Using Analytical Hierarchy Process to Determine Appropriate Minimum Attractive Rate of Return for Oil and Gas Projects in Indonesia[1]

By Lita Liana

Abstract

Under current project guideline, the regulator sets a 10% as single hurdle rate in determining oil and gas project economic for the Production Sharing Contract (PSC) contractor. A hurdle rate should represent project's Minimum Attractive Rate of Return (MARR) which not only include money available for investment, source and cost of funds but also perceived risks related to the opportunities.

This paper is developed to find whether 10% is an appropriate rate to evaluate contractor's project economic and seek what is the range of appropriate MARR to be used in different kinds of oil and gas projects in Indonesia.

In this paper the author demonstrates using Analytical Hierarchy Process (AHP) to determine range of project risks covers activity, project location and type of drilling to be included in the MARR. The paper concludes that a range of 14% to 34% covers most conditions so that the rate of 10% MARR for all projects is too low.

***Keywords**: Cost of capital, CAPM, WACC, hurdle rate, MARR, AHP, project risk*

1. Introduction

1.1 Oil and Gas Reserves and Investment Opportunity in Indonesia[2]

Statistically in 2011, Indonesia has total proven oil reserves of 7,732.27 Million Stock Tank Barrels (MMSTB) or 8% of Asia Pacific proven oil reserves and proven natural gas reserves of 152.89 Trillion Standardized Cubic Feet (TSCF) or 18% of Asia Pacific proven natural gas reserves. The capital investment to utilize those reserves also has been increased year by year. Investment realization in 2012 is US$15,57 Billion compare with 2011 of US$14,02 Billion. The higher investment can be seen from the activities in exploration and development drilling.

In 2012, there are 113 exploration wells and 809 development wells. SKK Migas (Oil and Gas Special Work Unit) as the Management of Production Sharing Contract (PSC) has approved 47 Plan of Development (PODs) from total proposed of 53 during 2012. Total cumulative production of those approved PODs is 956 Barrel Oil Equivalent (BOE) with total investment required to produce those reserves can achieved up to US$21.3 Billion. That information shows that oil and gas investment Indonesia has big contribution in the economic growth. As

[1] *Editor's note: This paper was prepared as a result of a course delivered by Dr Paul Giammalvo of PT Mitratata Citragraha in Jakarta, Indonesia. The paper was submitted to the Association for the Advancement of Cost Engineering International (AACEi) in partial fulfillment of the Certified Cost Professional (CCP) requirements. http://www.aacei.org/cert/whatCertOffers.shtml .*

[2] ESDM (2012), Statistik Gas Bumi. Retrieved from http://www.esdm.go.id/publikasi/statistik/cat_view/58-publikasi/240-statistik/342-statistik-gas-bumi.html

management of PSC, SKK Migas plays very important role in approving the oil and gas investment projects based on the proposal of PODs.

1.2 Single Hurdle Rate to evaluate all projects

Initially the upstream oil and gas management was handled by a single element under Pertamina. Meanwhile, Pertamina acted as regulator and player in the field of oil and gas. To avoid the conflict of interest and referring to the Law No. 22 of 2001, The Government agreed to appoint BP Migas as the oil and gas management/regulator for oil and gas contractor. In principle, the establishment of BP Migas is to separate the duties and functions of the authority of government as regulator/policy makers and player. The Government also wants to avoid direct involvement in making the contract with the investor.

In 2013, BP Migas was replaced by SKK Migas with reason that the regulation to set up BP Migas was violated the National Constitution Article 33 paragraph 3 which stated "The Earth and the water and the natural riches contained therein shall be controlled by the State and used for the welfare of the people"[3]. The existence of BP Migas as legal entity not as business entity has blurred the State's control.

