IMPROVEMENT OF THE UPSTREAM PROJECT VALUATION IN CONSIDERATION OF ABANDONMENT EXPENDITURE UNCERTAINTIES

AZUREEN ALYA ABU BAKAR

A dissertation submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Petroleum Engineering

Faculty of Chemical and Energy Engineering
Universiti Teknologi Malaysia

SEPTEMBER 2019

DEDICATION

This thesis is dedicated to my sweet son, Ahmad Hannan.

ACKNOWLEDGEMENT

This thesis and post-graduate studies would not have been completed without the ultimate guidance, support and direct help from various groups of people. I would like to extend my appreciation to my former colleagues in Vestigo Petroleum Sdn Bhd – Ang Duen Woei, Zarool Hassan, Ahmad Nazhri, Azmukiff M Kifli, How Lian Lee and the rest of the Reservoir Maturation, Reservoir Development and Drilling teams for not only piquing my interest in the field but also giving me the perspective of seasoned industry practitioners. I would also like to thank my mentors Saiful Azuan A Aziz and Syamsulzaidi Saifuzzaman for being great shoulders to lean on during the more difficult times.

My UTM classmates also played a major role in the completion of this course and thesis. Their perseverance, hard work and team spirit will never be forgotten. Buwa, Hakim, Rodhiah, Bior, Fahmi, and Fikri – until we meet again.

I would like to greatly thank my supervisor, Associate Professor Issham Ismail, whose teaching graces, dedication and compassion continue to awe and humble me in spades. Your guidance and generosity is deeply cherished.

Lastly, I would not have completed this without the support of my best friends and loved ones. My lovely parents Nick and Zaimah – I would not have discovered the joys in this world without your guidance and nurturing. My brothers Adam and Adrian, who ignited my desire to also obtain a Master's. Hakam, for unconditionally and lovingly taking care of our son on the long weekends, days and nights away from home that I took to study and work. Last but not least, the steady coffee, food and warmth since I started all this – the people who made Mikro, Taman Melawati another home for me.

ABSTRACT

This study intends to propose parameter adjustment for economic evaluation in considering abandonment expenditures (ABEX) during front end loading (FEL) of discovered petroleum resources. In maturing a petroleum field development, abandonment and decommissioning of wells and facilities requires consideration during FEL. FEL, long adopted by prominent E&P players worldwide is used to support capital investment decision-making where value i.e. expected monetary wealth is measured and evaluated by Discounted Cash Flow (DCF) analysis. However, the DCF approach is outdated and flawed where it does not capture fluctuation well. At FEL, where uncertainties are high, primarily on abandonment and decommissioning environments of the far future, inputs into the DCF may pose significant impact on the project valuation. This study reviews ABEX of sub-commercial contingent resources or shelved projects and economic evaluation method used in the author's organization and their parameters, identifying relevant and applicable adjustments that could be made associated to ABEX. Combining the revised ABEX with a modified economic model, a proposed set of categorical adjustments to is produced. The results show that the ABEX of the previously sub-commercial projects are optimized, streamlined and yield a more competitive number with revised semi-detailed estimates, allowing bigger gross revenue forecast throughout the production life. While discount rates are a business and organizational decision, a different escalation and inflation approach to ABEX elements result in a better far-sighted forecast, where uncertainties of abandonment activities can be zoomed into. Additionally, a standardized assumption for abandonment year before cessation of production is recommended to provide a more realistic evaluation of when ABEX is actually required to incur. These, in turn, improves the Net Present Value (NPV) of the projects tested as well as their viability and rank towards being sanctioned for development.

