Towards a Roadmap of IHC IQIP

Oil & Gas Market Analysis

Xiaoming Mark Ma

4501659

IHC IQIP Sliedrecht
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TU Delft

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by

Xiaoming Mark Ma

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Thesis committee:	Prof. dr. Eddy Van de Voorde,	TU Delft
	Asst. Prof. Ir. Koos Frouws,	TU Delft
	Dr. Ir. Hans Veeke,	TU Delft
	Ir. Ing. Mark Aelmans,	IHC IQIP

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Xiaoming Mark Ma
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Contents

1 Introduction

This chapter aims to give an introduction of this project. The background information will reveal why the project is helpful and necessary. The objective which follows will be defined based on the project background. Lastly, to achieve the objective, the main activities and scope of the work will be given.

1.1. Project Background

IHC IQIP is a new subsidiary of Royal IHC which specializes in innovative equipment for offshore and civil engineering projects. IHC IQIP focuses primarily on design, production, sale and renting of diverse equipment in sectors which are oil & gas, offshore wind, decommissioning and coastal & civil engineering. As a creative and innovative company, IHC IQIP supplies not only equipment but also smart solutions for foundation, installation and decommissioning in the oil & gas, offshore wind and coastal & civil market.

The oil & gas industry is changing rapidly, especially in the offshore oil & gas market segment. In the oil and gas sector, IHC IQIP has a broad range of offshore equipment for various applications.[34] [15] These applications include offshore structure installation, Floating Production System(FPS) mooring, (Ultra)deep water structure installation, conductor installation and subsea field development. The detailed equipment introduction will be discussed in a later chapter.

Since the demand for the equipment of *IHC IQIP* mostly comes from the upstream oil & gas market, it is obvious that *IHC IQIP* will also be influenced by the oil & gas market. However, this market is rapidly evolving influenced by the world economy, politics, and technological development. Also, the oil price was still relatively cheap in 2016.

This led to a survival mindset in the oil & gas industry and many companies continued reductions in capex and labour cost. This changed the supply and demand of the offshore oil & gas exploration and production structures.

To survive and win more profit in the current market, IHC IQIP is planning strategically to manage the risk and generate more profits. The oil & gas sector is one of the most important business sectors internally, so analysing the offshore oil & gas market mechanism and developing a market forecast is essential for IHC IQIP.

The oil companies will decide to build more offshore platforms if there is a positive NPV which comes from a rising oil price or other factors. Furthermore, there might be a time lag from offshore projects market to the offshore equipment market as well. The oil & gas offshore contractors, who are the clients of IHC IQIP, always need to purchase the equipment before the offshore structures installation.[1]

Currently, there is still no available research or analysis report to prove or validate the conjecture, which is the time lag between offshore projects and the offshore equipment market. If there is a change in the oil price or gas price, the offshore equipment market would

[1] Interview with Mark Aelmans, Innovation Specialist of IHC IQIP, Sliedrecht, January & 18th April 2017

experience the influence afterwards but the accurate time lag is unclear.[34] Obviously, this is not favourable for IHC IQIP to win more profits and manage risk.

Thus, IHC IQIP is planning to analyse the market and plot a roadmap for the oil & gas sector. It will contribute to their Research & Development plan, production plan and marketing strategies by matching the future market demand and the needed technology.

1.2. Project Objective

To plot the roadmap for the oil & gas sector, it is essential to do the market demand analysis and research the influencing mechanism of oil price on the offshore projects market and offshore equipment market. The equipment market of IHC IQIP is primarily the market of *offshore structures installation*.

Due to the higher cost of the general offshore oil & gas projects, the offshore oil & gas market slowed down as oil companies would not be able to break even if they were to build a new offshore oil & gas platform. When the oil and natural gas prices increase to the level at which the oil companies satisfied, the offshore oil & gas projects will be launched. The revaluation of the specific oil field development takes time and the project business plan has to convince the oil company stakeholders. More precisely, even if the oil price increases and is bigger than the break-even oil price, the procedure to employ a new offshore platforms takes time. This is referred to as the time lag between the energy market and the offshore upstream oil & gas market. This is another reason the downstream companies in offshore oil & gas sector like *IHC IQIP* need to do such market analysis to know the exact market value chain and influencing mechanism.

Thus, the first objective of this project is analysing the market mechanism of the offshore oil & gas equipment market. After the primary study of the offshore oil & gas equipment market, a second objective is analysing the time lag and influencing law of oil price on the offshore projects market. There is a time lag from the oil price and the upstream oil & gas industry, especially for the offshore oil & gas platforms market.[1] Based on this analysis, the market mechanism can be developed further and more accurately by the time lag study.

The second objective is analysing the future demand for the offshore oil & gas equipment based on the influencing mechanism and relevant data of the energy market and technology research.

Identifying the influencing mechanism and the future market demand could help the management board of IHC IQIP to reach its ultimate goal which is maximizing the profits and minimizing the potential risk in the oil & gas sector.

With the help of this market analysis, the demand for current and new products in the oil & gas sector will be estimated, which will contribute to the strategic and corporate planning. This allows the management board of IHC IQIP to be able to make the corresponding research and development plan, marketing plan and production plan which will help to achieve the ultimate goal.

1.3. Scope of Work

This project is deemed as part of the road map of oil & gas sector for IHC IQIP, mainly focusing on the market demand analysis. The first part is the fundamental research on market analysis, related marine technology and maritime analytical techniques.

