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Analysis and Mapping of Oil and Gas Well Drilling Cost in Offshore Areas in Indonesia

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ANALYSIS AND MAPPING OF OIL AND GAS WELL DRILLING COST IN OFFSHORE AREAS IN INDONESIA

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ABSTRACT

In 2016, oil price hit its lowest price at i.e., 43.14 US$/Bbl (average oil price in 2016) over the last 12 years. Since then, the Petroleum exploration and exploitation activities were decreasing worldwide due to the low oil prices and high cost of production (including cost of well drilling).

in 2017, Indonesia's oil and gas production reached 1.944,00 MBOEPD or 98.5% of the target and also there were 200 exploitation well drilled and lower than the number of well drilled in 2016 (227 well). Based on this condition, the government of Indonesia asks the Contractor to increase the drilling of oil and gas development well to maintain and increase the national oil and gas production. This paper will calculate and analyze the distribution of drilling cost in offshore area to help Contractors to find the area in Indonesia that has low drilling cost.

The purpose of this paper is, to divide the geographical areas of Indonesia into 4 different offshore areas (Natuna Sea, West Java Sea , East Java Sea and East Kal. - Makassar Strait). Then, to collect the data that related with cost of development well drilling (cost per depth) and distribute them to those aforementioned areas and finally define the area that has the lowest and the highest cost of development well drilling.

Based on the analysis of 144 development well drilling costs, East Kal. - Makassar Strait had the lowest drilling cost by 1.14 MUS$/ft, then followed by West Java Sea as the 2nd lowest co drilling cost by 1.77 MUS$/ft, meanwhile Natuna Sea had the highest drilling cost by 3.49 MUS$/ft.

Finally, this paper is expected to provide contractors with a quick look at development well drilling cost in offshore area in Indonesia and guide them to choose which areas of Indonesia that will be exploited and also help them to create their petroleum exploitation strategy in Indonesia by considering on these informations which will provide benefits for both government and contractor.

INTRODUCTION TO OIL AND GAS INDUSTRY IN INDONESIA

Introduction on SKK Migas

Based on Law of the Republic of Indonesia Number 22 of 2001 and Presidential Regulation Number 9 of 2013, the Government of the Republic of Indonesia formed an institution called Special Task Force for Upstream Oil and Gas Business Activities (SKK Migas). The Institution is assigned to manage the upstream oil and gas business activities under a Cooperation Contract. One of SKK Migas's functions is to approve Plan of Development (POD) documents or

proposal based on technical and economical evaluation.

Production Sharing Contract

Since 1966, the Production Sharing Contract (PSC) concept has been the basic form of cooperation with foreign oil companies working in petroleum exploration and production in Indonesia. Under the PSC regime, the period of contract shall not exceed 30 years. The exploration period is six years and is included in the 30-year period. The exploration period can be extended once but cannot exceed four years, which will further proceed to the production phase, if there is sufficient hydrocarbon. If the contractor fails to produce hydrocarbon commercially within ten years, the working area shall be returned to the Government of Indonesia.

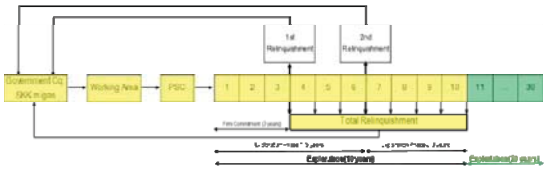


Figure 1. Production Sharing Contract Flow Diagram (Rukmana, 2011)

The duration of the PSC is 30 years from the date of the contract signed and may be extended for 20 years. Contract extensions can be proposed to the Minister of Energy and Mineral Resources through SKK Migas within two to ten years before the original contract expiry date. SKK Migas will further evaluate the proposal and provide recommendations for the ministry's approval.

Under PSC fiscal regime, in order to enable the project to be economically accepted, the Contractors may alternate the terms and conditions of the PSC, *i.e.*, changes in the percentage of First Tranche Petroleum (FTP) shares and split ratio (between Contractor and Government), request for incentives (Investment Credit and Interest Cost Recovery), Domestic Market Obligation holiday and depreciation acceleration.

