

Improvement of ERP Case Study Considering Sensitivity Analysis: A Techno-economic Study

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Abstract

Enterprise Resource Planning (ERP) is one of the solutions to solving problems related to supply chain visibility because it creates a framework that integrates the company's internal business processes. Companies that implement ERP can be integrated directly with suppliers and customers. This article discusses the improvement of the article by Mairawati et al. (2018), related to the analysis of the feasibility of investing in financial software, namely Enterprise Resource Planning (ERP). Previous research has evaluated the economic approach using investment feasibility criteria, the value of Net Present Value >0 , Payback Period <5 years (economic age), and implementation that results in savings of IDR 72,000,000. Then, this study add aspects of techno-economic calculations makes suggestions for improvement that have not been studied, such as income tax, depreciation, and sensitivity analysis to get more accurate results. The results show that the investment has Net Present Value of IDR 190,071,261.75, the Payback Period is 6 months, which means that the company will obtain the profit is much greater than the expected profit. So, the investment can be said that feasible. In addition, the results of the sensitivity analysis also show that the initial investment and annual costs have the same relationship with annual costs, a negative relationship. An increase of initial investment or annual fee will decrease the annual worth received and vice versa.

Keywords

Techno-economic, Enterprise Resource Planning, Income Tax, Depreciation, Sensitivity Analysis

1. Introduction

Enterprise resource planning (ERP) systems are indispensable for most larger and midsize firms and have changed how accounting information is collected, stored, processed, and disseminated (Guo et al. 2021). Altamony et al. (2016) also explained that ERP is a system of integrated applications used by organizations to manage the efficient and effective use of organization's resources such as raw materials, funds, technology tools, human resources, etc. Before

implementing the ERP system, a company must first consider the feasibility study of the investment. According to Aqidawati et al. (2021), techno-economic analysis can determine the feasibility of implementation by considering the costs and benefits of implementing standards. Besides, techno-economic analysis is needed to harmonize investment calculations for the budget estimate for installing a product (Istiqomah and Sutopo, 2021).

One example of applying an investment feasibility study has been carried out by Mairawati et al. (2018). The research conducted a feasibility study applied to a case study of the book Supply Chain Logistics Management (Fourth Edition) written by Bowersox et al. (2002). The project was to implement Enterprise Resource Planning (ERP) at Woodson Chemical Company, a chemical company in the United States. The investment feasibility study analyzes the Present Net Value (NPV) and Payback Period by considering the company's income and expenditure data provided. However, research by Mairawati et al. (2018) still has some shortcomings in conducting techno-economic studies related to the feasibility analysis of implementation investments. First, calculating the income received is uncertain. Second, the income and depreciation expenses are still unclear in the calculation. Third, it only considers the actual value of the rupiah so that it is less accurate to actual events. Fourth, there is no analysis of changes in each variable that can affect the decision.

Based on Sullivan (2015), most organizations consider the effect of income tax on the financial outcome of a proposed engineering project because income tax usually represents a significant cash outflow and cannot be ignored in decision making. In addition, this study also needs to consider depreciation because it is a non-cash expense that affects income tax, so when making a feasibility study for after-tax investments can consider it (Sullivan, 2015). Then, in this study, it is also necessary to consider the price change aspect to provide a more accurate value. Price change in the form of inflation and deflation can change the value of a currency both in cash inflows and cash outflows. In addition, according to Rezzouk and Mellit (2015), in the analysis of investment feasibility, it is also necessary to consider aspects of sensitivity analysis. The sensitivity analysis is optimal for studying the effect of several parameter variations. Many studies consider sensitivity analysis in their investment feasibility studies, such as Apriliana & Sutopo (2017) and Park & Yang (2017).

Based on the problems above, this research refines or develops Mairawati's research (2018). According to the evaluation results, the improvements complete a more comprehensive aspect of investment feasibility analysis. It starts by considering more complete data, calculating income tax and depreciation costs, and price change to sensitivity analysis. The urgency of this research is to provide a more comprehensive investment decision for companies that will implement ERP. In addition, it also provides convenience in knowing the effect of changes in something and better understanding investment projects with sensitivity analysis.

