International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 01 January 2023
DOI: 10.47191/ijcsrr/V6-i1-29, Impact Factor: 5.995
IJCSRR @ 2023
www.ijcsrr.org

Economic Feasibility Study of a Chemical Enhanced Oil Recovery Project in Indonesia Based on Conventional Discounted Cash Flow (DCF) And Real Option Valuation Model: Case Study at PT ABC

Junita Taskia Amin[1], Oktofa Yudha Sudrajad[2]
[1,2] School of Business and Management, Institut Teknologi Bandung, Indonesia

ABSTRACT: Indonesia had become an oil exporter that is recognized by the world for many years and joined The Organization of Petroleum Export Community (OPEC) – an organization that controls petroleum production, supplies, and prices in the global market – in 1962. However, oil production in Indonesia has been decreasing from year to year, one of which is due to the lack of investment in the exploration of new oil wells in Indonesia so the majority of upstream oil and gas work in Indonesia is exploiting old wells which will naturally decline steadily. This resulted in Indonesia becoming a net import oil country in 2003. Therefore, additional operations are needed to maximize oil production from these existing wells, one of which is by conducting Chemical Enhanced Oil Recovery (CEOR). The main objective of EOR itself is to mobilize the remaining oil by enhancing the oil displacement and volumetric sweep efficiency. PT. ABC, a subsidiary of PT. XYZ (a state-owned company under SKK Migas and PT Pertamina supervision) which is engaged in the upstream sector in Indonesia, is assigned by the government to carry out one of the CEOR projects that have been determined by the Government. This research covers the economic feasibility of the CEOR Project based on the conventional Discounted Cash Flow (DCF) and Real Option Valuation (ROV) Model. The revenue-sharing policy used for the project economic calculation is the gross split method. The result of the economic analysis using the DCF method is the project is not economically feasible to run as the net present value (NPV) shows negative which is -2,911 MUSD. However, the real option valuation model helped increase the value to 11,416 MUSD by adopting a strategic option which is an option to delay and time flexibility into the project. As a result, the project could be economically feasible if the operation is deferred to the following year and the oil price is over 85.2 USD/BBL.

KEYWORDS: Chemical Oil Enhanced Recovery, Discounted Cash Flow, Net Present Value, Oil and Gas, Real Option.

1. INTRODUCTION

Indonesia is well-known of being a rich country in natural resources and cultural diversity according to world bank (2022). Besides that, Indonesia has become the world's fourth most populous nation that has around 270 million populations today. The population keeps increasing with growth is in the range 1,1% each year and it is predicted that the population would reach about 280 million in 2025. The continuous increase in population results in a continuous increase in energy needs which is believed to have an impact on Indonesia's economic growth (Herdyanti, 2021).

As most of the energy consumed in Indonesia tastes from fossil energy (Herdyanti, 2021). Indonesia's oil consumption would keep increasing. İn the other hand, Indonesia's crude oil production has been steadily declining since the 1990s, owing to a lack of exploration and investment in this upstream industry. A very significant change occurred in Indonesia because domestic production cannot meet domestic demand. As a result, in 2004, Indonesia has become a net-oil importer (Hasan & Lasabuda, 2021).

The increasing amount of petroleum that must be imported to meet domestic needs has caused some adverse impacts. The main one is the weakening of the rupiah exchange rate against the dollar. Therefore, the Government is trying to suppress the increase in imports to develop the Indonesian economy. The government has set a large target of oil and gas production of 1 million barrels per day of oil and 12 thousand million cubic feet per day (MMSCFD) of gas production.

To realize the target in 2030, several EOR (Enhanced Oil Recovery) projects must be immediately planned and executed (Hasan & Lasabuda, 2021). Pertamina is assigned by the government to carry out the project as soon as possible. The project is located in PT. ABC's field so that PT. ABC who will be the operator of the project. However, there are obstacles that make the Company hesitate

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 01 January 2023
DOI: 10.47191/ijcsrr/V6-i1-29, Impact Factor: 5.995
IJCSRR @ 2023
www.ijcsrr.org

to carry out the project. This obstacle is due to the investment cost that is too high. So that proper economy feasibility study need to be conducted to ensure that the project is economically feasible to run.

Since oil and gas project involves high uncertaintes, the conventional Discounted Cash flow is not enough to measure whether this project could bring economic advantage or not. DCF does not consider uncertaintes that might occur in the future. In other words, this economic feasibility study requires complement model that could maximize the project's valuation so that decision would be more accurate and could give optimal valuation to the company.

According to Gennady (2008), there is developing theoretical suggestion that company valuations surpass that of conventional valuation methods (Discounted Cash Flow) and this variance can be recognized to option premiums. Every oil and gas project which is going to be explored in Indonesia must have a well-planned for its development this kind plan is commonly known as Plan of Development. It is a common knowledge that oil and gas field developments are the projects with both high risks and costs, and not to mention they are also influenced by high uncertainties. The alternatives could be the options to invest certain amount of money in the projects like work over job, infill drilling, adding some compressors in gas field particularly, delaying the investment or abandoning at any particular time during the project's contract. These kinds of flexibilities are called Real Options. Unlike the common traditional Net Present Value method, Real Options theory can take the risks which caused by the uncertainties and the flexibilities themselves taken into account for the decision making in the development of the field. Therefore, the study focuses on understanding the project's valuation based on the two models and prove strategic plan to the company.

2. LITERATURE REVIEW

2.1 Chemical Enhanced Oil Recovery Project

According to Ragab and Mansour (2020), one of the key EOR strategies is chemical enhanced oil recovery, which reduces residual oil saturation and boosts volumetric sweep efficiency by lowering water-oil mobility (polymer). Based on laboratory and real-world application data, Table 1 summarizes the screening requirements for chemical EOR methods. Chemical flooding EOR falls into the following categories:

- Polymer flooding.

In principle, a water-soluble polymer is used to raise the viscosity of the water, lowering the water-to-oil mobility ratio and increasing volumetric sweep efficiency. Polymer flooding works by decreasing the permeability of the rock to water while also increasing the viscosity of the water, or by bringing the water-oil mobility ratio closer to or below unity.

- Surfactant flooding.

Surfactants that are appropriately formulated can form microemulsions at the interface of the water and oil phases, resulting in a decrease in interfacial tension (IFT), which will mobilize residual oil and increase oil recovery. This EOR technique is challenging due to surfactant and co-surfactant adsorption on rocks, as well as surfactant Chromatographic separation during reservoir injection.

- Surfactant-polymer flooding.

