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PRIMARY RESEARCH

Managing production profile uncertainties in P field LLP project economic evaluation using factorial design

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Abstract

This study evaluates a new approach to perform an economic evaluation for the Low Low Pressure (LLP) project on the different platforms. P field is a Gas field in the Mahakam area, East Kalimantan, Indonesia. Since 1999, its production has decreased and is forecasted to fall below economical cut-off starting at the end of 2020.project may extend the life of the field. In 2016, An economic evaluation had been performed for the LLP pilot project on Platform 4 and Platform 5 but did not properly integrate the uncertainties behind the production profile. The new method proposed in this study develops a model from platform 2 data to capture production profile uncertainties by using factorial design. Monte Carlo simulation is applied to the model to obtain a production profile range. Economic analysis is then performed to calculate Net Present Value (NPV), Internal Rate of Return (IRR), and Payout Time (POT). Eventually, the new method concludes that the LLP project on Platform 2 will generate cumulative cash flow between 32.9 to 60.4 MUSD (NPV0) or 11.7 to 21.8 MUSD (NPV11) with IRR ranging between 27 to 34%. Therefore it is economical. Information gathered from Platform 2 evaluation hinted that only Platform 1 has the potential to be economical. Additional work is required to have a complete economic evaluation. However, the management should decide to go on with the platform 2 LLP project.

INTRODUCTION

"P" field is a Gas field in Mahakam area, Indonesia. Founded in 1984, it has been producing since 1999 through 8 offshore platforms and up to 171 wells. The field is currently on mature state, operating in Low Pressure (LP) condition where the average Well Head Pressure (WHP) is at 14 barg with average yearly production of 2017 at around 200 MMSCFD. After being produced for 18 years, reservoir pressure of the field has significantly decrease and will eventually stop flowing at current operating pressure. Based on the 2017 long term production forecast, the field's production rate will fall below economical cut-off rate of 50 MMSCFD in 2020.

In order to extend the life of the field, one of the possible effort is lowering the operating pressure to Low LLP at between 2.5 to 4 bars. An economic evaluation has been performed for pilot LLP project on Platform 4 and Platform 5. The results is that Platform 4 is not economical while Platform 5 deemed economical with Net Present Value at 11% discount rate (NPV11) at 15.16 M$ and IRR 7% at gas price 5 $/MMBTU (Hutabarat & Senoputra, 2017; Panti, Gempes, & Gloria, 2018). Sensitivity analysis performed at the time confirmed important impact of production profile to the NPV. However, the economic evaluation was done assuming only one production profile. Figure 1 shows the pipeline network map of the field, platform 4 and 5 is highlighted in gold.

The decision making process to sanction the project was very difficult mainly as management has different perception on the certainty of the production profile. During the course of the economical evaluation elaborated above, there are several uncertainties other than gas price which are not properly integrated in the evaluation. Sensitivity analysis perform at the time confirm important impact of produc-

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tion profile, gas price, fixed cost and start-up date changes to the NPV.

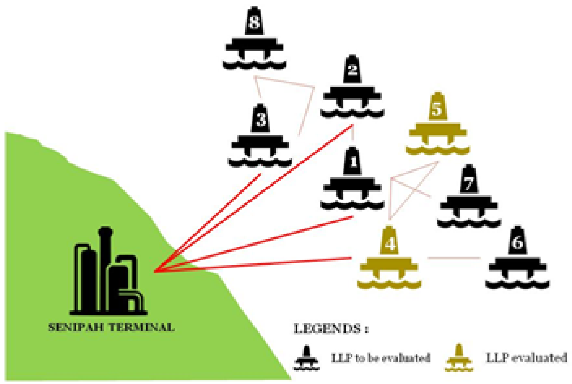

FIGURE 1. P field pipeline network map

However, the economic evaluation was done assuming only one production profile, one cost profile and one start-up date. In reality, these figures are actually uncertain. In addition to that, even though it is not evaluated in sensitivity analysis, the future discount rate is also uncertain in reality. This problem has been conveyed by many scholars, one of them is Jovanovic in 1999.

It is quite clear that investment decision-making never takes place under condition of certainty, but only under those of uncertainty or risk. It is therefore necessary to define and locate the investment decision making problem in its real conditions, and possibly find suitable and appropriate solutions. (Jovanovic, 1999).

Furthermore, as the need to maintain production become more important, the management wanted to evaluate LLP project for the remaining 6 platforms, named Platform 1, 2, 3, 6, 7 and 8. The platforms are producing form the same field (P field) but have different production rate and connected volume.

Therefore, the objectives of this study are (1) to develop a production profile which properly integrates important uncertainties to be used in economic evaluation and (2) to rank the economical feasibility of the 6 platforms based on the new developed economic evaluation method. The benefit of this study is to provide important information for the management in deciding whether to launch the project or not.