1.1 Objectives

This study aims to improve Mairawati's article (2018), which reviews the feasibility of investing in ERP implementation in companies to improve internal business processes. The research uses the NPV and PP methods, refined by considering income tax, depreciation, and sensitivity analysis.

2. Literature Review

The following explains the meaning and method of calculating depreciation expense, income tax, price changes, net present value, and payback period.

a. Depreciation Cost

According to Sullivan (2015), depreciation is a decrease in the value of the physical properties of an asset with the passage of time and use. Martani et al. (2012) said that depreciation is a method of allocating the cost of property, plant and equipment to systematically depreciate the value of the asset over the period of benefit of the asset. More specifically, depreciation is an accounting concept that assigns an annual deduction to pretax income. It can reflect time and usage on the value of assets in its financial statements. One way to calculate the depreciation value is the Straight Line method, assuming a constant depreciation value every year.

b. Income Tax

There has been no consideration of income taxes in our discussion of the engineering economy, except for the influence of depreciation and other types of deductions. We have primarily emphasized basic engineering economy

principles and methodology by not complicating our studies with income tax effects. There, however, is a wide variety of capital investment problems in which income taxes do affect the choice among alternatives, and after-tax studies are essential. How income taxes affect a project's estimated cash flows. Income taxes usually result from the profitable operation in evaluating engineering projects. The reason is quite simple: Income taxes associated with a proposed project may represent a significant cash outflow that should be considered together with other cash inflows and outflows in assessing the overall economic profitability of that project (Sullivan 2015).

c. Net Present Value (NPV)

Net Present Value (NPV) is a method that calculates the difference between benefits or revenues with costs or expenses (Adhikarisma, 2020). The NPV concept discounts all cash flows to their present value, cash inflows, and cash outflows to determine the benefit or deficit received (Sullivan 2015). If it has a positive NPV value ($NPV > 0$), the project will accept; and if it has a negative NPV value ($NPV < 0$), the project will reject. A positive NPV means that the company will benefit from the investment made. The cash flow used in the NPV analysis is already subject to tax value and actual value conversion.

d. Payback Period (PP)

Payback Period is the period required for the company to get a return on the investment made, calculated based on net cash flow during the analysis period (Sullivan 2015). The advantage of the Payback Period method is that it can be easily and simply calculated to determine the length of time for the return of investment funds, provides information about the length of the project break even, can be used as a risk consideration tool because the shorter the payback period, the shorter the risk of loss (Wijayanto, 2012). The disadvantage of this method is that it ignores investment receipts or proceeds obtained after the payback period is reached. This method also ignores the time value of money and does not provide information about additional value for the company.

e. Sensitivity Analysis

This step is sensitivity analysis to explore what happens to the project's profitability when the estimated values of several study variables are varied (Sullivan 2015). This sensitivity analysis is on 3 variables: the investment value, the annual fee, and the retribution price. The analysis in -50% -50% factor changes. This analysis will produce a spider plot graph that contains information about the range of changes in which the project is still profitable.

3. Methods

This research is an improvement from the previous research entitled "Investment Feasibility Analysis for the Implementation of Enterprise Resource Planning: A Case Study" by Mairawati et al. (2018). Improvements made in previous studies involve the value of depreciation, income tax, and price changes so that the analysis results are more accurate. The company's feasibility analysis of ERP is simple. The method used in previous research is the net present value and payback period with the assumption of a MARR of 13%. Sensitivity analysis used for comparing both alternative. In addition, the inflation rate in this study is, on average, over the last 10 years of 4.48%. The flowchart of this study shown at Figure 1.