ABSTRAK

Kajian ini bertujuan untuk mencadangkan pelarasan parameter bagi penilaian ekonomi dalam menimbangkan perbelanjaan peninggalan dan penyahkawalan ataupun 'abandonment expenditure' (ABEX) semasa 'Front End Loading' (FEL) sumber petroleum. Dalam membangunkan lapangan petroleum, peninggalan dan penyahkawalan telaga dan kemudahan memerlukan pertimbangan semasa FEL. FEL, lama diadopsi oleh organisasi minyak dan gas yang terkenal di seluruh dunia digunakan untuk membantu menilai dan membuat keputusan pelaburan modal di mana pulangan kewangan diukur dan dinilai oleh analisis 'Discounted Cash Flow' (DCF). Walau bagaimanapun, pendekatan DCF adalah agak ketinggalan di mana ia tidak berupaya untuk mengimbangkan turun naik beberapa parameter dengan tepat. Di FEL, di mana terdapat ketidakpastian yang tinggi, terutamanya pada peninggalan dan penyahkawalan persekitaran pada masa hadapan, input ke DCF mungkin memberikan impak yang signifikan ke atas penilaian projek. Kajian ini melihat semula ABEX projek-projek yang ditangguhkan dan kaedah penilaian ekonomi yang digunakan dalam organisasi pengarang dan parameter mereka, mengenal pasti pelarasan yang berkaitan yang boleh diubah dalam mempertimbangkan ABEX. Menggabungkan ABEX yang disemak dengan model ekonomi yang diubahsuai, satu set cadangan dihasilkan. Hasilnya menunjukkan bahawa ABEX projek-projek sub-komersial sebelum ini dioptimumkan, diselaraskan dan menghasilkan nombor yang lebih kompetitif dengan anggaran separuh terperinci yang disemak, yang membolehkan ramalan pulangan kewangan yang lebih besar sepanjang tempoh pembangunan lapangan petroleum. Walaupun kadar diskaun adalah ditetapkan oleh organisasi, anggaran peningkatan yang berbeza dan pendekatan inflasi kepada elemen ABEX menghasilkan ramalan pulangan yang lebih baik. Di samping itu, penetapan tahun pengabaian sebelum penghentian pengeluaran disyorkan untuk memberikan penilaian yang lebih realistik untuk pengeluaran ABEX. Ini berupaya memperbaiki nilai bersih semasa atau 'Net Present Value' (NPV) projek-projek yang dinilai.

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AACE	-	Association for the Advancement of Cost Engineering
ABEX	-	Abandonment Expenditure
CAPEX	-	Capital Expenditure
DCF	-	Discounted Cash Flow
E&P	-	Exploration and production
EMV	-	Expected Monetary Value
FEED	-	Front End Engineering Design
FEL	-	Front End Loading
FID	-	Final Investment Decision
IOC	-	International Oil Company
IRR	-	Internal Rate of Return
NCF	-	Net Cash Flow
NOC	-	National Oil Company
NPV	-	Net Present Value
OGUK	-	Oil and Gas UK
OPEX	-	Operating Expenditure
PIR	-	Profit Investment Ratio
PPMS	-	PETRONAS Project Management System
PSC	-	Production Sharing Contract or Contractor

CHAPTER 1

INTRODUCTION

1.1 Background

In the petroleum exploration and production (E&P) business, key investment decisions are made by the E&P operators through various stages of the petroleum asset. These begin from asset acquisition, exploration, appraisal, and development stages and followed by production of the hydrocarbon. Decisions are also made to improve the activities to extract, process and export with better economic return (Sahlawi, 2010). At the end of field life, abandonment of the asset will be undertaken.

During exploration and appraisal, decisions are made to sanction an exploration program such as seismic acquisition or drilling of a prospect. During development stage, results of the exploration and appraisal program will be investigated and concluded to define whether an opportunity to develop the hydrocarbon exists. In these steps taken towards decision-making, a certain definition of a hypothetical future development and return is quantified to estimate profitability for the operator.

Such evaluations are supported by a rigorous, proven methodology called Front End Loading (FEL) long adopted by prominent E&P players worldwide to support capital investment decision-making (Jafarizdeh and Bratvold, 2009). The FEL practice focuses on steps taken towards reducing risks in the scope of development and maximizing the economic return of the investment. Adejumo et al (2016) state that the effective management of risks and uncertainties, be it technical or non-technical, is vital in maintaining a healthy portfolio of hydrocarbon assets. FEL methodology measures and increases the level of project definition, contributed by multi-

disciplinary input from drilling, facilities, geoscientists, reservoir engineering and operations. Project definition can be viewed as three key areas: scope, schedule and cost. Risk mitigation from an early stage in the field development will increase the probability of the project success, which is primarily defined by economic value in the FEL process (Saputelli et al, 2013). Figure 1.1 represents the FEL process and its corresponding expected accuracy.

