CERTIFICATION OF APPROVAL

Field Development Cost Forecast in Malaysia

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CERTIFICATE OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project and I hereby state that work submitted is solely my own except the one specified in references. I also take the entire responsibility that the work submitted is not taken from any unspecified sources or persons work.

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Abstract

A Field development project is an early stage of a field cycle. Before any action is carried out there must be a study done to estimate all the cost involved to make a specific project worth to be approved. To achieve this many different software and techniques are applied to minimize investments and maximize the revenue. However, each project has their own requirements to be fulfilled making it harder to use certain software to obtain great result. The E&P industry has worked for years to develop software tools to help integrate various subject matter estimates into a unified model of the business plan for oil and gas assets.

Questor that developed by IHS is one of the tool that involve with cost estimation or in other word a tool that used to forecast the cost for a specific project of a field. It is include with project cost estimation for offshore structures and reduce the time for cost estimation for onshore by analyzing certain components. All these components are being considered before any summary of cost involved is finalized.

1 PROJECT BACKGROUND

1.1 Background Study

The development of the operational facilities for an oil or gas field is the largest investment an operator or a company will make during the lifetime of the field. The field development is the approach to the planning stages where leads to significant savings during later stages of the project life cycle. This early phase embrace from a single well extension to a huge development, from reservoir to market delivery, onshore or in the new deepwater boundary areas, jungle or arctic conditions.

For example, additional infill wells may be drilled, additional fluid handling capacity installed, secondary recovery initiated or compressors re-wheeled. One of the most remarkable projects of this is in the Brent field in the North Sea, where the production facilities have been converted from primarily oil to primarily gas production so that the reservoir can be depressurized. The same goes with a project dealing with different geological or terrain factor such as in Artic Region. Cost forecasting mostly covered by drilling and appraisal stages as offshore drilling represents a substantial part of CAPEX in all operating regions. All these required very detail data planning and field development cost forecast to measure the optimum investment in oil and gas exploration to achieve good profit in return.

1.2 Problem Statement

Current forecasting method for field development which is the earliest stage of oil n gas field production has some missing component that lead to inaccuracy of result obtained. By having this incomplete forecasting technique nearly all company specifically the service company will rush to unexpected solution that will cost them at unexpected cost. Among the elements missing that obviously seen is the absence in inter-dependency between major factors such as reservoir, pipeline, and well behavior and also rig management.

For instance, most of the oil and gas companies apply special modeling software to forecast their cost or pay another company as an advisor or known as consultant to guide them to the most accurate and finest cost forecasting. Current preferred software used to analyze oil and gas project is Questor and it is published by a company named IHS. Questor breaks down the costs into several high level categories such as Topsides, Jackets, Offshore Drilling and Pipelines. Within each category the costs are further broken down by Materials, Fabrication, Installation, Design and Project Management, Insurance and Certification and Contingency. The first step is to select a specific costs database to be used for the project which is linked to the IHS database itself and then the selection of specific parameters required for a certain project.

1.3 Objectives of Project

The objectives of this project are:

The main objective of this project is to manage the current forecasting method by taking one of the factors and to narrow it down till the most specific element and relate it with other factors as well. As for the project the author will do a research about how cost estimation or prediction will affect the project of a field for the later stage.

1.4 Scope of Study

The scope of study will be around the literature review (journals, thesis, and discussion). In general, the scope of study can be divided into two phases whereby the first phase is the study on background environment and the elements for the current software used which is Questor. At this point, research and analysis are both needed to compare the differences and similarities of the essential elements between Questor and other modeling software such as Inpro. Learning on these elements is important as we should aware of which factors are listed in top priority as later to be used in this project as basic features. The second phase is the more likely to collect the data possibly to extract it from the Questor itself and other resources. The data for instance, type of rig and pipelines are the most core elements for this project.

1.5 Feasibility of Project

The project is planned and scheduled to be done completely in a period of at most 8 months. The approach that the author used is by comparing the project that is carried out with proper cost forecasting with the one that has less appropriate forecasting tool. The analysis involves roughly the most basic factors as stated earlier to simulate the optimum result for the cost forecasting designed for a project in field development which is needed to determine the profit for the certain period of time.

