IMPROVING CORPORATE INVESTMENT DECISION THROUGH DECISION RISK ANALYSIS AND VALUE OF INFORMATION METHOD

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Abstract

This paper focus on how Decision Risk Analysis and VOI have been used to improve corporate investment decision on oil field development at PT. X.
Decision and risk analysis is an ideal tool for decision making in an environment of risk and uncertainty. The process enables a more holistic view to be made within the context of the overall objective to get clear understanding of the oilfield asset development. In the petroleum industry, the decision to develop new field must be made under conditions of uncertainty. The degree of uncertainty and the economic consequences that associated with such investment decisions can vary widely. Fail in performing good decision could lead to inefficient of a multi-billion dollar capital investment and will ultimately affect the financial performance of the firm. Although uncertainty can always be reduced by simply buying more information, there must be a point at which the cost of additional information exceeds its benefit.
This paper examines the problem of determining the point at which the development decision should be made. A complex decision problem is composed into separate components, form of a decision tree, on which perceptions of options, uncertainties and values can be explicitly represented. The methodology is applied to a real green-field development in Riau-Sumatera.

Key words: Corporate Performance, Decision Analysis, Value of Information, Risk and Uncertainty

1. Introduction

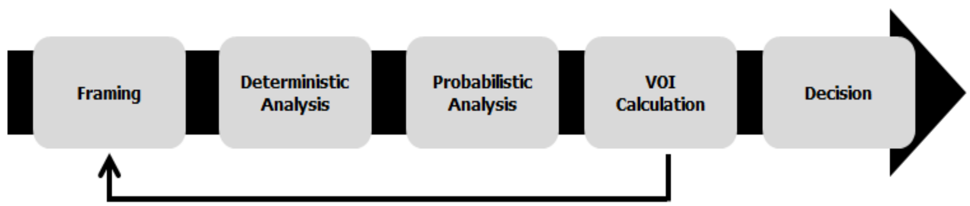
Investment decision to develop a new oil field in oil and gas company is decided under uncertainty environment. There are a lot of uncertainties to consider prior to make a high class and accurate decision. PT. X is one of the oil and gas company that operate in Sumatra-Indonesia under Production Sharing Contract with the Government of Indonesia. Investment efficiency is one of the Key Performance Index at PT. X to measure the performance of the firm beside production target and also Safety performance.

Current performance shows that some of investment decision performance was had a gap with actual production and financial performance of the project, some project deliver the result below the forecast of projection. That problem could be happen due to limited data to understand the subsurface condition and at the end will impact to the accuracy of oil production forecast that we make. Although uncertainty can always be reduced by simply buying more information, there must be a point at which the cost of additional information exceeds its benefit.

This paper will describe about how to answer problem of determining by implementing new Decision Risk Analysis and Value of Information assessment to understand the point at which data acquisition to reduce the uncertainty for the development decision should be made. This paper will present the actual project investment/valuation case that made by PT.X for new field ZZ development project that located in Sumatra.

2. Research Methodology

A decision risk analysis decision analysis describes a rational, consistent way to make decisions. Decision risk analysis is a systematic process with intermediate reviews that ensures quality decision (Skinner, 1999). It helps expose the investment uncertainties and quantifies their impact.
Decision risk analysis methodology provided a defined process leading up to project decision.
A process comprising five discrete stages that shown on picture 1 below:



Picture-1. DRA structured iterative process

Framing the problem
Framing is the first step in investment analysis. Framing defines the opportunity, sets the boundaries for the alternatives to consider in the economic analysis, clarifies the decisions needed and the decision criteria, and establishes alignment among the project team, decision makers, and stakeholders. To elaborate the framing, project team need describe the decision hierarchy, strategy table, influence diagram and also value measure, all the parameter will describe below.

