Project Capital Rationing using Discounted Cash Flow Method, Sensitivity Analysis and Monte Carlo Simulation: Case Study Tambura Oil Development

Muhammad Nadrul Jamal and Oktofa Yudha Sudrajat

ABSTRACT

This paper will analyze capital rationing on Tambura Insert PCP, which is currently in preparation. To prolong field production time, the company needs to find a most profitable method to produce oil in gas field which currently has no artificial lift infrastructure installed. One of possible options is using Progressive Cavity Pump or PCP in the well to lift oil from down hole to surface. PCP is driven by a surface motor installed at the wellhead, above the x-mas tree. Electrical power is required to run the motor. With no electricity source available, three strategy options must be chosen to commence the project. First is the “cable laying” option which has high capital upfront with very low operating costs. Second is “in situ genset installation” option which has lower capital with higher operating costs. And third is “rental basis” option which has very low upfront capital but much higher operating cost. A business situation analysis situation is first conducted to determine why this project is needed. It consisted of internal analysis using a resource-based view framework, external analysis using PESTEL and Porter Five Forces, and PSC context. The method used to evaluate the project is quantitative by calculating project economic and financial parameters using discounted cashflow analysis to compare which options are most profitable. The second consideration is sensitivity analysis to determine what parameter most affects each option. And the third consideration is risks analysis using Monte Carlo simulation to define which option has the most robust parameters. Discounted cash flow analysis shows Net Present Value of Tambura insert PCP Project valuation is positive at range 1.32-1.44 Million USD, which indicates as base case all options are feasible economically. Scenario analysis shows the lowest project net present value or NPV is negative as low as 1.09 MUSD, and the maximum NPV is 2.62 million USD. The sensitivity analysis of several parameters shows that this project is very sensitive to changes in oil price and oil production volume. And finally, Monte Carlo simulation shows that probability of failure or having negative NPV is ranging from 10% to 30%, which means the project has different risks based on options. In conclusion, comparing parameters from all the analysis, it is recommended to commence the project with Option-3, the rental basis option. Although not the highest, Option-3 provided the second best NPV with a very small difference with the first. It gives the best result for other economic and financial parameters. And in terms of risk, it has the lowest risks among other options. Despite the risk that already low, there still some mitigations that need to be implemented to further reduce potential risk, such as conducting a more thorough valuation analysis, reduce technical uncertainty from reserves and reservoir properties, and accuracy of oil production rate. The company also needs to conduct more research is required to forecast the future price fluctuations, considering the oil price is one of the highest risk parameters and the most sensitive aspect in this project.

Keywords: Capital Rationing, Project Valuation, Discounted Cash Flow Analysis, Scenario Analysis, Sensitivity Analysis, Monte Carlo Simulation, Risk Mitigation.

I. INTRODUCTION

In many cases, oil and gas fields have production time 15 to 30 years. For some fields with larger reserves, production can last up to 50 years. The oil and gas field production lifecycle can be divided into three stages. First is the ramp-up period, where production gradually increases from its startup rate. The second stage is the plateau period, where production reaches its peak and stabilizes. And the last is the decline phase, where production decreases at various rates. For oil fields, it ranges from 1% to 10% per year. Meanwhile for gas fields it can be as high as 50%.

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Tambura field is a gas field located in Makamah Block with very shallow water (0-4 m) facing Makassar straits. Currently operated by PT Makamah, Tambura field has been developed progressively in both its production zone: Shallow Zone and Main Zone. Having been produced since 1989, the field is now in its tail of production. To prolong the field production time, Company needs to find a way to produce oil in gas field with no artificial lift infrastructure. One of possible options is installing Progressive Cavity Pump or PCP to lift oil from down hole to surface, as shown in Fig. 1. PCP is driven by motor installed at wellhead, above x-mas tree. Electrical power is required to run the motor. However, since from the beginning the field was developed to produce gas, no electric power network is available to power up the motor. Thus, it is required to look for solutions to provide electricity in the most optimum way, especially from an economic point of view.