2 LITERATURE REVIEW

2.1 Fundamental Theorem of Forecasting

Cost forecasting is not something that we can just look from the past trends. We have to extract from the past observation the concepts, the relationships, the guidelines, from which the future may and within the confidence interval be predicted. Two very important points about the fundamental theorem for cost forecasting are:

1. Credibility is a major element in cost estimating. The credibility a manager gives to a cost forecast is based on the known experience of the cost estimator, or the lack of experiences if a completely new subject is considered and the seriousness of the cost estimator performing his/her job.

2. Compare the forecast and reality to improve our predictive capabilities. It is not pleasant to admit the gap between the forecast and the reality but once we seek for the explanation of how it is happen is the best way to improve ourselves

3. Capital & Operational Expenditures :

   Capital cost and operational cost estimations include historic and forecast data on leasing cost, operational cost, development cost, appraisal cost, exploration capital, transportation and pipeline infrastructure cost, processing cost and abandonment costs.

   Capital expenditure acquires or produces an asset whose value continues to be used (or consumed) over several financial years.

Operational expenditure refers to any cost on things whose value is used up within the same financial year. It is sometimes referred to as revenue costs because they are normally met by the income (or revenue) that a business earns in the current financial year and it can either be recurrent.

2.2 Forecasting Techniques

Forecasting techniques can be separated into two categories; qualitative and quantitative. Qualitative forecasting method is generally used when there is little or no data available for example, a new product. This method is less structured than the quantitative method. A judgment forecasting method elicits management's opinions to provide a forecast. The Delphi method is a formalized iterative forecasting technique that can be used to obtain executive opinions. The executives or managers use their industry knowledge, past industry experience, and intuition, to provide forecast estimates. Another qualitative method used, especially with a new product, is historical analogy

Quantitative forecasting methods use historical data to predict the future, so a lot of data must be available. These quantitative forecasting techniques can be further categorized into either time series or fundamental methods. Time series forecasting methods only use the time series data itself, and not any other data, to build the forecasting models. These time series techniques isolate and measure the impact of the trend in seasonal and cyclical time series components.

2.2.1 Factors Affecting Cost Forecast

An offshore oil field development involves several variables that affect the operational schedule involved in its management. Some of them are: drilling schedule, rig allocation, facilities acquisition, number and location of wells, rate of production decline, water and/or gas injection. All these variables are usually used as input to a reservoir simulator that generates a forecast of the production profile constrained to several assumptions. In this way, the production engineer has to consider several theories to achieve the best guess for the field development problem under study.

Stated below are the factors that should be considered before predict the cost for field development:

Offshore Cost Estimation:

- Topsides: from simple wellheads to complex drilling, production, and quarters (DPQ) platforms.
- Jackets: lightweight structures and conventional 4, 6 and 8 legged jackets, caissons and guyed towers.
- Gravity Based Structures: options for conventional condeep and slimline monotower designs.
- Pipelines: infield flowlines, export pipelines, multiple riser types and tie-in options.
- Offshore Loading Buoys: CALM Buoys, SALMs and Floating Loading Platforms with an option for storage.
- Floaters: options include Semis, FPSOs, Spar Buoys and Tension Leg Platforms (TLPs) mini Tension Leg Platforms (TLPs).
- Drilling: options include fixed or mobile drilling rigs, multiple well profile types and multilaterals
- Subsea: includes for templates, clusters, manifolds, flowlines and risers.

Onshore Cost Estimation:

- Wellsites: manifolding, equipment and flowlines.
- Drilling: various types of rig, multiple well profile types and multilaterals.
- Facilities: options for manifold stations, gathering stations and production facilities with full oil and gas processing.
- Terminals: options for inland and coastal terminals including storage and export systems.
- Pipelines: infield flowlines and export pipelines with options for different terrains, crossings and booster stations.
- Infrastructure: construction camps, roads, airstrips, buildings.