LITERATURE REVIEW

Gilbert (1954) could have been the first person who analyze the performance of systems composed of multiple components on oil and gas wells. The concept was then popularized by Brown (1984), Mach, Proano, and Brown (1979) in the oil and gas industries as Nodal Analysis™. This method is also applicable to be used to evaluate gas well performance under LLP production phase. It evaluates two performance curves; the inflow and outflow perfomance curve. The analysis will provide a production rate at each pressure condition. Production profile can be generated by combining the production rate with a decline curve (Arps, 1945) and gas well material balance which represent the volume of the gas inside the reservoir. Later on, experimental design can be used on the production profile in order to integrate the uncertainties lie beneath the calculaion.

Experimental design is a structured method used to evaluate relationship between the different factors affecting a process to the output of the process. It is widely used in statistics study, but also in petroleum engineering study as shown by Itotoi et al. (2010) and Kalla, White, et al. (2005). Among different method of experimental design, the one which is widely used in Oil and Gas engineering is the Full Factorial Design. Full Factorial Design (later on will be written as only "factorial design" for simplification) is probably the most intuitive form of experimental design. It is used to investigate the effect of two or more independent variables on one dependent variable. These independent variables are called "factors". Bose and Kishen (1940) and Plackett and Burman (1946) provide information on how to define combination of factors in order to properly evaluate the relationship between them. Itotoi in his publication "Managing Reservoir Uncertainty in Gas Field Development Using Experimental Design" (Itotoi et al., 2010) demonstrate how to use experimental design to calculate the probability of Connected Gas In Place (CGIP) and Estimated Ultimate Reserves (EUR). The idea is using experimental design method to create a set of simulation inputs resulting in a response equation. Monte Carlo simulation can be peformed on the response equation to gives a probability distribution of the parameters (Anggraini, Hereyanto., & Bhakti, 2017; El-Ghalayini, 2016; Van Elk, Gupta, Wann, et al., 2010).

The P field LLP initiative can be classified as an engineering or technical project (Larson & Gray, 2011). This kind of project requires investment; therefore the decision to execute the project mainly relates to its economic. It gives birth to Engineering Economy in which time value of money serves as a main concept (Prayogo, 2017). NPV, IRR and POT have been normally used by the company to evaluate engineering project economics.

RESEARCH METHODOLOGY

The study methodology consists of several stages as the following:

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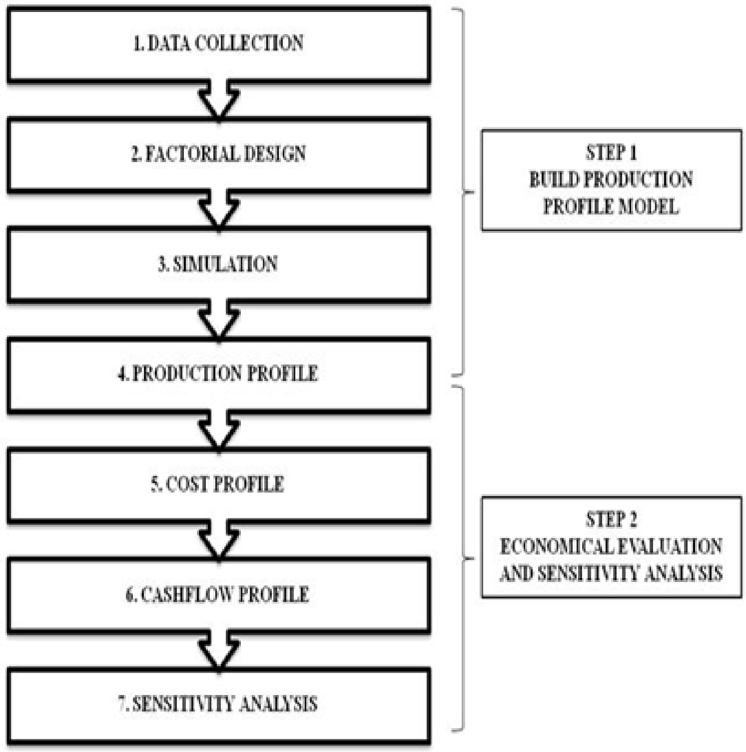

FIGURE 2. Study Methodology

Data Collection

Among the six platforms to be evaluated, Platform 2 has the most production and Connected Gas In Place (CGIP). This study shall used data from the platform.

Factorial Design

Full Factorial design is used to evaluate the relationship between several uncertain data on the production profile. It's essentially a form of an experimental design. It was selected among different kinds of experimental design technique as it is the most widely used, requires not too many runs and the response surface is expected to be not quadratic (Cavazzuti, 2012). This step will produce a list of input combination to be used on the simulation. This study used Minitab software to create the list, however other commercial software can perform the same action.

Simulation

The simulation will be performed on a numerical simulator called Gaspal which has been internally approved by the company for production profile forecasting (Mesdour, 2012). The simulator works by applying Nodal Analysis (Brown, 1984) and Gas Material Balance (Society of Petroleum Engineers, 1997) concept to calculate platforms production profile. The simulator has been used to develop production forecast by the P field operator since 2012.