Surfactant-polymer flooding entails sending a chemical slug composed of water, a co-surfactant (usually alcohol), an electrolyte (salt), and thicker, polymerized water. In this process, a surfactant with water and oil affinity is added to the polymer solution. The micellar solution is used to reduce the interfacial tension of the water-oil system in order to remove the leftover oil from the reservoir. Gogarty and Tosch patented the Mara-flood technique of SP flooding for Marathon Oil Company. In the injection profile of the process, a pre-flush (to generate the appropriate salinity environment), a micellar slug (surfactant, co-surfactant, and electrolyte), a polymer solution, and driving water are all injected.

- Alkaline-surfactant-polymer flooding.

One of the EOR procedures is alkaline flooding, which includes introducing alkaline substances into the reservoir to form in-situ surfactants. As a result, it will eventually provide the same results as surfactant flooding.

2.1 Conventional Discounted Cash Flow

In practice, we can readily find numerous discounted cash flow (DCF) models in a variety of publications. However, each piece of literature was basically predicated on the same concept, which was confined to calculating the project's net present value (NPV) throughout the duration of its whole life cycle, accounting for investment expenses, and the free cash flow phase of the producing phase (Kodukula & Papudesu, 2006). The NPV model is used to calculate the PV of a cash flow stream. To account for risk, this cash flow was discounted at an appropriate rate.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 01 January 2023
DOI: 10.47191/ijcsrr/V6-i1-29, Impact Factor: 5.995
IJCSRR @ 2023
www.ijcsrr.org

When determining a suitable discount rate, the weighted average cost of capital was considered (WACC). The WACC is calculated by adding the proportionate cost of equity and the after-tax cost of debt. Although there are other models, such as Arbitrage Pricing Theory, which is largely a multi-index model, the Capital Asset Pricing Model (CAPM) is used to assess the cost of equity, according to Elton et al (Elton, Gruber, Brown, & Goetzmann, 2003).

Kodukula and Papudesu stated asserted "In the DCF model, uncertainty is handled as a risk factor. There is no potential for profit. When assessing uncertainty with the WACC formula, only downside risk is taken into account. The value may be persistently underestimated due to the bias and high level of uncertainty" (Kodukula & Papudesu, 2006).

The NPV approach's deterministic viewpoint, which builds the base value on a certain set of cash flows, As a result, the NPV model does not account for flexibility. Because it assumes a fixed or planned trajectory, the NPV model cannot account for particular decisions. Munn refers to it as "an all or nothing approach, where management cannot change the investment direction" (Munn, 2006).

2.2 Real Option Valuation Model

The RO Valuation employs a variety of approaches. This approach computes the risk-adjusted net cash flow after adjusting for each source of uncertainty. After that, the cash flow PV of Real Options was estimated using a temporal adjustment. Based on the many approaches discussed above, the RO method is the most straightforward to employ for assessing project risk characteristics.

It is critical to understand that a Real Options valuation is based on the traditional Discounted Cash Flow model and that it supplements, rather than replaces, the DCF technique for generating the DCF that underpins an asset's value. Furthermore, if management has few options for flexibility or if the investment outcome cannot be avoided, ROV will be equalized using DCF valuation as a base case. Real option valuation should thus be viewed as an extension of classical DCF valuation (Trigeorgis, 1996; Mun, 2006; Kodukula & Papudesu, 2006).

The Monte Carlo Simulation may incorporate the several volatility origins into a single figure. The potential is estimated using DCF input values and the volatility of critical variables generated by Monte Carlo simulation. Initially, discounted cash flow sensitivity analysis was used to identify the variables that had a large impact on value (Kodukula & Papudesu, 2006).

Management flexibility may be completely included into the Real Options Value. The increased flexibility will result in a greater option premium in static NPV. The real options technique differs from the DCF method in that it allows for risk adjustment during the cash flow component, whereas the DCF method discounts for risk at the cumulative net cash flow (Samis et al. 2005; Blais et al. 2007; Schwartz and Cortazar 1998).

3. RESEARCH METHODOLOGY

In this research, the author utilized quantitative data. Quantitative data are measures of values or counts and are expressed as numbers. Quantitative data are data about numeric variables. Furthermore, the research method to collect the quantitative data required is primarily secondary research from both internal and external sources.

- Internal sources: Company's financial statement, projected financial plan of CEOR Minas Rokan Project,
- External sources: Public computer databases.

In terms of primary research, the author gathered data by conducting an interview to several experts that are working at the company. Below (Diagram 1) illustrates the stages that author take to do the study.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 01 January 2023
DOI: 10.47191/ijcsrr/V6-i1-29, Impact Factor: 5.995
IJCSRR @ 2023
www.ijcsrr.org