This part includes the oil & gas market research, offshore equipment technology study and statistical techniques. (Stopford, 2009) (Stevens, Sherwood, & Dunn, 1993) The study will focus on the influencing mechanism between economy, the oil & gas market and equipment market, instead of the economy analysis or energy market analysis.

Secondly, the oil & gas industry will be studied in terms of the different blocks in the value chain from upstream to downstream in the energy market. Additionally, the offshore oil & gas sector will be studied in terms of the offshore technology as well as the economics perspective.

Thirdly, the technology research of the offshore oil & gas equipment is needed. This section will look at the offshore oil & gas equipment in terms of marine technology including: main specifications, functions, target markets and corresponding competitiveness in the

varied market segmentations. This part will also contribute to the matchings of the marine technology and market demand, which are essential in the market analysis.

Furthermore, based on the available data from IHC IQIP, IHS, EIA and IEA, this project will analyse the past trends of the economy, offshore oil & gas projects market and the offshore equipment market. (Beck & Wiig, 1977) The data includes, but is not limited to: GDP, oil price, executed offshore oil & gas projects data, tendering offshore oil & gas projects data, and the sales record from IHC IQIP. In this chapter, the influencing mechanism of economic data and oil & gas price on the equipment market will be studied. This will then be incorporated in the analysis model afterwards.

The independent variables will be GDP, oil price and gas price. The dependent variable will be CAPEX of oil & gas companies or market demand index of the offshore equipment. Then, the most suitable model would be identified based on the data pattern and the economics principles. The chosen analysis software is from Excel and Python.

Once the model and the analysis software is chosen, the corresponding coefficients can be calculated and the influencing mechanism could be identified. (Kress & Snyder, 1994) If needed, the analysis can be divided into different time periods to reflect different economy environments, e.g. different GDP. After this, the trend of the data will be extrapolated.

In addition to the statistical analysis, the ideas from experts should be studied to validate the model above. These experts include the management board of IHC IQIP, main clients, R&D engineers, and the sales team. Then, considering the expert ideas, the statistical model could be updated by adding up some error correction coefficients or tuning some existed coefficients.

Last but not least, future scenarios will be made to give more reference to the management board of IHC IQIP. The scenarios should include the future market trend, the technology options and the market-technology matching.

1.4. Research Phases

Following the scope of work, it is important to plan the research and define the research phases clearly. This will avoid potential risks and contribute to the market analysis.

1.4.1. The Influencing Mechanism of the energy market on offshore market

To analyse the offshore oil & gas market demand for the equipment, which is the downstream of the offshore installation contractor business, the first research question is the influencing mechanism of the energy price on the offshore oil & gas market demand, including the time lag between oil price change and the market demand change of offshore equipment. Furthermore, because the equipment is used in the installation of the offshore oil & gas platforms. The market demand for the offshore equipment is closely correlated with the offshore oil & gas projects market demand, which is highly reliant on the energy market. However, the mechanism of the interaction between the energy market and the equipment market is unknown for IHC IQIP, which is a risk to profits in such a volatile energy market.

To manage the risk and catch the market opportunities, the influencing mechanism needs to be studied. For example, if the oil price increased or decreased, the equipment market demand would change due to the oil price change following some patterns. Precisely, this question could be divided into two parts. The first part is the influencing mechanism of the oil price on the offshore oil & gas platforms market demand, i.e. the regular patterns of the market demand.

The second part is whether there is any time lag between oil price and the offshore platforms market demand. If there is any time lag between these two markets, the length of the time lag must be studied.

1.4.2. Offshore Oil & Gas Platforms Installation Technology

To get a clear overview and deeper understanding of the target market[2] and important offshore equipment, the offshore oil & gas platform installation technology needs to be looked

[2]Target Market:A target market is a group of customers a business has decided to aim its marketing efforts and ultimately its merchandise towards.[5]

at. This includes the different platforms, the installation procedure, and the link between offshore platforms and offshore equipment.

Due to the fact that the offshore oil & gas industry contains a lot of technology-intensive processes, the market of this industry will surely be influenced by this feature. The different technology solutions weigh differently in terms of lead time, risk and cost. Though the focus of this project is the offshore equipment to install the offshore platforms, the technology of other stages in the industry value chain is important as well. For example, the different features and technology characteristics of varied offshore platforms naturally hold a strong correlation with the installation equipment.

Besides, there are a number of companies which also supply the offshore oil & gas equipment, which are the competitors of IHC IQIP. So the sales of IHC IQIP are not only determined by the offshore projects market but are also influenced by the technology competitiveness. The technology research can be finalised by interviewing the experts such as the R&D engineers who have a lot of experience in this sector, as well as the technical literature review.

This part of the research is the technical foundation of the offshore installation equipment market which supports the market mechanism and contributes to the time lag analysis.

1.4.3. The Future Market Demand Forecast

Based on the result of analysis above, together with current energy market data and offshore projects data, the future market trend of the offshore oil & gas equipment will be extrapolated using the time lag, if it exists and is positive. In this case, the oil price will be the forward indicator of the offshore installation market. If the time lag is not positive or not does not exist, then the future market demand forecast will not be executed.

1.5. Methodology

To analyse the market demand for the offshore oil & gas equipment, the methodology needs to be clarified to reach the objectives. Although there is not one fixed and developed theory for equipment market analysis, the methodology used in the maritime forecast could supply some general principles and there are five stages to follow. They are *Design model, Define relationships and collect data, Estimate equations and test parameters, Validate model* and *Prepare forecast*[40]. This project will follow these five stages above, with some changes as stated below.