There are several options that can be implemented for this project. The first option is laying cable all the way from central processing unit to the well platform. The first candidate of the insert PCP located 2.05 km away. This option has the highest initial investment and lowest operating cost. The second option is installing new genset on platform near the wellhead. This option has both initial investment and operating cost are considered moderate. And the last option is using rental genset. This option has the lowest initial investment but has the highest operating cost.

II. PROBLEM STATEMENT

The business issue is evaluating if this method will give value to the company or not. The other issue is deciding which strategy from the method will give the highest return at lowest risk. Consequently, project valuation must be performed to check if the alternatives solution is feasible or not, and which options give highest value. In addition, risk analysis is required to define which alternative has the lowest risk. This research is performed to answer several questions related to business issue:

- Which scenario of Tambura Insert PCP Project can increase company value by providing a positive return?
- How much will the Tambura Insert PCP Project be worth? Which scenario gives highest worth?
- What are the most sensitive parameters affecting the Tambura Insert PCP Project’s NPV? What is the potential upside or downside for the project result?
- From Monte Carlo simulation, what is the possibility of the project failing financially? Which scenario which hast lowest risk?

III. METHODOLOGY

The methodology applied in this study is a quantitative method for estimating project value of each option by analyzing its cash flow stream using the Discounted Cash Flow Method. Afterward, risk analysis is conducted to define which project gives lowest risk compared to its return. The risk is evaluated using three steps.

First is sensitivity analysis to find which parameter or variable the give impact to project economic the most. Second is scenario analysis to define base-case condition where the financial outcome is most likely to happen, best-case condition if everything goes better than plan, and worst-case condition where the most unfavorable result come to happen. And the last is quantifying the probability of the investment to fail using Monte Carlo Simulation.

IV. LIMITATION OF RESEARCH

Several limitations and data assumptions on this study are described as follows:
- The study is limited to project in one Tambura well as pilot. Potential Projects in other wells for future development are excluded.
- Estimated production volume is calculated by sub-surface team. Assumption on the production forecast is not part of this study.
Parameters used in this study are limited to several variables: production rate and volume, oil price, initial investment or capital expenditure, operational cost or operating expenditure, and inflation.

- The Economics calculation of cash flow for this project is performed using predictive analysis based on Tambura Insert PCP Project cost assumption which are gathered from market survey for related service potential vendor in 2021-2022, and in accordance with the terminology of the Production Sharing Contract (PSC) Scheme between Government of Indonesia and Contractor.

V. BUSINESS ISSUE EXPLORATION

A. Research Framework

Tambura field which is located at Makamh Block is a mature field, which currently at the end of development stage. There were still unproduced oil reserves. The business problem is that Tambura field was initially developed for gas production with no infrastructure for oil production. Insert PCP in Tambura Field is one of methodology to prolong the Makamah Block production time. It allows oil production by installing additional equipment to enable liquid lifting. The business problem is evaluating if this method will give value to the company or not. The other business problem is to decide which strategy from the method will give highest return at lowest risk.

To answer research question and objective, this study is using McKinsey’s seven step model as conceptual framework in Fig. 2.

- Define the Problem: Mature gas field, remaining oil unproduced, no artificial lifting facility.
- Breakdown and structure problem: check the business situation (PESTEL, Porter 5 forces, PSC), describe the project.
- Prioritize the issues: capital rationing.
- Build workplan.
- Conduct Analysis: project valuation with DCA, risk analysis with sensitivity and Monte Carlo simulation.
- Synthesize findings for the analysis.
- Develop recommendation and prepare a powerful communication.

B. Internal Aspect of the Company

According to Rothaermel, a firm needs sustainable competitive advantage in order to outperform the industry. Competitive Advantage is linked to Core Competencies, Resources, Capabilities, and Activities. Resources can be divided into two categories: tangible and intangible. Tangible resources have physical attributes and are visible. Examples of tangible resources are labor, capital, land, buildings, plant, equipment, and supplies. Intangible resources have no physical attributes and thus are invisible. Examples of intangible resources are a firm’s culture, its knowledge, brand equity, reputation, and intellectual property.