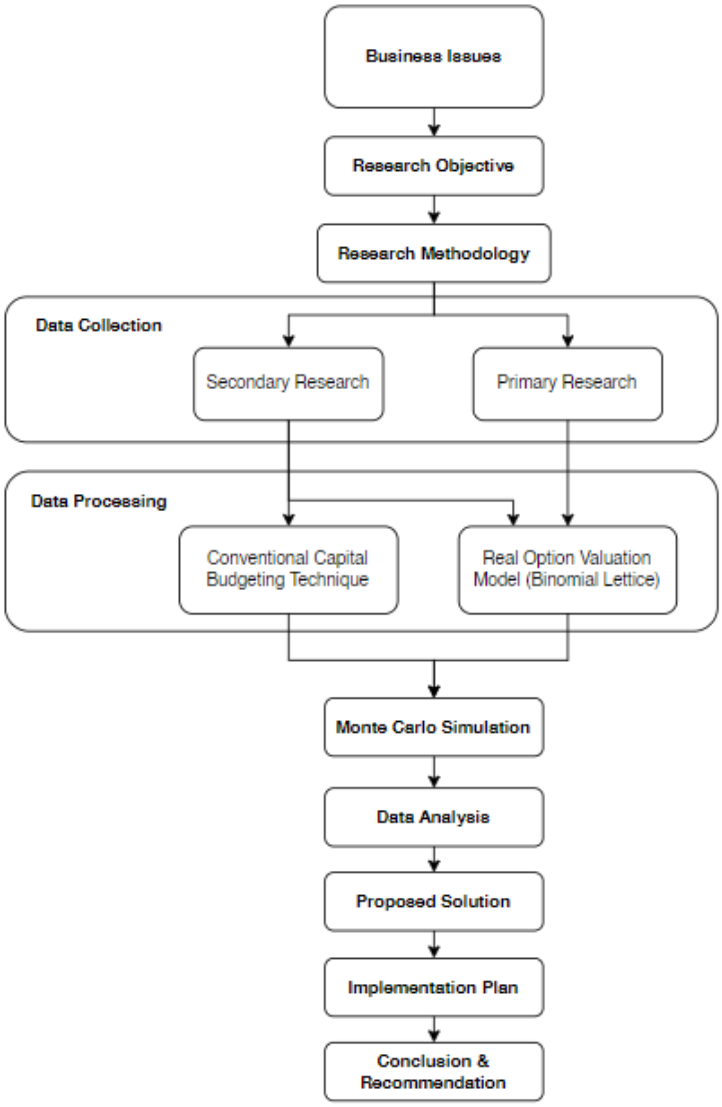

Diagram-1: The Research Stages

The initial step in the research process is the identification of the problem or issue. The next step is research objective that describes what the research is trying to achieve and explain why the author is pursing it. After that, the author identify the research methodology used. Research methodology is the specific procedures or techniques used to identify, select, process, and analyze information about a topic. Next, Data collection is conducted to gather information about a specific subject. In this final project, the author used quantitative data in this research. After collected the data, the author do the data processing whic is the process in translating the collected data set into valuable and usable information. The interpretation of the data that have been collected by using different analytical techniques according to the requirements of the management is called analysis. After that, the author proposed solution based on the analysis. Followed by the implementation plan which describes the tasks or actions required to implement the proposed solution in this project. Besides that, the author also set a timeframe and target dates for the completion of tasks or actions. Finally, the author would provide solutions along with the recommendation for next relevant research.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 01 January 2023
DOI: 10.47191/ijcsrr/V6-i1-29, Impact Factor: 5.995
IJCSRR @ 2023
www.ijcsrr.org

3.1 Conventional Capital Budgeting Technique

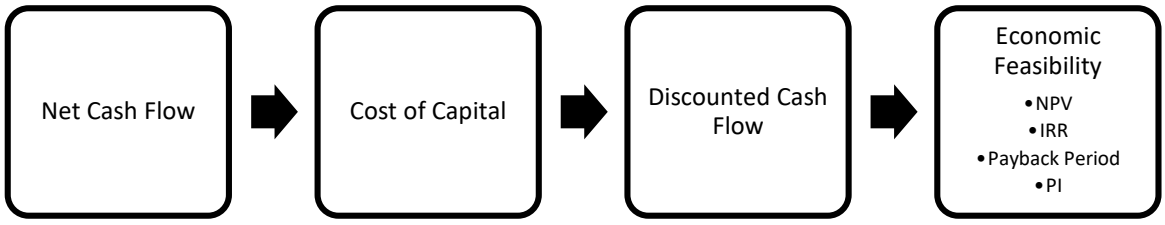

Diagram-2: Data Processing Flow

Capital Budgeting Technique starts with determine the net cash flow projection every year. The net cash flow is obtained by subtracting revenue from operating expenditure dan depreciation expense, then the value is deducted by tax expense and added by depreciation expense.

After obtaining the net cash flow of the project. The cost of capital is required to determine. To know the cost of capital the project. The author should find out the portion between equity and long-term debt obtained from the company's balance sheet. After that, the cost of equity and cost of debt must be determined. Finally, the cost of capital can be obtained by this formula ($w_i = Debt\ Portion, r_i = Cost\ of\ Debt, w_p = Equity\ Portion, r_p = Cost\ of\ Equity$):

$$r_a = (w_i \times r_i) + (w_p \times r_p)$$

After the cost of capital value is obtained, the author could calculate the discounted cash flow. Finally, the economic feasibility of the project based on the conventional capital budgeting technique can be conducted. The feasibility study is based on the Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period, and Profitability Index (PI). The basis of management considerations in deciding an investment project from the results of this NPV calculation is

1. Accept the project if NPV > 0, IRR > WACC, PI > 1
2. Reject the project if NPV < 0, IRR < WACC, PI < 1

3.2 Real Option Valuation Model

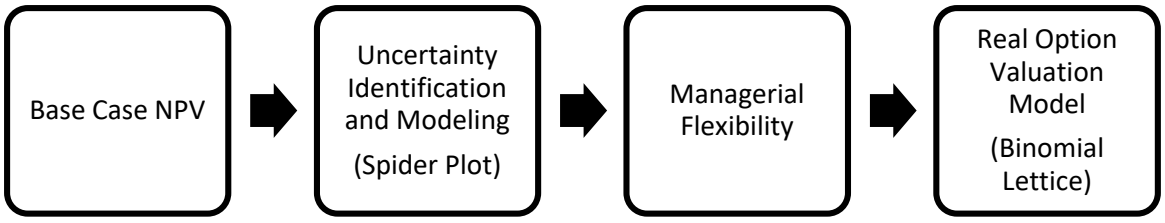

Diagram-3: Data Processing Flow

Finding out the base case NPV is the first step of using the real option valuation model. This base case NPV refers to the NPV obtained using the conventional capital budgeting technique. After that, the uncertainties require to be identified and determine the most uncertain variable using the sensitivity analysis. In this study, the author uses spider plot to analyse the variables' sensitivity. After obtaining the most uncertain variable, the next stage is determining the managerial flexibilities or options such as option to delay, option to invest, and option to abandon with the detailed parameters. Last, the real option valuation model can be conducted and analysed. In this study, the author uses binomial lettice to calculate the real option valuation.

3.3 Monte Carlo Simulation

A monte carlo simulation is a model used to predict the probability of a variety of outcomes when the potential for random variables is present. In this study, this simulation would be adopted for understanding the probability of NPV of the project based on

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 01 January 2023
DOI: 10.47191/ijcsrr/V6-i1-29, Impact Factor: 5.995
IJCSRR @ 2023
www.ijcsrr.org

Conventional Capital Budgeting Technique and Real Option Valuation Model. To run the simulation, software called ModelRisk is used in this study.

4. RESULT AND DISCUSSION

4.1 Conventional Discounted Cash Flow

To build the cash flow projection of the project, there will be several assumptions to be used such as: PSC policy will adopt the gross split, quantity sold is 100%, production life of 13 years with drilling activities occured for 2 years, followed by the first chemical injection for 1 year. Other assumptions and the details are explained below.

a. Revenue

Revenue is the result of the main operational activities of this project. Revenue before split / Gross Revenue from the CEOR project itself is generated by multiplying oil production with oil prices. Oil production in this project is projected to be produced in 2026 with a production period of 13 years which is until 2038. The production projection is based on field data carried out by the field team of the project in accordance with existing historical data. Revenue after split is the final revenue for the contractor which is used subsequently to calculate cash flow. For the calculation of Revenue After Split, it is necessary to calculate the split first which is used as a multiplier to get Revenue After Split. The split is based on calculations from PERMEN ESDM No. 8/2017 and PERMEN ESDM No. 52/2017 which consists of three compositions such as base split, variable split, and progressive split. Base split of oil used is 43%, variable split would be 46%, while progressive split will have slight change every year due to the cumulative production level.