2.2.2 Questor Parameters

The following parameters are required as an input to Questor:

- Reserve volume
- Reservoir depth
- Reservoir pressure
- Solution gas-oil ratio
- Water depth
- Fluid gravity
- Estimated ultimate recovery per well
- Average well productivity
- Distance to shore

2.3 USGS Circum-Arctic Oil and Gas Resource Appraisal (CARA)

2.3.1 Cost Adjustment (Artic Region)

1. Drilling rig:

(a) Consider the option and added expense of using a 'fourth generation' drilling rig

(b) Change the floating bare rig unit cost by 10 %

(c) Change the transportation cost by 10 %

(d) Increase the number of drilling days by 15 % to allow for the extra expense of site preparation

(e) Add logging days equal to the number of wells expected to be drilled

(f) Make the cost of Design and Project Management approximately equal to 10 %of the total drilling cost.

2. Topsides (oil processing facility on top of floating vessel):

Increase the material cost by 25 %

3. Booster pumps:

(a) Install a pump capable of sustaining a flow of oil for approximately every 200 km or more as defined by the onshore oil booster pump scheme

(b) Add the cost of cable at the rate of $100/m

(c) Calculate the number of days for cable installation by dividing the length of the pipe in km by 4, and introduce the cable installation cost (possibly $200,000/day)

(d) Make the Design and Project Management Cost equal to 10 percent of the total cost.

4. Ice management:

Use the 'special item' in the Field/Project cost under the 'Offshore' tab of the Total Operating Cost Summary for adding possibly as much as $500,000,000 per year.

5. Pipelines:

(a) Insulate all offshore pipes in water depths of more than 200 m

(b) Bury pipes where water depths are less than 200 m to avoid scouring by ice berg

(c) Insulate onshore pipe.

For Artic Region, there are several adjustments need to be done in term of cost estimation because of the unique operating conditions and ice management concerns that impact the initial resource development.

3 METHODOLOGIES

Data or information gathering is the most important part for the whole project. The data are required from other parties or resources since it cannot be created by our own. It should be reliable from the trusted resources corresponding to the market demands and the current technology. In this project most of the data will be extracted from the Questor itself. The remaining will be obtained by means of the discussions and the journal posted by some of the service company.

Data selection is the next stage for the project progress. All the data acquired will be chosen depending on the certain criteria. For this project, the author will select the basic and core element to be set in the software later. The purpose of choosing limited element are because of the project feasibility time frame is at most 8 months and more detailed and research should be gone through by collaboration of several people or researcher.

Questor Methodology:

1. Develop resource cost curves.

2. Make a number of runs with Questor using a range of values for each of the following variable (Reserve volume, Well productivity, Reservoir/drilling depth, Water depth, Distance to shore)

3. Use results from the runs to develop statistical cost functions.

3.1 Project Activities

- Reading journal and published papers on the area of study (OnePetro, SPE, Knovel, Octopus and etc)
- Study on the topic of cost estimation, early phase of development and cost forecasting.
- Study on the latest software used to analyze process simulation and economic impact for instance Questor and Inpro.
- Review and study on the software manuals/tutorials.
- Carry out the analysis (using software).
- Discuss on the results obtained with supervisors, superiors, and senior lecturers/staffs, experts.
- Improve on the analysis to get better results or to get a further result on the investigation.
- Continue on Questor familiarization.
- Doing comparison between international and in Malaysia cost estimation for field development.
- Requesting real field development report from PCSB Sarawak Operations (SKO) to study about cost forecasting in Malaysia.
- Attending IHS Seminar about Petroleum Economics and Policy Solutions (PEPS)

3.2 Gantt Chart

Table 6: Project timeline

No	Detail/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Topic selection/confirmation														
2	Preliminary Research Study														
3	Project Flow Planning														
4	Submission of Preliminary Report														
5	Study on Questor														
7	Acquiring Input Data														
8	Economy Analysis														
9	Report preparation														
10	Submission of Interim Report														
11	Final Oral Presentation														