Some regulations published by BP Migas currently are still valid. Related to the investment rule, in 2010, SKK Migas (BP Migas at that time) was issued a guideline for proposing a POD with regulation No. 0072/BP0000/2010/S0. The guideline covers on process of preparation, application, evaluation and approval by Oil and Gas Minister and/or SKK Migas. Specifically in evaluation, the economic indicator uses for Government portion is Present Value of all Government Take and percentage of Government Income to Total Revenue. While economic indicator for Contractor is Net Cash Flow (NCF), NCF/Gross Revenue, Cost Recovery (CR), CR/Gross Revenue, Internal Rate of Return (IRR), Net Present Value (NPV) and Pay Out Time (POT). It is mentioned that in calculating the Contractor NPV is suggested using one single hurdle rate which is 10%.[4]

1.3 Problem Statement

Yearly increment of oil and gas investment and huge reserve available in Indonesia has to be balanced with the appropriate project evaluation. The project has to be analyzed with the proper tools in order to produce the real beneficial to The Country. The objectives of this paper are:

- to explore whether a single hurdle rate i.e. 10% is an appropriate rate for the regulator to evaluate contractor project economic or not.
- to find the appropriate calculation of hurdle rate to be used in different kinds of oil and gas projects in Indonesia by considering risk in activity, location and drilling type of project and also country risk.

[3] Utama,A.C.(2012). Tahun 2012:Kinerja Optimal Industri Hulu Migas. Retrieved from : http://www.skspmigas-esdm.go.id/buletin/bumi-january-2013/
[4] BPMigas(2010). Surat Keputusan No.KEP-0072/BP00000/2010/S0 Tentang Pedoman Tata Kerja Plan of Development (POD).

2. Estimating the Hurdle Rate

Project evaluation is calculating a project return with an appropriate discount rate. A company will invest to a project or execute a project which gives greater expected return than company's cost of capital. If a company uses debt and equity to finance the project, company's cost of capital is the Weighted Average Cost of Capital (WACC) which calculated portion of debt and portion of equity.

Sullivan (2012:529) WACC formula:

$$\lambda\,(1\text{-}\,t)\; i_b \;+ (1-\;\lambda)\; e_a \qquad \text{(Equation 1)}$$

Where:

λ	= the fraction of total capital obtained from debt;
$(1-\;\lambda)$	= the fraction of the total capital obtained from equity;
t	= effective income tax as decimal;
i_b	= the cost of debt financing;
e_a	= the cost of equity; CAPM

Ross (2009:342) the cost of equity is calculated by using CAPM formula:

$$R_S = \;\beta_S\,(R_M -\; R_F) + \;R_F \qquad \text{(Equation 2)}$$

Where:

R_F	= Risk Free
β_S	= Beta Stock Risk
$(R_M -\; R_F)$	= Market premium

Company's hurdle rate should also quantify other risks to be added into the WACC. This is for the true reflection of company's hurdle rate in evaluating a project or it can be calculated as Minimum Attractive Rate of Return (MARR). Each investment project has its own MARR because its own degree of riskiness. The corporate MARR is appropriate for the entire portfolio of corporate investment but not for an individual project in the portfolio.

3. Project Risk Category for Oil and Gas Investment in Indonesia

3.1 Project risk by activity type[5]

The upstream activities sometimes refer as exploration, acquisition, drilling, developing and producing oil and gas. As general the upstream activities can be categorized as finding or exploring and developing oil and gas. Therefore, the upstream activities sometimes refer as Exploration and Production activities (E&P activities).

a. Exploration Activities

Oil and Gas exploration involves the work of geoscientists using a variety of Geological and Geophysical (G&G) techniques to identify areas far beneath the earth's surface that may contain petroleum reserves. Some G&G techniques include seismology studies provide detailed information about subsurface structures by recording the reflection of sound waves on subsurface formations. The 3-D seismic and currently 4-D monitor how certain reservoir properties (i.e. movement of fluids, temperature and pressure) change in response to production.

[5] Wright, C.J.,Gallun,R.A.(2008).Fundamental Oil and Gas Accounting.Fifth edition,Penwell corporation.

By knowing the movement, the oil and gas and/or water can be anticipated before it affects the production. The unknown factors in the exploration phases are so big therefore it carried on a higher risk than the development activities.

b. Development & Production Activities

Once a reservoir found, it should be calculated whether the available oil and gas reverse is economically viable or not. The way to find out that is to drill wells into formation. During the drilling phases, some data was obtained and at the end of drilling process, a decision is to be made whether there are sufficient oil and gas reserves to justify completing the well. If the oil and gas reserves are enough to justify that it is economically viable, then the exploration well is completed and production can be started.