Firstly, *literature research and expert interviews*[3] will contribute to the steps including *Design model*, *Define relationships and validate model*, based on the economics principles and the oil & gas industry value chain. Especially the offshore oil & gas installation technology research will set a solid technical foundation of the market analysis. Because if the technology changed largely, the market will surely be effected.

As for *Estimate equations and test parameters*, which is the quantitative research part, due to the limited database, the correlation analysis of the data series can help to further reveal the market mechanism. After the step *Validate model*, *future scenarios* will be prepared based on the analysis results and different possibilities, which is the last step.

[3]The experts are Research & Development engineers, Sales managers and the Executive Directors of IHC IQIP

2

Literature Research

2.1. Introduction to the Literature Research

Since the focus of this project is the offshore oil & gas platform installation equipment market analysis, the foundation of the market analysis will be the offshore installation technology, which will be elaborated in another chapter due to its importance.

In addition to that, the equipment market analysis is part of the maritime economy. Thus it is important to review the related maritime economics theory, which will be elaborated on in this chapter.

2.1.1. Introduction of maritime economics

Maritime economics is not only about shipping but all marine activities. In addition to the conventional merchant shipping, there are also other vessel operations activities, shipbuilding activities, marine resources related activities, marine fisheries activities and other marine related activities such as maritime tourism and maritime IT. These marine activities also have similar economics characteristics such as capital-intensive, high technology and complex industrial structure.

Offshore oil & gas activities belong to the *marine resources activities* in the list above. It is also part of the maritime economy. More precisely, offshore oil & gas is a special sector at the intersection of the energy industry and maritime industry. This means that the theory of maritime economics can be applied for offshore oil & gas industry as well. To give an overview, merchant shipping is the primary activity of the marine activities accounting for an estimated 31% share in 2004 among all kinds of marine activities. The central role of shipping identified by the economists is supplying the transport needed to promote economic development. The offshore oil & gas part is estimated about 8% of the turnover of all marine activities in 2004. Precisely, its turnover was estimated about 113,366 million US dollars.[40] The central role for the global offshore oil & gas industry is to supply the oil & gas energy for humans and the economy.

Due to the special maritime environment and complex industrial structures, it is difficult to simply manage the business in the maritime industries based only on normal business principles. Hence, in maritime industries including shipping, shipbuilding, maritime resources and other related marine activities, marine economists developed the regrading theories to assist the market analyst to explain the current market trend and forecast the future scenarios. In other words, to do a high-quality market analysis, maritime economics is quite essential to be used as a theory foundation.

2.1.2. Maritime Market Forecast

As stated in the beginning of this chapter, to help the decision makers in the marine related industry, market research is needed to explain the current marine market and forecast the future scenarios.

The offshore oil & gas industry belongs to the marine related industry. As the offshore oil & gas industry is very capital intensive and sophisticated, market forecast is vital for the management board decision-making process. Another reason is that the offshore platforms and offshore equipment have a relatively long delivery time and design time.[42] [28] Without a market to reference, decisions made now which will affect for the next 25 years or at least several years may result in a big loss.

The forecasting model also has some limitations in terms of accuracy. In reality the market will be influenced by many factors. However, in forecasting model, the factors included are only some of the important factors, instead of all influencing factors. This means the analysis will not fully reflect the reality and the forecast may vary from the future. [40] However, professionally using every available piece of information to make an educated decision in maritime industry can help to increase the probability to win more profits in the maritime industry.

For example, there are many external influencing factors which will effect the offshore oil & gas market. If the most influencing factors could be used in the forecast, the probability of forecast will be much better than a forecast based on few factors. However, the purpose of rational forecasting is not to predict precisely but to reduce uncertainty. [40] Future market forecasting is not about the future but about obtaining and analysing the right information about the present. By doing this, the future scenario can be better forecast.

Practically, maritime forecasting is important for shipowners, bankers, shipyards, engineering companies, rating agencies, and ports, as they would be more successful if they can predict the future better than their competitors[40]. For example, with a future market demand trend extrapolation, the decision-makers could weigh up the risk of the potential R&D plan of specific equipment series and have an overview of the future market trend as well as what might be the potential new market demand.

The shipping market is the upstream of the shipbuilding market just as the offshore oil & gas market is the upstream market of the offshore equipment market. There is a basic economic rule in the shipping market which is to make sure the minimum resources are used to transport the world's trade. Similarly, the oil & gas market is required to produce energy products at minimum cost level. If the oil corporation spent more money than expected in exploration and production stage, then the company will have trouble striving to a positive balance. Understanding this basic economic principle will help the analyst to explain the offshore oil & gas installation equipment market.

2.1.3. Types of Variables for the Market Forecast

To better forecast the market, there are some principles of forecasting to make sure the forecast is useful for the decision makers, including *Relevance, Rationale and Research.* Relevance is the initial aspect to be confirmed in the starting stage of a market analysis.[40] Obviously, it makes no sense if the market analysis produces correct but useless results. For example, perhaps the market analysis model could forecast the oil consumption and production in a specific area. However, it could not be directly used for the stakeholders of this project. Rationale and Research are also very important. To make sure the Relevance principle is fulfilled, the correct variables for such market analysis need to be selected.