Table 7: Key Milestone

	1st Semester				2nd Semester			
Milestone	**Feb**	**Mar**	**Apr**	**May**	**June**	**Jul**	**Aug**	**Sept**
Completion of topic selection								
Completion of field development analysis								
Completion of economy analysis								
Report documentation								

4 RESULTS AND DISCUSSION

4.1 Results

All the results obtained for this project is basically have been improved or there are several assumptions being added as for the real data involved in a real operation is confidential and it is not easy to acquire it. The author had already run 2 project for the questor which the first one are the average of field development for the whole Malaysia operation and for the second project is total for Bintulu operation conducted by PCSB SDN. BHD (D35, Bayan, D18, J4 and Temana). The results shows later mostly presented in production achievement of respective project.

Table 1: Average Malaysia Production:

Recoverable Reserves	50.7 MMbbl
Gas Oil Ratio	3750 scf/bbl
Reservoir Depth from LAT	1310 m
Reservoir Pressure	140 bara
Reservoir Length	3.18 km
Reservoir Width	1.59 km
Water Depth	38.4 m
Oil Density @ STP	35.2 ° API
Initial Water Cut	10 %
Gas Molecular Weight	31.1
CO2 Content	8 %
H2S Content	0 ppm
Productivity	(Medium) 16 MMbbl/well
Peak Well Flow	(Medium) 6 Mbbl/D
Distance to Operation Base	120 km
Distance to Delivery Point	120 km
Maximum Drilling Stepout	3 km
Maximum Ambient Temperature	33° C

Figure 1: Daily Production Profile

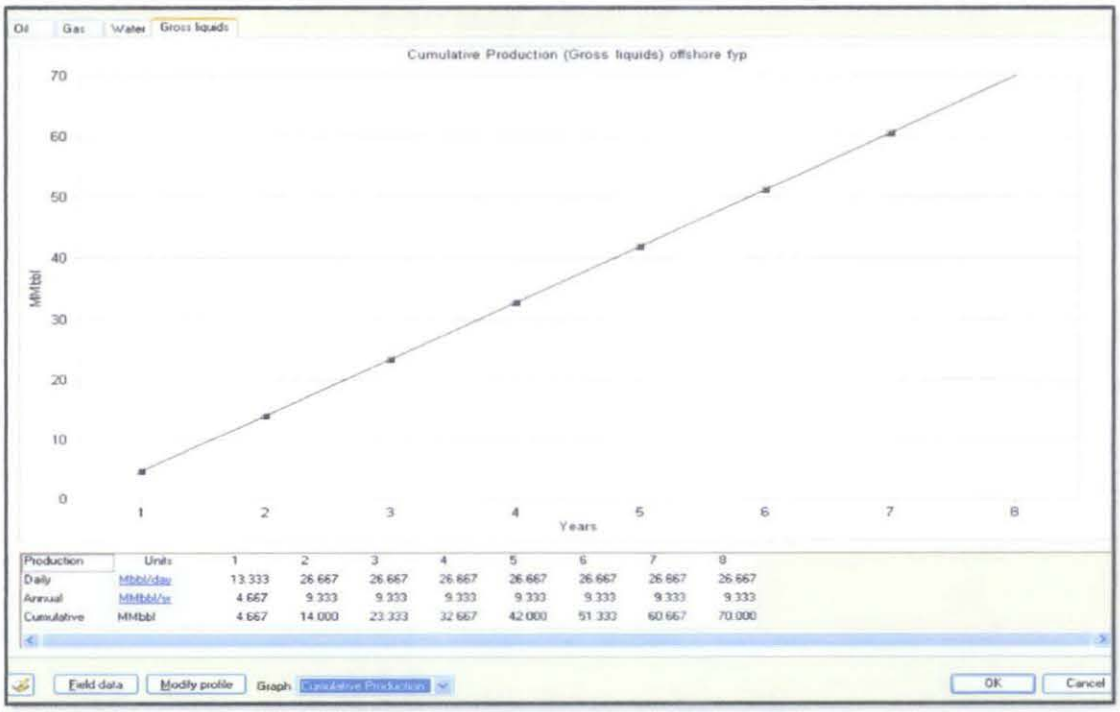


Figure 2: Cumulative Production Profile

Design Flow Rates:

Peak Daily Average	24 Mbbl/day
Design Factor	1.1
Oil Production Flowrate	26.4 Mbbl/day
Associated Gas Flowrate	98.9 MMscf/day
Gross Liquid Flowrate	29.3 Mbbl.day
Water Injection Capacity Factor	1.1
Water Injection Flow (1.1 x gross liquid rate)	32.3 Mbbl/day
Gas Injection Flowrate	98.9 MMscf/day

Table 2: Bintulu Cluster Production:

Recoverable Reserves	50.7 MMbbl
Gas Oil Ratio	3750 scf/bbl
Reservoir Depth from LAT	1310 m
Reservoir Pressure	140 bara
Reservoir Length	3.18 km
Reservoir Width	1.59 km
Water Depth	38.4 m
Oil Density @ STP	35.2 ° API
Initial Water Cut	10 %
Gas Molecular Weight	31.1
CO2 Content	8 %
H2S Content	0 ppm
Productivity	(Medium) 16 MMbbl/well
Peak Well Flow	(Medium) 6 Mbbl/D
Distance to Operation Base	120 km
Distance to Delivery Point	120 km
Maximum Drilling Stepout	3 km
Maximum Ambient Temperature	33° C

(*Using the same value of data as the previous project*)

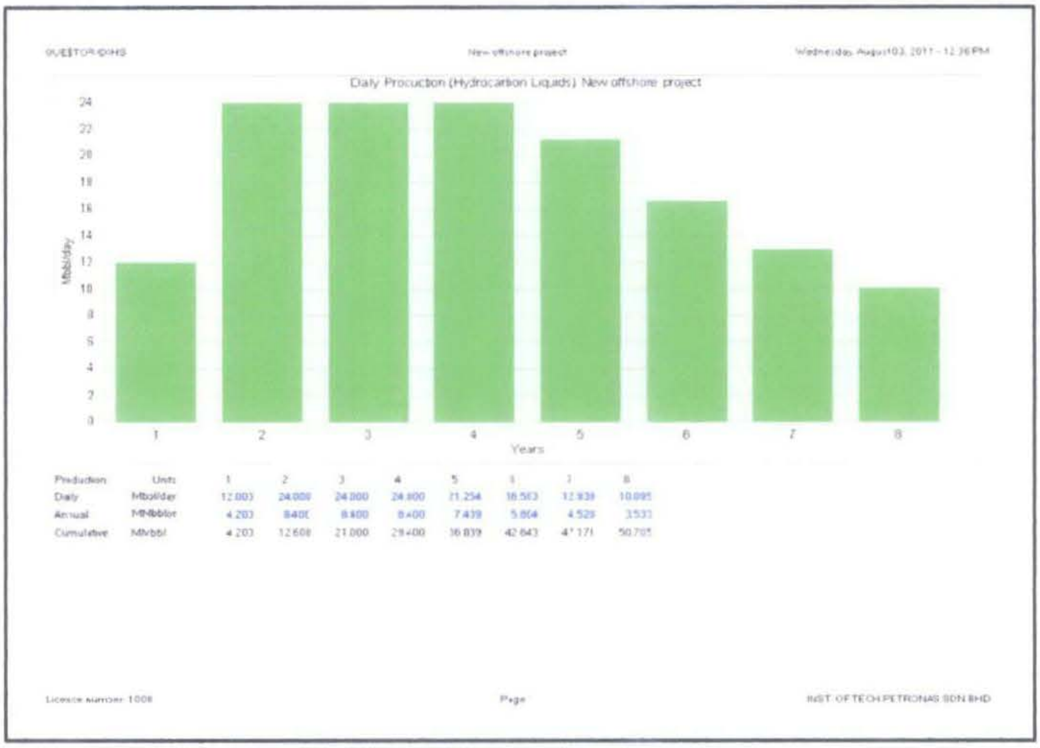


Figure 3: Daily Production Profile (Bintulu)

