EVOLUTION OF OFFSHORE TECHNOLOGY A CASE OF STRATEGIC INTERACTION IN OIL INDUSTRY

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Abstract

Offshore operation in oil and gas industry defined as any drilling and production operation located or operating on a body of water, at some distance from the shore relatively to what identified as onshore operation which is generally means in land operation. Offshore drilling and production operation was a relatively new industry compare to the history of oil industry it self. Technologies take major part in development of offshore project, technologies make what impossible become possible in offshore industry. Offshore drilling and production industry can be possible because of technology innovation. However the drive to explore offshore resources come from high demand on oil and gas as well as depleted resources in onshore resources. One suggested that there is strategic interaction among entities in oil industry, as for offshore operation the strategic interaction lead to evolution of offshore technology. The strategic interaction between two relatively same profiles oil related company will depend on the cost of technology. There is tendency in oil and gas industry, if one company successful in using a kind of technology the other companies will follow the pad. Technology takes a big part in offshore drilling and production industry. The strategic interaction in offshore industry related to the cost of technology.

Keywords: offshore technology, strategic interaction, technology evolution

Abstrak

Kegiatan operasi lepas pantai dijabarkan sebagai setiap tindakan pengeboran dan usaha produksi yang terletak di atas badan air dan berjarak tertentu dari daratan tempat dilakukannya tindakan pengeboran dan usaha produksi daratan. Tindakan pengeboran dan usaha produksi lepas pantai merupakan jenis industri yang relatif baru dibandingkan dengan kegiatan industri migas lainnya. Inovasi teknologi memberi peran yang besar pada pengembangan proyek lepas pantai, teknologi mengakibatkan hal mustahil menjadi dapat dilakukan di industri lepas pantai. Walaupun demikian pendorong utama tindakan eksplorasi lepas pantai muncul dari permintaan yang tinggi akan produk migas disertai menurunnya cadangan migas di daratan. Berdasarkan hal tersebut ditemui adanya interaksi strategis pada industri migas, khusus untuk kegiatan lepas pantai interaksi strategis tersebut mengakibatkan evolusi teknologi lepas pantai. Untuk dua perusahaan yang sama besarnya, maka interaksi strategis akan dipengaruhi oleh harga teknologi yang mereka kembangkan. Kecenderungan yang terjadi pada industri migas, jika sebuah perusahaan sukses berkat bantuan suatu jenis teknologi maka perusahaan saingan akan mengikuti langkah tersebut. Teknologi berperan besar pada industri lepas pantai dan pada umumnya interaksi strategis pada industri lepas pantai berhubungan dengan harga teknologi.

Kata Kunci: *teknologi lepas pantai, interaksi strategis, evolusi teknologi*

1. INTRODUCTION

Offshore drilling and production operation was a relatively new industry compare to the history of oil industry it self. Oil industry has started since 1850, however offshore industry just started in 1950 and the deep water exploration start in 1975 while the production at 1995.

Offshore operation in oil and gas industry defined as any drilling and production operation located or operating on a body of water, at some distance from the shore [4] relatively to what identified as onshore operation which is generally means in land operation. According to Global Business Intelligence Research - GBIR [8], the global offshore drilling expenditure has increased especially during the period of 2004 to 2008. The peak of offshore expenditure was in 2007 to 2008 with total estimates expenditure from 2000 to 2008 was $350 billion. The major project of the expenditure is located at US Gulf of Mexico, West Africa, Brazil and Asia Pacific. Furthermore GBIR suggests, to 2015 the expenditure will grow 6.6% annually. This due to the depletion of reserve in onshore and sallow waters as well as the advancement in seismic, drilling and production technologies.

Technologies take major part in development of offshore project, technologies make what impossible become possible in offshore industry. Offshore project barrier mostly come from the environment, the harsh weather and the deep of the ocean. Another factor that makes offshore project become more visible is the development of 3D and 4D seismic that allow the precise interpretation of formation.