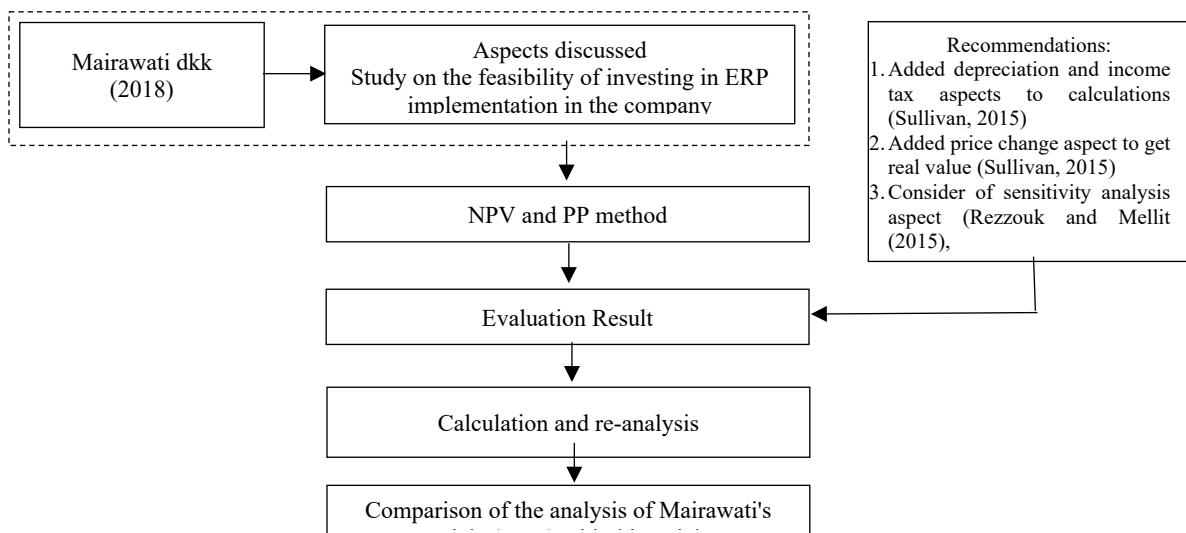


Figure 1. Research Methodology

4. Data Collection

This data collection is from a study case about the Woodson Chemical Company as North America's sixth-largest chemical company. Table 1 shows the company's income and expenditure data in 1997-2001.

Table.1 Income and Expenditure Data

Year of	Income (IDR)	Expenditure (IDR)
1	877,524,945	664,880,583
2	926,677,783	716,818,498
3	1,040,263,745	890,170,698
4	988,401,102	881,138,017
5	995,777,791	901,913,183

Source: Bowersox et al. 2002:635

The company wants to invest in financial software used to facilitate the company's performance so that company data will be easily accessed and updated. Table 2 shows the investment costs for the procurement of financial software.

Table 2. Software Procurement Investment Cost

Investment	Price (IDR)
System and Programing	40,000,000
New hardware	40,000,000
Network device	16,800,000
Training	24,100,000
Testing	8,000,000
Total	128,900,000

Source: Puspanendra 2012

In addition to investment costs, the company also has to pay maintenance costs every year. This maintenance cost has a different value every year due to differences in the frequency of maintenance and routine repairs of hardware and applications. Table 3 shows variable cost of software installation.

Table 3. Variable Cost of Software Installation

Variable Cost	Year 1	Year 2	Year 3	Year 4	Year 5
Application maintenance	5,000,000	5,000,000	5,000,000	3,000,000	3,000,000
Hardware maintenance	9,600,000	9,600,000	36,600,000	9,600,000	38,600,000
Total	14,600,000	14,600,000	41,600,000	12,600,000	41,600,000

Source: Puspanendra, 2012

5. Results and Discussion

5.1 Estimated depreciation and income tax

The calculation of depreciation expense in this study uses the straight-line method, with a useful life of 8 years according to Indonesian Constitution Number 36-year 2008 as group I. Based on existing investments, the total actual investment cost related to hardware and device needs is IDR 56,800,000.00. Salvage value based on a survey on the marketplace is assumed to be 10%. Table 4 shows the annual depreciation.