Production Profile

The simulation will produce a production profile model. Monte Carlo (Evers & Jennings, 1973) technique is then used on the model to create a range of production profile. This range of production profile is the main component for the revenue or income assumption of the LLP project.

Cost Profile

The information of the cost profile is gathered from the pilot project and internal evaluation.

Cashlow Profile

Having the production and cost profile, Cashflow profile can be generated. Economic indicators such as NPV, NPV at 11% discout rate (NPV11) and POT were calculated to provide information whether the project is lucrative or not.

Sensitivity Analysis

A sensitivity analysis was performed to evaluate the impact of capital expenditure (CAPEX), fuel gas, gas price and discount rate changes to the project economics.

RESULTS AND DISCUSSION

Data Collection

Platform 2 data is collected from routine measurement and engineers evaluation. 8 parameters were listed from a total of 16 wells. These parameters are those required for

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simulation. They are Gas Production Rate (Qg), Wellhead Flowing Pressure (WHFP), Wellhead Flowing Temperature (WHFT), Condensate to Gas Ratio (CGR), Water to Gas Ration (WGR), Current Reservoir Pressure (Pres), forecasted Reservoir Pressure in 2021 (Pres 2021); the expected LLP project start-up date; and forecasted Gas Production Rate in 2021 (Qg 2021). Appendix A summarizes all the parameters.

TABLE 1. Platform 2 data set

Well	Qg	WHFP		WHFT	CGR	WGR	Pres	Pres 2021	Qg 2021
	mmscfd	barg	psia	deg C	stb/mmscf	stb/mmscf	psia psia	mmscfd	
2-1	5.3	13	206	79	0	57	583	421	0
2-2	1.9	13	203	44	0	1	1213	930	0
2-4	0.4	12	186	51	93	121	730	679	0.5
2-5	6.1	13	203	80	0	7	673	560	3.5
2-6	0.5	13	196	50	160	5	670	640	0.4
2-10	0.0	11	165	31	0	0	400	400	0
2-11	1.9	13	203	44	0	1	905	804	0.7
2-12	1.9	14	210	52	20	42	1198	1129	0.4
2-13	0.4	22	329	32	0	0	1383	1383	0
2-16	0.7	13	203	50	0	11	1504	1195	0.4
2-17	3.1	12	186	65	0	14	746	746	0
2-18	0.7	12	187	58	1	4	667	667	0
2-19	2.1	21	315	62	1	40	1254	981	0
2-20	3.3	12	189	77	3	13	962	912	0
2-21	1.0	12	192	48	3	13	508	506	0
2-23	0.2	11	180	39	0	1	1575	1575	0

Factorial Design

Factorial designs built in this study will evaluate the relationship of 4 input factors to the output which are LLP project gain; or simply Gain; and the decline factor (d) of the production profile. The factors are CGIP, Abandonment Pressure (Pab), Minimum gas production rate cut-off (Qg min) and gas production rate increase due to LLP (ΔQg). While Gain and d is determined as output as they are required to create as simplified decline curve (Arps, 1945) based production profile.

The 4 factors chosen as factorial design input is based on source of production profile uncertainties learned during pilot project evaluation and author experience in the field. ΔQg and Pab are results of nodal analysis. The Nodal Analysis is a sophisticated evaluation which requires a lot of data ;reservoir pressure (Pres), Bottom-hole Flowing Pressure (Pwf), Factor of Pseudo-forcheimer inflow performance (A & B), WHP, Tubing Length (L), Fluid density (ρ), Velocity inside tubing (v), friction factor (f) and tubing diameter (d); with uncertainties. Therefore the results will accumulate all of the uncertainty. As it is an accumulation, it has a high degree of uncertainty thus becomes important to be properly evaluated. CGIP is calculated based on Pres and cummulative production (Gp). The Pres is very difficult to measured and it changes overtime following depletion. It makes the CGIP become uncertain. Based on author experiences on the field; the uncertainty range of CGIP is by +/- 10%. Qg min value is derived only based on observation, and by assumption that at LLP condition, the value should be lower compared to LP condition. Therefore the Qg main is considered to be highly uncertain. Table 2 summarizing the factors of factorial design and their Min and Max values.

TABLE 2. Factorial design factors

Factors	Min	Max
CGIP (Bcf)	180.5	220.6
Pab	0.08	0.11
Qg Min	0.1	0.3
ΔQg	3	5.8

Simulation

Using the factors, a combination of runs were built with the help of Minitab software. These run were then entered to Gaspal simulator to create sets of production profile. Gain and d values were calculated from each of these production profiles . The results is presented in Table 3.