Similar as establishing weather forecast model, the first step of a market analysis is identifying the variables related to the subject. First, the analysis will assume some variables related to the subject and analyse the data to measure the relationship between the chosen parameters with the market supply and demand for offshore equipment. For example, if the chosen parameters are oil price, and GDP of specific countries and regions, by analysing the historical data of these parameters and the market record, the relationship could be identified as long as the relationship is significant and stable. In other words, the analysis could help to judge if the parameter is useful and authoritative to the forecast model. [40] [25] [9]

If the relationship is stable and significant, the influencing mechanism could be identified and stated clearly. If the relationship between the chosen parameters and the market record is not consistent or not significant, then the model needs to test and incorporate more consistent variables into the forecast model for the future market of the offshore equipment market. Besides, time-scale of the historical data analysis is supposed to be determined after

the analysis attempt and the literature research. [40]

In the forecast model, there are 4 different types of variables which are referred as 'tangible', 'technological', 'behavioural' and 'wild card'. [24] 'Tangible' variables are physically verifiable with high degree of predetermination. This type of variables is reasonably predictable compared to other kinds of variables if researched sufficiently. 'Technological' variables are always closely connected with the technology innovations or progress. Generally, it is hard to forecast but possible to generate a reasonable view after research. For example, A version of this type of variable could be the productivity of the offshore drilling rigs or the equipment technology characteristics.

'Behavioural' variables depend on the way people behave. For example, in the offshore equipment industry, if most companies know from the forecast that the demand for oil & gas will rise in the future, it may result in an oversupply of offshore drilling platforms which drives down the oil & gas price. Afterwards, the demand of the offshore equipment will drop again. It may lead to a loss if the offshore equipment company invested too much to do an innovation aiming to catch the market which every company thought it would be profitable.

Last but not least, 'Wild cards' includes unpredictable sudden events such as hurricanes. Though the forecast model could not predict these variables but considering them as a reality will contribute to a better forecast.

In this analysis the focus will be on the offshore oil & gas equipment market, the variables which matter will be the Tangible and the Technological variables. [13][47]

The factors to be considered are economic factors, energy market factors, and the technology factors. For example, the variables can include but not be limited to GDP, crude oil price (spot price), offshore oil & gas projects data, market supply of the offshore oil & gas installation equipment, and the sales intake of IHC IQIP in offshore oil & gas sector.

Understanding the market forecast variables will help structure the market analysis model and find out the key factors for the offshore installation equipment market. Combining this with the solid offshore installation technology research, the market analysis will be more convincing and useful for decision makers of the company.

2.1.4. Preparing for the Market Forecast

There are three predominant steps to be done before the forecast, which will be further elaborated below.

Defining the decision

The different decision-makers will expect different focus of a market analysis. Thus, the forecasters need to determine what is the focus of their analyses. In our case, as IHC IQIP is planning to make a road map for its oil & gas sector, the focus will be the influencing mechanism of the oil & gas market on offshore equipment market. To be more precise, the expectation of this market analysis is to give solid economics theory support to the road map making process of IHC IQIP in the oil & gas sector.

Similar to some machinery manufacturers in the shipbuilding industry, IHC IQIP is also an equipment supplier. Machinery manufacturers will look at the trends in ship construction, future developments in operational management of ships, ship operating economics, and the activity of competitors. [46] In this case, it is rational to assume that it will be beneficial to analyse the trends on offshore projects, change in the oil & gas industry, maritime economics and the activity of other offshore equipment suppliers. [40]

The decision should be defined as the influencing mechanism of the oil & gas market on the offshore oil & gas installation equipment market, which will contribute to the road map making process of IHC IQIP.

Who makes the forecast

In the maritime industry, the statistical data is limited and often too late to be useful to a company trying to maximize the profit. Additionally, some variables like market sentiment are too mercurial to be quantified in a forecasting model. Even with these drawbacks, the objective market analysis based on the statistical data is also needed and would be helpful.[40]

Because the decision-makers will make decisions based on their experiences and sentiment, which risks losing perspective. Thus, supporting balanced market decisions is the most useful move for the decision-makers. For example, IHC IQIP is making a road map for the coming 5 years. It has already collected the market intelligence information about the market from the sales team, engineers, clients, and competitors. Adding up the data-based market analysis would help the road map more objective in case there is any mistake due to the sentiment or some other factors.

In short, the road map of IHC IQIP will combine the collected market intelligence and structured market analysis combining marine technology and maritime economics.

The objective of the forecast

As equipment manufacturer, IHC IQIP could use the forecast of oil exploration or production (E&P) projects which use its equipment for its future market demand. To be more precise, the sectors of Oil&Gas market includes five sectors: *Structure installation, FPS mooring, (Ultra)deep water, Conductor installation and Subsea field development.* Based on the fact that the clients usually do projects for all these sectors, this market analysis will not separate the analysis per market segment. But for future analysis, dividing the market analysis to a smaller market segment can be an improvement potential.

2.2. Market Analysis Theory

Market analysis is vital for the development and strategic planning process of a company. In this project, to plot the roadmap in oil & gas sector for IHC IQIP, a market analysis is essential. It will include the opportunity analysis in the offshore oil & gas sector, as well as the techniques needed in the opportunity analysis. [39]

2.2.1. Market segmentation

Market segmentation is the foundation of a market analysis in a specific market. Though there are some market segmentations, these market sectors are not isolated compartments. Because the investors could move their investments from one market sector to another.[40] This requires a lot of market knowledge including the market structure, market value chain, main clients, main products and sales records. [15]

Generally, a market segment is defined as ”a group of present or potential customers with some common characteristic which is relevant in explaining (and predicting) their response to a supplier’s marketing strategy.” [48] Also, considering the reorganisation and current business units within IHC IQIP, the market segments in the oil & gas sector in IHC IQIP have *Structure installation, FPS mooring, (Ultra)deep water, Conductor installation and Subsea field development*. *Decommissioning* is also part of the oil & gas business. However, as the decommissioning market grew largely in the passed years, this part was separated as a new sector which is parallel with the oil & gas sector. [15] [34]

Using this market segmentation, the market of the oil & gas sector is more differentiated. Moreover, the market analysis can be launched more accurately.