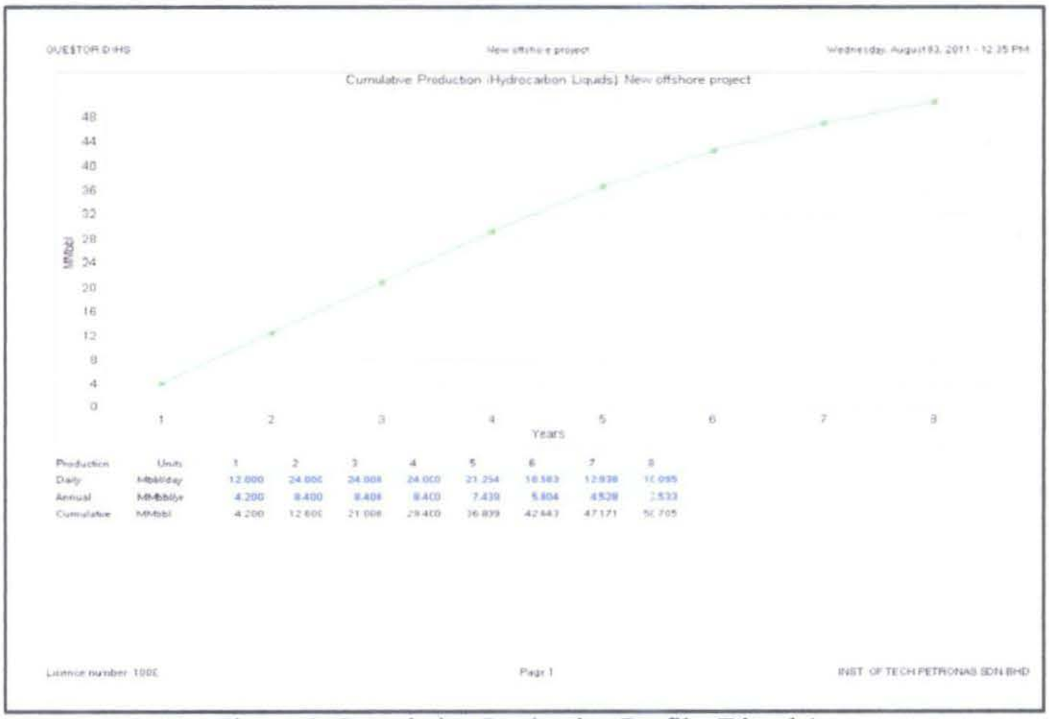
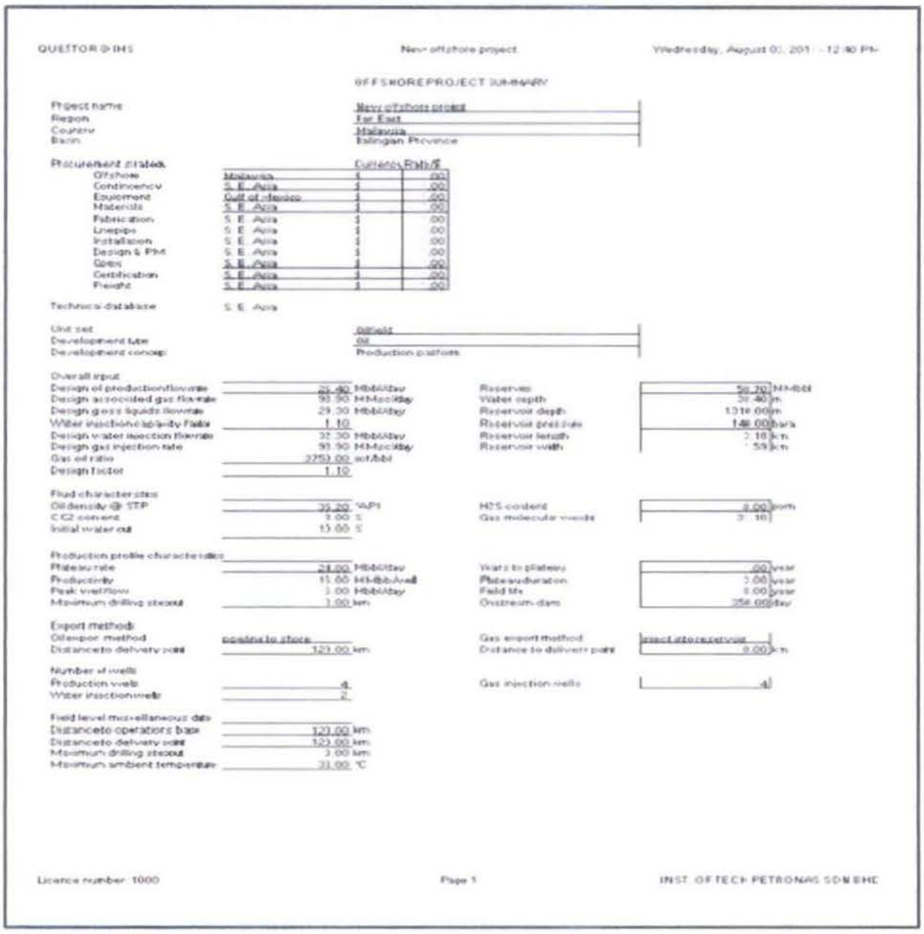