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TABLE 3. Run combinations and gaspal simulation results

Run	CGIP	Pab	Qg min	Qg	Gain (Bcf)	d
1	180.5	0.12	0.3	5.8	10.5	0.190
2	180.5	0.08	0.3	5.8	17.2	0.090
3	180.5	0.08	0.3	3	8.3	0.100
4	220.572	0.08	0.1	5.8	28.8	0.008
5	180.5	0.12	0.3	3	8.8	0.093
6	180.5	0.08	0.1	5.8	21.7	0.051
7	220.572	0.12	0.3	3	13.1	0.027
8	220.572	0.08	0.1	3	14.1	0.016
9	220.572	0.12	0.1	5.8	17.9	0.082
10	220.572	0.12	0.3	5.8	16.9	0.092
11	220.572	0.12	0.1	3	14.7	0.010
12	180.5	0.12	0.1	3	10.8	0.057
13	220.572	0.08	0.3	3	13.3	0.024
14	180.5	0.08	0.1	3	10.9	0.063
15	180.5	0.12	0.1	5.8	12.6	0.149
16	220.572	0.08	0.3	5.8	25.1	0.028

Having the simulation results, the response equation can be generated with the help of Minitab software. The results are the following : Gain = 55.54 - 0.4023 CGIP - 563.2 Pab - 267.7 Qg min - 10.13 Qg + 4.276CGIP*Pab + 1.472 CGIP*Qg min + 0.1150 CGIP*Qg + 2503 Pab*Qg min + 90.57 Pab*Qg + 37.37 Qg min*Qg - 13.93 CGIP*Pab*Qg min - 0.9470 CGIP*Pab*Qg - 0.2496 CGIP*Qg min*Qg - 408.9 Pab*Qg min*Qg + 2.562 CGIP*Pab*Qg min*Qg

Gain = 55.54 - 0.4023 CGIP - 563.2 Pab - 267.7 Qg min - 10.13 Qg + 4.276CGIP*Pab + 1.472 CGIP*Qg min + 0.1150 CGIP*Qg + 2503 Pab*Qg min + 90.57 Pab*Qg + 37.37 Qg min*Qg - 13.93 CGIP*Pab*Qg min - 0.9470 CGIP*Pab*Qg - 0.2496 CGIP*Qg min*Qg - 408.9 Pab*Qg min*Qg + 2.562 CGIP*Pab*Qg min*Qg

The response equation were then tested againts the simulation results using linear regression. Figure 3 shows the plot between response equation and simulation result for Gain and d. The figure shows that the match is very good with R^2 = 0.9994 for Gain and R^2 = 0.9999 for decline rate (d).

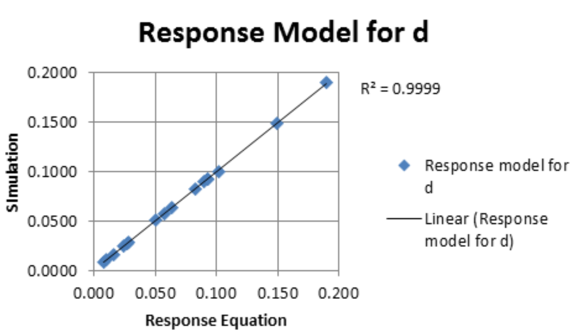

FIGURE 3. Structural relations among the main constructs

Production Profile

Having the results of the response equation, the next step is to build a production profile based on those results. The profile can be built by applying Qg (which was used as the model input) and d (result of response equation) to decline curve equation as follows:

$$q_t = q_0 * e^{-dt} \tag{1}$$

Where :

q_0 = initial gas reta at t = 0

q_t = gas rate at t = t

d = decline rate per month

t = time in month

The profile is then compared to the ones generated by GasPal simulator. Figure 4 compares the results of Gaspal (straight line) and the model (dotted line).

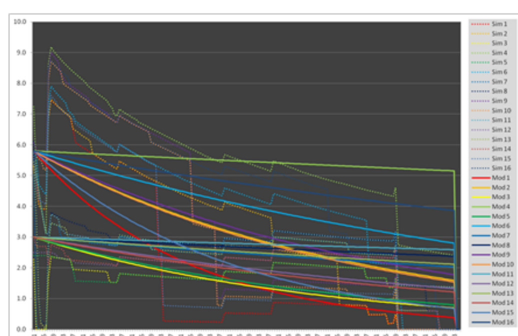

FIGURE 4. Comparison between production profile generated by gaspal simulator and model

Analysing Figure 4, the model gives siginificant differences compared to the simulated model on cases with max Qg,

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while it give acceptable representation for the cases of min Qg. It is due to the death of several wells in the baseline which is impossible to mimic by the model govern only by 3 variables. However, the cumulative gain is respected. Author believe that the model can still be used by keeping in mind that its production profile is pessimistic in the early timesteps and gradully become more optimistic in the longer step. This situation will actually gives a more cautious economic evaluation. The economic calculated from the model will be lower than if they were calculated using simulated profile in cases with max Qg.