$$d_k = \frac{(B-SV_N)}{N}$$

$$d_k = \frac{(56,800,000-5,680,000)}{8}$$

$$d_k = \frac{51,120,000}{8}$$

$$d_k = \text{IDR } 6,390,000$$

Table 4. Annual Depreciation

End of Year, k	Annual Depreciation (IDR)	Accumulated Depreciation (IDR)	Book Value (IDR)
0	-	-	56,800,000
1	6,390,000	6,390,000	50,410,000
2	6,390,000	12,780,000	44,020,000
3	6,390,000	19,170,000	37,630,000
4	6,390,000	25,560,000	31,240,000
5	6,390,000	31,950,000	24,850,000
6	6,390,000	38,340,000	18,460,000
7	6,390,000	44,730,000	12,070,000
8	6,390,000	51,120,000	5,680,000

From calculating the depreciation value using the straight-line method, the annual depreciation of tangible assets is IDR 6,390,000, with a salvage value at the end of a year of IDR 5,680,000. This study also considers the calculation of income tax. The corporate income tax rate, in general, is 25% of the taxable income according to Article 17 paragraph (1) part b of Indonesian Constitution Number 36-year 2008 concerning Income Tax. Table 5 shows the calculation of the income tax.

Table 5. After-Tax Cash Flow (ATCF) Computation

End of Year, k	Before Tax Cash Flow (BTCF)	Other Expenditure	Depreciation and Maintenance	Taxable Income	Income tax at 25%	After-Tax Cash Flow (ATCF)
0	(128,900,000.00)	-	-	-	-	(128,900,000.00)
1	877,524,945.00	664,880,583.00	20,990,000.00	191,654,362.00	47,913,590.50	143,740,771.50
2	926,677,783.00	716,818,498.00	20,990,000.00	188,869,285.00	47,217,321.25	141,651,963.75
3	1,040,263,745.00	890,170,698.00	47,990,000.00	102,103,047.00	25,525,761.75	76,577,285.25
4	988,401,102.00	881,138,017.00	18,990,000.00	88,273,085.00	22,068,271.25	66,204,813.75
5	995,777,791.00	901,913,183.00	47,990,000.00	45,874,608.00	11,468,652.00	34,405,956.00

5.2 Investment Feasibility Calculation

a. Net Present Value

Net Present Value (NPV) is an investment decision rule that considers the value of cash flows at the project level compared to the initial investment. An investment is said to be feasible if the NPV is positive. On the other hand, if the NPV is negative, then the investment is not feasible. Table 6 shows calculation of NPV.

Table 6. Calculation of Net Present Value

Year	ATCF (IDR)	Real Value Adjustment (i=4.48%)	ATCF Real (IDR)	Adjusment (P/F, 13%, N)	PW (IDR)
0	(128,900,000)	1	(128,900,000.00)	1	(128,900,000.00)
1	Rp143,740,772	0.957104324	137,574,913.99	0.884955752	121,747,711.50
2	Rp141,651,964	0.916048688	129,760,095.51	0.783146683	101,621,188.43
3	Rp76,577,285	0.87675416	67,139,453.43	0.693050162	46,531,009.10
4	Rp66,204,814	0.839145198	55,555,451.56	0.613318728	34,073,198.87
5	Rp34,405,956	0.803149498	27,633,126.29	0.542759936	14,998,153.86
NPV Result					190,071,261.75

The result of subtracting income with depreciation, maintenance, and income tax in the first to fifth years produces ATCF (Cash Flow After Tax). Then, multiply the result with the amount of inflation obtained from the average of the last ten years to get the actual value. The basis for the NPV analysis by considering the MARR of 13% uses the real ATCF. From these calculations, the NPV value is IDR 190,071,261.75 or NPV > 0, which indicates that the investment is positive and can be said to be feasible.

b. Payback Period dan IRR

Payback Period (PP) method is a method for calculating the length of the period required to return the money that has been invested from the annual cash inflows (proceeds) generated by the investment project (Giatman, 2017). The eligibility criteria for accepting several investment alternatives based on the payback period is to choose the investment that has the shortest payback period. Table 7 is a recapitulation table for the calculation of Payback Period on this research investment.