PT Makamah as an operator of mature field needs to maintain its competitive advantage by continuously finding a new way to produce oil and gas in an efficient way. One of the activities today is looking for projects that can unlock remaining oil and gas reserves. Tambura Insert PCP project is one of the potential projects. However, to ensure the project can be performed successfully, resources are required from within the company.

1) Tangible Resources

PT Makamah has sufficient manpower to formulate and execute projects, including Tambura Insert PCP. The manpower includes project preparation, such as planning, procurement, installation, and supervision. As part of National Oil and Gas Company Group, PT Makamah have sufficient funding to run its projects. PT Makamah is an ex-termination block, with infrastructure already in place. Due to the cost recovery scheme for previous operator, all the property, plant, and equipment are owned by government but available for PT Makamah to operate. However, for Tambura Insert PCP Project, some infrastructure is not readily available, and it is part of research question need to be answered.

1) Intangible Resources

PT Makamah personnel are already professionals in their fields. Have proven skills and experience. In addition, many employees participate in training and seminars related to the business world, which can improve their knowledge and abilities. PT Makamah personnel (previously under Total E&P Indonesie) have been operating in the oil and gas sector in Indonesia since 1960. With long experience in the oil and gas sector, this factor can be an added value.
Experience and recognition from the international community related to the world of oil and gas make PT Makamah quite respected in the oil and gas sector. In the past, PT Makamah has been experienced in running PCP in Handil Field. This experience can be used to support installation of Insert PCP in Tambura Field. The use of integrated information technology Information technology at PT Makamah is integrated and supports the company's business processes.

C. Industrial Situation

Industrial situation is evaluated using external environment analysis: PESTEL Framework. The PESTEL model is a framework for categorizing and analyzing a significant range of external influences (political, economic, technical, ecological, and legal) that may impact a corporation (Rothaermel, 2021). These elements can both provide opportunities and risks for the corporation. The author would like to use the PESTEL model in this study to arrange and to analyze the influence of external pressures on PT Makamah in general, and Makamah Block especially Tambura Insert PCP Project.

1) Political Factors

In Indonesia, as in the international political economy, oil and gas has also become a major energy source in development as well as a mainstay in foreign exchange earnings. Besides important for the country, oil and gas has also become a necessity for almost the entire population of Indonesia. Therefore, oil and gas must be managed as well as possible to meet domestic needs and to provide the greatest welfare of the people. As a national oil and gas company, PT Makamah has greater pressure to fulfill its production target from the government. As the impact, PT Makamah needs to formulate strategy to support this demand. Accelerating Tambura Insert PCP project is one of the methods.

2) Economic Factors

Apart from direct impact from government revenue, oil and gas activity including its project will have multiplier effect both locally and nationally, depending on scale of the project. Tambura Insert PCP is no exception. With this project, the economic impact is not only during initial installation but also during the project lifetime.

3) Sociocultural Factors

Society's culture, traditions and values should be considered when regulating corporate strategy. Indonesia is an archipelago country with many ethnic communities and languages. Some parts of Indonesia embrace and respect local culture and traditions. Investing while respecting local culture is a difficult challenge for companies.

The Makamah Block is operated by the state-owned company PT Makamah. By hiring only local workers, the company is making a positive contribution to Indonesia's productivity growth rate. The high quality of the nation's human resources shows that the country can compete with other companies in the upstream business of the oil and gas industry. Makamah operation is also close to local village; thus, the activity and project shall consider the impact on people.

4) Technological Factors

R&D accounts for less than 0.1% of total GDP in Indonesia. Many new technologies are developing rapidly in the world market. Indonesia strives to adopt the latest technology to compete with other countries. PT Makamah as part of oil and gas industry is highly dependent on utilization of latest technology to produce hydrocarbon more efficiently. Tambura Insert PCP Project use latest technology for PCP series: insert system. This technology enables the pump to be installed in existing wells without major modification on the completion.