To perform an economic evaluation, it requires two alternatives at the minimum. On the perimeter of this study, the first alternative is a base case, in which the field produce without LLP project on any of the 6 remaining platforms. While the second alternative is where LLP project is deployed in platform 2. Additional alternatives may be created in the future for other platform using the method proposed by this study. The economic evaluation will be limited only until 2040 following production forecast availability. The new method proposed in this study will be applied only on platform 2 LLP project, while the base case only assume one scenario which was extracted from the company long term production forecast.

Production profile model allows direct application of Monte Carlo simulation. 1000 simulation were performed to build an cumulative distribution frequency for both Gain and d. It was done using Crystall Ball™ plug ins available on Microsot Excel. The results are shown in Figure 5.

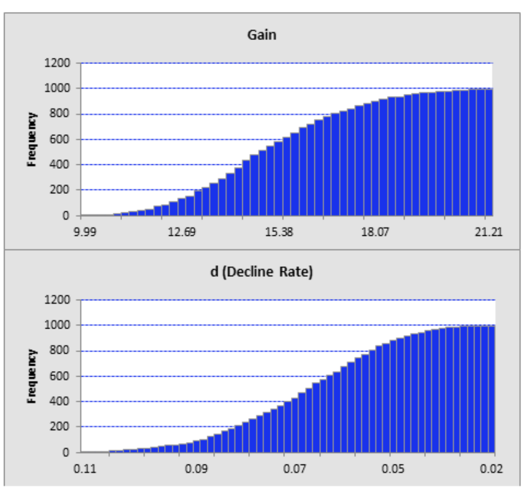

FIGURE 5. Cumulative distribution function for a) gain and b) decline rate (d)

TABLE 4. Percentiles for gain and d from monte carlo simulation

Percentiles	Gain	d
P100	9.88	0.143
P90	12.45	0.088
P80	13.30	0.080
P70	13.98	0.074
P60	14.45	0.068
P50	14.94	0.064
P40	15.59	0.059
P30	16.22	0.055
P20	17.03	0.050
P10	18.15	0.044
P0	22.05	0.022

The values of Gain an d are then paired on its related percentile. The results is available in Table 4. Production profile uncertainty therefore can be quantified by applying each pair to the decline curve equation (Equation 1). Taking the P10, P50 (base) and P90, the production profile comparison range can be observed in Figure 6. These profiles will serve as a basis for cashflow calculation.

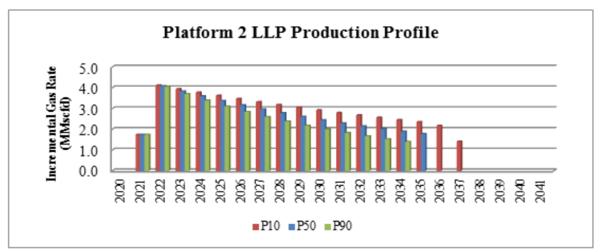

FIGURE 6. Platform 2 LLP production profile

Cost Profile

Cost profile for each platform is divided into two parts; fixed cost and variable cost. The fixed cost is normally associated with the capital expenditure (CAPEX) or initial investment of the project. Variable cost is associated with the operational expenditures (OPEX). Together they create the project cost profile. The fixed cost for the platform 2 LLP Project consists of construction cost and booster compressor price. The construction need to be paid in 2020 while the booster compressor is to be purchased in 2021. The value of this fixed cost is taken from previous project information and is presented in Table 5. It is need to be noted that for the base case (of the economic evaluation), there are no CAPEX as there is no new project or investment.

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TABLE 5. Fixed cost assumption breakdown

Description	Cost Estimate (kUS$)
Structure	575.29
Piping	1737.1
Mechanical	801.17
Instrumentation	1152.09
Electrical	715.98
Commisioning	335.89
Marine Spread	3883.18
Descriptio	n Cost Estimate (kUS$)
TECHNICAL COST	9200.71
EMS CPY	1844.31
Contingency	679.98
Provision for Detail Engineering	750
CONSTRUCTION COST (1)	14279.6
Booster Compressor	1800
Mobilization	254.84
Certified Lifting Equimpnet	69.3
BOOSTER COMPRESSOR (2)	2124.14
TOTAL (1+2)	16403.74

The variable cost or OPEX for a gas field producing through platforms consists of several elements. Table 6 summarises the assumption used for each element to calculate the variable cost. Routine cost related to cost of personnel, each platform is operated by 4 operators. Logistic includes cost of material, transport, fuel etc which are required for every visit. 100 visits are scheduled for the whole field each year. Maintenance cost is assumed to be 0.5% from the cost of platform construction for each year or 145000 US$ per year. 0.7 litre of corrosion inhibitor is added for every 1 MMSCF produced gas, or equal to 1.47 US$ per MMSCF. 0.5 litre of other chemical is also added for every 1MMSCF produced gas, equal to 1.25 US$ per MMSCF. Indirect cost is assumed to be 40% of the direct case (all mentioned above). It is based on statistics of cost allocated to "P" field on elements which is budgeted in lumpsum basis for the whole company. These elements include well intervention and processing cost. However, for the platform 2 LLP project perimeter, none of the elements mentioned above are applicable. The only variable cost is essentially the cost of fuel needed to operate the compressor engine which equal to 0.5 MMSCF per day. This value need to be multiplied by the gas price of the corresponding year, thus the cost will change as a function of the gas price.