2.2.2. Market analysis/forecasting

There are several different market analysis time-scales including Momentary, Short-term, Medium-term and Long-term which are used for different purposes.

Momentary forecasts are mainly used by the decision-makers who have to decide quickly to catch an opportunity. For example, the chartering broker could deal with the short-term decisions more easily with the momentary forecasts.

Short-term forecasts in maritime industry often cover a period of months. Since it covers the budget year most companies get involved in this forecasting activity. From the forecaster’s point of view, there is more to work with and better chance of being right. The business cycle and shipyard or equipment manufacturer orderbook are usually well defined. Besides, the forecasting ”future” is close enough to make forecasts based on fundamentals plausible, increasing the chance of harnessing information.

Medium-term forecasts generally use a time-scale of 5-10 years. This is also the second popular forecast scale, after short-term forecasts. According to the business of IHC IQIP, this type is the most suitable.

Long-term forecasts have a logical span of 25 years, which is roughly the life time of the offshore structures. The long-term forecasts will be useful for the large shipping companies, shipbuilders, services providers, port authorities, and governments.

According to the forecasting applications matrix which is presented by Martin Stopford [40], Short-term and Medium-term time scales are more popular. Also, most of the support industries are interested in the medium term. As *IHC IQIP* is an equipment manufacturer which belongs to the support industry, together with the road map's time scale being 5 years, the time scale of the data analysis for offshore equipment could be set at 5 years at this moment.

There are 3 different ways of approaching the forecast which include Market report, Forecasting Models and Scenario analysis. A market report is a written study of the fundamental market information. It is descriptive but will generally include some statistical analysis and the forecast mode, though not an integrated model. The market report is a qualitative report to help the readers get an overview of the market.

The forecasting model is much more structured and it normally analyses the segment of the market mathematically. It is an econometric model with a series of variables. The forecasting model is mainly supplied by a few maritime intelligence companies. Sometimes the large corporations will also have their own models for different market sectors. For example, offshore oil & gas service company may have a model of the oil & gas supply and demand, especially for the offshore Exploration &Production activities.

Limited by the model assumptions, the accuracy of the forecasting model is not guaranteed. Under the condition where there are limited database, the suitable forecasting model could not be set up. For example, there was not the whole market supply data of offshore equipment market. In this case, even a complex forecasting model could not give a rational result of the future market trend.

In terms of the Scenario Analysis, it is a little bit different compared with the other two approaches. Scenario Analysis starts by identifying the critical issues which the decision-makers have to deal with in the future. Then it will work backwards to analyse the forces which lie behind every issue identified in the beginning.

For example, in this project, the market mechanism of the offshore equipment is the key issue. It could be divided into several sectors and the corresponding scenarios for each sector. Understanding the different approaches helps researchers define the task and understand the limitation of current methodology and market analysis.

2.2.3. Market Research Methodology

The aim of a market research is to summarize all the relevant facts about the market, examine trends and draw conclusions about what might happen in the future. Preparing a market research requires both technical and commercial knowledge. In addition, market research will also contribute to make strategic decisions.

The functions of market research include education and prediction. If the forecasts are going to make a market research of Oil&Gas installation equipment market, there are a series of questions that need to be answered. For example, how big is the oil & gas offshore equipment market size and how will the general macroeconomics influence the energy market. More specifically, the question can be: How will the energy market influence offshore projects market or how will offshore projects market influence the offshore equipment market.

Since pure statistical analysis could not fully reflect the market, the project will also incorporate the expert ideas from the management board, main clients, R&D engineers, and the sales team of IHC IQIP. Basically, the market analysis methodology is a combination of the methodology from market analysis and market research.

If there are no new offshore oil & gas projects, there are no new orders for the equipment of IHC IQIP. The market demand for the offshore equipment is dependent on the new offshore

projects. [1] This is because the installation equipment is used for installing the new offshore platforms or the subsea development project.

Since the new offshore projects come from the oil companies which highly depend on the oil price, research on the relationship between oil price and the offshore installation market is beneficial for the market mechanism study.

In addition to the qualitative analysis of the market, the quantitative research is important as well. The reason for this is that there is a need to measure the time lag between the oil price and the sales of IHC IQIP. Thus, the statistical research is needed which will be elaborated in the coming chapter.

In terms of the data sources, there are 3 available data sets including crude oil prices, the installation database of offshore oil & gas platforms and the sales data of *IHC IQIP.*

To conclude, it is essential to research on the theory of market analysis and maritime economics. This will help to have an overview of the possible research methods in this market analysis and avoid potential risks. Besides, the research of market analysis methodology is essential for such a market analysis project.

For example, after analysing the different features of the quantitative analysis and qualitative analysis, this market analysis chose to combine the quantitative research and qualitative research as analysis methodology, and then the market mechanism of *IHC IQIP* can be understood better and the results of the market analysis can be further used to contribute to the decision making for *IHC IQIP.*

In addition to the literature research, the energy market is also important for this market analysis project, which is the source of market demand for the offshore oil and gas installation market. And energy market is always correlated with the economy. Thus it is important to research the global energy market and macro economy. This will be done in the next chapter.