5) Ecological Factors

Hydrocarbons will be important for the stability and development of the international economy in the coming decades. However, the oil and gas sector have a significant impact on overall environmental degradation from exploration and production activities, oil spills, gas flaring and oil refining. The social impact of activities, especially in remote communities, is also of professional interest.
Balancing energy security goals with environmental sustainability is critical to meeting growing energy demands. Ways to improve energy efficiency and boost the oil and gas business should also be suggested. From producers to consumers, everyone involved in the oil and gas industry supports the concept of green energy.

6) Legal Factors

The supreme law governing the administration of Indonesian oil and gas is based on the 1945 Constitution of the Republic of Indonesia, specifically Article 33, paragraphs 2 and 3, which are essential to the nation and essential to the lives of the people. It states that the manufacturing sector that makes an impact is essential to the nation. Constitutional control of the state. Earth, water, and the natural resources it contains are under the jurisdiction of nations and are used to maximize people’s prosperity.

D. Competition Landscape

Industry analysis is a method of assessing industry profit potential and influencing a company's strategic business role within the industry. Michael Porter developed the renowned Five-Force model to help managers identify the potential interests of various companies and organize their respective companies to achieve and maintain a competitive edge. Porter's Five Forces Model provides a framework for identifying his five factors that influence industry profit potential and firms' competitive strategies. Fig. 5 illustrates a competitive analysis of the five factors in the oil and gas industry.

1) Threat of new entrants

The threat of new entrants to the oil and gas industry can be considered low due to high barriers. The biggest obstacle is the high initial investment needed to start the operation. Developing oil fields, extracting hydrocarbon from resources hundreds or thousands of meters below the surface, and delivering it to the buyer costs millions or billions of dollars and requires sophisticated equipment. Another barrier is permitting requirements, high-tech use, and complex government policies.

2) Bargaining power of buyers

In Indonesia, PT Makamah is one of few oil and gas companies available. With limited player, buyer has not many options to switch to another oil and gas company. Thus, the bargaining power of buyers can be considered low.

3) Bargaining power of suppliers

Oil and gas companies have many suppliers and are typically specialized for the industry and the product is not much differentiated. Many major service providers in the petroleum industry are fully involved in the entire lifecycle of the oil and gas sector. These companies may be major international oil companies, oil-rich countries, or institutions that control the world's oil supply and influence global oil prices. With this number, and limited oil company to be served, the bargaining power tends to be low.

However, in today’s condition where demand of services in oil and gas industry is increasing, suppliers’ bargaining power is increasing. This is due to the economic growth after 2 years contraction during pandemic and driven by recent geopolitical condition between Russia and Ukraine. So, it can be concluded that these factors cause the bargaining power of supplier is medium.

4) Threat of substitute products

New and renewable energy is a direct substitute of fossil energy in which oil and gas is part of it. In today’s trend, where green energy is emerging and starting to take place, it is highly possible that can pose a threat to oil and gas companies. Today, the proportion of new and renewable energy is still low. More than 80% of world energy sources are still dominated by fossil fuel, of which more than 60% of the is oil and gas. However, soon these substitutes can potentially disrupt the oil and gas industry. Thus, the threat of a substitute product shall be considered medium.

5) Rivalry among existing competitors

In the industry, the existing players will compete to increase their share. Especially in the oil and gas industry, the competition is not only about gaining market share, but more about having higher production. Thus, companies compete to find resources. Since available blocks to be explored is limited, the rivalry in the oil and gas business is considered high.

E. Oil and Gas Contract Scheme

Exploration and production activities in the upstream oil and gas business are complex and long-term business processes that are highly regulated. There are several fiscal schemes of upstream oil and gas business contracts in the world, especially in oil and gas producing countries as shown in Fig. 6.

