

Feasibility Study on Improvement of Investment Lithium Batteries by Considering Depreciation and Income Tax

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Abstract

A lithium battery is a very lightweight battery but has better storage capacity and longer endurance than conventional batteries. Developing lithium batteries for motorcycles requires a business feasibility analysis to replace a motorcycle with lithium batteries. Lithium batteries are lightweight, environmentally friendly and safer than other types of batteries. This article is an improvement from Kurniyati et al. (2016), which discusses the feasibility of investing in the lithium battery business for motorcycles. Previous articles have not considered taxes and interest rates inflation. Therefore, improvements are needed to produce a better outcome. In this article, a feasibility analysis of investing in the lithium battery business using the NPV (Net Present Value), PP (Payback Period), IRR (Internal Rate of Return) method with a MARR value of 7.5% and a time horizon of 8 years. In addition, this article also considers the tax rate and interest rate inflation. Based on the calculations, the NPV value > 0 is IDR 198,366,208.00, the PP value is 14 years, four months longer than the eight-year time horizon, and the $IRR < MARR$ is 12%. Therefore, investment in the lithium battery business for motorcycles is not feasible and contradicts the research of Kurniyati et al. (2016), which has not considered income tax and inflation interest rates. Then, all values can meet the feasibility test aspect when the initial selling price increases by 5%.

Keywords

Feasibility analysis, Lithium battery, Income tax, Depreciation, Interest rate inflation

1. Introduction

Most of the issues have been lithium battery technology issues in recent years. Currently, lithium batteries are very close to people's lives, such as public street lighting, solar power plants, handy talkies, and accumulators for motorcycles (Wijayanti et al. 2018). Lithium Ferro Phosphate (LiFePO₄) battery is the most widespread type. The advantage of this lithium battery is that it is very light, weighing up to one-fifth of the wet batteries commonly used

in conventional motorcycles (Lowe et al. 2010). In addition, lithium batteries also do not require much maintenance and are environmentally friendly because they do not use acidic liquids. Lithium batteries have become famous for their excellent characteristics such as rechargeable battery, portable, power decreases slowly when not in use, has high power, and others. One example of development currently being carried out is the development of lithium batteries in motor vehicles, especially two-wheeled motorcycles (Astuti et al. 2014). Khofiyah (2019) also said in business, developing this lithium battery pack can increase by 20% value-added products. In implementing these innovations, companies need to know in advance whether the lithium battery idea is feasible or not, both market and financial. In this case, it is necessary to conduct an investment feasibility study.

Based on Kurniyati et al. (2016) financial analysis, namely investment in this lithium battery business. Kurniyati et al. (2016) conducted the financial analysis using several analytical methods. These methods include Net Present Value (NPV), Break-Even Point (BEP), Payback Period, and Internal Rate of Return (IRR). This research shows that the investment project for lithium battery production is feasible with an NPV value of Rp. 782,459,584, BEP value of 24,303 units, payback period of 4 years and three months, and IRR 24% of the initial investment of Rp. 1,203,000,000. However, Kurniyati et al. (2016) 's research still has several shortcomings in conducting assessments related to the analysis provided and causing the results to be less accurate. This study has not considered the variables of income tax, depreciation, and price changes. So, considering the right aspects, BEP, and less accurate analysis.

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). Meanwhile, depreciation is a non-cash to "match" the yearly fraction of value used by an asset to produce income over the asset's life. The need to consider the depreciation aspect of this asset over its useful life as an expense is to provide a more accurate feasibility study (Sullivan 2015). In addition to taxes and depreciation, price changes also affect the feasibility study. Price changes in the form of inflation and deflation can change the value of a currency both in cash inflows and cash outflows. Kaldellis (2002) explains that inflation rates (price change) are essential in conducting a feasibility analysis. Alnasser (2014) also explains that BEP calculation is essential in a feasibility study because it can provide information about the sales volume needed to cover the total cost of designing a plan to generate profits. In addition, it is necessary to carry out a sensitivity analysis for the project because it provides information on the relative importance of model input parameters and assumptions (Saltelli et al. 2019).