TABLE 6. Variable cost assumptions

Elements	Assumption
Routine Cost	40000 US$ per person
Personnel	4 person per platform
Logistics	100 per visit per person
Visits	100 per year
Maintenance	145000 US$
Corr Inhibitor	1.47 per MMSCF
Other Chem.	1.25 per MMSCF
Indirect Cost	40% of the direct cost

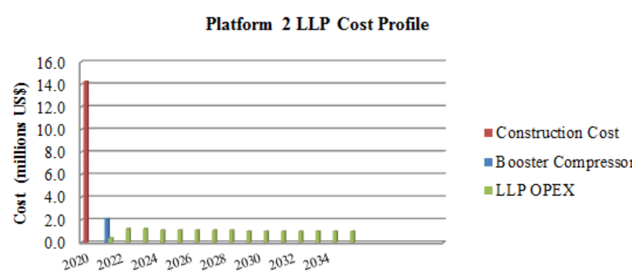

FIGURE 7. Platform 2 LLP cost profile

Having the information of fixed and variable cost, author was able to developed the Platform 2 LLP project cost profile as presented in Figure 7. The reference gas price for this profile has been defined internally by the company. It is $6.56 /MMBTU for 2018–2021, and $5.07 /MMBTU for 2022 onwards. Assuming 1 MMBTU = 1 MMSCF. This price figures will also be used for the cash flow profile.

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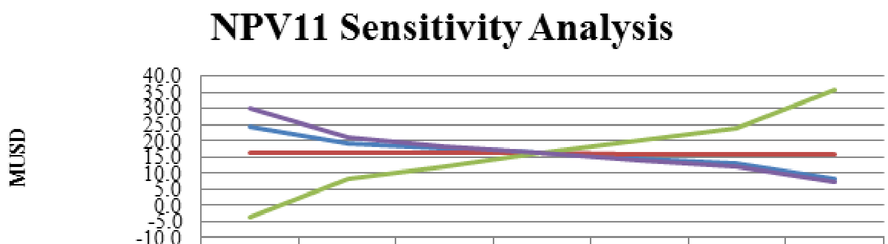
Cashflow Profile

Cashflow analysis can be conducted having the production and cost profile (Chang, Ouyang, Teng, Lai, & Cárdenas-Barrón, 2019). The profile is presented in Figure 8. The figures shows cashflow of the project at three different production scenario, as well as its cumulative cash flow. The project will generate NPV between 11.7–21.8 MUS$ at discount rate equal to 11%, with the base case of 16.2 MUS$. The green area in the graph were able to illustrated the uncertainty of the cumulative cashflow. However, observing that even at the MIN case the project still generate positive NPV11, decision maker can be almost 100% certain that the project is profitable. It has been also evaluated that the IRR of the project is between 27%-34%, which again shows how lucrative the project is.



	-50%	-20%	-10%	Base	10%	20%	50%
CAPEX	24.3	19.4	17.8	16.2	14.5	12.9	8.1
Fuel Gas	16.3	16.2	16.2	16.2	16.1	16.1	16.0
Gas Price	-3.7	8.2	12.2	16.2	20.1	24.1	36.0
Discount Rate	30.0	20.9	18.4	16.2	14.1	12.2	7.3

FIGURE 8. Platform 2 LLP project NPV11 sensitivity analysis

Figure 8 illustrated how different assumption or changes on CAPEX, Fuel Gas and Discount Rate will not jeopardize the project economic. CAPEX decrease to -50% will increase the project NPV11 up to 24.3 MUSD or about 50% and vice versa, shows a linear correlation between CAPEX to the NPV11 value. Discount rate has a more important impact to the NPV11 as if its increases by 50% to 16.5%, the project will loose 53% of its NPV11 value. While Fuel Rate effect can be neglected as it will only cause +/- 0.1 MUSD change to the NPV11. On the other hand, Gas Price value may cause the project to be ineconomic. Should gas price fell 50% to only $3.3/MMBTU in 2020 and $2.5/MMBTU in 2021 onwards, then the project will not be economic. This information will give alert to the company and decision maker to keep a close watch on the gas price forecast before sanctioning the project.

Economic Evaluation

Having integrated the uncertainty of the production profile on platform 2 economic evaluation, stakeholders may consult directly the economic indicators shown in Table 7. The indicators shows encouraging NPV0, NPV11, IRR and Payout value for Min, Base and Max case. In addition to that, a sensitivity analysis provided in Figure 8 will allow decision maker to evaluates uncertainty related to different external aspects: CAPEX, Fuel Gas, Gas Price and Discount Rate. Therefore, author believes that this research has been able to answer the first objective of the study: to develop a production profile which properly integrates important uncertainties to be used in economic evaluation.