Table-1: The Revenue Projection of The CEOR Project

Year	Oil Production (MMBO)	Oil Price (USD/BBL)	Revenue before split (MUSD)	Gross Split	Revenue after split (MUSD)
2023	0	74.65	0	92.26%	0
2024	0	71.45	0	91.59%	0
2025	0	70.56	0	92.39%	0
2026	812.25	70.58	57328.79	92.61%	53092.19
2027	679.20	72.58	49296.18	92.61%	45650.73
2028	191.57	74.67	14304.86	92.11%	13175.49
2029	1147.99	77.26	88693.89	91.58%	81228.08
2030	936.02	79.57	74479.39	90.94%	67727.83
2031	202.12	81.84	16541.83	90.36%	14946.78
2032	850.82	83.72	71230.78	89.79%	63958.12
2033	1253.79	85.87	107663.27	89.32%	96164.83
2034	211.16	87.68	18514.16	88.78%	16437.34
2035	46.66	89.04	4154.86	88.33%	3669.99
2036	441.91	90.82	40133.88	87.99%	35313.80
2037	210.82	92.55	19511.02	87.55%	17080.92
2038	37.45	93.76	3511.13	87.11%	3058.63
2039	0	94.89	0	86.81%	0
2040	0	94.89	0	86.53%	0
2041	0	94.89	0	86.53%	0

b. Capital Expenditure

Capital expenditure or capex is a large initial cost for a long-term project. In this project, the capex is divided into tangible and intangible capex.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 01 January 2023
DOI: 10.47191/ijcsrr/V6-i1-29, Impact Factor: 5.995
IJCSRR @ 2023
www.ijcsrr.org

Table-2: The Capital Expenditure Projection of The CEOR Proeject

Item	Unit	Total	2023	2024	2025	2026
Capital Expenditure	**MUSD**	**90457.83**	**22730.97**	**59700.34**	**7762.75**	**263.76**
Depreciable Capital Expenditure		71462.98	21957.86	41478.61	7762.75	263.76
Tangible Drilling	MUSD	2694.67	0.00	2694.67	0.00	0
Offplot Production Facility	MUSD	22147.14	8067.55	12516.31	1563.28	0
Onplot Facility	MUSD	46621.17	13890.31	26267.63	6199.47	263.76
Pre FEED	MUSD	2301.23	2301.23	0.00	0.00	0
Production Facility Upgrade	MUSD	6626.95	1651.46	4030.53	944.96	0
Water Treatment Facility Upgrade	MUSD	21876.38	5451.68	13305.28	3119.43	0
Polymer/Soda Ash/Brine Facility Upgrade	MUSD	11636.36	2899.82	7077.27	1659.27	0
Surfactant/ EGBE Facility Upgrade	MUSD	2531.83	630.94	1539.87	361.02	0
Lab Upgrade	MUSD	1648.42	955.17	314.69	114.80	263.76
Non-depreciable Capital Expenditure		18994.85	773.11	18221.73	0	0
Intangible Capex	MUSD	18994.85	773.11	18221.73	0	0
Intangible Drilling	MUSD	12120.66	773.11	11347.54	0	0
Road & Location	MUSD	3559.24	0	3559.24	0	0
Recompletion Old Wells	MUSD	3314.95	0	3314.95	0	0

c. Operating Expenditure

Operating expenditure or opex in this project is divided into 3 things, namely operation and maintenance which has the largest composition, property tax, and Abandonment and Site Restoration (ASR).

Table-3: The Operating Expenditure Projection of The CEOR Proeject

Year	Operating Expenditure (MUSD)	Operation and Maintenance (MUSD)	Property Tax (MUSD)	ASR (MUSD)
2023	0	0	0	0
2024	0	0	0	0
2025	42171.41	42171.41	0	0
2026	8273.57	8049.30	28.27	196.00
2027	8183.61	6808.17	1179.44	196.00
2028	60549.98	59335.03	1018.95	196.00
2029	9257.48	8894.26	167.22	196.00
2030	10238.96	8075.90	1967.06	196.00
2031	63055.66	61332.24	1527.42	196.00
2032	7632.04	7071.09	364.95	196.00
2033	10447.05	9123.42	1127.64	196.00
2034	8318.08	5925.79	2196.28	196.00
2035	35954.02	35351.13	406.89	196.00
2036	3810.47	3495.36	119.10	196.00
2037	3786.35	2748.07	842.27	196.00

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 01 January 2023
DOI: 10.47191/ijcsrr/V6-i1-29, Impact Factor: 5.995
IJCSRR @ 2023
www.ijcsrr.org

Year	Operating Expenditure (MUSD)	Operation and Maintenance (MUSD)	Property Tax (MUSD)	ASR (MUSD)
2038	1769.14	1175.88	397.27	196.00
2039	37.56	0	37.56	0
2040	38.02	0	38.02	0
2041	38.02	0	38.02	0

d. Depreciation

Depreciation in upstream oil and gas projects occurs from the time of production which is in 2026. Depreciation occurs in tangible capital which is tangible. The depreciation rates used annually are 25%, 19%, 14%, 11%, and 32%.

e. Domestic Market Obligation (DMO) Fee.

Domestic Market Obligation or DMO is the obligation of producers to sell part of their oil production to meet domestic needs. DMO on oil and gas projects is set at 25%. For this project, the production is purchased at the normal price so that the DMO Fee becomes 0.

f. Income Tax

The income tax used is the income tax that follows the provisions of Law Number 7 of 2021 concerning the Harmonization of Tax Regulations (UU HPP). Through this HPP Law, the income tax has changed to 22% starting in the 2022 tax year.

g. Net Cash Flow Projection

After doing the calculation of revenue (after gross split), operating expenditure, depreciation, tax, and interest expense then the net profit for contractor will be obtained. Depreciation will be used declining balance method based on Government Regulation no 27 year 2017. Below is the projection of the net cash flow of the project.

Table-4: The Cash Flow Projection of The CEOR Proeject

Item	EBTDA (MUSD)	Depreciation (MUSD)	EBT (MUSD)	Cum. EBT (MUSD)	Income Tax (MUSD)	Contractor Cash Flow (MUSD)	Cum. Cash Flow (MUSD)
Total	218986.49	71462.98	147523.51	0	43745.68	96675.33	0
2023	-773.11	0	-773.11	-773.11	0	-22730.97	-22730.97
2024	-18221.73	0	-18221.73	-18994.85	0	-59700.34	-82431.32
2025	-42171.41	0	-42171.41	-61166.26	0	-49934.16	-132365.48
2026	44818.62	17865.75	26952.87	-34213.39	0	44554.86	-87810.62
2027	37467.12	13399.31	24067.81	-10145.58	0	37467.12	-50343.50
2028	-47374.49	10049.48	-57423.97	-67569.55	0	-47374.49	-97717.99
2029	71970.60	7537.11	64433.49	-3136.05	0	71970.60	-25747.39
2030	57488.87	22611.33	34877.54	31741.48	7673.06	49815.81	24068.42
2031	-48108.88	0	-48108.88	-16367.40	0.00	-48108.88	-24040.46
2032	56326.08	0	56326.08	39958.68	12391.74	43934.34	19893.88
2033	85717.78	0	85717.78	125676.46	18857.91	66859.87	86753.75
2034	8119.26	0	8119.26	133795.72	1786.24	6333.02	93086.78
2035	-32284.04	0	-32284.04	101511.69	-7102.49	-32284.04	60802.74
2036	31503.34	0	31503.34	133015.03	6930.73	24572.60	85375.35
2037	13294.57	0	13294.57	146309.60	2924.81	10369.77	95745.11
2038	1289.49	0	1289.49	147599.09	283.69	1005.80	96750.91