2. OFFSHORE TECHNOLOGY EVOLUTION

Offshore industry can be describes as technology oriented industry. The technologies in this industry has been used in other industry including the space program [1]. This advancement in technology has make possible to explore to deeper water. The technology advance can be traced from the design of the platform to utilization of remotely operated vehicle for subsea system maintenance.

For the offshore operation development there where six critical technology elements, which are vessel positioning, remote control, risers and umbilicals, installation method, intervention methods and inspection, maintenance and repair [7]. However other technologies such as vessel design and drilling also take big part in offshore operation development [5].

According to Tanaka, Okada & Ichikawa [9], launching drilling operation in offshore is much more complicated than onshore operation and more expensive. The features that make the offshore drilling become more complex and costly are the need of artificial land which provides by using floating or bottom supported rigs, crews accommodation as well as service system (i.e.: cementing and geophysical logging) and drilling system, due to distance, are in artificial land; the space for these three essential factors would be limited.

Offshore Vessel Evolution

Offshore mobile unit has been one of key factors in offshore drilling operation growth. The design of offshore mobile unit has purposes to deal with offshore drilling operation problems. According to Howe [5], offshore mobile unit defined as any portable unit containing a drilling rig capable of drilling in open water 20 ft or deeper. This includes submersible, jackup, floating, tender-type mobile platform, and special mobile workover rigs; but excludes any non-floating vessels.

Furthermore Tanaka, Okada & Ichikawa [9] added, offshore drilling rig structures can be categories as mobile drilling unit and stationary drilling unit. Mobile drilling unit defined as offshore drilling unit that easily to move to another drilling operation area. In this definition includes self propeled drillships with APE that also known as dynamic positioning system (DPS), semisubmersible, submersible, and jackup rigs.

There were two types of stationary platforms drilling structures which used for developing offshore fields; self-contained platforms and tender or jackup assisted platforms. Self-contained platform is a large production facilities that equipped with all essential drilling operation. The other type is smaller platform that needs support from service vessel to provides the essential necessity such as crews accommodations. Stationary rig is merely artificial land that does not have privilege of mobility.

Offshore platform preferences are based on water depth and the state of sea and wind, the selections are as follows:

a. less than 25 m water depth is using submersible rigs or swamp barges
b. less than 50 m in calm water is using tender of jackup rigs
c. less than 400 m in mild water is using self-contained platforms
d. between 15 m to 150 m depth may use jackup rigs
e. between 20 m to 2000 m may use drillships or semisubmersible rigs (anchored)
f. between 500 m to 300 m may use drillships or semisubmersible rigs with APE
g. in isolated area with icebergs is using drillships with APE
h. in severe sea conditions may use semisubmersible rigs or new generation drillships

Evolution of Submersible Rigs

Barnsdall-Hayward "Breton Rig 20" was the first offshore mobile unit that operate in 1949. It was design by John T. Hayward, the father of offshore mobile unit. The mobile unit took philosophy of low cost, portable, and followed the movement of tide and wave, that become the philosophy of recent vessels.

The first submersible rig, Barnsdall-Hayward "Breton Rig 20" was evolve from swamp barges that can be used to drill in marshes and protected bays or rivers at maximum 10 ft water depth. The first barge was build in 1933, it is called the Giliasso-type barge with U-shaped hull, long-narrow slot which allowed for placement rig at amid-ships. The other barge design was twin barges connected by a truss, the rig place at between the barges. To compensate with the water-depth requirements, another design called "posted barges" raised the drilling decks by adding vertical structures.

The problem occur in barges is when totally submerged the units will be unstable. The Breton Rig 20 design were the answer for this problem. The Breton Rig 20 utilize pontoons that could afloat while barge will set to bottom. After the bottom was set to minimize the wave force the pontoons were lowered.

Other innovation was hinged pontoons that provide stability while sinking. However was not successful and the rigs that already used this system were converted to fix pontoons (Mr. Charlie and American Tidelands 101). The Mr. Charlie also known in using the innovative idea of large-diameter columns to increase stability which will later evolved to SPAR design.