Fig. 5. PT Makamah’s Porter Five Forces.

Fig. 6. Oil and Gas Business Scheme (Aziz, 2017).
Government of Indonesia is currently implementing a production sharing contract (PSC) system in managing the upstream oil and gas business together with oil and gas company as PSC Contractor or known as Kontraktor Kontrak Kerja Sama (KKKS). Government of Indonesia is represented by Satuan Kerja Khusus Migas or SKK Migas. In this system, the government has full control in managing oil and gas resources and retains its ownership.

Until 2017, PSC scheme in Indonesia was using cost recovery system and then changed to PSC gross split afterwards. PSC Gross Split is PSC scheme where the revenue is split before deducted with operational cost, thus it is paid by contractor share and the government no longer has the obligation to recover operating costs. Makamah Block is an area which still uses the PSC cost recovery scheme because it was signed before implementation of Gross Split regulation.

F. Project Description

Well TM-XXX initially was designed to produce gas. Thus, this well has no artificial lifting capability such as gas lift or pump. To enable production, an artificial lift needs to be installed. In this case, Insert PCP is selected considering its flowrate, availability for installation without retrieving existing tubing, and simplicity of operation. The Tambura Insert PCP project consisted of two major components: downhole equipment, the insert PCP itself and surface equipment to power up the PCP.

1) Insert PCP installation

This stage involves the installation of PCP downhole equipment using jack unit as shown in Fig. 8. First, i-BOP is installed above the existing x-mas tree. Next step is installing riser, triple BOP, and remote jack unit. After the setup is ready, insert PCP is then run and installed inside the well. To activate the pump, the drive head is installed at the wellhead. The drive head is powered by electricity regulated by VSD. This VSD will be connected to the power source, one of major decision points for the project.

2) Power generation

After downhole equipment is installed, the PCP needs electric power to enable its operation. There are three options for power generation:

1. Cable laying option: Power generation from central processing area
2. In situ genset installation: Power generation from owned genset installed nearby
3. Rental basis: Power generation from rented genset positioned in front of wellhead platform.

In cable laying option, electric power will be sourced from main genset in Central Processing Unit (CPU). Although the distance from CPU to the well is around 1.5 km, the cable required is more than 2 km due to topography of the area, as shown in Fig. 9.
For in situ genset installation, there will be an additional platform installed near the existing wellhead platform as shown in Fig. 10. A new genset will be installed on this platform. There will be additional cost for the genset and platform, however the cost for cable will be much lower. Compared to 2000 m for option 1, cable requirement for this option is less than 50 m. This is a significant reduction for the initial investment. As a tradeoff, there will be additional costs for operation: fuel and supervision. For the third option, rental basis, there will be no additional surface installation required, since all the equipment will be located on a portable self-propelled barge or LCT as illustrated in Fig. 11. Since the equipment is located near the well, instrumentation and electrical devices shall be suitable for use in hazardous areas.

VI. BUSINESS SOLUTION

A. Discounted Cash Flow Analysis

Discounted cashflow is performed using two major data and assumption: operational and financial. Operational data and assumptions include production forecast, capital expenditure, and operating expenditure. Financial data and assumptions include depreciation and cost of capital. Based on these data, discounted cashflow is built for all the three options and then compared to see which option gives highest financial parameter result.

1) Production Profile

Based on the study from subsurface team, reserve which will be booked for Tambura LLP Compression Project is 0.4 MMBbls from one well located near processing area. The forecast of oil production is illustrated in Fig. 12.

2) Capital Expenditure

This project is estimated to require various investment as basis of assumption. This Capital Expenditure or Capex estimation includes dredging to clear access for work barge, installation of PCP down hole equipment, and surface facilities connection from genset to wellhead platform. The estimation of Capex is a breakdown as shown in Table I.