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 01 January 2023
DOI: 10.47191/ijcsrr/V6-i1-29, Impact Factor: 5.995
IJCSRR @ 2023
www.ijcsrr.org

Item	EBTDA (MUSD)	Depreciation (MUSD)	EBT (MUSD)	Cum. EBT (MUSD)	Income Tax (MUSD)	Contractor Cash Flow (MUSD)	Cum. Cash Flow (MUSD)
2039	-37.56	0	-37.56	147561.52	0	-37.56	96713.35
2040	-38.02	0	-38.02	147523.51	0	-38.02	96675.33
2041	-38.02	0	-38.02	147485.49	0	-38.02	96637.32

h. Weighted Average Cost of Capital

Cost of Debt

Cost of Debt is a funding activity obtained from long-term loans. These long-term loans can be in the form of loans through banks, shares, crowdfunding, donations, and government grants. To calculate cost of debt, the author uses syntetic rating model. The rating for a firm can be estimated using the financial characteristics of the firm. Below are the steps how to calculate the cost of debt:

- Identify the interest coverage ratio by dividing EBIT by the company's interest expense.

$$Interest\ Coverage\ Ratio = \frac{EBIT}{Interest\ Expense} = \frac{4{,}581{,}003}{153{,}978} = 29.75$$

  This Interest coverage ratio shows that the estimated bond rating of the company is AAA based on Damodaran
- Identify the company default spread
  With the bond rating found and the 15-year maturity of the project, the company default spread would be 1.01% based on PHEI.
- Risk Free Rate
  For the risk free rate for this case, the author would use BI 7 days repo rate which is 7.3%
- Indonesia's default spread
  Since, according to Damodaran, Indonesia's estimated Moody's rating Baa2, the company has a default spread of 1.62%.
- Cost of Debt
  After determining the company default spread, risk-free rate, and country's default spread, the author would be able to calculate the cost of debt. Below is the calculation.

$$r_i = Company\ default\ spread + Rf + Indonesia's\ default\ spread$$

$$r_i = 1.01\% + 7.3\% + \frac{2}{3} \times 1.62\% = 9.39\%$$

- After-tax Cost of Debt
  To get the after-tax cost of debt, the cost of debt need to be multiplied by the tax rate which is 22%.

$$r_i = 9.39\% \times 22\% = 7.33\%$$

Cost of Equity

Cost of Equity is the minimum rate of return that the company can theoretically provide to shareholders. The cost of equity is given as compensation for the risk that investors are willing to take to invest in the company (Gitman & Zutter, 2015).

Based on the perspective of investors, there is a return that is expected to be obtained through dividends, or an increase in the value of a given investment. The expected return, or cost of equity, is related to the financial risk inherent in the funds they invest in the company's business activities.

The CAPM method will be adobted to calculate the cost of equity. The reason for using this method is that this company as well as parent company have not gone public so the dividend discount model method cannot be applied to determine the value of its cost equity. CAPM method is also useful for helping investors see the level of risk in the project, whether or not it is following their expectations. This risk is represented by symbol β. The value of β varies, if β > 1, then the company is very volatile (risk is quite large) whereas if β > 1 then the risk is not too big and the company is less volatile than market movement. The following shows a description of the assumptions used in calculating the cost of equity using CAPM.

- Risk-free rate of return will be used the historical data from IBPA 15 years government bond which is 73%

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 01 January 2023
DOI: 10.47191/ijcsrr/V6-i1-29, Impact Factor: 5.995
IJCSRR @ 2023
www.ijcsrr.org

- Beta number will be used the average historical 5-year data of PT. Elnusa and Medco (same business line) which is 1,67.
- Data on market return will be based on historical data JKSE in 15 years (2007-2022) as the average of market movement.
- Risk premium is obtained by deducting the market return with the risk-free rate.

$$R_s = R_f + [\beta \times (r_m - R_f)$$
$$R_s = 7{,}3\% + [1{,}67 \times (9\% - 7{,}3\%] = 12{,}75\%$$

Since R2 shows the highest cost of equity, this number would be used to calculate the WACC. The reason of using the highest cost of equity, to produce more accurate, reliable, yet secured output.

Weighted Average Cost of Capital

WACC is the weighted average of the firm's capital structure such as cost of equity and cost of debt. Cost of equity and cost of debt has been calculated by using CAPM method as mentiond above. WACC will represents the expected return on portfolio from all the firm's debt and equity. The calculation of WACC is described as below.

$$r_a = (w_i \times r_i) + (w_p \times r_p) + (w_s \times r_{r\ or\ n})$$
$$r_a = (39\% \times 7{,}33\%) + (61\% \times 12{,}75\%) = 10{,}64\%$$

After do the calculation, the author obtained that the WACC is 10,88%. This amount is considered moderate which indicates the risk that the company would bear toward this project is moderate too.

i. Feasibility Analysis Based on Conventional DCF

After obtaining the net cash flow of each year throughout the period from 2023 to 2041 and the weighted average cost of capital as a discount rate, the author would be able to calculate the valuation using discounted cash flow or also known as Net Present Value (NPV). The first step in the economic analysis is by determining a Discounted Cash Flow (DCF) model that will apply to the base case of the company's project development to obtain NPV, IRR, Payback Period, and Profitability Index. The summary of economic parameters of the CEOR Project for the cash flow model are shown in the table below.

Table-5: The Economic Values of The CEOR Project

Economic Parameters	Value
NPV (MUSD)	-1,806.44
MIRR	8.88%
Payback Period (Year)	10
PI (MUSD)	0.02

From table 5, it shows that the discounted cash flow resulted in a negative NPV of -1,806 MUSD which means that the project is not feasible economically as the value is below zero. Besides that, the IRR of the project is below the WACC as the standard minimum of return rate of the project. As the NPV is negative, this causes the PI doesn't meet the requirement as well. Last, the project's payback period is considered moderate which is 10 years.