Table 7. Payback Period Calculation

Year	Cashflow	Accumulated Cashflow
0	(Rp 128,900,000.00)	(Rp 128,900,000.00)
1	Rp 212,644,362.00	Rp 83,744,362.00
2	Rp 209,859,285.00	Rp 293,603,647.00
3	Rp 150,093,047.00	Rp 443,696,694.00
4	Rp 107,263,085.00	Rp 550,959,779.00
5	Rp 93,864,609.00	Rp 644,824,388.00

$$\begin{aligned}
 \text{Payback period} &= \frac{n+(a-b)}{c-b} \times 1 \text{ Year} \\
 &= \frac{5+(128,900,000 - 550,959,779)}{(644,824,388 - 550,959,779)} \times 1 \text{ Year} \\
 &= 0.5 \text{ year} \\
 &\approx 6 \text{ months}
 \end{aligned}$$

The table above results from processing and calculating the Payback Period (PP) in the ERP implementation feasibility analysis. After knowing the amount of accumulative inflow, the next step is to calculate the amount of PP using the formula. The amount of PP obtained is for 0.5 years or 6 months. The PP time is greater than the planned time horizon, which is 5 years. Therefore, the ERP investment can be feasible based on the size of the PP. The existence of depreciation and tax values causes income to decrease compared to previous studies (Mairawati, 2018). Then, the IRR calculation was also carried out using the excel formula and obtained an IRR value of 153.96%, which indicates the IRR>MARR (13%).

5.3 Proposed Improvement

The proposed improvement stages in this study are as follows:

a. Preventable Costs

By calculating investment feasibility, the company's decision to implement the software will save costs. Assuming employee reduction costs or staff payroll costs can save the cost. Before implementing this financial information system or ERP application, IDR 144,000,000.00 per year. Tangible savings analysis resulted in the following savings:

$$\begin{aligned}
 3x (\text{employee salary} \times 12 \text{ month}) &= 3 \times (\text{IDR } 2,000,000 \times 12) \\
 &= 3 \times \text{IDR } 24,000,000 \\
 &= \text{IDR } 72,000,000
 \end{aligned}$$

So, the benefit of reducing employees by implementing ERP with this type of financial software is IDR 72,000,000 from the initial employee payroll cost of IDR 144,000,000.00 per year.

b. Risk Analysis

In implementing ERP, the company must meet several conditions, such as the communication needs of using ERP by all parties who can access the ERP, such as employees, suppliers, customers, and partners. So, the ease of accessing ERP is significant to meet the effectiveness of using ERP. Several significant things are the key to the success of ERP system implementation that the company and the ERP system developer should improve, namely management commitment and training on the use of the ERP system. Management commitment is needed so that the ERP system that has been built and implemented in the company is used optimally as a whole so that the ERP system functions can run properly. Then the training factor becomes important because users get information on how to use all the

functions in the existing ERP system to the fullest. Implementing an ERP system aims to increase and strengthen the effectiveness of existing resources within the company.

c. Sensitivity Analysis

There is a sensitivity analysis to determine the effect of several variables on the annual cash flow value to be received. There are 2 variables analyzed: initial investment and annual cost. Table 8 shows spider plot for sensitivity analysis.