[1] Interview with Michael Schaap, the Technical Director of *IHC IQIP*, March 2017, Sliedrecht

3

The Link between the Global Energy Market and World Economy

3.1. Introduction

Offshore oil & gas platform installation market belongs to the upstream of the whole oil & gas industry. More precisely, the market demand for the offshore equipment, offshore oil & gas vessels and other offshore oil & gas services ultimately come from energy market. Thus, it is vital to study on the energy market, as well as the macro economy and other related energy demand drivers.

Energy is important for continuing human development and the human development also increases the energy demand. Throughout history, the increasing human population, urbanization and modernization has driven up global energy demand. [1] There is no clear economical equation to explain the correlation between energy and economy (GDP) but higher global energy production is associated with higher global GDP.[41]

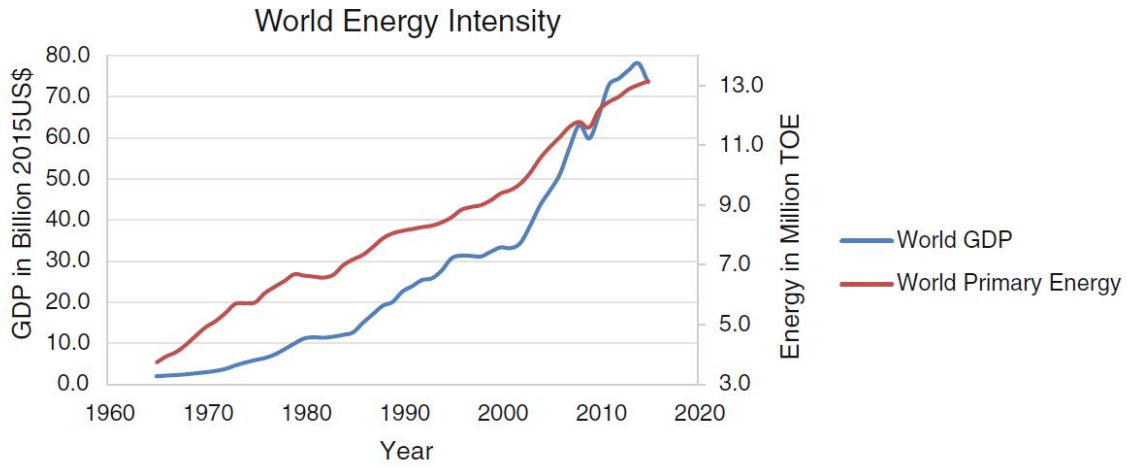

Figure 3.1: World energy intensity (*Source: World Bank 2016*)

As shown in the 3.1, the world economy is highly correlated with the world primary energy. To avoid double counting, the data used here is the world primary energy, which is the energy directly from the nature, including oil, gas, coal etc. For example, electricity was produced by using primary energy like coal or oil. Thus, the electricity will not be calculated in the world primary energy scope.

In the last decades, the overall energy demand has increased. Meanwhile, due to the environmental pollution and political safety issues, the clean energy demand is increasing

and the conventional energy market was, and will be, influenced by this trend as well.

Examining global energy demand over the forthcoming years will contribute to the foundation of the analysis of market demand for the offshore structure installation equipment. Generally, if the global market demand increases, the demand for offshore energy will more or less increase as well, and vice versa. Hence the research of the energy market is very important and it contributes to the offshore oil & gas market demand analysis.

As the global economy strongly affects the energy demand in the world, the nexus between economy and the energy market will be studied to support the global energy demand forecast. Furthermore, the link between oil price and the macro economy is not fully established but important to discuss and add to the research results.

Due to the fact that the objective of this project is to analyse the market demand for the offshore installation equipment, the market of the offshore energy is much more important than other sectors. Thus, the value chain of the offshore oil & gas industry needs to be studied, as well as the details of offshore oil & gas industry. The technology details of the offshore oil & gas industry will be discussed in *Chapter 4*. The energy forecast from different institutes will be reviewed as well.

Based on the economic relations between different market segments within the energy market, the historical data of the global energy market and the offshore oil & gas equipment market data will be analysed together to study on the link between these two market segments.

3.2. Global Energy Market

As discussed above, the energy demand has increased in the past centuries. There have been varied forms of energy employed globally, which could be divided into three types: fossil fuel, nuclear energy and renewable energy[1] Thus, the energy market can be divided into different market segments and the oil & gas market is one of these market segments. In addition to analysing the global energy market demand, the proportion of oil & gas has to be studied.

3.2.1. Current Energy Market

According to the *U.S. Energy Information Administration*, the total world energy consumption will rise 48% from 549 quadrillion British thermal unit[2] in 2012 to 815 quadrillion Btu in 2040. According to analysis from The International Energy Agency (IEA), the energy demand will rise by 1.5% each year through 2030.

Most of the growing energy demand through 2030 will be met by conventional energy including oil, gas and coal, even though the proportion of these conventional energy is decreasing.[17] This energy demand will be translated into the offshore projects including installation demand, which is good for the current players in oil & gas industry including the contractors and the subcontractors such as *IHC IQIP*.

The current oil and gas prices are relatively low and stable which results in less exploration and production activities in the oil & gas industry. It is even less in offshore oil & gas sector due to the higher marginal cost. There are many drivers for oil & gas prices, including the supply, demand, political issues, financial shock and the influence of shale gas from America. These factors are too dynamic to forecast. Thus, the forecast of the oil price is mostly wrong. Instead of forecasting oil price, this project will use the current oil price and the influencing mechanism such as the time lag to forecast the future demand for the offshore oil & gas equipment.