Evolution of Jackup Rigs

The first jackup rig was build in 1955 by the Royal Dutch/Shell Group for drilling operation in Persian Gulf. The early jackup was taken to the drilling location by two barges. After the jackup take position, the barges leave the place. This makes the jackup vulnerable when in setting the legs and the barges expose to wave force. The other innovation was by separate the jackup into two parts, the legs and upper deck. The problem in early pile supported jackup rig was the penetration to sea floor, that may tipped over the rig. The solution to this problem is using large-diameter "cans". The next innovation was to answer the bending stress problem as the jackup rigs been use in deeper water. The innovation includes truss-type legs and jacking devices with pneumatic boots/hydraulics slips. The next major development was in implementing mast to the legs to increase rig foot hold.

Evolution of Floating Rigs

Floating rigs had significant design innovations. Not all the prototypes of early floating rigs were successful. Floating rigs could be classified as self-propelled vessels which generally called drilling ship and non-propelled such as barges and semi-submersibles. Early drill ships was mostly used to take core as geological sample. The early drill ships put the rig at the center to increase stability.

The first dynamic positioning equipment were instal in 1961 on Global Marine's "CUSS I" allowing the possibility of drilling in deeper sea (3000 to 11,700 ft). The first automatic positioning equipment (APE) drilling vessel were Shell's Eureka. Larger vessel where built taken advantages from APE, from previous generation of 3000 tons to 5500 tons.

The other evolution of floating rigs were from barges to submersible then become semi-submersible to drill in depth water. The first semi-submersible was developed in 1961, one of the advantages of this kind of platform compare to drilling ship is the stability performance to hold high wave. Disadvantage come from positioning that involves trimming, towing and mooring problems. The problem has been fix in the next generation to improve capability of semi-submersible rig.

Offshore production platforms

There were several types of production platform which can be categories as bottom-suported platform and floating platform.

Bottom supported platform types are template platform, compliant tower, and gravity platform. The most common is template platform. This kind of platform consist of jacket, piles and deck. The jacket and piles fixed to sea floor act as supporter of the deck. This kind of platform have various functions, from the well protection to production fluids as well as drilling operation due to field development. Template platform normally not provide with fluids storage capability. The working deep for template platform is up to 500 m. To install template platform at more than 500 m deep will be costly due to maintenance capability. Compliant tower is design to solve this problem.

Gravity platform is a relatively stable platform that get benefit from it's structure own weight. The supporter part of this platform is made of concrete that provide weight for stability as well as space for fluids storage and field development trough cluster system drilling. This kind of platform make the exploitation of North Sea was possible. One example is Troll A platform own by Stadoil. It massive build help the platform to deal with North Sea harsh environment.

The problems with bottom supported platform that get benefit of stability are the long lead time and cost effectiveness to water depth. Utilizing floating platform mooring to the sea floor will become logical solution. Another benefit from this kind of production is the possibility of using the production platform at the different site after abandonment. The floating production platform types are semi-submersible production platform, floating production storage and offloading system (FPSO), tension legs production platform (TLP) and spar platform / deep-draft caisson vessel (DDCV).

The first floating production platform was a semi-submersible oil drilling unit that has been modify to become production platform, the modification and time saved by the modification improved the project economics. Today, for deep water application, to satisfied the conditions the unit must purposely build not a modification from drilling unit. The floating production unit keep at the position by mooring system, in as much the well head completion will be subsea completion and the fluids get to the surface by the help of marine riser. The downgrade of using floating production unit is limited payload as well as no storage capability.

FPSO is a ship-shaped production facilities with or without propulsion. The first FPSO was a modified tanker. The FPSO is suitable to be use in remote are due to its large payload and large storage capacity, where the pipeline was not an option. To keep the vessel at the place, mooring system is used. Well can be completed by either subsea or separate platform.

TLP is special production platform to work in deep-water of 500 m to 1200 m. TLP is essentially a semi-submersible that keep stationary by using tendons. Tendons are made of steel tubulars and tensioned by excess buoyancy. The tendons attached to the seafloor using piles. Because of the TLP design, the well completed at the deck. It takes benefit from the surface completion and the maintenance.

