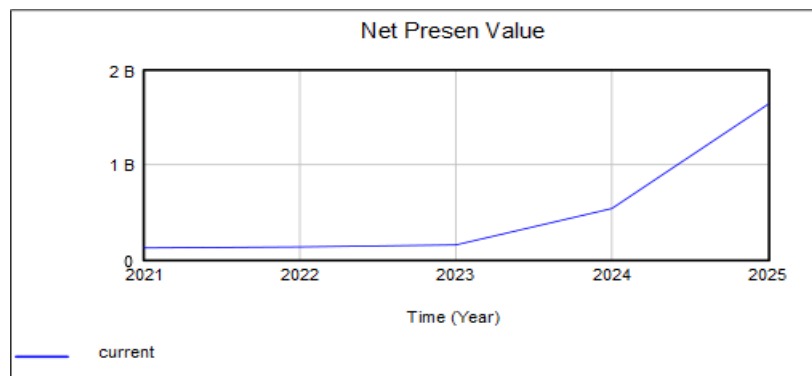


Figure 1. NPV Simulation Chart

b. Cash Flow

As the number of customers increases, business income also increases, raising revenue. On the other hand, expenses will also rise due to other associated costs, which may reduce the company's net cash flow. As shown in Figure, an increase in cash flow.

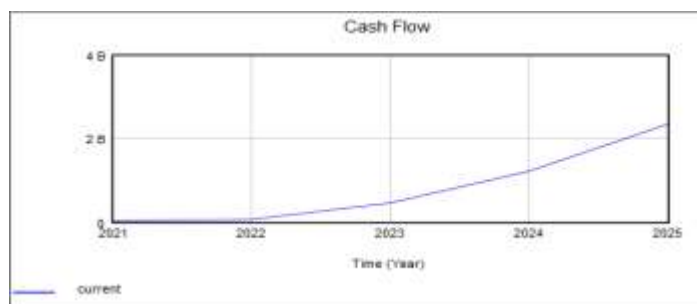


Figure 2. NPV Simulation Chart

Based on the data analysis in results, the results show the investment feasibility value for the ERP implementation project using the Engineering Economy approach with methods such as Net Present Value, Internal Rate of Return, and Payback Period. Following these calculations, a dynamic system modeling simulation was conducted to determine the influence of each variable affecting the cash flow. The dynamic system simulation results are as follows:

Net Present Value Simulation Model

Net Present Value is a feasibility analysis method to determine the net value at the present time. In this calculation, the investment value is Rp. 18,982,483, and the company's annual revenue is Rp. 733,597,524. The planned investment period is 5 years. Annual expenses are Rp. 702,892,380, derived from product and general & administrative costs. From the simulation model, the NPV value is calculated yearly, reaching Rp. 119,654,313 by the 5th year. The NPV calculation table is as follows:

Table 3. Net Present Value Simulation

Year	$i = 3.5\%$	Present Worth Cost	Present Worth Benefit	NPV
0	-	Rp. 18,982,483	-	-
1	6.709722222	Rp. 679,134,618	Rp. 708,801,928	Rp. 10,684,827
2	18.997	Rp. 1,335,284,654	Rp. 1,393,615,216	Rp. 39,348,079
3	28.016	Rp. 1,969,223,292	Rp. 2,055,246,823	Rp. 67,041,048
4	36.731	Rp. 2,581,794,001	Rp. 2,694,577,065	Rp. 93,800,581
5	45.151	Rp. 3,173,629,385	Rp. 3,312,266,181	Rp. 119,654,313
Total		Rp. 9,739,065,950	Rp. 10,164,507,213	Rp. 425,441,264

Table shows that the NPV simulation for each year with a 3.5% interest rate results in values > 0. The NPV increases annually, reaching a total of Rp. 425,441,264 by year 5. The total Present Worth Cost and Present Worth Benefit are Rp. 9,739,065,950 and Rp. 10,164,507,213, respectively.

CONCLUSION

This study has demonstrated that implementing an ERP system in the Cosmetics and Household Needs Sub- Sector is financially feasible and strategically beneficial. Using an engineering economic approach, including Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP), the investment analysis revealed positive outcomes. The calculated NPV of Rp. 119,654,313 indicates that the investment will generate significant net gains over the 5-year period. Furthermore, the IRR of 50.38%, which far exceeds the interest rate of 3.5%, confirms the project's profitability. The Payback Period of 7 months shows a quick return on investment, well within the planned timeframe.

Dynamic system simulation using Vensim further supported these findings, showing consistent increases in NPV and positive trends in cash flow over time. The model accounted for changing variables such as income, expenses, and customer growth, providing a comprehensive understanding of the ERP system's long-term impact on financial performance.

In conclusion, integrating engineering economic analysis with system modeling has proven effective in evaluating ERP investment feasibility. The results suggest that adopting an ERP system will enhance operational efficiency and provide strong financial returns, making it a worthwhile investment for companies in the Cosmetics and Household Needs Sub-Sector.

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