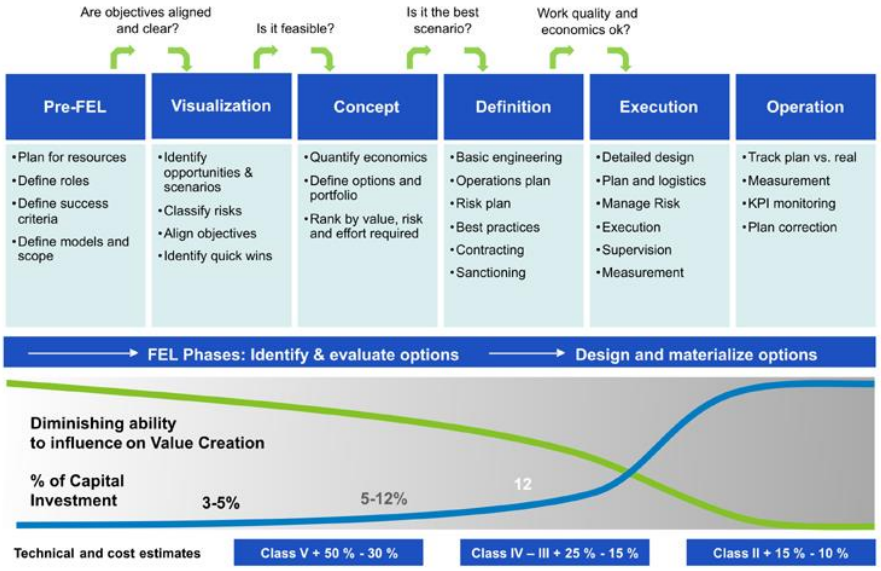

Figure 1.1 Front End Loading process and objectives (Frontender Corporation, 2018)

The FEL project definition and risk mitigation efforts are evaluated throughout the process. Once a project scope has been defined, and the development and production of hydrocarbon is forecasted, FEL enables its valuation through economic analysis. FEL reiterates this process to achieve the optimum reservoir and surface development concepts that returns the maximum value. Value in this context is 'wealth' in monetary terms (Jafarizadeh and Bratvold, 2009). This is achieved through quantification of technical inputs, i.e., the capital costs required to erect facilities to process and evacuate the hydrocarbon, capital costs to drill and complete the wells to

produce the optimum production rates over a period of time, operating expenditures of the field as well as costs of abandonment and decommissioning of the field.

These inputs are then considered in an economic model to generate a profitability indicators such as Net Present Value (NPV), Internal Rate of Return (IRR) and Profit Investment Ratio (PIR). Well known methodologies to yield these indicators include Discounted Cash Flow (DCF), European Option Valuation: Black-Scholes Model and Mean Reverting Model (MRM) for Oil Price. However, the DCF methodology is the one widely accepted in the industry for project valuation (Huerta and Aliaga, 2015). The discounted cash flow model allows for the calculation of the NPV through summation of all incoming and outgoing future cash flows. In E&P, incoming cash flow is generated from revenue of petroleum sales, while outgoing cash flow typically denotes capital expenditure (CAPEX), operating expenditure (OPEX), tax, royalties, and cost of abandonment and decommissioning (ABEX). While CAPEX concerns expenditure on developing the field in the near foreseeable future, i.e., three to five years looking forward from time of economic evaluation and a more accurate market trending and forecasting can be achieved, OPEX and ABEX estimation relies on a judgment of costs and fluctuations as far as 20 years into the future.

This inherently presents an uncertainty into the economic evaluation itself. As the FEL process is value-driven, a significant importance is placed on economic evaluation results and decisions to proceed with maturing the project further depends on value. Hence, the uncertainties of the technical input presented into the model must be managed. Key areas of concern that are identified in the DCF methodology are market dynamics, mathematical procedures, assumptions around project dynamics and determination of model parameters (Williger et al., 2017). In the area of project dynamics, many operators recognize that projects and ventures possess future flexibility, especially those to be executed well into the future such as abandonment and decommissioning of fields. Williger et al. (2017) also state that this flexibility is difficult to be quantified in an economic analysis.