In recent years, the oil & gas industry has witnessed many far-reaching events, including the oil-producing countries exerting greater control over resources like Russia and Venezuela, major technological advances in deepwater drilling and shale gas and so on. [17] Furthermore, due to the issues such as energy security and geopolitics, the energy market is not a perfectly competitive market.

These changes definitely altered the supply and demand for oil & gas. All these events contributed to the energy consumption forecast which will increase by 30 to 40 percent by

[1] renewable energy: This form of energy is called ”renewables”, including hydro power, wind energy, solar energy, etc.
[2] British thermal unit: also known as BTU.

2030. [1]

Though the oil & gas market is largely influenced by the shale gas boom in America, the higher marginal cost is the current greatest difficulty for the shale oil & gas producers. But the proportion of shale gas is relatively small within a short time. Thus the conventional oil & gas will still be the mainstream of the oil & gas market.

3.2.2. Introduction of Fuel Type

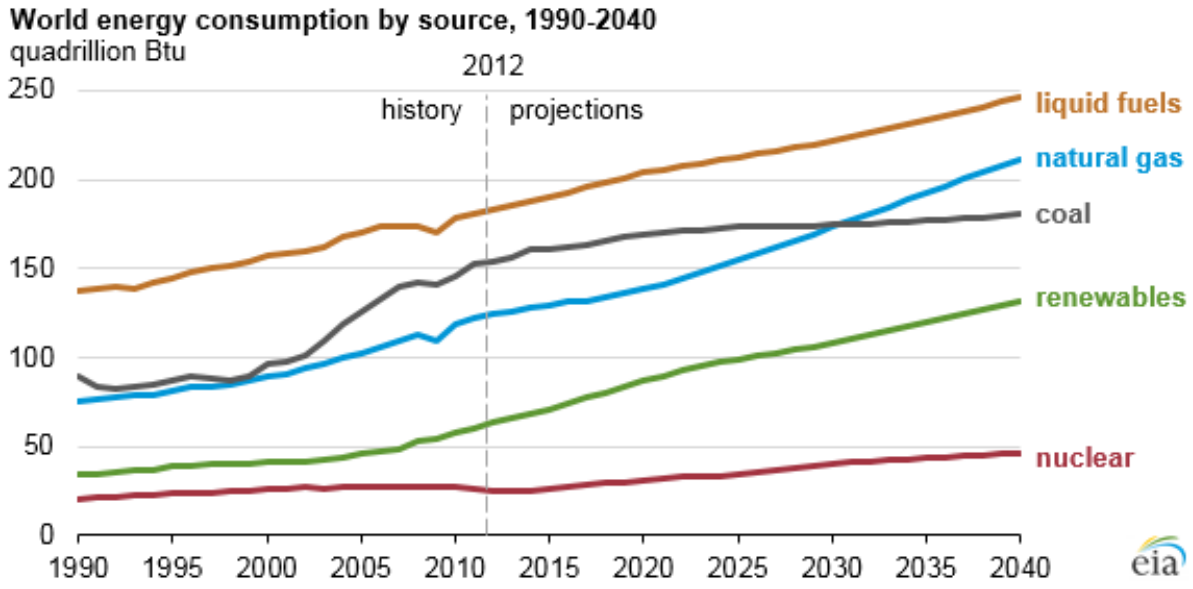

Figure 3.2: World energy consumption by energy source, 1990-2040, quadrillion BTU (Source: EIA)

As shown in 3.2, every type of energy consumption is increasing and will grow until 2040. Renewable energy is the fastest-growing energy source over the forecast period. Coming after the 2.6% growth rate of renewable energies, nuclear power is the second fastest-growing energy source by 2.3% per year. [44] Until 2040, fossil fuels will continue to provide most of the energy in the world. This includes liquid fuels, natural gas, and coal. In total, they will account for 78% of the global energy consumption in 2040.

The oil & gas industry is one of the most important, most complex, and largest global industries. This industry supplies the important products including personal consumables like transportation fuels as well as thousands of petrochemical products. In addition to the impact on the lives of normal people, the oil & gas industry also impacts national security, international conflicts, and geopolitics. The oil & gas industry is also vital in the global economy and greatly influenced by the world economy. [17] Renewable energies are developing at a fast pace and will continue growing in the coming decades but conventional oil & gas are still the main types of energy consumption.

Unlike a conventional supply-demand model, the natural gas consumption is driven by supply. Natural gas consumption will increase by 1.9% annually from 120 trillion cubic feet (Tcf) in 2012 to 133 Tcf in 2020 and 203 Tcf in 2040. The increasing supplies of natural gas is mainly from shale formations in America and Canada. [43]

Technological development also contributes to the change of the energy market. For example, the application of the horizontal drilling and hydraulic fracturing technologies increased the productivity of the wells largely in the United States of America. These techniques are also applied in other parts of the world. With the newly found natural gas resources, the increasing demand of the natural gas will be supplied.

In addition to the energy discussed above, there are a few new and important renewable energies including hydropower and wind. Due to environmental problem pressures, political issues and technology development, renewable energy has become increasingly important. [1] [3] From 2012 to 2040, the renewable energy will account for two-thirds of the increment

of total energy demand. [43]

3.3. The nexus between energy and economic growth

As for the nexus between macroeconomy and energy, there is no clearly-defined function or influencing mechanism due to complexity. However, there is some research concerning the relationship between the energy and gross domestic product (GDP) or gross national product. As discussed in 3.1, the world energy intensity has increased in the past decades.