Decision hierarchy,
Following on the principle that projects be decision-driven, the Decision Hierarchy helps us sort Decisions into three categories:
☐**Givens** are those decisions that have already been made. These need to be validated by the DE.
☐**Strategic Decisions** (also called Focus Decisions) are those considered to be the most critical to address at this stage of the project. The project team will be considering alternatives for these decisions in this phase.
☐ **Tactical or Non-Focus Decisions** are decisions remaining to be made that are more appropriate for a later phase (i.e., less urgent) and/or of less impact than the Focus Decisions.
Contents of the *Decision* Hierarchy should be decisions we can make; this tool is not to include uncertainties, attributes, or facts about the opportunity, or be an action list.

The Strategy Table provides a summary of the Strategic Decisions and lists the range of alternatives for each. The Strategy Table is a key decision tool and should be front and center for the project team. Gaining clarity regarding the decisions and alternatives listed therein should be the priority of any decision-driven work plan.
Develop strategic themes, as needed, by selecting a variety of internally consistent paths through the table, each of which includes no more than one alternative from each decision. The objective is to obtain a set of 3-7 significantly different, creative, and doable strategic themes that span the alternative space without having to analyze every possible path. Fine tuning variations on the leading strategic theme can be tested later in the analysis to seek the optimum alternative. Trying to evaluate too many alternatives from the start frequently generates so many numbers that insights are difficult to obtain; and much time could be wasted modeling similar alternatives, or variations of a theme, that are all equally unattractive.

Influence Diagram is a network diagram of system variables with lines indicating the direction of influence or time-sequenced relationships; variables and formulas can be quantified and expected values solved by an iterative process as an alternative to decision tree calculations.

Value Measure is a set of economics parameters that we going to evaluate as a base of decision is made.

Deterministic Analysis

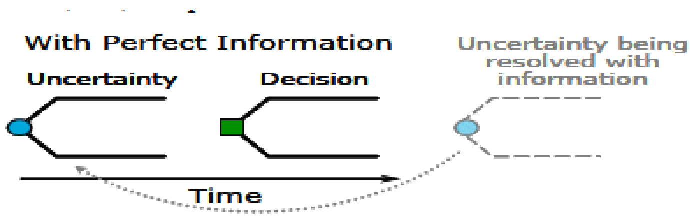
Deterministic Analysis is a set of a model where all parameters are fixed or determinate. The Analysis is simply to make following questions need to answers and get the insight of our model is make sense or need some revision prior to develop a probabilistic analysis.

Probabilistic Analysis

Probabilistic analysis is a structured approach of using statistically based tools and methods to deal with uncertainty. It provides us with a common language and approach to understanding and presenting information. Once a problem is framed and from the results of deterministic analysis uncertainties are defined that demand further examination, we can use the tools of probabilistic analysis to make the available information more useful. Expected Value (EV) is a key concept in probabilistic analysis. Probabilistic analysis not only gives us the structure to look at problems as basic as this question, but also provides a framework to deal with very complex investments. Calculation of an EV requires assigning probabilities to the different possible outcomes. At this stage we need to run a decision tree and cumulative probability outcomes. Decision trees have a basic structure of nodes and branches that can model events over time. They incorporate decision nodes and uncertainty nodes. Branches represent the alternatives or choices at a decision node or the potential outcomes at an uncertainty node. Uncertainty nodes have probabilities associated with each branch. This is the dominant approach for doing probabilistic evaluations. Cumulative probability curves (sometimes referred to as S-curves) allow us to compare the risk versus return of the alternatives along with the range of possible outcomes. They are the displays of the outcome results of a decision tree evaluation.

VOI Calculation

Value of Information is useful to understand if additional information or control on an uncertain variable would change a decision; only then is there economic value in gaining that additional information, control, or learning. In most investment decisions, we have the choice of spending time and money to acquire new information to help make the decision. Examples include performing seismic studies before drilling exploration wells, drilling delineation wells before setting a platform size, building/running pilot plants before building a commercial refining unit, or completing marketing surveys before launching a hydrogen business. This "value of information" is the difference between the expected value of the investment with the information and the expected value without it. Bayes Theorem provides the analytical framework for efficiently completing value-of-information assessments. The first approach is to calculate the *value of perfect information*, which implies an uncertainty will be resolved with perfect reliability before a key decision must be made. We can do this easily with decision trees. We simply change the order of the nodes, bringing the uncertainty that we want to test before the decision and recalculating the tree (see schematic below).
The value of information (VOI) is equal to $EV_{with\ info} – EV_{without\ info}$.