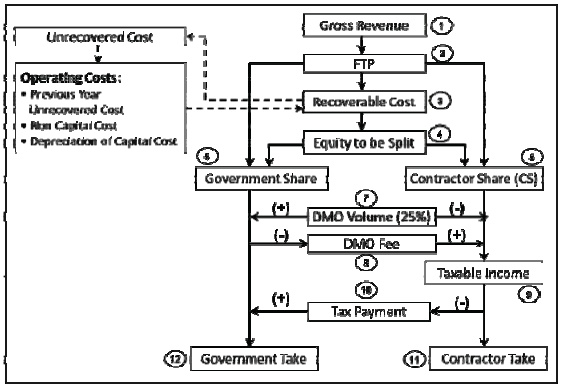


Figure 2. Production Sharing Contract (PSC) Diagram (Lubiantara, 2013)

In general, oil and gas price highly depends on the world market. As the market price is very volatile, the Contractors (both oil and gas) must properly manage their costs, risks and technology. Based on that, in August 2016, Minister of Energy and Mineral Resources attempted to create a new paradigm of upstream oil and gas management with the Government Regulation Number 52 of 2017 on Gross Split Production Sharing Contracts. This regulation set out a new fiscal and economic structure for PSCs based on dividing gross production between the state and Contractors, without a mechanism for the PSC Contractor to recover operating costs.

The purpose of the establishment of a Gross Split PSC include (Tahar, 2017):

a. Encourage robust and expeditious exploration and exploitation efforts.
b. Encourage oil and gas contractors to be more efficient and perceptive to the price volatility.
c. Encourage the Contractors to be more accountable in managing and controlling their expenditures.

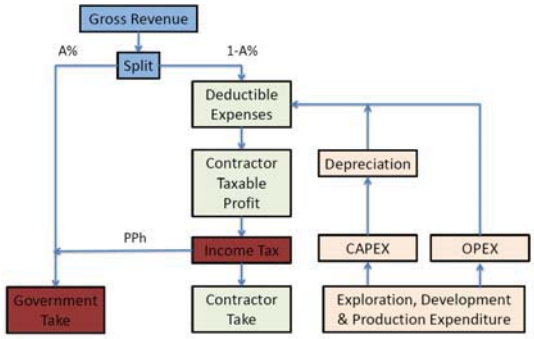


Figure 3. Gross Split PSC Diagram (Tahar, 2017)

As for the benefits that are expected with the implementation of Gross Split PSC, they include (Tahar, 2017):

a. the concept of "Share Pain - Share Gain"
b. business risks mitigated through incentive split
c. shorter business processes: it is expected the Contractor will save around two to three years on the procurement process and achieve early production
d. decrease cycle time and cost of first gas and oil
e. enhanced involvement of local contents to achieve a greater split.

Plan of Development

In Indonesia, the term Field Development Plan (FDP) is usually known as Plan of Development (POD). A POD is a plan to develop one or more oil and gas field in an integrated way to produce hydrocarbon reserves optimally by considering the technical, economic and other aspects.

There are several types of POD as follows:

1. POD I
   POD I is the first plan to develop oil and gas field once a PSC is signed. This POD is subject to Ministry of Energy and Mineral Resources ("MEMR")'s approval. In general, the first POD must be proposed and approved before the end of a ten-year exploration period. Should there be no approval given by MEMR within the stated exploration period, the working area must be returned to the Government, and all exploration costs shall be borne by contractors. The first approval of POD signifies the end of exploration period and the contractor shall proceed to development and production phase in the next 20 years.

2. POD 2 *etc*.
   A plan to develop oil and gas field in another structure different from POD I, but in the same working area. POD 2 *etc*. shall be approved by SKK Migas.

3. POD Optimation (ex. POFD)
   A plan to develop oil and gas to produce the incremental of hydrocarbon from existing POD whenever estimated reserves are higher than what was predicted and established in a POD. The processing facilities in POFD will use the existing facilities in the previously approved POD. POFD is subject to SKK Migas's approval.