Figure 4: Cumulative Production Profile (Bintulu)

Design Flow Rates:

Peak Daily Average	24 Mbbl/day
Design Factor	1.1
Oil Production Flowrate	26.4 Mbbl/day
Associated Gas Flowrate	98.9 MMscf/day
Gross Liquid Flowrate	29.3 Mbbl.day
Water Injection Capacity Factor	1.1
Water Injection Flow (1.1 x gross liquid rate)	32.3 Mbbl/day
Gas Injection Flowrate	98.9 MMscf/day

Since the results for both projects are almost similar, it is sufficient to generate one summary for both projects. The summary consists of several data such as field life and on stream days and also the parameters listed at the table above.



QUESTOR IHS — New offshore project — Wednesday, August 03, 2011 - 12:40 PM

OFFSHORE PROJECT SUMMARY

Project name	New offshore project
Region	Far East
Country	Malaysia
Basin	Balingian Province

Procurement strategy

		Currency	Rate/$
Offshore	Malaysia	1	.00
Contingency	S. E. Asia	1	.00
Equipment	Gulf of Mexico	1	.00
Materials	S. E. Asia	1	.00
Fabrication	S. E. Asia	1	.00
Linepipe	S. E. Asia	1	.00
Installation	S. E. Asia	1	.00
Design & PM	S. E. Asia	1	.00
Opex	S. E. Asia	1	.00
Certification	S. E. Asia	1	.00
Freight	S. E. Asia	1	.00

Technical database: S. E. Asia

Unit set	Oilfield
Development type	Oil
Development concept	Production platform

Overall input

Design oil production flowrate	26.40 Mbbl/day	Reserves	50.20 MMbbl
Design associated gas flowrate	98.90 MMscf/day	Water depth	39.40 m
Design gross liquids flowrate	29.30 Mbbl/day	Reservoir depth	1316.00 m
Water injection capacity factor	1.10	Reservoir pressure	148.00 bars
Design water injection flowrate	32.30 Mbbl/day	Reservoir length	2.18 km
Design gas injection rate	98.90 MMscf/day	Reservoir width	1.59 km
Gas oil ratio	3750.00 scf/bbl		
Design factor	1.10		

Fluid characteristics

Oil density @ STP	35.20 °API	H2S content	0.00 ppm
CO2 content	3.00 %	Gas molecular weight	[illegible]
Initial water cut	15.00 %		