The activities for completing the well and placing it into production can be included:

- Obtaining and installing production casing
- Installing tubing
- Perforating
- Installing the Christmas Tree
- Constructing the production facilities and installing flow lines

3.2 Project risk by location[6]

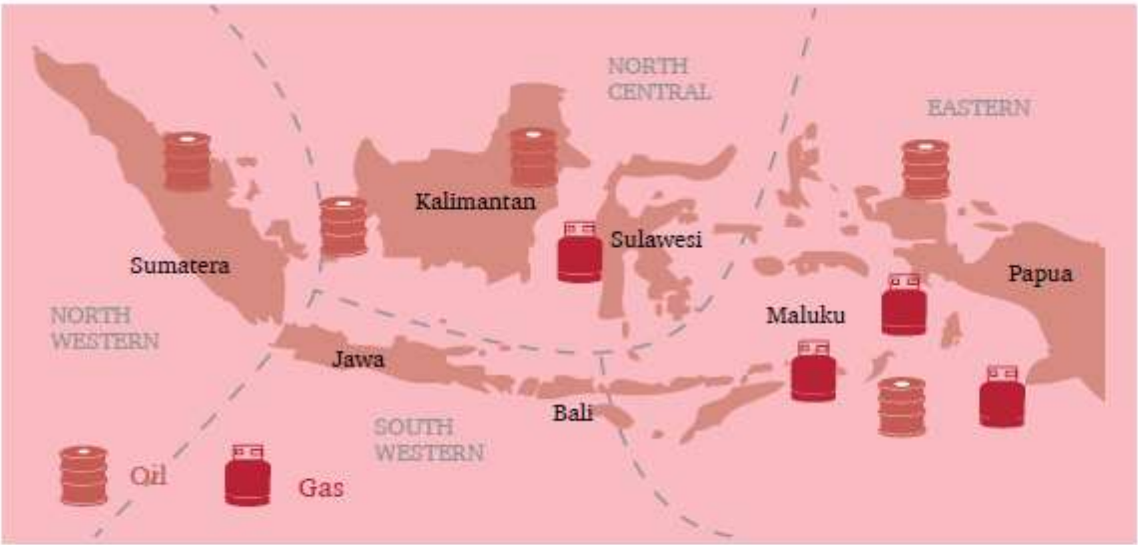

Figure 1: Map of Indonesia (source : Price Waterhouse Coopers)[7]

a. North Western Indonesia

The north western part of Indonesia covers Sumatera island. This area is made up of Mesozoic economic basement. This area call as Tertiary Basin and it provides the vast majority of Indonesia's petroleum resources. Majority of this area are mature exploration wise and major

[6] Price Waterhouse Coopers (2012). Indonesian oil and gas survey 2012.
[7] Price Waterhouse Coopers (2012). Indonesian oil and gas survey 2012.

discoveries have been made. The remaining future exploration in this area depends on small features of stratigraphic plays.[8]

b. South Western Indonesia

The south western part of Indonesia covers Java, Bali and Lombok islands. The structure of this area almost the same as the north western part. This calls also as Tertiary Basin and has vast majority of oil and gas reserves.

c. North Central Indonesia

The north central part of Indonesia covers Kalimantan and Sulawesi islands. This area is made up a series of continental fragments welded together, each with its own unique geology. Combination between the western part and eastern part can be found in this area.

d. Eastern Indonesia

The eastern part of Indonesia covers Seram, Halmahera islands (this two calls as Maluku), Irian Jaya island and Banda Arc. Approximately half of the Indonesian basins are in eastern Indonesia and many of them remain undrilled. This area is much more complicated and variable geology than in others area and filled with many unknown since it is less explored. Thus it still has many large untested features and still has higher exploration cost and risk. The area is more predominant volcanic and metamorphic. The size of the basin would also put a risk on the volume potential resources.