Table 8. Spider Plot for Sensitivity Analysis

% Change	Initial Investment	Annual Worth
-50%	Rp 71,539,080.38	Rp 11,626,188.67
-40%	Rp 52,865,498.65	Rp 4,935,185.28
-30%	Rp 34,191,916.92	(Rp 1,755,818.11)
-20%	Rp 15,518,335.19	(Rp 8,446,821.49)
-10%	(Rp 3,155,246.54)	(Rp 15,137,824.88)
0%	(Rp 21,828,828.27)	(Rp 21,828,828.27)
10%	(Rp 40,502,410.00)	(Rp 28,519,831.66)
20%	(Rp 59,175,991.73)	(Rp 35,210,835.04)
30%	(Rp 77,849,573.46)	(Rp 41,901,838.43)
40%	(Rp 96,523,155.19)	(Rp 48,592,841.82)
50%	(Rp 115,196,736.91)	(Rp 55,283,845.21)

Figure 2 shows sensitivity graphic of investment on ERP.

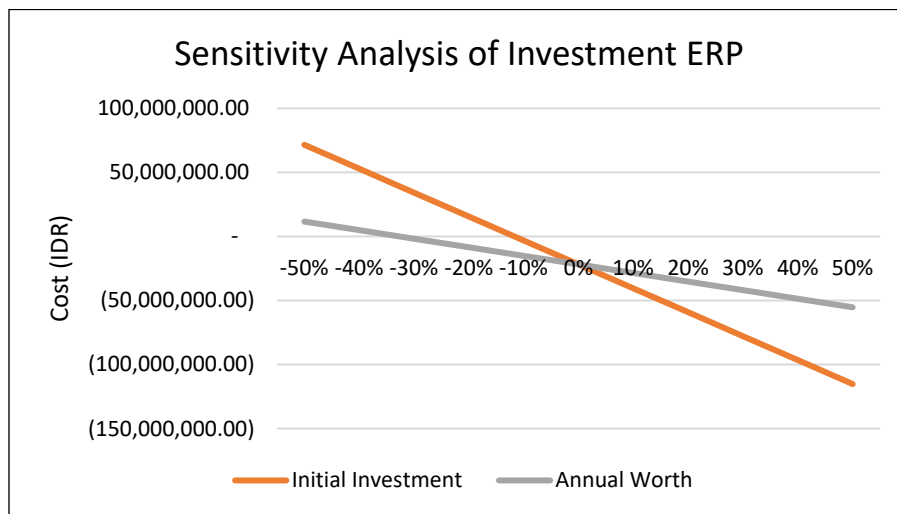


Figure 2. Sensitivity Analysis of Investment on ERP

Based on the graph, changes in the variable's value affect the value of annual worth. Initial investment and annual costs have the same relationship with AW, a negative relationship. An increase in the initial investment or annual fee will decrease the Annual Worth received and vice versa.

5.4 Validation

The stages of the proposed improvement in this study consist of a comparison table from this article with the article by Mairawati et al. (2018) regarding the feasibility study of this ERP software investment case study. After doing the calculations, the analysis results as shown in the Table 9.

Table 9. Comparison Result

Indicator	Mairawati (2018)	This Study
NPV	IDR 444,385,872.00	IDR 190,071,261.75
Payback Period (PP)	7 months	6 months
MARR	13%	13%
Real Value Conversion (i%)	-	4.48%
Income tax	-	25% * Net Income
Internal Rate of Return (IRR)	-	153.96%
Depreciation Cost	-	IDR 6,390,000
Cost Savings	IDR 72,000,000.00	IDR 72,000,000.00

6. Conclusion

Based on the analysis in this study, the conclusions obtained consist of:

- a. The applied economic efficiency shows that the investment in implementing the Enterprise Resource Planning is economically feasible. Eligibility is considered achievable based on the analysis of the NPV value of IDR 190,071,261.75 or $NPV > 0$ with PP for 6 months. In addition, the study also considers income tax, depreciation, and price changes. So the value is obtained as a basis for analysis closer to the actual value. Thus, the investment can be said to be feasible.
- b. This ERP implementation can provide IDR 72,000,000.00 or the equivalent of saving 3 employees. In addition, the success of ERP implementation will take place if it is improved by both the company and the ERP system developer, especially the commitment of top management and training in the use of the ERP system so that the purpose of implementing the ERP system is to improve and improve the efficiency of the existing ERP system.

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