DDCV is the most recent type of floating production platform. It is deeply submerged, consist of spar hull and deck. The platform using mooring system to keep it stationary. The advantages of this platform are relatively stable for deep-water operation, well can be completed at the deck, and oil storage capability.

Subsea production systems

In offshore production, especially in deep-water production, utilizing subsea production system is a must. Building and installing offshore platforms are expensive, the technologies to make the design of platforms become possible are significant. However it would be uneconomic to develop offshore resources if every offshore field need a platform, thus the technologies of subsea system has innovated. The produced fluids either piped or use tanker to transport to storage or processing facilities. To maintenance the subsea system ROV is used, operated by a worker from the platform/vessel near by.

Today the technology development has reach reliability improved and confidence that even the system is used in shallower environment. Subsea production system consists of subsea christmas tree, subsea manifold, subsea boosting and processing and subsea control system.

Subsea production system usually managed from a single collector to increased economics and efficiency. One collector, any kind of production vessel, will provides service for several well this called cluster system. The development of cluster system was started at the drilling time, while from the single point the drilling platform can drill several well by using directional drilling technique.

3. TECHNOLOGY REQUIRED BY FLOATING UNIT

For the offshore operation development there where six critical technology elements, which are vessel positioning, remote control, risers and umbilicals, installation method, intervention methods and inspection, maintenance and repair

[7]. Tanaka, Okada & Ichikawa [9] added, special technologies that make big differences between floating unit capability compare to mobile bottom-supported rigs are station keeping system, marine riser system, and drillstring motion compensator. The technology was develop to overcome the effect of wave movement up and down as well as weather includes the wind and current effect.

Stationkeeping system is used to maintain the floating unit at the precise range above the subsea wellhead. The conventional methods is by using anchor mooring system which utilize chains, wire ropes and / or combination of chains and wire ropes. The more sophisticated method is DPS. DPS utilize several independent thrusters attached to vessel hull. The system work automatically by using integration of computer, subsea wellhead acoustic beacon and satellites signals. The position of the vessel were based on the wellhead location, mark by using acoustic beacon, and satellites signals such as global positioning system (GPS). The signals from both subsea wellhead and satellites analyzed by computer and if the computer received indication that the vessel has move from it acceptable limit position, then it will give command to move the thruster/thrusters to make it sure the vessel at the designated position.

Marine riser system take part as conduit for returning drilling fluids as well as for running drill stem and casing to the seafloor from the floating unit. It consists of riser pipes, riser tensioner, and ancillaries. The marine riser system is connected to the subsea BOP. It works together with the riser tensioner system from the vessel that will pulled it up to make a vertical connection.

Drilling operation in the floating unit would be difficult due to wave motion that make the weight on bit fluctuate in parallel with floating unit oscillation. To solve this problem, motion compensator was invented. Two types of this technology are bumper sub and heave compensator. A bumper sub is used as part of drill string, it is placed near the top of drill collars. At the upper part of the bumper sub, a telescopic mandrel positioned and will slides in and out in response to the heave motion of the vessel. Another benefit of a bumper sub is it able to transmit the torque from the drill stem to the drill collars to rotate the bit.

The Heave compensator utilized hydraulic or pneumatic cylinders that will compensate the drill stem load while the drill stem remain in stationary position, the same way as the work of spring, as the heaves force occur in the floating unit. There are two types of heave compensator relate to the placement at the derrick. The first one is crown-mounted heave compensator and the other is in-line heave compensator which hung bellow the traveling block.

Deepwater Technology

Access to deep water resources requires technology development. The technology development includes drilling technology, field development technology and intervention technology.

The major development concepts of offshore industry can be categorize as the field size and the working deep. For small field in shallow water the best solution is using stationary platform and the well completion located at the platform, this type known as wellhead platform. For small field in deep water the solution is by using floating vessel with subsea completion. For major field in shallow water the use of contain production facilities such as production, drilling, and quarters (PDQ) platform are recommended. The completion would be at the platform. For deep water production project, the completion will be subsea completion, however for small field and for major field,the recommendations are mobile floating unit and FPSO respectively.