Based on the problems above, this study enhances or develops the research of Kurniyati et al. (2016). The improvements made are to complete a more comprehensive investment feasibility analysis, starting from considering more complete data, calculating income tax and depreciation, price changes, and recalculating feasibility aspects to BEP sensitivity analysis. The urgency of this research is to provide better investment decisions for companies that will implement lithium battery business innovations. In addition, it also provides convenience in knowing the effect of changes in something and better understanding business investment with sensitivity analysis. This study aims to improve Kurniyati's article (2016), which conducted a feasibility study of investment to find out whether this lithium battery is feasible to be marketed in Indonesia to compete.

2. Literature Review

Estimating future cash flows for feasible alternatives is critical in the analysis procedure. The most difficult, expensive, and time-consuming part of an engineering economy study is estimating to analyze costs, revenues, valuable lives, residual values, and other data about the alternatives (Sullivan 2015). So, the primary purpose of conducting a project feasibility study is to avoid losing too much capital to run an unprofitable project. This study aims to improve a calculation of feasibility study of battery business investment by considering depreciation and income tax. The following is a brief description of some of this research's improved methods.

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. 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. Break-even Analysis

Analysis of the break-even point is a point of production where the sales proceeds have the same value as the total cost required. The project implemented must produce and distribute its products greater than or equal to the number of break evens to make a profit (Sullivan 2015). The formula of the break-even point is:

$$EW_A = f_1(y)$$

Information:

EW_A = Equivalent value (PW inflow – PW outflow)

y = Factors that affect the value of EW

In addition to getting factor points, break-even can also be mapped in a graph to determine the project's characteristics. It is helpful to see the interval at which one alternative is better than the other.

d. 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. 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 “Feasibility Analysis of Lithium Battery Business for Motorcycles: Case Study” by Kurniyati et al. (2016). Improvements made in previous studies involve the value of income tax and inflation interest rates so that the analysis results are more accurate. The methods used in previous studies are NPV, BEP, PP, and IRR. In addition, the inflation rate in this study has been average for the last ten years of 4.48%. The data used in this study comes from the article of Kurniyati et al. (2016), with other supporting data. The research methodology in more detail is on the Figure 1.