4. POP
   A plan to produce one or two exploration wells that had been drilled to collect and analyze the subsurface data to find more commercial reserves (if any) that can be continued to field POD. Similar to POFD, the processing facilities in POP will use the existing facilities in the previously approved POD. POP is subject to SKK Migas's approval.

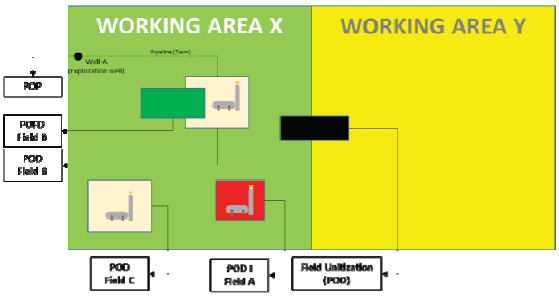


Figure 4. Types of Plan of Development

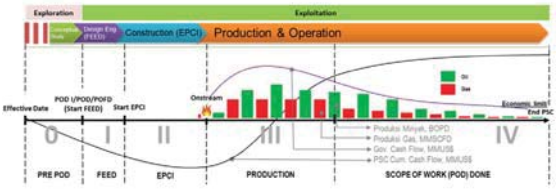


Figure 5. Project Cash Flow and Stages of Exploitation Activities (SKK Migas Report, 2016)

The exploitation activities in field development consist of 4 (four) stages:

1. Phase I: Phase after POD approval in the form of FEED implementation or preparation for engineering, procurement, construction and installation (EPCI), drilling and at this stage, there is no hydrocarbon production (on-stream).
2. Phase II: Implementation phase of EPCI and at this stage, there is no hydrocarbon production (On-stream).
3. Phase III: The stage when there is hydrocarbon production in the field, and there are still unfinished POD work programs.
4. Phase IV: The stage when there is hydrocarbon production in the field, and the implementation of the POD work program has been completed.

Since the establishment of SKK Migas, a total of 424 PODs have already been approved (as of December 2016). In 2015, there were 57 approved PODs, the highest number of PODs since 2002, while the oil price was at its lowest point since 2005. The increasing number of POD approvals indicates that investing in Indonesia's oil and gas industry is still considered very attractive and this might have been caused by the flexibility of terms and conditions of the PSC regime in Indonesia that helped the projects become economically acceptable.

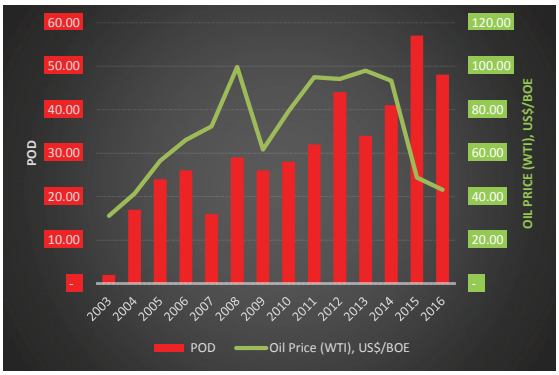


Figure 6. Plan of Development (POD) Approvals vs. Oil Prices for Period of 2003 – 2016
(SKK Migas, 2016)

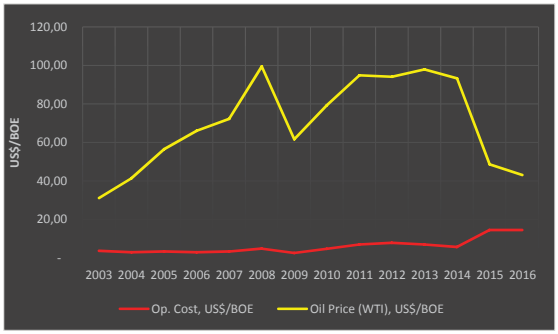


Figure 7. Oil Prices vs. Operating Cost of POD in Indonesia for Period of 2003 – 2016

Based on statistical analysis, the operating costs of the POD are far below the oil prices (Figure 7), although in 2016 has reached the highest since 2003 and was close to the oil prices.