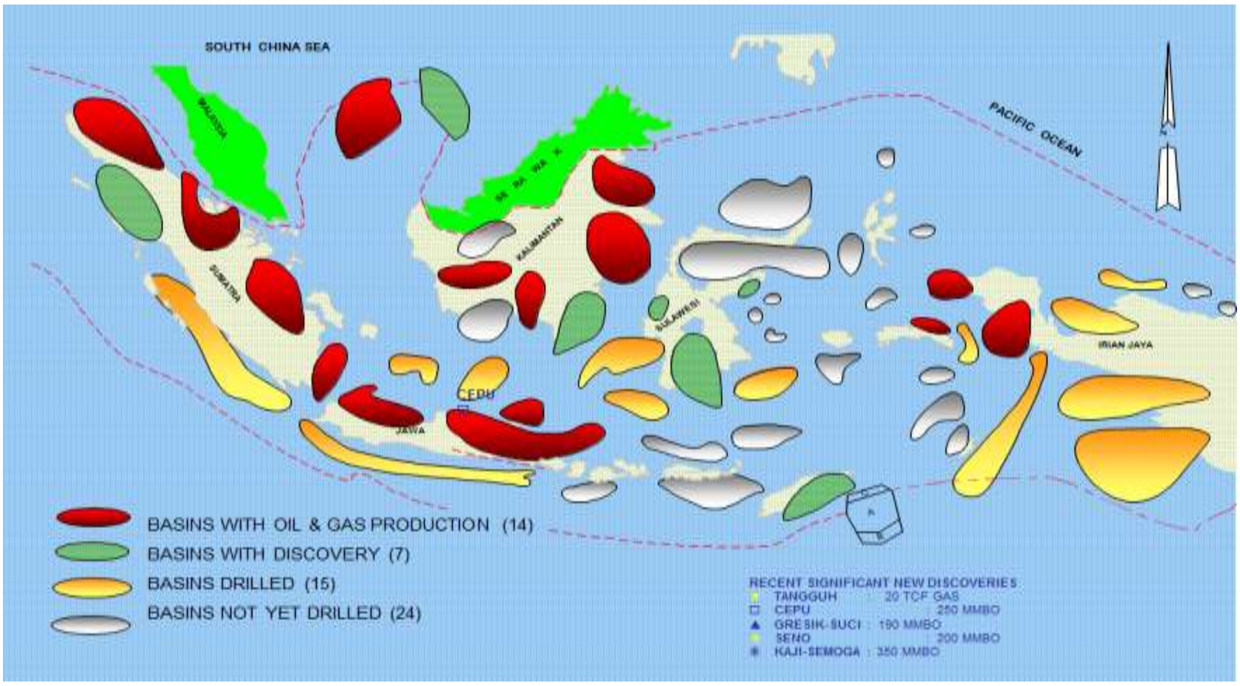

Figure 2: Indonesia Basins (source : reservoir engineering internal presentation)[9]

---

[8] John, C (1998).Complex Eastern Indonesia poses exploration challenges. Oil and Gas Journal:Sept21,1998.ProQuest pg.91
[9] Internal ConocoPhillips Presentation (2008). Reservoir engineering overview.

3.3 Project risk by drilling type[10]

Figure 3: Drilling Rigs (source: reservoir engineering internal presentation)[11]

a. Onshore Drilling

For the onshore drilling the choice of drilling rig depends on target depth, access facilities to the site and the availability of the derrick.

b. Offshore Drilling

Offshore drilling is having another concern on the depth of water, climatic conditions and remote of the logistic access. The offshore drilling conducted from platforms which either float or fixed to a sea bed and which capable of performing all function normally as in the onshore area which includes divers' support and meteorology station. Self-raising or jacks up rigs are generally used in shallow waters. Barges and semi-submersible with dynamic positioning tend to be kept for deeper water. These mobile units only remain stationary during drilling which can last between several weeks and several months.

c. Deep Water Drilling

The deep water drilling is categorized for any wells drilled in depth more than 1,000 feet[12]. By the end of 2008, the world's total offshore oil reserve is 213 billion barrels (approximately 18% of total oil reserve) in which deep water contributes 25 billion barrels. The volume found in the deep water is increasing yearly together its cost trends as the availability of funding and also some expertise made it possible to be done by smaller operator. The cost and risk drilling in deep water is not linear compare with the depth. Some technical challenges arise due to complication in the extreme environment.

---

[10] Jeanne, N.B.(2007).Oil and Gas exploration and Production : Reserves, Costs,Contracts. Technip.
[11] Internal ConocoPhillips Presentation (2008). Reservoir engineering overview.
[12] Llyods, (2011). Drilling in extreme environment : challenges and implications for the energy insurance industry.