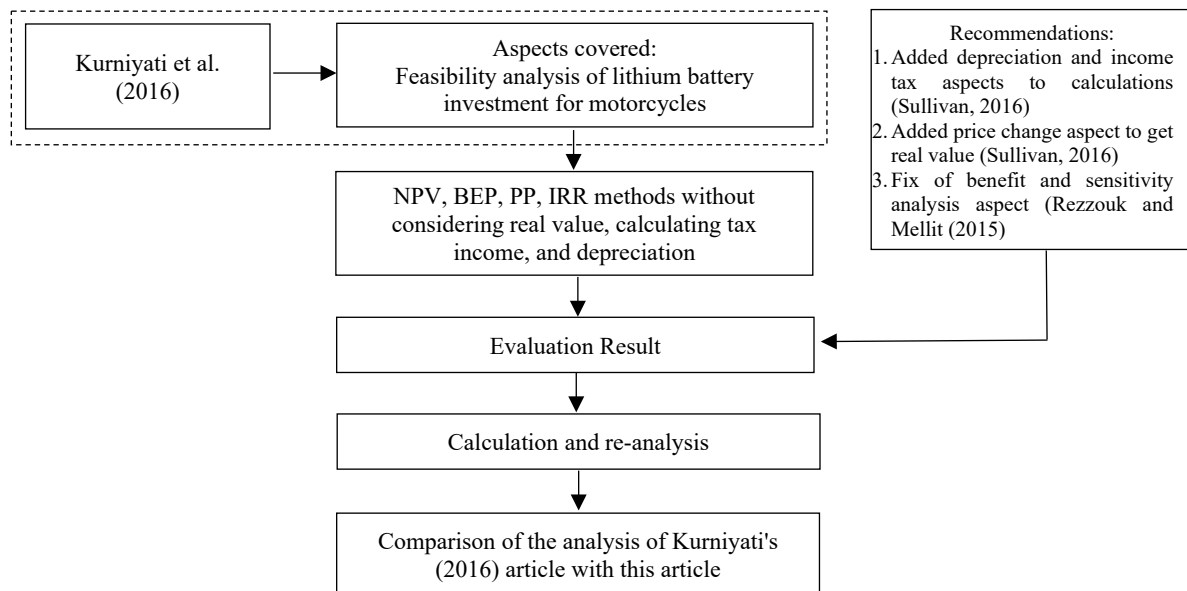


Figure 1. Research Method

Based on the research method, the evaluation results suggest improvements in this study compared to Kurniyati's (2016) article is shown in Table 1.

Table 1. Comparison of Kurniyati's Article (2016) with this study

Kurniyati (2016)	This Study
There is no income tax calculation yet	The addition of income tax on the basis, according to Sullivan (2016), to determine the feasibility of investment. The amount of income needs to be deducted by the amount of tax first to produce the ATCF (After-Tax Cash Flow) value.
No depreciation calculation yet	The addition of the amount of depreciation in the calculation. Because the need to consider the depreciation aspect of this asset over its useful life as an expense is to provide a more accurate feasibility study (Sullivan, 2016)
There has been no consideration of the price change aspect	The addition of the price change aspect, in this case, is the interest rate aspect of inflation so that the results of the analysis provide actual or real values as a basis for decision making (Sullivan, 2016)
Calculation of NPV, IRR, PP, BEP, and sensitivity analysis that is not	Improved perfect calculations by considering aspects of income tax, depreciation, price change, resulting in a perfect calculation of the feasibility aspect, BEP, and sensitivity analysis

Source: Data Processing Results

4. Data Collection

Based on the flowchart above, some data is needed to support the recalculation and analysis process from previous research and other supporting sources. The following is the data used in the study in Table 2.

Table 2. Investment Plan and Assumptions Used

Parameter	Value (IDR)
Selling price of the product from the factory	310,000
Sales Target Units per year	38,057
MARR	7.50%
Period	8 year

Source: Kurniyati, 2016

Table 3 shows data on the estimated initial investment cost consisting of the cost of procuring machines and research costs used for lithium battery needs.

Table 3. Estimated Initial Investment Cost

Total Investment Cost	Value (IDR)
Machine procurement costs	1,188,000,000
Research costs	15,000,000
Total investment	1,203,000,000

Source: Kurniyati, 2016

The table above shows that the initial investment cost for developing Lithium Batteries for motorcycles is Rp. 1,203,000,000.00. Table 4 shows data on the amount of gross income from a lithium battery factory which will be the basis of input in calculating the investment feasibility study.

Table 4. Gross Income

End of Year	Gross Income (IDR)
1	229,763,323
2	261,549,748
3	294,925,495
4	329,970,028
5	366,766,789

Source: Kurniyati, 2016

5. Results and Discussion

5.1 Estimation of Income Taxes

Based on the existing gross income data, calculate the estimated income tax of 25% according to Government Regulation no. 46 of 2013 concerning Income Tax. Table 5 shows the calculation of income taxes.