The distribution of types of the POD in Indonesia (as of December 2016) can be seen as follows:

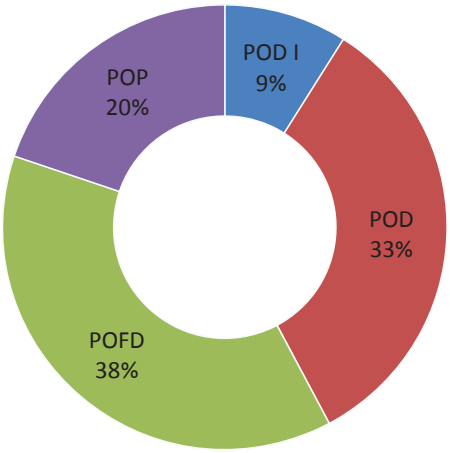


Figure 8. Distribution types of the POD

Based on Figure 8, we may infer that the PODs were dominated by POFD (38%) followed by POD (33%). The high percentage of POFDs shows that the number of proven reserves was higher than previously valuated by the earlier approved PODs.

Oil and Gas Prospect in East Region of Indonesia

As per 2016, There are 280 Contracts Areas (CAs) in Indonesia that is 30% in explloitation phase (85 CAs) and 70% in exploration phase (195 CAs).

Here is the distribution of Contract Area in Indonesia:

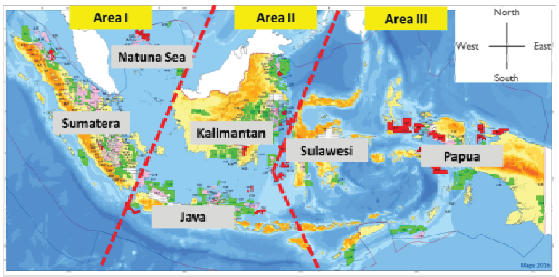
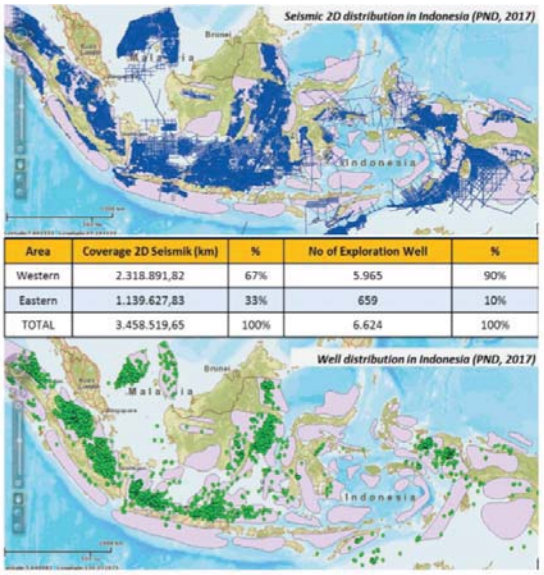


Figure 9. Maps of Contract Areas in Indonesia per 2016

Based on fig. 9, in an exploitation point of view, Area I (Sumatera and Riau Islands) becomes the area that has highest number of contracts area by 49% of total CAs, while area III (Eastern Indonesia) has the lowest number of contract area by 25% of total CAs.

In an exploration point of view, Area II (Java, Madura and Kalimantan) becomes the area that has the highest number of contract areas by 38% of total CAs, while area III (Eastern Indonesia) has the lowest number of contracts area by 28% of total CAs.



Area	Coverage 2D Seismik (km)	%	No of Exploration Well	%
Western	2.318.891,82	67%	5.965	90%
Eastern	1.139.627,83	33%	659	10%
TOTAL	3.458.519,65	100%	6.624	100%

Figure 10. Comparison of Exploration Activity between Western and Eastern Indonesia (Patra Nusa Data, 2017)

Figure 10 shows the distribution of exploration activity in Indonesia showing that the 2D seismic covers ± 2.4 million km in western region, while the eastern region was only covered by 1.1 million km. The number of exploration wells also shows the unequal condition with 5.965 wells drilled in Western Region, far beyond the Eastern Region with 659 wells spudded in the region during 1871-2017 (Wardana, 2017).