Figure 4: Location of deep water drilling oil fields (source : Petroleum Economist)[13]

4. Analytical Hierarchy Process (AHP)[14]

The AHP is a process for making a decision in an organized way to generate priorities. To make the comparison it is required a scale of number that indicates how many times more important or dominant one element is over another element which respect to the criterion with respect to which they are compared.

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgment slightly favor one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgment slightly favor one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favor very strong over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is the highest possible order of affirmation

Table 1: The fundamental scale of absolute numbers (source : T. L. Saaty, 2008)[15]

A pairwise comparison matrix for each criterion is the next result to be calculated until it finally obtained priorities for the sub criterion.

[13] Llyods, (2011). Drilling in extreme environment : challenges and implications for the energy insurance industry.
[14] Saaty, T.L. (2008). Decision making with the analytical hierarchy process. Int. J. Services Sciences, Vol.1, No.1.
[15] Saaty, T.L. (2008). Decision making with the analytical hierarchy process. Int. J. Services Sciences, Vol.1, No.1.

5. Application of WACC in Indonesia

Based on top 5 biggest 2013 predicted producing oil and gas contractors in Indonesia[16] and with the detail assumption on WACC components, the WACC calculation for each company is as follows :

Company	Production (BOED)	Risk Free (Rf) (%)	Market Risk Premium (Rm) (%)	Beta (β)	CAPM (%)	% Debt	% Equity	After Tax Cost of Debt (%)	WACC (%)
	1	2	3	4	5	6	7	8	9
Total	382.20	3.17	8.80	1.49	11.56	0.25	0.75	1.02	8.93
Chevron	355.00	3.17	8.80	1.17	9.76	0.07	0.93	7.44	9.58
BP	290.30	3.17	8.80	2.15	15.27	0.26	0.74	-2.86	10.61
Pertamina	196.90	3.17	8.80	1.17	9.76	0.23	0.77	4.03	8.44
ConocoPhillips	173.60	3.17	8.80	1.11	9.42	0.25	0.75	6.69	8.74
Average WACC									9.26

Table 2: WACC Calculation (source : author)[17]

The above calculation based on the following assumptions:

- Risk Free (Rf) is based on US Treasury Note for period of 30 years
- Market Risk Premium (Rm) is based on 2012 Aswath Damodaran study on Equity Risk Premium (ERP) : Determinant, Estimation and Implications
- Beta (β) is based on the information of beta stock from yahoo finance (for public listed company) and based on beta industry from Aswath Damodaran study (for non-public listed company)
- Portion of debt and portion of equity based on each company financial statement ended in 2011.

By using the PERT Formula, the representative WACC can be calculated as follows:

Average WACC = 9.26%
Min – Max = 10.61-8.44 = 2.17
(Min – Max)/6 = 0.36
Z 90% = 1.285
Sigma = 0.64
Variance = 0.77
Representative WACC as per PERT Formula = 9.26% + 0.77 = 10.04%

[16] Detik Finance (2012). Ini perusahaan paling kaya minyak dan gas di Indonesia. Retrieved from:http://finance.detik.com/read/2012/09/11/114646/2014532/1034/ini-perusahaan-paling-kaya-minyak-dan-gas-di-indonesia
[17] By Author

6. Application of MARR calculation in Indonesia

6.1 Hierarchical Tree

The purpose is to determine range of project risk based on activity, location and drilling