Production profile characteristics

Plateau rate	24.00 Mbbl/day	Years to plateau	.00 year
Productivity	15.00 MMbbl/well	Plateau duration	3.00 year
Peak well flow	3.00 Mbbl/day	Field life	8.00 year
Maximum drilling stepout	3.00 km	Onstream days	358.00 day

Export methods

Oil export method	pipeline to shore	Gas export method	inject into reservoir
Distance to delivery point	123.00 km	Distance to delivery point	0.00 km

Number of wells

Production wells	4	Gas injection wells	4
Water injection wells	2		

Field level miscellaneous data

Distance to operations base	123.00 km
Distance to delivery point	123.00 km
Maximum drilling stepout	3.00 km
Maximum ambient temperature	33.00 °C

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4.2 Discussion

Both results show that at the year 1, the production is quite low which is 13.333 Mbbl/day for average Malaysia and 12.0 Mbbl/day for Bintulu Cluster. The trending for both projects is similar when the production going up and maintain the same for the next 3 years which is 26.667 Mbbl/day and 24 Mbbl/day for average Malaysia and Bintulu Cluster respectively before the the change in the graph shows the declination for the fourth year which make the production decrease consistently for the next several years.

All these data for the field production is run for offshore while on the onshore side there will be some changes for the parameters used. During the process of running the simulation there are also various elements that should be considered before completing the project. The elements are exporting method which is in this project the input inserted is pipeline to shore, procurement strategy that consists of contingency, equipment used, material used, fabrication, installation, design and also certification. For these two projects, type of equipment use is similar with the one used in Gulf of Mexico.

Other data involved is the number of development well selected. For this portfolio (project) the total of development wells are 10 (production 4, water injection 2, and gas injection 4)

Offshore Operating Cost Summary:

Offshore operating cost summary

		Totals	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Grand total operating cost	$	325,919,000	38,229,000	38,884,000	38,884,000	40,147,000	40,533,000	51,614,000	38,822,000	38,806,000
Direct costs										
Operating personnel costs	$	58,752,000	7,344,000	7,344,000	7,344,000	7,344,000	7,344,000	7,344,000	7,344,000	7,344,000
Inspection & maintenance costs	$	57,074,000	5,817,000	5,817,000	5,817,000	5,817,000	6,138,000	16,034,000	5,817,000	5,817,000
Logistics & consumables costs	$	98,570,000	12,271,000	12,351,000	12,351,000	12,351,000	12,339,000	12,318,000	12,301,000	12,288,000
Well costs	$	8,704,000	447,000	891,000	891,000	1,901,000	1,901,000	891,000	891,000	891,000
Insurance costs	$	29,736,000	3,717,000	3,717,000	3,717,000	3,717,000	3,717,000	3,717,000	3,717,000	3,717,000
Direct costs total	$	252,836,000	29,596,000	30,120,000	30,120,000	31,130,000	31,439,000	40,304,000	30,070,000	30,057,000
Field/project costs	$	73,083,000	8,633,000	8,764,000	8,764,000	9,017,000	9,094,000	11,310,000	8,752,000	8,749,000
Tariff costs	$	0	0	0	0	0	0	0	0	0

Figure 5: Offshore operating cost summary

Above is the summary of the project operating cost for 8 years. During the mid of production years the grand total cost is among the highest obtained because of the inspection and maintenance cost. It is understandable to have this because without proper maintenance of the equipment used such as compressors, pump and generators the production or the well itself may become ineffective or become idle faster than it was predicted earlier.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on the results obtained for the simulation using Questor, it should be a must for a company to analyze the best and suitable cost forecasting software to minimize an unexpected cost cause by an unexpected problem. In other words, precise cost forecasting for field development helps a lot in improve and optimize the revenue/profit for a company.

5.2 Recommendation

There should be an extra course offered to the students to enhance their skill from the economy side as the engineering students must also be equipped with enough cost-cutting measure information to fulfil today standards of competitive world.

Form the Questor and project part; it should be continue later on to produce a fine system that is might be similar with the Questor but in the simpler version.

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