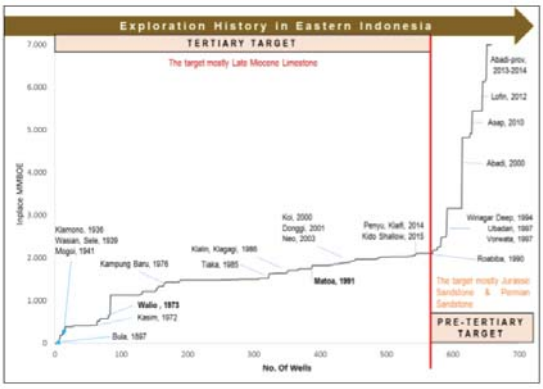


Figure 11. The Creaming Curve of Eastern Indonesia Region

In 2017, SKK Migas has launched its first Memoir titled Eastern Indonesia Hydrocarbon Potential. This book was inspired by the unbalanced exploration activity between the Western and Eastern Region in Indonesia. By launched this memoir, SKK Migas promotes Indonesia's potential in Eastern Region which well known as the home of the Pre-Tertiary Discoveries. The creaming curve of the Eastern Indonesian Region shows that the Pre-Tertiary is one of the key to increase the nation's oil and gas reserves. The Pre-Tertiary shows the growing trend while some of the Tertiary play shows the stagnant trend which indicated the mature condition due to the discovery size and the number of wells drilled (Wardana, 2017).

The eastern indonesia also has an interesting facts of commercial reserves distribution. The results of the bubble map of Commercial Reserves are as follows:

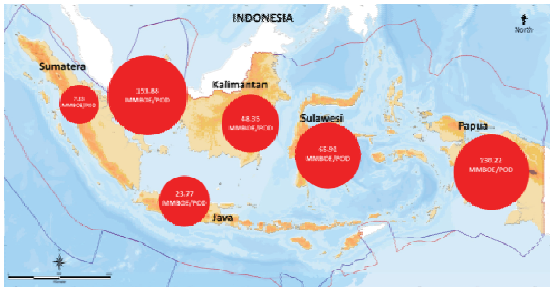


Figure 12. Bubble Map of Commercial Reserves per POD

As seen in fig.12, Natuna has the highest Commercial Reserves of 153.88 MMBOE/POD. Meanwhile, Sumatera has the lowest Commercial Reserves of 7.83 MMBOE/POD. Thus, it can be concluded that Eastern Indonesia tend to have big enough Commercial Reserves per project (POD), meaning that the petroleum exploration and exploitation activity is highly recommended to be conducted in Eastern Indonesia (IPA, 2018).

PROBLEM STATEMENT

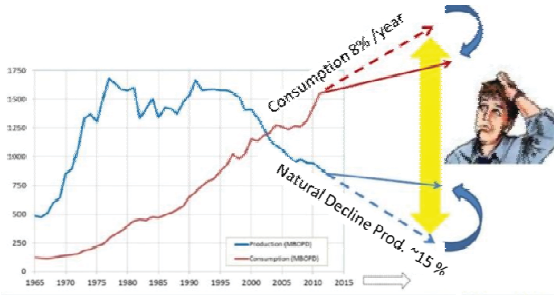


Figure 13. Oil Profile (Production vs Consumption)

Currently, the amount of oil production is inversely proportional to the amount of oil consumption, of which production is only around 700 thousand barrels per day, and consumption of about 1.6 million barrels per day (source : Gde Pradnyana, 2014). Indonesia's consumption increases annually by 8%. While production annually decreased about 15%.

In 2017, the drilling activity in Indonesia reaches the lowest number over the last 5 year. Total well drilled were about 200 well (37 offshore + 163 onshore). Here is the oil and gas drilling activity in Indonesia year 2014 – 2017.

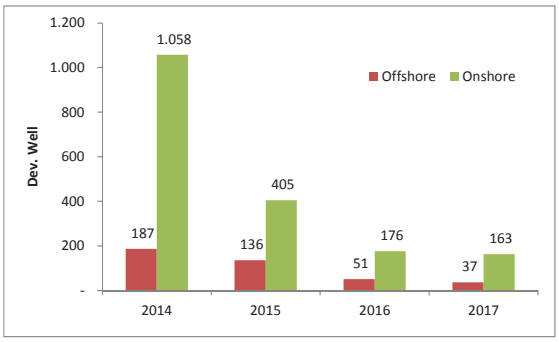


Figure 14. Drilling Profile 2014 – 2017

The low drilling numbers in 2017 may caused by the low oil price. Based on data, the oil price in 2016 reach the lowest price by 43 US$/bbl (Average).