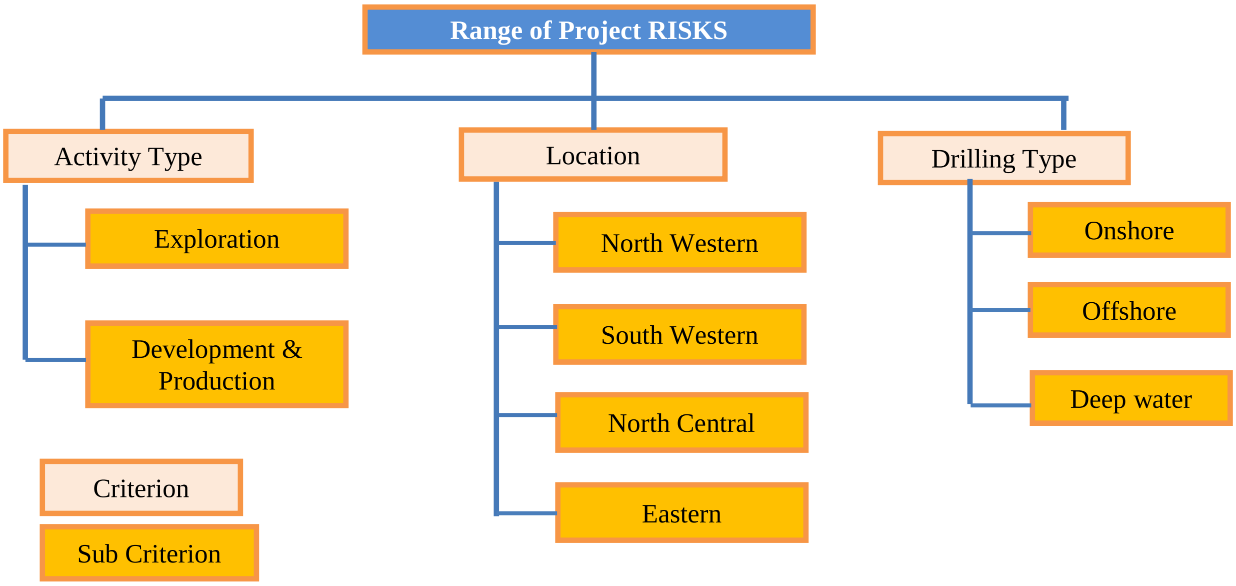

Figure 5: Range of Project Risk Hierarchical Tree (source : author)[18]

6.2 Judgment for Relative Ranking

Those criterions is synthesized to determine the relative rankings for each sub criterion

Activity	Exploration	Dev & Prod
Exploration	1	9/1
Dev & Prod	1/9	1

Table 3: Pairwise comparison matrix of Activity Criteria (source: author)[19]

Location	North Western	South Western	North Central	Eastern
North Western	1	3/5	5/7	1/9
South Western	5/3	1	3/7	7/9
North Central	7/5	7/3	1	3/5
Eastern	9	9/7	5/3	1

Table 4: Pairwise comparison matrix of Location Criteria (source: author)[20]

Drilling	Onshore	Offshore	Deepwater
Onshore	1	3/7	3/9
Offshore	7/3	1	5/7
Deepwater	9/3	7/5	1

Table 5: Pairwise comparison matrix of Drilling Criteria (source: author)[21]

[18] By Author
[19] By Author
[20] By Author
[21] By Author

6.3 Matrix algebra to calculate for each criterion ranking

Activities Type

Exploration	1.00	9.00
Dev & Prod	0.11	1.00

1.00	9.00
0.11	1.00

		Matrix Result	Matrix Rank	
2.00	18.00	20.00	0.9000	The highest Risk
0.22	2.00	2.22	0.1000	The lowest Risk
		22.22	1.0000	

Location

North Western	1.00	0.60	0.71	0.11
South Western	1.67	1.00	0.43	0.78
North Central	1.40	2.33	1.00	0.60
Eastern	9.00	1.29	1.67	1.00

1.00	0.60	0.71	0.11
1.67	1.00	0.43	0.78
1.40	2.33	1.00	0.60
9.00	1.29	1.67	1.00

				Matrix Result	Matrix Rank	
4.00	3.01	1.87	1.12	10.00	0.0957	The lowest Risk
10.93	4.00	3.34	2.00	20.28	0.1941	The third highest Risk
12.09	6.28	4.00	3.17	25.54	0.2445	The second highest Risk
22.48	11.86	10.31	4.00	48.65	0.4657	The highest Risk
				104.46	1.0000	

Drilling Type

Onshore	1.00	0.43	0.33
Offshore	2.33	1.00	0.71
Deep water	3.00	1.40	1.00

1.00	0.43	0.33
2.33	1.00	0.71
3.00	1.40	1.00

			Matrix Result	Matrix Rank	
3.00	1.32	0.97	4.32	0.1573	The lowest Risk
6.81	3.00	2.21	9.81	0.3569	The second highest Risk
9.27	4.09	3.00	13.35	0.4858	The highest Risk
			27.49	1.0000	