Table 5. Calculation of Income Taxes

End of Year	BTCF (IDR)	Depreciation (IDR)	Taxable Income	Income Tax (25% x PKP)	ATCF
0	-1,203,000,000.00				-1,203,000,000.00
1	229,763,323.00	148,500,000.00	81,263,323.00	-20,315,830.75	209,447,492.25
2	261,549,748.00	148,500,000.00	113,049,748.00	-28,262,437.00	233,287,311.00
3	294,925,495.00	148,500,000.00	146,425,495.00	-36,606,373.75	258,319,121.25
4	329,970,028.00	148,500,000.00	181,470,028.00	-45,367,507.00	284,602,521.00
5	366,766,789.00	148,500,000.00	218,266,789.00	-54,566,697.25	312,200,091.75
6	405,403,387.00	148,500,000.00	256,903,387.00	-64,225,846.75	341,177,540.25
7	445,971,815.00	148,500,000.00	297,471,815.00	-74,367,953.75	371,603,861.25
8	488,568,665.00	148,500,000.00	340,068,665.00	-85,017,166.25	403,551,498.75

Based on the calculation above, it is obtaining the After-Tax Cash Flow (ATCF) value at the end of the first to eighth years. The depreciation value is considered in Kurniyati's research (2016) in calculating the tax value. It also calculates the amount of depreciation using the straight-line method, drawn from the investment cost for the procurement of machinery of 1,188,000,000.00. The depreciation cost is IDR 148,500,000.00.

5.2 Investment Feasibility Analysis

a. Calculation of Net Present Value (NPV)

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 NPV

Year	ATCF (IDR)	Adjustment Real Value (i=4,48%)	ATCF Real (IDR)	Adjustment (P/F, 7.5%%, N)	PW
0	(1,203,000,000)	1	(1,203,000,000.00)	1	(1,203,000,000.00)
1	209,447,492	0.957120980	200,466,589.06	0.927815921	185,996,093.02
2	233,287,311	0.916080571	213,709,972.96	0.860842384	183,970,602.58
3	258,319,121	0.876799934	226,494,188.34	0.798703269	180,901,648.75
4	284,602,521	0.839203612	238,839,463.52	0.741049610	176,991,891.26
5	312,200,092	0.803219383	250,765,165.17	0.687557627	172,415,501.78
6	341,177,540	0.768778123	262,289,829.14	0.637926913	167,321,740.94
7	371,603,861	0.735813671	273,431,201.28	0.591878746	161,838,116.60
8	403,551,499	0.704262702	284,206,268.87	0.549154524	156,073,158.37
NPV Score					182,508,753.28

ATCF (After Tax Cash Flow) is obtained based on the amount of income that has been reduced by the value of depreciation and income tax in the first to eighth years. Then, this value is multiplied by the amount of inflation obtained from the average of the last 10 years to get the real value. The real ATCF is then used as the basis for the NPV analysis by considering the MARR 7.78% (Kurniyati, 2016). From these calculations, the NPV value is IDR 182,508,753.28 or NPV > 0, which indicates that the investment can be said to be feasible.

b. Calculation of Payback Period (PP)

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. The following is a recapitulation Table 7 for the calculation of the feasibility of this research investment.

Table 7. Calculation of PP

Year	PW	Cumulative PW
0	(1,203,000,000)	(1,203,000,000)
1	185,996,093	(1,017,003,907)
2	183,970,603	(833,033,304)
3	180,901,649	(652,131,656)
4	176,991,891	(475,139,764)
5	172,415,502	(302,724,263)
6	167,321,741	(135,402,522)
7	161,838,117	26,435,595
8	156,073,158	182,508,753

$$\begin{aligned}
 \text{Payback period} &= \frac{n+(a-b)}{c-b} \times 1 \text{ Year} \\
 &= \frac{6+(1,116,208,594)}{1,482,975,383-1,116,208,594} \times 1 \text{ Year} \\
 &= 14.48 \text{ Year} \\
 &\approx 14 \text{ Year 5 Month}
 \end{aligned}$$

The Table 7 above is the result of processing and calculating the Payback Period (PP) formula for the lithium battery business 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 14 years and five months. The PP time is greater than the planned time horizon of 8 years. Therefore, the lithium battery business investment is not feasible based on the size of the PP. This condition is caused by the relatively small income and decreases when considering depreciation and taxes.

b. Calculation of Internal Rate Return (IRR)