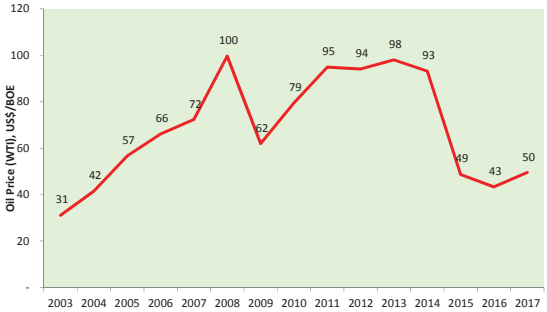


Figure 15. Oil Price History

The Low oil price also caused the low exploration and exploitation activities worldwide including Indonesia. east region in Indonesia

Based on this condition, this paper will evaluate and analyze the oil and gas drilling cost in Indonesia to let the contractors (investors) know how much the cost needed to drill a well in Indonesia and also to let them know the area in Indonesia that has highest and lowest drilling cost and this paper also try to attract the investor to do some investments in Indonesia.

METHODOLOGY

For this paper, we mapped divide the geographical areas of Indonesia into 4 different offshore areas (Natuna Sea, West Java Sea , East Java Sea and East Kal. - Makassar Strait). Furthermore, the data for from 144 development well drilling costs have been collected, and the reserves and drilling costs calculated and distributed between these areas.

The following diagram summarizes the mapping process for this research:

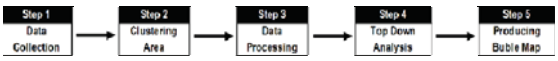


Figure 16. Methodology of Analysis and Mapping of Development Drilling Costs

Here is the explanation of the methodology:

1. **Data Collection**
   The 144 data of development drilling costs in offshore area between year 2013 – 2015 were collected, especially the data that related ot the cost of drilling per feet (US$/ft) in Offshore area in Indonesia.

2. **Clustering Area**
   Indonesia has been divided into 4 areas (Natuna Sea, West Java Sea , East Java Sea and East Kal. - Makassar Strait). We consider the classification of 4 (four) geographical areas to be reliable as we view that the existence of projects are pretty big in those areas.

3. **Calculation Process**
   The 144 data then distributed into 4 area mentioned above. After that, test these data using Control chart analysis to find the data outlier and ensure that this data is accepted statistically.

   All control charts have three basic components:

   a. a centerline, usually the mathematical average ($\bar{x}$) of all the samples plotted.

$$\bar{X} = \frac{\sum (X_1 \ldots X_n)}{n} \quad \text{... eq. 1}$$

Where n is the number of data observed

b. Upper and lower statistical control limits (UCL, LCL) that define the constraints of common cause variations.

$$UCL=\bar{\bar{X}}+3\sigma$$

$$LCL=\bar{\bar{X}}-3\sigma \quad \text{...eq. 2}$$

Where σ is the number standard deviation

c. Performance data plotted over time.

Here the result of control chart analysis in each area.

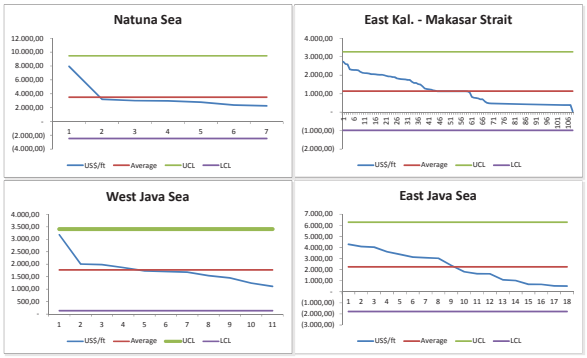


Figure 17. Control Chart Analysis of Drilling Costs in 4 (four) Clustered Areas in Indonesia

Based on the control chart analysis, it can be seen that all data are statistically are accepted to be processed due to the data samples are inside the Control limit (UCL & LCL). Then calculate the drilling cost per ft of each area using the formula below:

$$Drilling\ Cost\ per\ ft\ Area\ X = \frac{Total\ Cost\ of\ Drilling\ Cost\ per\ ft\ Area\ X}{Total\ Well\ Area\ X} \quad \text{... eq. 3}$$

The rationale for using this is to obtain the value of the drilling costs as these variables can show the potential areas as well as investment costs required to develop those areas.