6.4 Hierarchical Tree with Matrix Rank Result

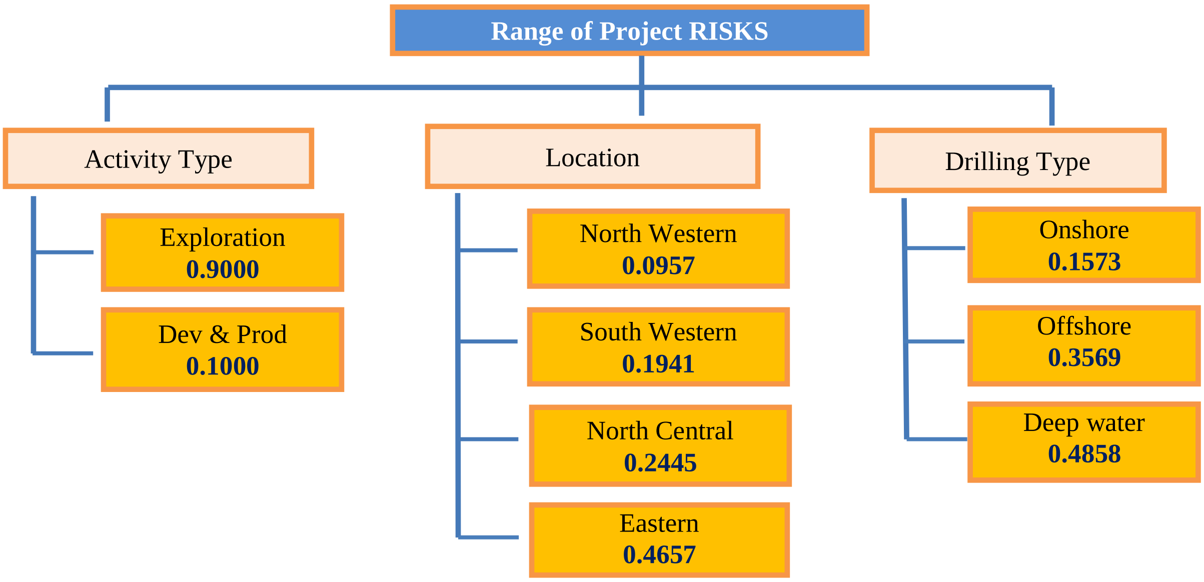

Figure 6 : Hierarchical Tree with Matrix Ranking Result (source : author)[22]

6.5 Risk scoring for each project in different activity, location and drilling type

Category			Result	Result (%)
Activity Type	Location	Drilling Type		
Exploration	North Western	Onshore	0.0136	1.36%
Exploration	South Western	Onshore	0.0275	2.75%
Exploration	North Central	Onshore	0.0346	3.46%
Exploration	Eastern	Onshore	0.0659	6.59%
Exploration	North Western	Offshore	0.0307	3.07%
Exploration	South Western	Offshore	0.0623	6.23%
Exploration	North Central	Offshore	0.0785	7.85%
Exploration	Eastern	Offshore	0.1496	14.96%
Exploration	North Western	Deepwater	0.0418	4.18%
Exploration	South Western	Deepwater	0.0849	8.49%
Exploration	North Central	Deepwater	0.1069	10.69%
Exploration	Eastern	Deepwater	0.2036	20.36%
Development & Production	North Western	Onshore	0.0015	0.15%
Development & Production	South Western	Onshore	0.0031	0.31%
Development & Production	North Central	Onshore	0.0038	0.38%
Development & Production	Eastern	Onshore	0.0073	0.73%
Development & Production	North Western	Offshore	0.0034	0.34%
Development & Production	South Western	Offshore	0.0069	0.69%
Development & Production	North Central	Offshore	0.0087	0.87%
Development & Production	Eastern	Offshore	0.0166	1.66%
Development & Production	North Western	Deepwater	0.0046	0.46%
Development & Production	South Western	Deepwater	0.0094	0.94%
Development & Production	North Central	Deepwater	0.0119	1.19%
Development & Production	Eastern	Deepwater	0.0226	2.26%

Maximum Risk

Minimum Risk

Table 6 : Risk Scoring based on Risk Matrix Rank (source : author)[23]