Internal Rate of Return (IRR) is a method for measuring the rate of return on internal (Kasmir and Jafar, 2012). The information obtained from the IRR method is related to the ability of cash flow to return investment capital in the form of % of time period and how much obligation must be fulfilled. The Minimum Attractive Rate of Return (MARR) calculation from the average investment interest rate of 7.5%, the inflation rate of 4.48%, and the risk level of 5%, so that the MARR is 12%. This year, investment interest rates and inflation rates are on Bank Indonesia (BI) interest rates. The IRR calculation in this study uses an interest rate of 8% and 15%. If the calculation of IRR > MARR, the business is feasible (Sullivan 2015). Table 8 shows calculation of IRR.

Table 8. Calculation of IRR

End of Year	8%	15%
0	(1,203,000,000)	(1,203,000,000)
1	186,480,548	174,318,773
2	184,930,209	161,595,443
3	182,318,891	148,923,605
4	178,843,117	136,557,238
5	174,672,640	124,674,606
6	169,953,716	113,395,131
7	164,811,997	102,792,916
8	159,355,090	92,907,533
TOTAL	198,366,208	(147,834,753)

The existing IRR formula is used after obtaining a comparison table of the two interest rates.

$$\begin{aligned}
 \text{IRR} &= i_1 + \frac{(i_2-i_1) \times \text{NPV}_1}{\text{NPV}_1 - \text{NPV}_2} \\
 &= 8\% + \frac{(15\% - 8\%) \times 198,366,208}{198,366,208 - (147,834,753)}
 \end{aligned}$$

= 4%

Based on the results of the IRR calculation, the IRR value is 4%. The IRR value is less than the specified MARR value, so this investment is said to be not feasible.

c. Incremental Comparison

The incremental comparison is an analysis to make a comparative decision. This study it is using three analytical indicators to determine investment feasibility. After doing the calculations, the analysis results as shown in the following Table 9.

Table 9. Incremental Comparison

Indicator Analysis	Value	Criteria	Feasible Category
NPV	IDR 198,366,208	NPV > 0	Feasible
IRR	4%	IRR > MARR	Not Feasible
Payback Period	14.4 Years	PP < n	Not Feasible

Then, comparing three indicators for analysis and the NPV value shows that the investment in lithium batteries can be feasible. In contrast, the IRR and PP values indicate a category that is not yet feasible. Based on the three analyzes, lithium battery investment is not feasible. It contradicts previous research (Kurniyati 2016), which showed that the investment was feasible. The difference between the two is that the calculation of the investment feasibility study conducted by Kurniyati (2016) has not considered income tax and real value. Thus, the analysis results are less accurate and do not to the existing natural conditions.

5.3 Proposed Improvement

This proposed improvement stage consists of a break-even and sensitivity analysis to obtain information about the potential impact on an equivalent value due to the variability in the estimates of the selected factors.

a. Break Even Analysis

The break-even point is when the sales value equals the total cost. The initial selling price of this product is IDR 310,000 per unit (Kurniyati 2016). The results of the BEP calculation show that the minimum sales volume is 34,410 units. If the lithium battery unit has reached the above sales figures, the business unit has reached the break-even point, has not suffered losses, and has made a profit. The graph of this analysis is in the Figure 2 below.