Abandonment and decommissioning in oil and gas field developments is the tail-end phase of an asset's life cycle. The abandonment of a field is typically triggered

when the field has reached its economic limit, i.e., revenues from selling the extracted hydrocarbons are not sufficient to cover expenses (Jafarizadeh & Bratvold, 2012) or the asset has exceeded its design life (Mimmi et al., 2017). Other than economic factors, decommissioning is necessary when options for extending the field life are exhausted (Jahn et al., 2017). The prime purpose of decommissioning is to ensure the area of hydrocarbon development has been free of hazards for the local population and the restoration of the environment to its original conditions (Nicotra et al., 2010). The activities towards these objectives must be in compliance with applicable regulations of the country of operations and company guidelines. The activities involved in achieving a hydrocarbon and hazard-free field include plugging and abandoning a well and the removal of the facilities that were involved during production of the field (Nicotra et al., 2010).

As described earlier, in FEL stages, from as early to asset acquisition to a later stage as conceptual engineering of a selection development option, iterative economic evaluations are conducted to determine the development strategy to return maximum value. Thus, abandonment and decomissioning scope of work must be defined at a high or conceptual level with an acceptable accuracy range, depending on the degree of definition of the development itself, i.e., what type of facilities to be installed or number of producing zones in a well. A simplistic view of decommissioning is the act of ‘reverse installation’ (Climate and Pollution Agency, 2011) albeit in a more dangerous environment, i.e., live hydrocarbon and risk of aging structures. Its corresponding cost estimation (ABEX) will then be developed to become a technical input in economic evaluation.

The key considerations in developing the decommissioning cost estimation involve multiple levers (Nicotra et al., 2010). Firstly, the location or country in which the operator had installed the facilities and produced determines the type of petroleum arrangement to be entered and how abandonment and decommissioning is treated. Some countries’ oil and gas host authority adopts different policies towards pooling abandonment funds from petroleum contractors, e.g., fixed value per annum, fixed value upfront into an abandonment fund, or a yearly cess payment depending on production (Shafinah, 2018). Secondly, in the case of estimating a decommissioning cost to be converted into yearly payments agreeable by the host authority, a conceptual

identification of decommissioning techniques must be conducted. Various tools and methods such as multi-criteria decision tree analysis and multi-attribute approach of the alternatives in platform removal and disposal are adopted during this stage (Fowler et al., 2013; McCann et al., 2016). This will then enable a bottom-up activity or work-breakdown based cost estimation within an acceptable accuracy. Nicotra et al. (2010) recommended the costs at the development's FEL stage to be of +/- 25% accuracy, while ongoing review towards the end of production life to achieve +/- 15% accuracy for decommissioning cost estimation, where the engineering works are to be kicked off to further narrow down the procedures and methods involved that are technically feasible, safe, and meet the HSE and regulatory requirements of the host authority.

1.2 Statement of Problem

Strategic decision-making by E&P corporations revolve around creating value through petroleum ventures and the NPV method is still the yardstick of project valuation. A conceptual weakness discussed by Willigers et al. (2017) is the reliability and measurability of long-run costs and benefits. They highlighted that the planning and choices made on the Brent field in 1970s affected its infrastructure decommissioning execution in 2017, almost five decades later. For fields that will be producing for an extended amount of time, the expenditures forecasted far into the future will be discounted away at an escalated and inflated price. Moreover, E&P industry-wide discounting rates are generally too high for investments with long payback periods. This may cause undervaluation of projects at FEL stage. Volatility of oil price, technologies and market globalization also contribute to uncertainties in project valuation.

In every field development and investment scenario, the cost forecast which will suffer the biggest impact of discounting and uncertainties would be abandonment and decommissioning costs (ABEX). An ABEX estimation is developed by assessing decommissioning options of a particular concept identified and selected, which are subject to the economic model's assumptions depending on FEL stage. The one-size fits all approach cannot be applied to all projects from marginal to large fields with extensive production life (Willigers et al., 2017).