Development of well completion: with surface units; subsea wells or dry wells. hybrid development: deep subsea wells tied back to shallow platform (hub platform) Subsea to shore development

Due to the technologies development achievement deepwater exploration and production has rapidly increase in past ten years. One example of offshore evolution in technology is the offshore development in Norway. In the past, the offshore in Norway use staitionary platform such as gravity platform for drilling and production. Today in Norway floating production and subsea systems is implemented, while in the future there is plan to install pipeline connections directly from subsea wellhead to onshore plant.

4. STRATEGIC INTERACTION IN OIL INDUSTRY

In the research of how the oil industry pursue strategic interactions as a consequence of market structure, Voola [10] simulated strategic interaction of two identical oil industry in oligopoly market structure. As model Voola used strategic interaction in using seismic technology.

According to Voola, strategic interaction in oil industry will occur in four scenario relatively to cost reducing technology. The first scenario is neither of the player implements new technology, the second and the third scenario is when one of the player invest in the technology while the other not and the last scenario is both of the player invest the technology simultaneously. Voola explains that relationship of the cost of technology to payoff ordering can be differ into five possibilities; from the highest cost to zero cost. Voola suggests, for the highest cost and the second highest cost the dominant strategy would be strictly not implemented the technology. For the middle cost, would be mixed strategy either to buy or not to buy that considering uncertainties. For the second lowest and lowest of zero cost the dominant strategy would be implemented the technology. However for the second lowest cost there is possibility that players caught on prisoner's dilemma due to the better situation for the players is not to use the technology.

In conclusion Voola stated that there is indication of strategic interaction in oil industry moreover, strategies have been a significant part of forging oil industry structure. Another point from Voola is merger as a logic way for players in oil industry to survive from the competition.

Offshore Industry Strategic Interaction

As mention above, offshore drilling and production industry can be possible because of technology innovation. However the drive to explore offshore resources come from high demand on oil and gas as well as depleted resources in onshore resources [9].

The strategic interaction between two relatively same profiles oil related company will depend on the cost of technology [10]. Although the technology make impossible become possible, however if the price to high then it will not do much. Different thing happen if a rival company acquired the technology regardless the price. The other industry should make decision to used or not used, however the uncertainty will mostly affected the decision. The most problematic is when the question of how the technology will benefit the rival and the possibility of the technology makes rival company dominated market.

Nevertheless, unable to acquired certain technology most likely will make the company behind the another company that used the technology. Discussing the cost if the price is too high the logic strategy is not to used the technology, and if the price is high but profitable the logic strategy will be acquired the technology by considering uncertainties. If the price of technology is low or even zero using the technology would be the best strategy.

In case of deep water exploration, almost all major oil and gas company moving towards deep water exploration, however not every company will get the same result due to uncertainties such ah location, technology applied, expertise, etc. There is tendency in oil and gas industry, if one company successfull in using a kind of technology the other companies will follow the pad.

As example of strategic interaction in offshore industry is the case of Transocean (RIG) company. Two case that can be the examples are the acquisition of Santa Fe International (GSF) and the threat from ChevronTexaco (CVX). In 2007 Transocean merger with Global Santa Fe. From the biggest US rigs provider it become the second biggest service company in the world after Schlumberger N. V. (SLB). The merger give more opportunity to Transocean to become player in deep water drilling as Santa Fe International specializes in offshore drilling. In the competitors side, there were high probability that other companies in same area do the same thing to negate the Transocean domination in deep water exploration.

ChevronTexaco has partnered with Massachusetts Institute of Technology (MIT) in developing technology to explore ultra-deepwater. This will make two prong treat to Transocean first if ChevronTexaco acquired the technology and establish its own business, Transocean will loss one of big costumer and the second ChevronTexaco most likely will become another Transocean competitor in deep water exploration.

5. CONCLUSIONS

Technology takes a big part in offshore drilling and production industry, it makes the impossible become possible. However the drive to explore the offshore area come from high demand on oil and gas as well as run off resources in onshore area.

The strategic interaction in offshore industry related to the cost of technology is an essential feature of the industry. Merger and acquired the technology that needed to explore the deeper area are several strategic interaction that might happen.

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