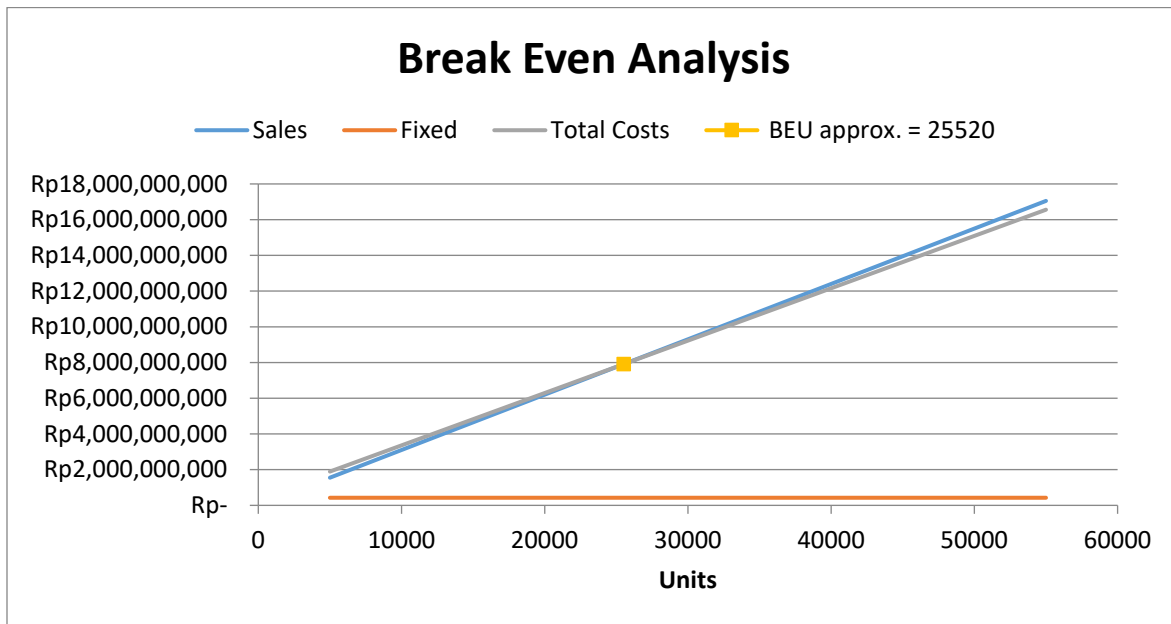


Figure 2. Break Even Analysis

b. Sensitivity Analysis

After conducting a financial feasibility analysis, a business has a high risk that may reduce the success of this project. This study conducted a sensitivity analysis to project the changes experienced on the parameters that influence it. The parameters discussed in this study are changes in product sales and changes in costs. (Table 10).

Table 10. Sensitivity Analysis Based on Changes in Product Selling Prices

Selling Price	NPV	IRR	Payback Period
IDR 310,000	IDR 198,366,208 > 0	4% < MARR	14.4 < n year
IDR 317,750	IDR 912,828,592 > 0	17% > MARR	9.1 < n year
IDR 325,500	IDR 1,999,674,925 > 0	36% > MARR	6.1 > n year

Based on this research, the eligibility requirements that are the basis for measuring an investment consist of $NPV > 0$, $IRR > MARR$ (12%), and $PP < n$ (8 years). The results of the calculation of the sensitivity analysis above show that the increase in the selling price is directly proportional to the level of feasibility of the investment. So, when the initial selling price is to be increased by 2.5%, it causes the MARR, which was initially not feasible by 4% because it is less than the MARR value, it increases to 17% and shows a number that is more than the MARR value which means it is feasible. Likewise, an increase in the initial selling price of 5% causes the value of the Payback Period to decrease, which was initially due to 14.4 years or exceeding the stipulated time limit (8 years), decreasing to 6.1 years, which is greater than that time limit. So that all values can meet the feasibility test aspect when the initial selling price is to be increased by 5%. The feasibility test results between this study and Kurniyati's (2016) research are due to the absence of consideration of income tax and depreciation at the beginning of the calculation. Thus, the feasibility test results do not provide an accurate decision.

5.3 Validation

The validation stage compares Kurniyati's article (2016) and the proposed improvement in this study shows on Table 11.

Table 11. Comparison Result

Aspect	Kurniyati (2016)	This Study
NPV	IDR 444,385,872.00	IDR 198,366,208.00
Payback Period (PP)	8 year	14.4 year
MARR	13%	12%
Real Value Conversion (i%)	-	4.48%
Income tax	-	25% * Net Income
Depreciation Cost	-	IDR 148,500,000.00
Breakeven point (unit)	24,303	25,520

Based on the Table 11, the improvement of Kurniyati et al. (2016) on this study provides several additional considerations such as income tax, depreciation cost, and actual value conversion or inflation interest rates to obtain more accurate analysis results.