Here is the result of data analysis:

Table 1. Drilling Cost per Feet

No	Area	Sum Dev. Well	US$/ft	Average, US$/ft	Min. US$/ft	Max. US$/ft
1	Natuna Sea	7,00	24.484,07	3.497,72	2.243,38	7.934,18
2	West Java Sea	11,00	19.503,31	1.773,03	1.110,35	3.178,18
3	East Java Sea	18,00	40.503,47	2.250,19	509,21	4.282,08
4	East Kal - Makasar Strait	108,00	123.143,52	1.140,22	45,00	2.730,01
	Total	144,00	207.634,36			

4. Analysis

Perform Top-down analysis of the drilling costs from 4 (four) areas. This analysis wa done to assess which areas have the highest and the lowest costs of drilling.

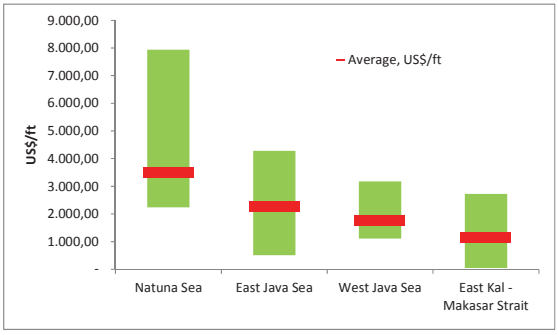


Figure 18. Drilling Cost Profile (Min., Max. and Average))

5. Bubble Map

Produce bubble map of the drilling costs from 4 (four) clustered areas as to provide the big picture of the geographical areas in Indonesia that will help Contractors to identify the most attractive ones.

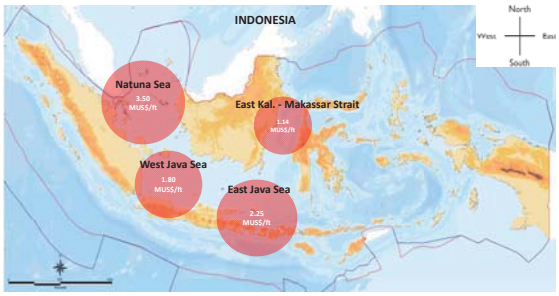


Figure 19. Bubble Map of Drilling Costs

The analysis above shows that East Kal. – Makassar Strait has the lowest average cost of drilling by 1.14 MUS$/ft US $3.24/BOE compared to other areas of Indonesia, while Natuna Sea has the highest (3.50 MUS$/ft). In other words, the eastern indonesia tends to have the low drilling cost. The results of drilling cost analysis above support and strengthen the petroleum creaming curve (fig. 11) and the analysis of the commercial reserves (fig. 12) which means that the Eastern Indonesia become the most interesting and potential area to be explored and exploited due to big commercial reserves per POD and have a tendency of lower drilling cost.

CONCLUSSIONS AND RECOMMENDATIONS

Based on the analysis of 144 data of Drilling cost year 2013 – 2015, East Kal. – Makassar Strait has the lowest average cost of drilling by 1.14 MUS$/ft US $3.24/BOE compared to other areas of Indonesia, while Natuna Sea has the highest (3.50 MUS$/ft).

These analyses show that Eastern Indonesia tend to has low drilling cost compare to the wester area of Indonesia, meaning that the petroleum exploration and exploitation activity is highly recommended to be conducted in Eastern Indonesia.

Despite the current adverse conditions, this paper provides insights for the investors and helps them create and revisit their strategy and portfolio to invest in Indonesia's oil and gas industry.

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