TABLE 7. Platform 2 LLP project economic indicators

Parameter	Min (P90)	Base (P50)	Max (P10)
NPV0 (MUSD)	32.9	44.6	60.4
NPV11 (MUSD)	11.7	16.2	21.8
Payout Time	4y & 3m	4y & 1m	3y & 8m
IRR (%)	27	30	34

To conclude the economic evaluation, the Platform 2 LLP project economic indicators has to be compared with another alternatives. Therefore, the second objective ;to rank the economical feasibility of the 6 platform based on the new economic evaluation method; can be achieved. It is done by generating production profile for each remaining platform using the derived response equation. Sets of different CGIP and ΔQg assumption were prepared for each platform to be used as input, while there are no differences in the Pab and Qgmin assumptions. The result for Gain is presented in Table 8.

Table 8 indicates that the production profile model is not compatible with the 5 remaining plaforms. All gain figures (except for P10 case of Platform 1) show negative values. It is invalid as technically, gain value should always be positive. Author conclude that as the model was derived from Platform 2 range of inputs, it will not apply for different input range. Therefore dedicated model need to be developed for each platform, using their own input range.

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TABLE 8. Gain model results of all platforms

Platform	CGIP			ΔQg			Gain		
	Min	Mid	Max	Min	Mid	Max	P90	P50	P10
1	71.5	89.4	111.8	1.7	2.2	2.9	-3.5	-0.1	1.2
2	180.4	200.5	220.5	3.0	4.1	5.8	12.5	14.9	18.2
3	18.2	22.7	28.4	3.3	4.4	5.9	-11.3	-9.0	-7.1
6	9.1	11.4	14.2	2.6	3.5	4.7	-11.2	-9.3	-7.4
7	18.6	23.2	29.0	1.6	2.1	2.8	-7.4	-6.1	-4.5
8	30.1	37.6	47.0	6.3	8.4	11.2	-13.8	-10.7	-8.2

However, while working on platform 2 economic evaluation, Author observed two things that may quickly hints whether having the LLP project on the platform will be economics or not. The first thing is that the Platform B will achieve Break Even Point (BEP , when the cumulative cashflow starting to be positive) in 2024 or after producing 4.9 Bcf. Second is that the Gain of platform 2 is between 6.2% (min) to 9.1% (max) of the CGIP. Having this information, we can quickly anticipate which of the platform having the potential to be economic: when 9.1% of its CGIP is bigger than 4.9 Bcf. Table 9 shows platform CGIP ranking. It shows that only Platform 1 has the potential to be economics. Therefore author recommends to perform investment analysis using the method described in this study as a way forward only on platform 1.

TABLE 9. Platform CGIP ranking

Platform	CGIP	6.2%* CGIP	9.1%* CGIP
2	200.5	12.4	18.2
1	89.4	5.5	8.1
8	37.6	2.3	3.4
7	23.2	1.4	2.1
3	22.7	1.4	2.1
6	11.4	0.7	1.0

In the end, as further works need to be done for the remaining platform, the second objective of the study has not been completed. However the economic evaluation can still be done but only for the two available alternatives : 1) Base case and 2) with Platform 2 LLP project. Table 10 summarizes the result. The base case will generate up to 467.2 MUS$ revenue until 2040, with 50.1 MUS$ cost, which only consist of operational expenses (OPEX). The IRR and POT is unavailable as there are no additional investment. Platform 2 LLP project will provide up to 20% additional revenue but with a 68% increase which mainly consist of Capital Expenditure (CAPEX). The NPV0 and NPV11 value may seem even smaller compared to the base case, with a maximum increase only 14% and 7% repsectively, nevertheless,ones should consider the high IRR of 27-34% which shows how lucrative the project is. Based on the available information, the management should decide to go on with the project, if the budget to cover the cost is available.

TABLE 10. Economic evaluation results

		Alternatives	
Paremeters	Base	Platform 2 LLP	Δ (%)
Cost (MUSD)	50.1	(+)30.9 - 33.9	62-68%
Revenue (MUSD)	467.2	(+)63.8 - 94.3	14-20%
NPV0 (MUSD)	417.1	(+)32.9 - 60.4	8-14%
NPV11 (MUSD)	294.2	(+)11.7 - 21.8	4-7%
IRR	-	27% - 34%	-
POT	-	4 yrs 3 months - 3 yrs 8 months	-

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CONCLUSION

This study is able to conclude on the following:

1. This study has managed to build a production profile than captures uncertainties behind it. It was done by creating a factorial design based model and applying Monte Carlo simulation on it. A range of production profile was produced which serves as an input for the economic evaluation. The method was used to evaluate Platform 2 LLP project concluding that it will generates cummulative cashflow between 30.9to 60.4 MUSD (NPV0) or 11.7 to 21.8 MUSD (NPV11) with IRR ranging between 27 to 34%. Therefore the project is deemed economic.