[22] By Author
[23] By Author

* : Not applicable - Deep water only exists in North Central and Eastern Location.
Example Result for Exploration Eastern Deep water =
Exploration (0.9000) * Eastern (0.4657) * Deep water (0.4858) = 0.2036 or 20.36%

7. Conclusion

The MARR for each oil and gas project in Indonesia can be calculated by adding that risk scoring of project risk and country risk with formula:

WACC + Risk Scoring + Country Risk[24] (equation 3)

- The most risky project is the Eastern Exploration Deep water project with 20.36%. The MARR should be **10.04% + 20.36% + 4.13% = 34.53%**
- The least risky project is the North Western Production and Development Onshore project with 0.15%. The MARR should be **10.04% + 0.15% + 4.13% = 14.32%**

Answer to Research Question #1

The single hurdle rate of 10% cannot represent the MARR for all oil and gas projects in Indonesia. It is found that the number is too low which has not included the project risk by activity, location and drilling type and also the country risk.

Answer to Research Question #2

The appropriate range rate should be around 14.32% to 34.53% depend on the activity, location and drilling type that the project will be conducted in Indonesia. It should be identified by each company's risk tolerance to adjust the MARR to be in line with the corporate strategy and risk analysis.

[24] Damodaran (2012). Country default spread and risk premiums. Retrieved from :http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ctryprem.html

Bibliography

Anwar, Ade (2013). W4_ADE_Determine WACC and MARR from financial data.

Askin, et.al.(2012). Valuation assignment 3 : the midland case.

Damodaran, A. (2002) *Investment valuation* (2nd ed.). New York: John Wiley and Sons.

Eschenbach, T., & Cohen, R. (2006). Which interest rate for evaluating projects? Engineering Management Journal, 18(3), 11-19.

Haas, R. Dr., Meixner, O. Dr. An illustrated guide to the Analytical Hierarchy Process, University of Natural Resources and Applied Life Science, Vienna.

Johnson, H. (1999). Corporate finance manual : determining cost of capital, First edition, Financial times, Prentice hall.

James, T. B. (2006). Developing discount rates in a global environment. Valuation Strategies, 9(3), 10-19+.

Jonhson, M.A., (2006). Capital budgeting in upstream oil and gas : a review of the technique, processes and context.

Johnston D., & Bush J. (1998). International oil company financial management in nontechnical language. Oklahoma: PennWell.

Johnston D. (1994). International petroleum fiscal systems and production sharing contracts. Oklahoma: PennWell.

Khan, M. Kabir, F. Parra, R.J. (2003). Financing large projects : using project finance techniques and practices. Singapore: Pearson Prentice Hall.

Khan, A., Fiorino, D., (1992) The capital asset pricing model in project selection : a case study. Engineering economist.

Pareja, I.V., Tham, J. (2011) An introduction to the cost of capital Patricia, A. R., & Glenn, P. R. (2002). Capital budgeting practices of the fortune 1000: How have things changed? Journal of Business and Management, 8(4), 355-364.

Price Waterhouse Coopers (2010). Oil and gas indonesia: investment and taxation guide. Jakarta.

Ramirez, A., Rambaud, S., Canadas, J., (2012) Discount rate and cost of capital : some more about the puzzle.

Ross, S.A., Westerfield R. W., Jaffe J., Jordan B.D., (2009). Modern financial management (8th ed.). Chapter pp. 162-169.

Sullivan, William G., Wick, Elin M., Koelling, C. Patric. (2012). Engineering Economy, Fifteenth edition, Prentice hall.

Tarantino, D. (2006). Assessing new project risk by determining new project beta values. Physician Executive,32(3), 68-70.

Ted, G. E., & Stephen, L. A. (2002). Selecting i--engineering economy needs a consensus. The Engineering Economist, 47(1), 90-90.

About the Author

Lita Liana

Jakarta, Indonesia

Lita Liana is an oil and gas professional has worked on many companies with multicultural environment namely Conocophillips Indonesia, Inpex Corporation and Pertamina (Persero). She is currently a commercial advisor at Shell Upstream in Indonesia. Lita has 12 years experiences in petroleum project economics, new business development appraisal, asset commercial and portfolio. She holds a bachelor degree in Business Administration and a master degree in Financial Management both from University of Indonesia (UI). She lives in Jakarta, Indonesia and can be contacted at litana5@yahoo.com.