6. Conclusion

Based on the analysis in this study, the conclusion obtained is that the economic efficiency applied for shows that the investment in the feasibility of the lithium battery is not economically feasible. Even though the NPV value of this investment is IDR 198,366,208.00 or $NPV > 0$, the PP value analysis is 14.4 years or $PP > n$ (8 years). In addition, the IRR value (4%) is lower than the MARR value (12%). This research contradicts previous research (Kurniyati, 2016), which indicates that this investment is feasible. The difference in research results is due to several considerations not being reviewed, such as income tax, depreciation, and price changes in previous studies. Then, all values can meet the feasibility test aspect when the initial selling price increases by 5%. The results of the sensitivity analysis show that currently investments that receive depreciation and income tax schemes are considered less feasible if the price used in the case study still refers to the research of Kurniyati et al (2016). As time goes by, every year the country will experience increasing inflation. For sure this will affect the investment value of a business. Thus, in compiling an

investment feasibility analysis, it is better to pay attention to depreciation costs, income tax, fuel costs, and the inflation rate of a country.

References

- Alnasser, N., Shaban, O. S., & Al-Zubi, Z., The effect of using break-even-point in planning, controlling, and decision making in the Jordanian industrial companies, *International Journal of Academic Research in Business and Social Sciences*, 4(5), 626, 2014.
- Astuti, R., Yunaristanto., Sutopo, W., Purwanto, A., Nizam, M., Timing Model to Launch Spin-off Company: The Case Study of Mini Manufacturing Plant 10kWH Li-Ion Batteries, *Proceedings of the International MultiConference of Engineers and Computer Scientists*, Hongkong, 2014.
- Giatman, M. *Ekonomi Teknik*. Jakarta. Rajawali Pers. 2017.
- Kaldellis, J. K., An integrated time-depending feasibility analysis model of wind energy applications in Greece, *Energy Policy*, 30(4), 267-280, 2002.
- Kasmir, Jakfar. *Studi Kelayakan Bisnis*. Edisi Revisi. Jakarta: Kencana. 2012
- Khofiyah, N. A., Sutopo, W., & Nugroho, B. D. A., Technical feasibility battery lithium to support unmanned aerial vehicle (UAV): A technical review, *Proceedings of the International Conference on Industrial Engineering and Operations Management*, Vol. 2019, pp. 3591-3601, 2019.
- Kurniyati, I., Sutopo, W., & Astuti, R. W., *Analisis Kelayakan Bisnis Baterai Lithium Untuk Sepeda Motor: Studi Kasus*, 2016.
- Lowe, M., Takuoka., Trigg., Gereffi, *Lithium-Ion Batteries for Electric Vehicles: The US Value Chain*, 2010.
- Rezzouk, H., & Mellit, A., Feasibility study and sensitivity analysis of a stand-alone photovoltaic–diesel–battery hybrid energy system in the north of Algeria. *Renewable and Sustainable Energy Reviews*, 43, 1134-1150, 2015.
- Saltelli, A., Aleksankina, K., Becker, W., Fennell, P., Ferretti, F., Holst, N., & Wu, Q., Why so many published sensitivity analyses are false: A systematic review of sensitivity analysis practices, *Environmental modeling & software*, 114, 29-39, 2019.
- Sullivan, W.G., Wicks, E.M., Koelling, C.P., *Engineering Economy 16th Edition*, New Jersey: Pearson Education, 2015.
- Wijayanti, C. I., Sutopo, W., & Zakaria, R., Goal Programming Model for Capital Budgeting Investment of Lithium Accumulator Production Unit for Motorcycle, *In 2018 5th International Conference on Electric Vehicular Technology (ICEVT)*, pp. 107-111, IEEE, 2018.

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