4.2. Real Option Valuation Model

a. Base Case NPV

Base Case NPV that is used in the real option valuation calculation is the NPV that is obtained from the DCF calculation which is -1,806 MUSD. There would be strategic options would be adopted along with the uncertainties determined in the next stage. After that, modified NPV would be shown in the ROV modelling basen on the time flexibilities and probabilities.

b. Uncertainty Identification and Modeling

To determine the uncertainty need to be involved in the real option calculation, sensitivity analysis should be conducted. Sensitivity analysis performed to show the impact of changes in uncertainty parameters assumption to overall project NPV. From the analysis result, parameter that most affects the NPV of the project could be identified.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 01 January 2023
DOI: 10.47191/ijcsrr/V6-i1-29, Impact Factor: 5.995
IJCSRR @ 2023
www.ijcsrr.org

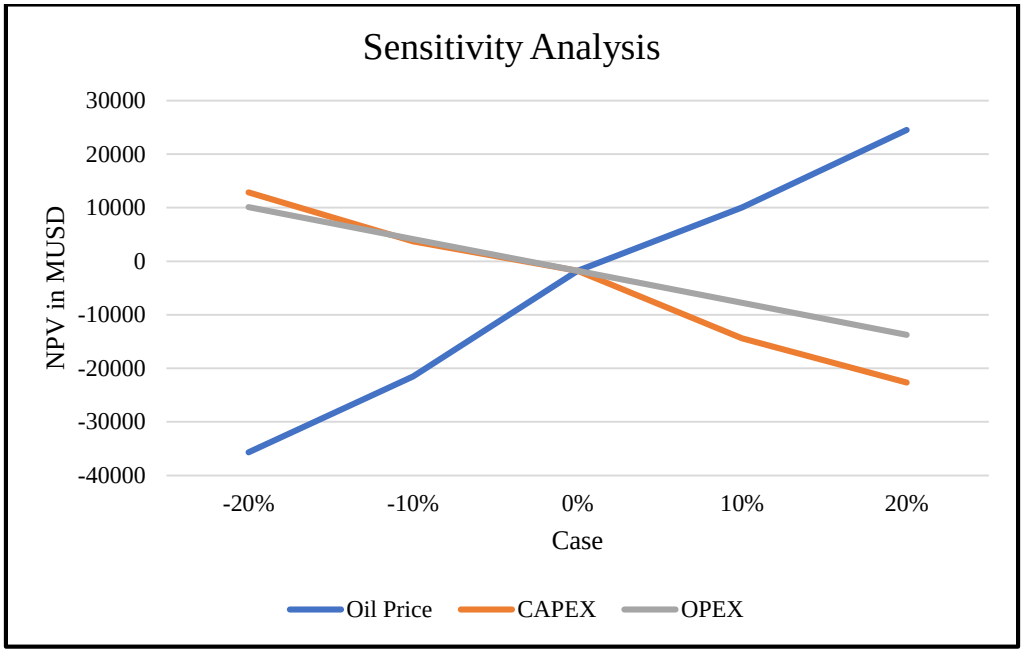

Figure-1: Sensitivity Analysis of The CEOR Project's Variables

From Figure 1, it can be seen that the uncertainty that most affect the NPV project is oil price. When oil price declines by 20% the NPV would decrease significantly from -1,807 MUSD to around -35,000 MUSD and vice verca. As a consequence, oil price would the uncertain variable for calculating project valuation using real option valuation model.

c. Managerial Flexibility Incorporation

According to book, the key advantage and value of real option analysis is to integrate managerial flexibility int valuation process. Such a concept would be more attractive on an intuitive level to most managers. The alternatives that could be implemented in this project are:

1. Start the project or Invest
   This alternative would be applied if the NPV shows above 2 MMUSD. This alternative assumes the oil price is not wildly fluctuated which is according to the forecasted oil price.
2. Delay the project
   This alternative would be implemented if the NPV is between -30 MMUSD and 2 MMUSD. In this alternative, the company decide to defer the project to certain time which could finally make the project's valuation increased. The maximum period to delay (t) is 5 years.
3. Abandon the project or Give Up
   This alternative would be applied if the NPV shows below -30 MMUSD. This strategy basically is a strategy to save the investment if the oil price does not meet the target to increase the project's valuation or the decrease in oil price exceeding the cost of production and absorb all of company's resources

d. Real Option Valuation Analysis

To perform a real option valuation, researchers must first determine the initial parameters that are assumed based on the data base case scenario, history, and expert judgment.

The type of option used in this project is a call option where a company wants to invest in the CEOR project which is described by number 1. The underlying asset used is the NPV when time is 0 or the base case NPV. Because the maximum period for delay is 5 years, the dividend yield used is 20%. From the projected cash flow that has been made, the resulting standard deviation or volatility is 18%. The lettice step used is 10 so that the stepping time from period 1 to the next period is 0.5. From these data, a multiplier is obtained for the uncertain variable, which is the oil price. For up step size, obtained 1.14 and for down step size is 0.88.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 01 January 2023
DOI: 10.47191/ijcsrr/V6-i1-29, Impact Factor: 5.995
IJCSRR @ 2023
www.ijcsrr.org