2. This study is unable to rank the economic feasibility for LLP project on the 6 remaining platforms. The newly developed production profile model is only applicable for platform 2, thus invalid for the remaining 5 platform. However, based on CGIP ranking, only platform 1 is likely to have an economical LLP project. Eventually economic evaluation can only be was performed only on two alternatives: base case and Platform 2 LLP. The result is that the management should decide to go on with the Platform 2 LLP project if the budget to cover the cost is available.

IMPLICATIONS

Evaluating the conclusion above, and considering problems author encountered on the course of the study, several recommendation can be derived as follows:

1. To build production profile model and add Platform 1 LLP project as an alternative to the economic evaluation. Platform 1 is likely to have a lucrative LLP project.

2. Similar approaches need to be performed on all Oil and Gas Project as it will allow better judgment on the project economic as well as raising alert on factors that may challenge the project economically.

REFERENCES

Anggraini, R. M., Hereyanto., & Bhakti, S. (2017). The influence of leadership style and organizational climate on performance Uay Banjarmasin. *International Journal of Business and Economic Affairs*, *2*(5), 297-309. doi:https://doi.org/10.24088/ijbea-2017-25004

Arps, J. J. (1945). Analysis of decline curves. *Transactions of the AIME*, *160*(01), 228-247. doi:https://doi.org/10.2118/945228-g

Bose, R. C., & Kishen, K. (1940). On the problem of confounding in the general symmetrical factorial design. *Sankhyā: The Indian Journal of Statistics*, *6*(9), 21-36.

Brown, K. E. (1984). *The technology of artificial lift methods*. Tulsa, OK: Pennwell Books.

Cavazzuti, M. (2012). *Optimization methods: From theory to design scientific and technological aspects in mechanics*. New York, NY: Springer Science & Business Media.

Chang, C.-T., Ouyang, L.-Y., Teng, J.-T., Lai, K.-K., & Cárdenas-Barrón, L. E. (2019). Manufacturer's pricing and lot-sizing decisions for perishable goods under various payment terms by a discounted cash flow analysis. *International Journal of Production Economics*, *218*, 83-95. doi:https://doi.org/10.1016/j.ijpe.2017.08.020

El-Ghalayini, Y. (2016). The effects of high performance work system on employee attitudes: A study of international organization. *Journal of Administrative and Business Studies*, *2*(5), 248-263. doi:https://doi.org/10.20474/jabs-2.5.5

Evers, J. F., & Jennings, J. W. (1973). How to use monte carlo simulation in profitability analysis. In *SPE Rocky Mountain Regional Meeting,* California, CA.

Gilbert, W. (1954). Flowing and gas-lift well performance. In *Conference at Drilling and Production Practice,* Bangkok, Thiland.

Hutabarat, T., & Senoputra, R. (2017). *Peciko phase 8a re-evaluation*. Balikpapan, Indonesia: Al Mawardi Prima.

Itotoi, I. H., Ojeke, A., Nnamdi, D., Umurhohwo, J., Benjamin, O., & AkaChidike, K. (2010). Managing reservoir uncertainty in gas field development using experimental design. In *Nigeria Annual International Conference and Exhibition,* Jakarta, Indonesia.

Kalla, S., White, C. D., et al. (2005). Efficient design of reservoir simulation studies for development and optimization. In *SPE Annual Technical Conference and Exhibition,* Dallas, TX.

Larson, E. W., & Gray, C. F. (2011). *Project management: The managerial process*. New York, NY: McGraw-Hill Irwin.

Mach, J., Proano, E., & Brown, K. E. (1979). *A nodal approach for applying systems analysis to the flowing and artificial lift oil or gas well*. New York, NY: Society of Petroleum Engineers.

Mesdour, K. (2012). *Sisi nubi gas pal model*. Balikpapan, Indonesia: Koekoesan Publishing.

ISSN: 2414-309X
DOI: 10.20474/jabs-5.2.4

Panti, E., Gempes, M., & Gloria, P. (2018). The mediating effect of risk management strategies on the relationship between attitude constructs and sustainability of banana production in Southern Philippines. *International Journal of Business and Administrative Studies*, *4*(2), 68-77. doi:https://doi.org/10.20469/ijbas.4.10004-2

Plackett, R. L., & Burman, J. P. (1946). The design of optimum multifactorial experiments. *Biometrika*, *33*(4), 305-325. doi:https://doi.org/10.2307/2332195

Prayogo, D. P. (2017). *Introduction to engineering economics*. Surabaya, Indonesia: ITS Publisher.

Society of Petroleum Engineers. (1997). *Petroleum reserves definitions.* Retrieved from https://bit.ly/2Jd53L6 (Accessed on 15 July, 2016)

Van Elk, J. F., Gupta, R., Wann, D. J., et al. (2010). Probabilistic aggregation of oil and gas field resource estimates and project portfolio analysis. *SPE Reservoir Evaluation and Engineering*, *13*(01), 72-81.

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