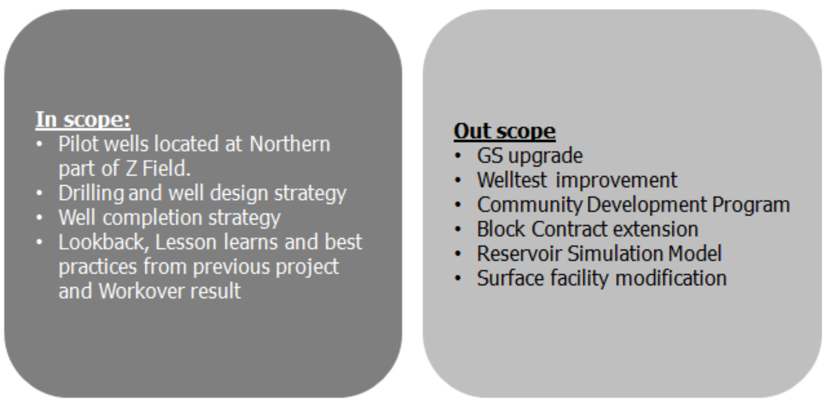
Picture-2. Schematic of Decision Tree for VOI process

3. Research Result

Framing the problem

The first step on evaluating project or investment decision is framing the problem, by conduct appropriate scope on framing session, the development will be more focus on the in scope and not taking a much effort on the out-scope list.

Picture below shows an in-scope and out-scope of project development for field ZZ:

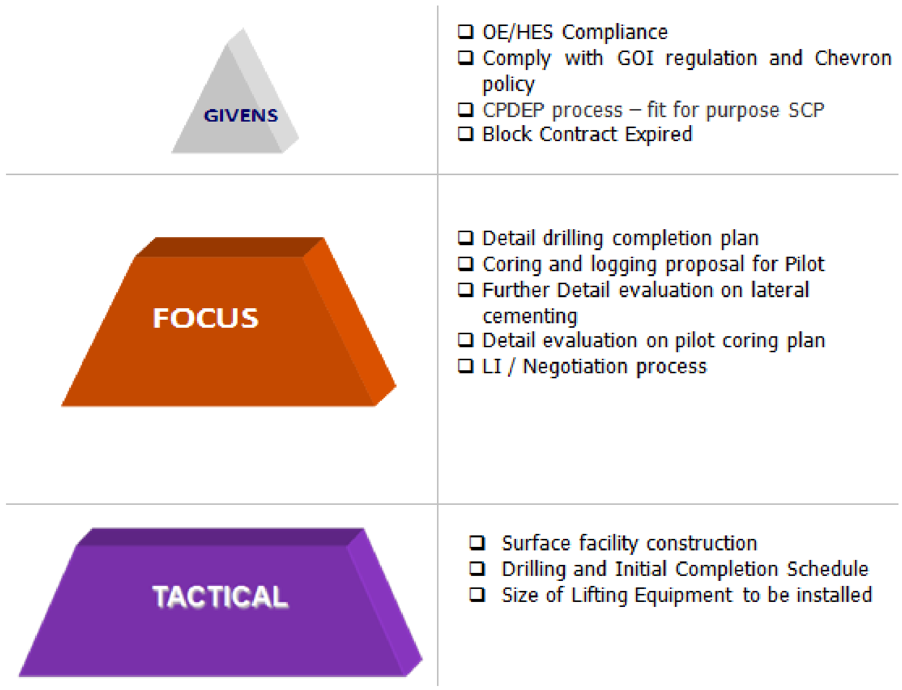


Picture-3. Project Framing Result of Field ZZ

Field ZZ project development will exercise all the list that included on in-scope box, and for the rest of out-scope box's list will be discussed and handled by separate team. Pilot well location is needed to understand the real reservoir condition and also to modified the reservoir simulation study based on the actual result from core and production profile that we get from pilot wells. Later on in this paper will discuss about is the cost for purchasing/drill pilot wells is suitable for the rest of full-field project development.