<table>
<thead>
<tr>
<th>Options</th>
<th>Capex Tangible - Total</th>
<th>Drilling Tangible</th>
<th>Insert PCP Material</th>
<th>Surface Tangible</th>
<th>Cable</th>
<th>Platform</th>
<th>Machinery</th>
<th>Capex Intangible - Total</th>
<th>Dredging Cost, intangible</th>
<th>PCP installation, intangible</th>
<th>Total Capex</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.11</td>
<td>1.61</td>
<td>111</td>
<td>0.11</td>
<td>0.11</td>
<td>0.00</td>
<td>0.00</td>
<td>0.28</td>
<td>0.15</td>
<td>0.13</td>
<td>2.39</td>
</tr>
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<td>2</td>
<td></td>
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<td></td>
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<td>3</td>
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</tr>
</tbody>
</table>

3) Operating Expenditure

OPEX, often known as operating expenditures, varies between alternatives. This OPEX estimate takes into account the cost of renting generator barge equipment, the cost of crew, as well as logistical costs for the tugs, gasoline, and supporting sea trucks (supervision and engineering). The estimation of Opex schedule is breakdown shown in Table II.

<table>
<thead>
<tr>
<th>Options</th>
<th>Power Generation</th>
<th>LCT + genset rental (USD/day)</th>
<th>Genset Fuel (litres/day)</th>
<th>Supervision</th>
<th>Seatruck rental (USD/day)</th>
<th>Seatruck Fuel (litres/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>0.00</td>
<td>250</td>
<td>0.00</td>
<td>200</td>
<td>150</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>0.00</td>
<td>250</td>
<td>0.00</td>
<td>200</td>
<td>150</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>0.00</td>
<td>250</td>
<td>0.00</td>
<td>200</td>
<td>150</td>
</tr>
</tbody>
</table>

4) Depreciation

Depreciation will be determined in accordance with PSC terms at the beginning of the month in which the asset is placed into service, with a monthly depreciation for the initial Calendar Year. The declining balance depreciation method is used to determine how much of a capital cost can be recovered each year. The capital cost of each asset at the start
of each such year shall be multiplied by the depreciation factors which are determined by the group, for the purpose of calculating each such year's allowable recovery of capital cost. Tambura inserts PCP is categorized in Group 2 as Drilling and Production tools, equipment, and instruments, with 25% factor and 5 years useful life. Depreciation applied only for tangible cost.

5) Discount Rate

In a discounted cash flow (DCF) analysis, the discount rate is the interest rate that is used to calculate the present value of future cash flows. This assists in determining whether the cash flows from a project or investment will be more valuable than the capital expenditure required to fund it in the present. In this research, the cost of capital will be used as discount rate.

The Cost of Debt is calculated using average debt and average interest expenses in the last five years, taken from financial statements. Cost of equity is calculated by using Capital Asset Pricing Model (CAPM), with beta coefficient calculated using available data of publicly traded companies based on modified CAPM formula.

WACC calculation resulted 10.33%, slightly lower than Company’s hurdle rate at 10.45%. The latter will be used as the discount rate.

6) DCF Valuation Result

Net Present Value of Tambura insert PCP Project valuation is positive amounting 1.32-1.44 Million USD, that indicates project revenue exceed the cost in all options, and it could be considered as feasible project and worth to invest. The highest among others is option-1, followed closely by option-3. The lowest NPV is Option-2. The Internal Rate of Return for this project exceeds the discount rate of the Company. The result of IRR supports the conclusion from NPV that the project is profitable.

Based on the Payback Period variable, this project is forecast to reach breakeven point one to two years after it commences production. The project expects that at that time, the investment expenditures will have been recovered through cash flow generated.