Year	0	1		2		3		4		5	
Period	0	1	2	3	4	5	6	7	8	9	10
Oil Price	75.0	85.2	96.7	109.9	124.8	141.7	161.0	182.8	207.6	235.8	267.8
NPV	(1,807.0)	12,789.0	40,924.0	72,878.0	100,038.0	139,495.0	184,307.0	235,201.0	293,003.0	358,651.0	433,208.0
Option Value	-	12,789.0	40,924.0	72,878.0	100,038.0	139,495.0	184,307.0	235,201.0	293,003.0	358,651.0	433,208.0
Action?	Delay	Invest	Invest	Invest	Invest	Invest	Invest	Invest	Invest	Invest	Invest
Oil Price		66.0	75.0	85.2	96.7	109.9	124.8	141.7	161.0	182.8	207.6
NPV		(21,499.0)	(1,807.0)	12,789.0	40,924.0	72,878.0	100,038.0	139,494.0	184,306.0	235,200.0	293,002.0
Option Value		-	-	12,789.0	40,924.0	72,878.0	100,038.0	139,494.0	184,306.0	235,200.0	293,002.0
Action?		Delay	Delay	Invest	Invest	Invest	Invest	Invest	Invest	Invest	Invest
Oil Price			58.1	66.0	75.0	85.2	96.7	109.9	124.8	141.7	161.0
NPV			(40,881.0)	(21,499.0)	(1,807.0)	12,789.0	40,924.0	72,877.0	100,038.0	139,494.0	184,306.0
Option Value			-	-	-	12,789.0	40,924.0	72,877.0	100,038.0	139,494.0	184,306.0
Action?			Give Up	Delay	Delay	Invest	Invest	Invest	Invest	Invest	Invest
Oil Price				51.2	58.1	66.0	75.0	85.2	96.7	109.9	124.8
NPV				(54,598.0)	(40,882.0)	(21,500.0)	(1,807.0)	12,789.0	40,923.0	72,877.0	100,037.0
Option Value				-	-	-	-	12,789.0	40,923.0	72,877.0	100,037.0
Action?				Give Up	Give Up	Delay	Delay	Invest	Invest	Invest	Invest
Oil Price					45.1	51.2	58.1	66.0	75.0	85.2	96.7
NPV					(72,546.0)	(54,598.0)	(40,882.0)	(21,500.0)	(1,807.0)	12,788.0	40,923.0
Option Value					-	-	-	-	-	12,788.0	40,923.0
Action?					Give Up	Give Up	Give Up	Delay	Delay	Invest	Invest
Oil Price						39.7	45.1	51.2	58.1	66.0	75.0
NPV						(88,348.0)	(72,546.0)	(54,599.0)	(40,882.0)	(21,500.0)	(1,808.0)
Option Value						-	-	-	-	-	-
Action?						Give Up	Give Up	Give Up	Give Up	Delay	Delay
Oil Price							34.9	39.7	45.1	51.2	58.1
NPV							(102,262.0)	(88,348.0)	(72,546.0)	(54,599.0)	(40,882.0)
Option Value							-	-	-	-	-
Action?							Give Up	Give Up	Give Up	Give Up	Give Up
Oil Price								30.8	34.9	39.7	45.1
NPV								(114,513.0)	(102,262.0)	(88,348.0)	(72,546.0)
Option Value								-	-	-	-
Action?								Give Up	Give Up	Give Up	Give Up
Oil Price									27.1	30.8	34.9
NPV									(125,300.0)	(114,513.0)	(102,262.0)
Option Value									-	-	-
Action?									Give Up	Give Up	Give Up
Oil Price										23.9	27.1
NPV										(134,798.0)	(125,300.0)
Option Value										-	-
Action?										Give Up	Give Up
Oil Price											21.0
NPV											(143,160.0)
Option Value											-
Action?											Give Up

Figure-2: The Binomial Tree Model of The CEOR Project's Valuation

After the modeling is done, data can be analyzed which consists of the binomial tree of assets, changes in NPV, option values, and actions taken. The option value indicates the decision lattice where the decision rule is applied. Asset tree is calculated forward from period 0 to 10. From the results of the real option valuation calculation, it was found that the project could be feasible by delaying the project to year 1 with a minimum oil price of 85.2 USD/BBL.

4.3 Monte Carlo Simulation

When employing Monte Carlo simulation techniques, every assumption of a project model's variable is random. By simulating an NPV calculation, it will provide a distribution of values with matching probability levels. This method was done using computer software called ModelRisk. Because of recent advances in computer technology, this simulation calculation can be accomplished quickly. In this study, Monte Carlo Simulation of logarithmic rate of return performed using 1000 iterations resulting the mean probability distribution that represents combined uncertainty factors of market risks and technical risks. Market risk components are oil price and technical risk component is oil production. This simulation is conducted for both conventional discounted cash flow and real option valuation model.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 01 January 2023
DOI: 10.47191/ijcsrr/V6-i1-29, Impact Factor: 5.995
IJCSRR @ 2023
www.ijcsrr.org

Conventional Discounted Cash Flow

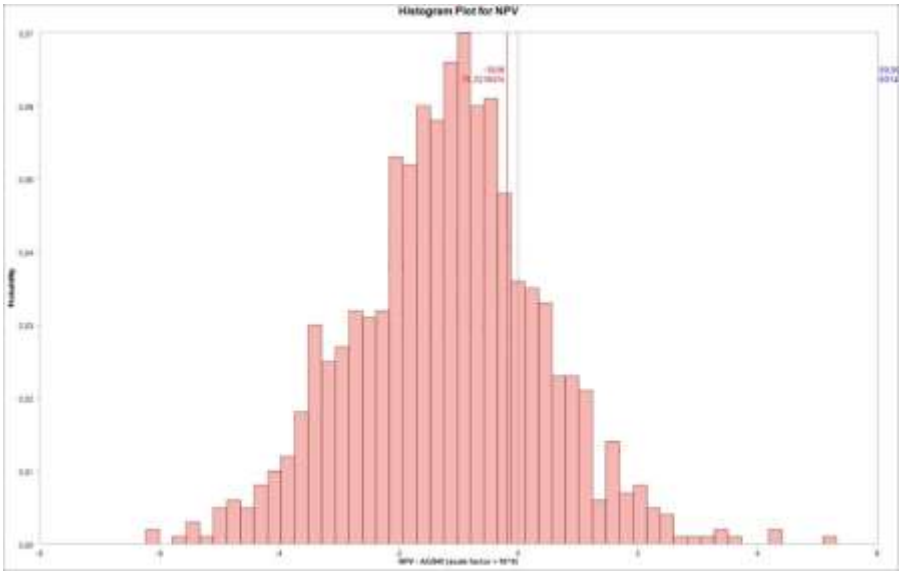

Figure-3: Forecast Distribution of Logarithmic NPV based on DCF

The distribution of the NPV based on conventional discounted cash flow is illustrated by the Figure 3. As can be seen from the simulation, the project has a probability of 76% for the NPV as calculated which is -1,806 MUSD. This probability indicated that the project is predicted to have minus NPV if the project run in less than 6 months from now.