Decision hierarchy also developed for this ZZ project that sort into three part, Given, Focus, and Tactical. The Givens are decisions already made or to be made by the decision makers alone. The Focus decisions are for the study team to make recommendations to the Decision Review Board. And The Tactical decisions are those for which some valid assumption can be made by the study team or whose outcome has little bearing on project value.

Picture below shows a diagram of decision hierarchy for project ZZ development.



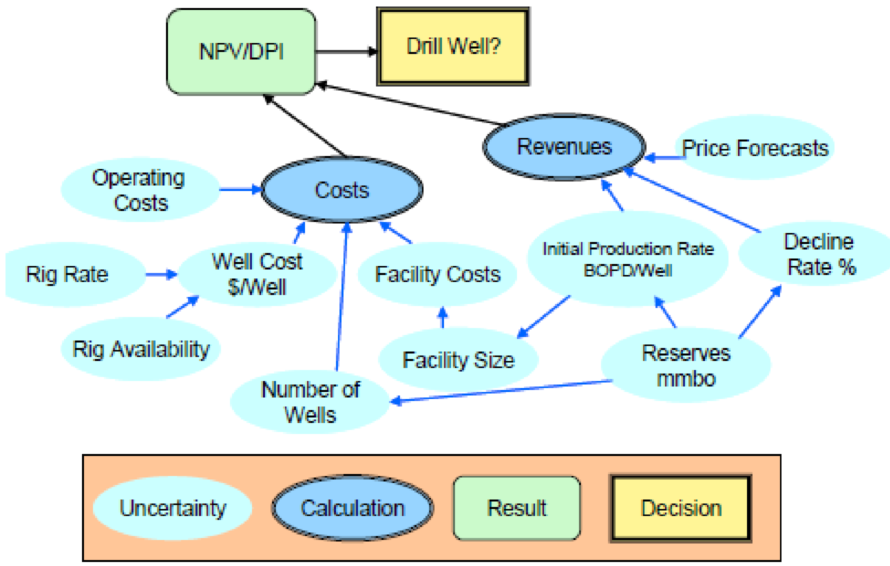
Picture-4. Decision hierarchy table of Field ZZ

The strategy table tool is employed to rationalise a wide range of potential outcomes into a few easily evaluated strategic options. The Strategy Table is a key decision tool and should be front and center for the project team. Develop strategic themes, as needed, by selecting a variety of internally consistent paths through the table, each of which includes no more than one alternative from each decision. The objective is to obtain a set of 3-7 significantly different, creative, and doable strategic themes that span the alternative space without having to analyze every possible path. Below is the strategic table of this project:

		Decision Criteria			Key Uncertainties												
No.	Phase 2 Alternative	Potential Resources (MMBO)	Economic Risk	Technology Doability	1. Effective Reservoir (3 or 5 ohm cut off)	2. Effective Drainage Area & Well Spacing	3. Hydraulic Fracturing Geometry	4. Net Thickness	5. Completion Strategy	6. Primary Stress Regime	7. Effective Porosity	8. Clay bound water	9. Swi/Swirr	10. Permeability & Transmissibility (kh)	11. Reservoir Continuity	12. Swelling Sensitivity	13. Land Issue
1	Low grade location + Vertical well + Openhole + Frac	488	H	H	✓												
2	Low grade + HZ + Openhole + Frac + Coring	488	H	M	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓
3	High grade + directional + Openhole + Frac + Coring	163	L	M				✓	✓		✓	✓	✓	✓			✓
4	High grade + HZ + Open&Casedhole + MultiFrac + Coring	163	L	M		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
5	Low-High grade + Vertical + Cased hole + Frac + Coring	488	M	H	✓			✓			✓	✓	✓	✓			
6	Low-High grade + directional + Openhole + No Frac + Coring	488	M	H	✓			✓	✓		✓	✓	✓	✓			✓
7	Low-High grade + HZ + Open&Casedhole + MultiFrac-No Frac + Coring	488	M	M	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
					6 Top Uncertainties												