### TABLE III. SUMMARY DCF

<table>
<thead>
<tr>
<th>Options (in MUSD)</th>
<th>Option-1</th>
<th>Option-2</th>
<th>Option-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor Cash in</td>
<td>6.48</td>
<td>7.49</td>
<td>7.82</td>
</tr>
<tr>
<td>Cost Recovery</td>
<td>3.90</td>
<td>5.27</td>
<td>5.98</td>
</tr>
<tr>
<td>Net Entitlement</td>
<td>2.58</td>
<td>2.23</td>
<td>1.84</td>
</tr>
<tr>
<td>Contractor Cash out</td>
<td>3.90</td>
<td>5.27</td>
<td>5.98</td>
</tr>
<tr>
<td>CAPEX</td>
<td>2.39</td>
<td>1.89</td>
<td>0.39</td>
</tr>
<tr>
<td>OPEX</td>
<td>1.38</td>
<td>3.25</td>
<td>5.46</td>
</tr>
<tr>
<td>OPEX Incremental</td>
<td>0.13</td>
<td>0.13</td>
<td>0.12</td>
</tr>
<tr>
<td>Net Cash Flow</td>
<td>2.58</td>
<td>2.23</td>
<td>1.84</td>
</tr>
<tr>
<td>DCF Analysis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discounted Cash Flow</td>
<td>1.44</td>
<td>1.33</td>
<td>1.41</td>
</tr>
<tr>
<td>Payback Period (year)</td>
<td>1.79</td>
<td>1.58</td>
<td>0.48</td>
</tr>
<tr>
<td>Discounted PBP (year)</td>
<td>2.22</td>
<td>1.90</td>
<td>0.53</td>
</tr>
<tr>
<td>Net Present Value</td>
<td>1.44</td>
<td>1.33</td>
<td>1.41</td>
</tr>
<tr>
<td>Profitability Index (times)</td>
<td>2.02</td>
<td>2.11</td>
<td>5.44</td>
</tr>
<tr>
<td>Discounted PI (times)</td>
<td>1.57</td>
<td>1.66</td>
<td>4.41</td>
</tr>
<tr>
<td>Contractor IRR</td>
<td>36%</td>
<td>41%</td>
<td>176%</td>
</tr>
</tbody>
</table>

Option 1 and option 2 have typical upstream oil and gas projects with capital intensive in the initial periods. The Profitability Index of the Insert PCP Project is 1.6 times for option 1 and 2, indicating the probability of a project with more cash inflow than cash outflow. As for Option-3, since it has very low initial investment, the profitability index is much higher at 4.4 times. In terms of project revenue after the production phase, it would continue to decline along with increase of water cut and decrease in reserve.

Of the three options, option-1 and option-2 similarly give the highest overall project revenue. Option-2 and option-3 similarly give the highest revenue for the Company, from contractor take and cost recovery. Although Option-3 gives the highest IRR due to very low initial investment, it gives lowest net contractor take cumulatively due to highest overall cost spent for the entire project.

B. Risk Analysis

There are several risk variables that will be evaluated in this research because they constitute a large part of revenues or costs and/or uncertain in nature:

- Oil Production Realization. The actual production will be impact of actual reserve volume, reservoir performance, and PCP performance.
- Actual Oil price. Based on history, it fluctuates following global conditions.
- OPEX is not expected to have significant changes, but it is still a significant part of the cost in some options.
- CAPEX might change based on procurement result and a significant part of the cost in some options.
- Inflation Rate will be evaluated if it gives major impact on NPV.

1) Sensitivity Analysis

Sensitivity analysis examines the individual effects of several independent variable values on a certain dependent variable. This analysis is also called What-if Analysis. During the analysis of certain parameters, it is assumed that the other parameter is constant, or ceteris paribus assumption. For the analysis, 25% plus and minus of swing will be used to check which parameter gives the highest impact on NPV.

The sensitivity analysis on several parameters shows that this project is very sensitive to changes in oil price and oil production volume. As the most dominant key parameter,
price changes would give impact NPV result.

Change in both the oil production volume and oil price can give even more significant impact on project NPV. However, the strategy to minimize risk in case of during low oil price or unexpected production result only available for Option-3 where the project can be stopped in the middle with no significant expenses upfront.

The second important factor varies based on option. Option-1 is sensitive to capital expenditure, option-2 sensitive to capital and operating expenditure, meanwhile option 3 is sensitive to operating expenditure.