The NPV method is used in project valuations in PETRONAS' front end loading approach: Asset and prospect evaluation (pre-FEL), concept identification (FEL 1), selection (FEL 2) and Front End Engineering Design (FEED) (FEL 3). At prospect or discovered resource evaluation stage, technical inputs are provided within a big range of accuracy and uncertainties are significant, inclusive of ABEX. At prospect evaluation stage, the margin of error compounds from volume, production profile up to surface facilities. In turn, assumptions on abandonment and decommissioning are also subject to big uncertainties and margin of error. Due to the nature of NPV method, ABEX remains a compulsory input into the model. The conservative, high or even 'wrong' estimation and economic assumption may cause a project or venture to not be declared as viable. Additionally, due to the nature of

decision gate reviews, the project is then recommended to be shelved, i.e., no appraisal wells are drilled, no volumetric assessment can be made and uncertainty gap cannot be narrowed. The asset then may be de-booked. Similarly for FEL 1 to 3 stages, project definition and risk mitigation for abandonment should be conducted in parallel with wells and surface facilities design to improve confidence in assessing decommissioning options and in turn, cost estimation.

1.3 Hypotheses

The hypotheses of this study are listed as below:

1) Quantifying far-future risks and uncertainties in ABEX estimation will yield great inaccuracy.

2) A bottoms-up ABEX estimation improves the accuracy of project valuation in marginal field environments, but not for fields with expected production life beyond 10 years.

3) Discounting rates used in upstream project valuation is too high and undervalues projects.

4) High escalation and inflation rates are not relevant for abandonment execution of more than 10 years into the future.

1.4 Objectives

The objective identified for this research study is to propose unique parameter adjustment for economic evaluation of abandonment expenditure forecast at early front end loading for discovered resources.

1.5 Scope of Study

There are five scope of investigation and analyses that require to be executed to satisfy the objective of this research:

1) Data acquisition, collection and database establishment of:

- Technical and commercial data of recently executed abandonment and decommissioning projects in Malaysia.

- Shelved PETRONAS prospects and projects' technical and commercial data used for economic evaluation.

2) Investigating recently executed abandonment and decommissioning projects in Malaysia in the past 5 years and their actual costs compared to projection during FEL economic evaluation.

3) Investigating PETRONAS' shelved prospects and discovered resources' last known economic evaluation inputs and recording their ABEX assumptions at the shelving decision point.

4) Reviewing PETRONAS' economic evaluation methods at different FEL stage and treatment of ABEX.

5) Identifying the applicable and appropriate parameter adjustment of ABEX in economic models to enable increase of contingent resource development.

6) Proposing categorical improvement to the economic analysis by changing assumptions surrounding ABEX such as timing, pricing model, escalation and inflation, discount rate used.

1.6 Significance of Study

This study is aimed to ultimately propose an acceptable estimation approach to ABEX estimation at FEL stages and its treatment in economic evaluation that does not cause opportunity loss through deterministic decision-making processes and gate reviews. Opportunity loss in this study is defined as shelved projects that have high ABEX and premature assumptions made and applied onto ABEX in economic evaluations. In Malaysia, reserves replacement ratio (RRR) is at a worrying figure in comparison to International Oil Corporations (IOCs) such as Royal Dutch Shell and ExxonMobil. Developments of new assets must be pursued to maintain growth of PETRONAS and in turn, the nation.

Should the study prove a trend in ABEX estimation versus actual expenditure of comparable decommissioning projects and the increase of contingent resource viability through adjustment of ABEX input and economic modelling, the approach will be proposed to PETRONAS for reviewing project realization and investment decisions put forth by Production Sharing Contractors (PSC).

1.7 Chapter Summary

This chapter introduces the industry-wide concept of stage-gate decision-making process, the Front End Loading (FEL) with evolving project definition and accuracy, centered around yielding the best "value" for E&P operators. Value or monetary wealth expected to be gained by E&P operators are calculated often through the NPV method where DCF concept is applied. This model is flawed for developments with extensive production life where flexibility of the future is ignored and are subject to the same assumptions applied to inputs of the near future i.e. capital costs and oil prices of the next few years upon development. Abandonment and decommissioning, the late-life phase entered by the asset is the parameter most affected by this DCF model and will potentially cause opportunity loss as early as asset acquisition stage.

This study intends to investigate the impact caused by big accuracy ranges of ABEX as well as its blanket economic model assumptions used during FEL stage and propose a categorical improvement to showcase viability of contingent resources that suffered from shelving or de-booking. If proven, the approach will be proposed for adoption by PETRONAS' FEL process and ultimately its regulatory arm, Malaysia Petroleum Management to review PSC field developments.

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