Picture-5. Strategic table of Field ZZ development

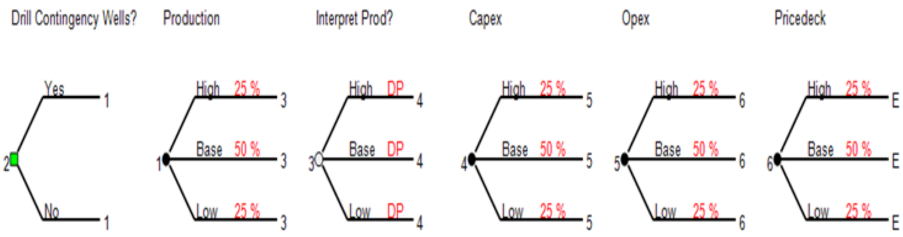
Influence Diagram is developed for this project to determined what variables are that impacted to NPV generated. Decision is to drill well and expected the production rate for revenue generated. All cost also need to determine for developing this influence diagram.



Picture-5. Strategic table of Field ZZ development

Deterministic Analysis
A spreadsheet based evaluation model was built to generate the economic input parameters for all for each the strategic options. The deterministic analysis reduced the complexity of the problem by allowing over 50 variables to be condensed into the 5 factors for each strategy having the greatest impact on project value. The deterministic analysis focuses attention on the key uncertainties. This in turn allows resources to be allocated to resolution of those uncertainties having the greatest impact on project value. Deterministic analysis can display the impact of a wide range of outcomes of any single variable and compare the results with those of other variables.

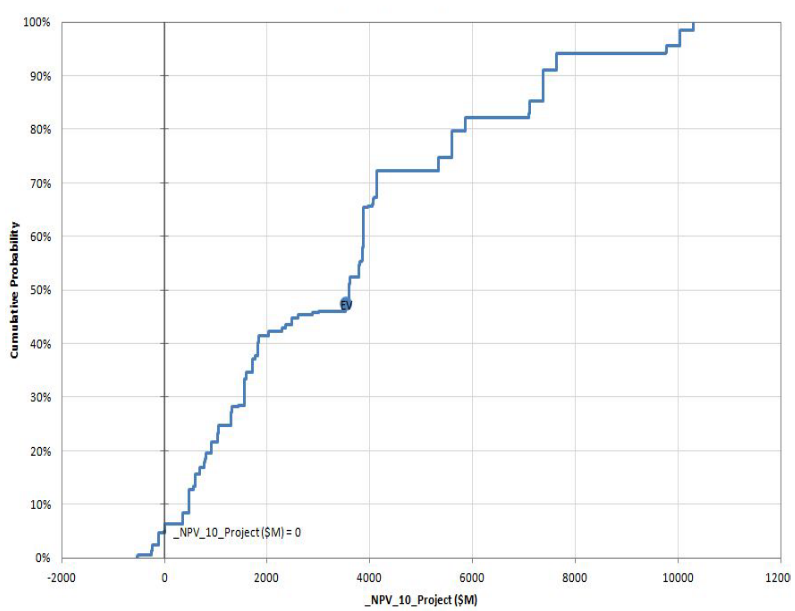
Probabilistic Analysis
Probabilistic analysis is a structured approach of using statistically based tools and methods to deal with uncertainty. Decision tree was developed by using Simultaneous Decision Analysis (SDA) Tools, to help us to calculate all iteration to the parameter that already generated on excel spreadsheet for deterministic analysis.
Developed decision tree structure and the result of NPV and DPI for this project shown below:



Picture-6. Decision Tree Structure of Field ZZ development

Based on iteration calculation we got the range of Net Present Value for this project that plotted as cumulative probability plot for each opportunity and probability of parameter that generated the NPV. Discount rate 10% is applied on this calculation as per corporate investment guidance.