2) Scenario Analysis

In this research, several assumptions are made for each variable to build scenario analysis:

- Oil Production Realization. In best case scenario, we can expect lower water cut at 28-30%, thus giving upside of 120% production. At worst case, water cut can increase to 70% at early production, or liquid rate drop to 100 barrel per day due to poor pump performance, thus gives downside of 40% from expected production.

- Actual Oil price. Based on the last 10 years data, on average the ICP can deviate -24% and +21% from yearly mean price. This deviation will be used as worst case and best-case scenario respectively.

- OPEX components majority is fuel and unit rental. Since the rental is on a contract basis, the price is not expected to change throughout the project. Thus, the only change is expected from fuel, which is the inverse of oil price.

- CAPEX. It is assumed that cost deviation will be +10 and -10% for worst case and best case.

- Inflation Rate. will be assumed at 4.04% as base case, refer to average inflation rate during last 10 years. Worst case it can be as high as 8.24% based on average 20 years, and best case can be as low as 2.6% based on average in last 5 years.

Using scenario above, in the worst case the project will give negative NPV for all options. Meanwhile in the best case, the NPV can increase almost twice. This indicates that the project has a high range of economic uncertainty. Among the three options, Option-3 has the lowest range due to lower impact from parameter uncertainty.

3) Monte Carlo Simulation

Using variables in sensitivity analysis, Monte Carlo simulation shows the scenario when these variables vary from worst case parameters to best case parameters over 1,000 iterations. The data is presented in cumulative probability distribution.

According to Jenkins et al. (2011), if the cumulative probability distribution crosses the zero “cut-off” mark, then there is a risk of having a negative NPV that must be weighed against the probability of getting a positive return.

From the simulation, all three options have cumulative probability distribution cross zero at range 10-30% probability, meaning all the option has more than 50% probability of success. However, since the three options are mutually exclusive, one option must be selected from among the three.

Fig. 14. Sensitivity Analysis Tornado Chart Option-1.

Fig. 15. NPV Range from scenario analysis.

Fig. 16. Comparison probability distribution among three options.

Jenkins et al. (2011) argues that if the cumulative probability distributions of the returns of mutually exclusive projects do not intersect at any point, then one should always choose the project whose probability distribution curve is farther to the right. For Tambura Insert PCP case, Option-3 or Option-1 shall be selected over Option-2. This is because given the same probability, the return of Option-3 and Option-1 is always higher than the return of Option-2. And finally, Option-3 shall be selected over Option-1 due to it having lower risk.
VII. CONCLUSION

Based on discounted cashflow valuation and risk analysis, as base case, the insert PCP Project is viable and profitable for management to carry out until the end of the project time. This conclusion will be reached only if all the criteria given in previous chapters are fulfilled. However, among the three options, there are differences in each parameter as shown in TABLE IV.

In summary, Option-1 has the highest NPV, lowest financial parameters, and medium risks. Option-2 has the lowest NPV, medium financial parameter, highest risks. An Option-3 has medium NPV (minor margin from highest), highest financial parameter, and lowest risks. Considering the uncertainty in production volume and oil price it is recommended to take Option-3 as a course of action. Doing this, the company can still recover considerably high NPV with lowest risk.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Option-1</th>
<th>Option-2</th>
<th>Option-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV (MUSD)</td>
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<td>1.32</td>
<td>1.41</td>
</tr>
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<td>IRR</td>
<td>36%</td>
<td>41%</td>
<td>176%</td>
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<td>PBP (year)</td>
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<td>1.9</td>
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<tr>
<td>PI (times)</td>
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<td>1.7</td>
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<tr>
<td>NPV range</td>
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<td>Low</td>
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<tr>
<td>Sensitivity</td>
<td>Capex</td>
<td>Capex + Opex</td>
<td>Opex</td>
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<tr>
<td>Risk</td>
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CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

REFERENCES