Real Option Valuation

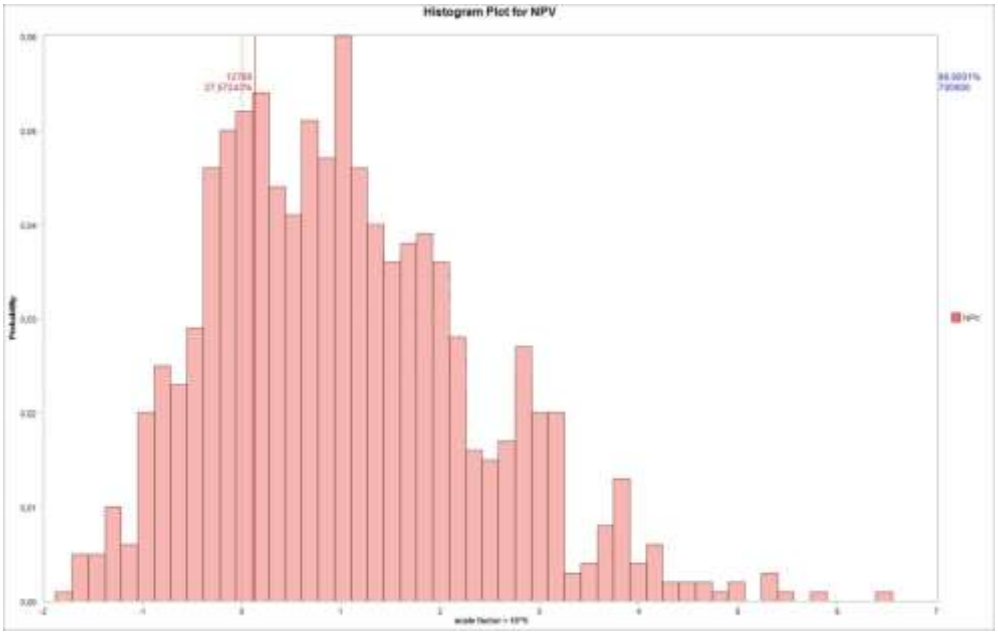

Figure-4: Forecast Distribution of Logarithmic NPV based on ROV

The distribution of the NPV based on conventional discounted cash flow is illustrated by the Figure 4. As can be seen from the simulation, the project has a probability of around 28% for the NPV as calculated which is 12,789 MUSD. This probability indicated that the project is predicted to have quite low prediction to have that valuation if the project is delayed to next six months. However, from the simulation we can see that the project would have higher probability to have positive NPV if it is delayed.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 01 January 2023
DOI: 10.47191/ijcsrr/V6-i1-29, Impact Factor: 5.995
IJCSRR @ 2023
www.ijcsrr.org

5. CONCLUSION

From the results of this study, it can be concluded that this project is not economically feasible when using the traditional DCF method which does not at all consider changes that may occur in the future and other strategic options. From the calculation results, it is found that the NPV is below 0 which is -2900 MMUSD, the Internal rate of return is below the WACC which is 10%, the POT is quite long for CEOR or oil and gas projects, and the Profitability index is very low below 0 From this, it can be said that all economic parameters do not meet the requirements for this project to run.

However, after calculating the valuation using the ROV which takes into account the uncertainties resulting from this project, it can be said that this project is still economically feasible. This model gives companies a strategic choice to invest now, postpone, or just leave the project. Where if the project is delayed for approximately 1 period or 6 months, the project can produce a higher value of 11,460 MMUSD which exceeds the requirement with a minimum oil price of 85.2 MUSD/BBl. However, if the oil price does not reach 85.2 MUSD/BBL in the first period, it is better for the company to move the project back to the next period.

It can be seen, with the real option valuation model, companies are given choices that can increase the company's accuracy in making decisions. The decisions taken are expected to provide maximum and optimal value to the company. From the modeling, it can be concluded that the company is better off delaying its project to get a higher project value later.

After knowing the results of the research in this final project, the researcher has summarized the recommendations that can be implemented to benefit the company and further researchers. Here are some recommendations that researchers can give to companies.

- To delay to the right time which can produce higher value or give up only if the expected value cannot be achieved, because if forced it can give losses to the company which can disrupt its financial condition and reputation.
- If the government is urging the project to run even though its value does not meet the criteria, it is advisable to have additional incentives from the government that can increase the value of the project.
- Can implement the real option valuation model in future projects so as to get results that have higher flexibility so as to reduce the risk of missing out on existing opportunities that can benefit the company in terms of finances and its portfolio.

For the recommendations for further researchers, internal and external analysis can be carried out which can have an influence on the sustainability of oil and gas projects, especially the CEOR project so that it can provide a more accurate strategy for the company.

REFERENCES

1. *Badan Pusat Statistik* (2022). Retrieved November 16, 2022, from https://www.bps.go.id/indicator/12/1975/1/mid-year-population.html
2. Fitnawan, E. A. Y., Harsum, W. A., Hasan, A., Hannanu, M. I., Paulus, S. L., Dharma, S., Subhono, B., Lasabuda, A., Supriyadi, R. A., Ciptadi, S., Amanda, R., Mansyur, B., Kusumawati, I., Barliansyah, A., & Zein, A. A. (2021). Towards achieving Indonesia's oil production target of 1 MMBOPD by 2030: An outlook from IATMI Norway. *Society of Petroleum Engineers - SPE/IATMI Asia Pacific Oil and Gas Conference and Exhibition 2021, APOG 2021*. https://doi.org/10.2118/205753-MS
3. Gennady, L. (2008). Valuing Corporate Growth Using Real Options. In *Source: The Kyoto Economic Review* (Vol. 77, Issue 2). https://about.jstor.org/terms
4. *Indonesia Overview: Development news, research, data | World Bank*. (2022). Retrieved November 16, 2022, from https://www.worldbank.org/en/country/indonesia/overview
5. Kodukula, Prasad., & Papudesu, Chandra. (2006). *Project valuation using real options : a practitioner's guide*. J. Ross Pub.
6. Korra Herdyanti, M. (2021). *ANALISIS KAUSALITAS KONSUMSI ENERGI TERHADAP PERTUMBUHAN EKONOMI DI INDONESIA (CAUSALITY ANALYSIS OF ENERGY CONSUMPTION ON ECONOMIC GROWTH IN INDONESIA)*. http://trijurnal.lemlit.trisakti.ac.id/index.php/petro
7. *Net Present Value (NPV) Rule: Definition, Use, and Example*. (2021). Retrieved November 16, 2022, from https://www.investopedia.com/terms/n/npv-rule.asp
8. *Project Valuation Using Real Options A Practitioner's Guide*. (2006).
9. Ragab, A., & M. Mansour, E. (2021). Enhanced Oil Recovery: Chemical Flooding. In *Geophysics and Ocean Waves Studies*. IntechOpen. https://doi.org/10.5772/intechopen.90335

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 01 January 2023
DOI: 10.47191/ijcsrr/V6-i1-29, Impact Factor: 5.995
IJCSRR @ 2023
www.ijcsrr.org

10. *THROUGH MASSIVE, AGGRESSIVE, AND EFFICIENT ACTIVITIES ANNUAL REPORT*. (n.d.).
11. Sabelfeld, K. (2022). Randomized Monte Carlo algorithms for matrix iterations and solving large systems of linear equations. *Monte Carlo Methods an`d Applications*, *28*(2), 125-133. https://doi.org/10.1515/mcma-2022-2114
12. Gitman, L. J., & Zutter, C. J. (2015). *Principles of Managerial Finance Fourteenth edition*. 410-461. www.pearsonmylab.com.
13. Morton, D., & Tejada, J. (2013). *A Practical Guide to Sensitivity Analysis of a Large-scale Computer Simulation Model*.

Cite this Article: Junita Taskia Amin, Oktofa Yudha Sudrajad (2023). Economic Feasibility Study of a Chemical Enhanced Oil Recovery Project in Indonesia Based on Conventional Discounted Cash Flow (DCF) And Real Option Valuation Model: Case Study at PT ABC. International Journal of Current Science Research and Review, 6(1), 275-289