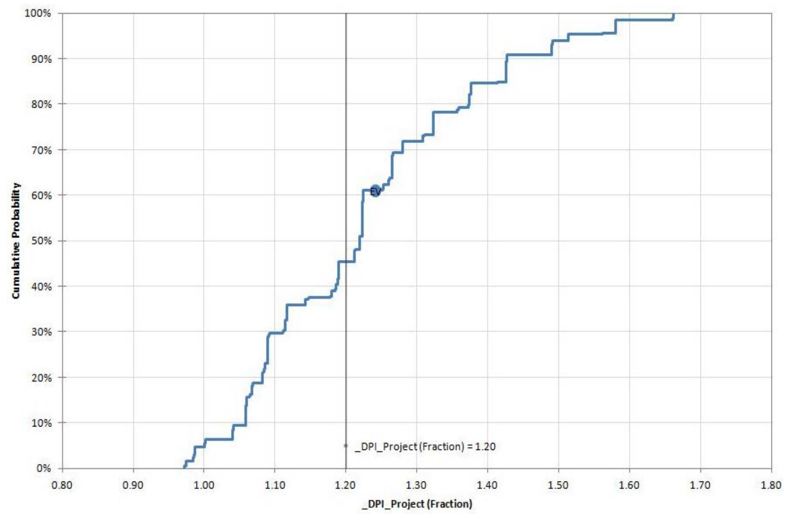
In the graphic below shows that the Expected Value of NPV for this project development is $ 3.89 Million, and probability to get an NPV at discount rate 10% below 0 is only 5%.



Picture-7. NPV result of Field ZZ development

Another decision criterion that needs to exercise is DPI (Discounted Profitability Index), DPI is an indicator of how much value is added per dollar invested (i.e., how efficient is the project in using capital). DPI was developed in 1964 to deal with evaluating acceleration projects where, due to the multiple sign changes in the cash flow, ROR can produce multiple rates. DPI also helps overcome the *bigger is better* predicament with NPV, where large projects generally generate large NPV values and will be preferentially selected if no consideration is given to the efficiency of the investment. DPI is also a good metric when operating in a capital-constrained environment.

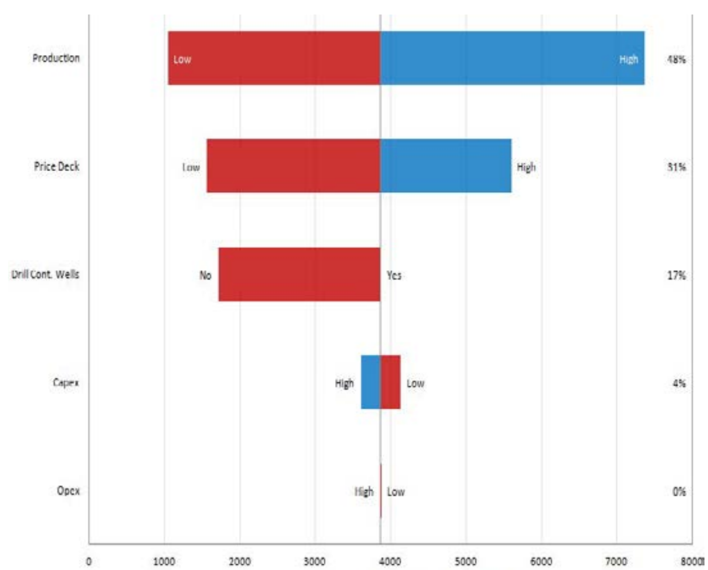
The EV DPI is equal to: 1 plus the ratio of the EV NPV divided by the present value of the "before-tax investments". Below is shown a distribution of DPI at discounted rate 10% for this project.



Picture-8. DPI Probability result of Field ZZ development

EV DPI shows that only 3% of probability for this DPI gives DPI below 1 where it means this project is very feasible and economics to develop.

Tornado chart also generated to understand which parameters has very significant influence to generate NPV for this project. Shown on the picture below that production and oil price is the most two parameters that have high influences to NPV generated.

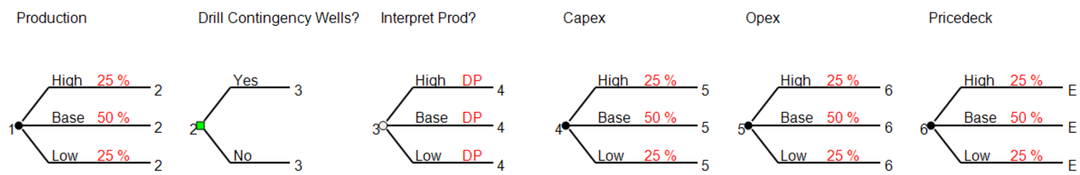


Picture-9. Tornado chart for NPV generated of Field ZZ development

Since oil price is out of our control, one of parameter that under our control is production. To proving the production forecast we need to drill a pilot well prior to develop a full field development. However there is also uncertainty to get a good core and expected good core result from drilling those two pilot wells. Two pilot wells proposed at the location that referencing a low quality reservoir and high quality reservoir. Need some capital to drill those pilot well, next chapter will discuss about is the capital that we spending to drill those two wells is suitable enough for full field development or not.

VOI Calculation

To determine the value of information, sequence of decision tree was modified. To solve the uncertainty than decision to drill/full field development was decided. The uncertainty node of production is putting in front of decision node, it is explained that after we understand the production profile from pilot wells, we then can decided to develop this project for full-field development or stop the development. Decision tree structure can simply describe on the picture below:



Picture-10. Decision Tree Structure for VOI of Field ZZ development

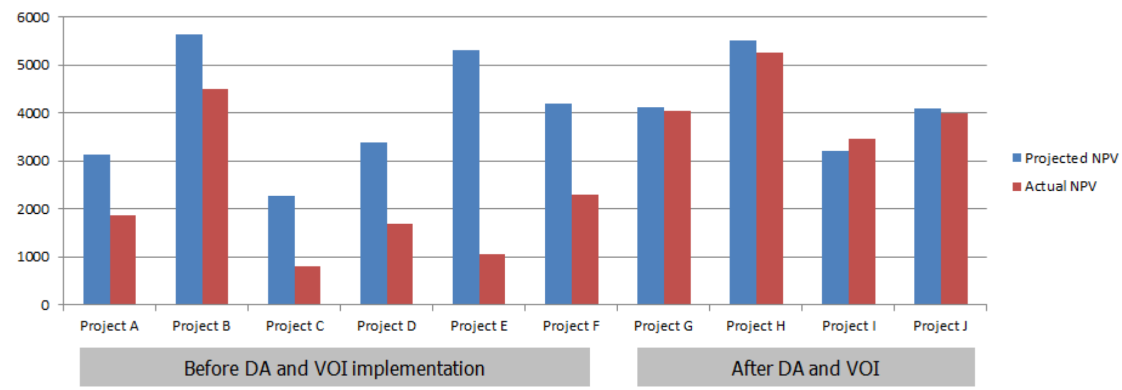
Then we rerun the probabilistic result for all the parameters that we need to understand. In this paper will show for the NPV only as the one of project's decision criteria. Based on iteration result for this perfect information NPV gives a result of NPV = $3.92 Million.

VOI Calculation simply can be calculated with EV NPV $_{\text{with info}}$ – EV NPV $_{\text{without info}}$.
Then VOI = $3.92 Million – $ 3.89 Million = $ 0.03 million.

4. Discussion

Value of Information result that already describes on chapter 3 shows that EV NPV of VoI is \$0.03 Million. That's mean the effort to drill the pilot well is worth since it will give the VoI NPV is bigger than zero. By understanding the production profile which is the most affected parameter for NPV generation, we expect the accuracy of investment that we made is better. So by the end of the day the company will easily predict and forecasting its financial performance.

The improvement is shown on the graph below for several project investment decision made by PT.X. The result shown that the NPV projection before DA and VOI method were implemented there are a gap between the projected and the actual, however after implementation VOI method the gap is very close almost around 90% accurate.



Picture-11. Comparison of project performance

Improving NPV actual result compare to projected will give much values on capital investment allocation, and by the end of the day will improve the firm's financial.

5. References

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