According to the research of *U.S. EIA* the world energy consumption is strongly influenced by economic growth and structural changes. There are several different drivers behind the increase of the energy demand, including the urbanization, increasing transportation demand, increasing appliances equipment, as well as the increasing population.

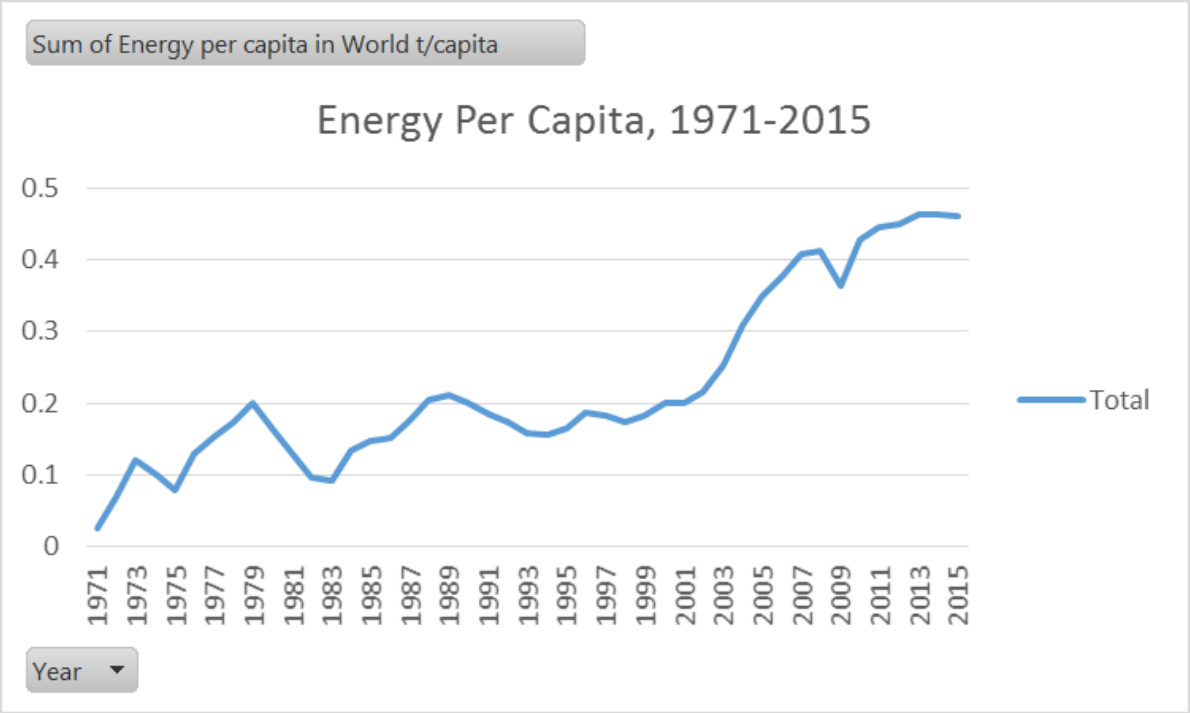

Figure 3.3: Energy per capita

As shown in Figure 3.3, the global energy use per capita increased greatly in the past decades. This factor will also contribute to the increasing future energy demand. Non-OECD countries are witnessing a change of the industrial structure from energy-intensive to service-oriented. This explains the plateau ending of the *energy per capita* curve from 1971 to 2015.

As for the causality relationship between GDP and energy consumption, there have been several previous studies. In 1978, John Kraft and Arthur Kraft first studied the relationship between energy consumption and gross national product (GNP) in the USA. In the analysis, the causality test was running from GNP to energy consumption. [20] After this research, similar studies follows. However, the results sometimes conflicted with each other, especially when there are different sampling countries such as developed and developing countries.

More recently, the focus has moved to the relationship between GDP and the energy consumption, especially in developing countries. Compared with the analysis above, the results were not more conclusive.

Considering the methodology the analysis used, the causality test widely used the causality technique from Granger and Sims, which were criticized for producing and yielding inconsistent results. [14]

In another study regarding to the causality between energy consumption and GDP in South Korea and Singapore, *Glasure and Lee* found that there is no causal relationship between energy and GDP for South Korea but a positive result shown in Singapore's data. [11]

G-7 [3] is a group of developed countries which account for a large proportion in the whole global economy output. During research on the countries belonging to G-7 and 9 of the top 10 emerging countries by *Ugur Soytas and Ramazan Sari*, varying results appeared in these 16 countries. [4] For example, in Turkey, France, Germany and Japan, the causality runs from energy consumption to GDP. Argentina's data shows that it has a bidirectional relationship between energy consumption to GDP. For Italy and Korea, the causality relationship is reversed.

In conclusion, there are varying causality relationships in different research samples. In other words, there is not a clear one-way causality relationship between energy and the economic growth. The relationship between energy and the economic growth is complex and needs to be analysed based on the reality of the certain country or district. Due to different industrial structure and other economic conditions of different countries all over the world, the causality between the economic growth and energy consumption is different from country to country.

Considering the supply and demand model of oil & gas, the oil and gas prices are influenced by both sides of supply and demand. Only based on GDP, the global demand of the oil & gas is hard to estimate. However, considering the global energy consumption and economic growth, the global energy demand is increasing even if there is no directional link between energy consumption to GDP in some countries. Based on the energy technology, the proportion of oil & gas will be still stable until 2040. Thus, the demand for oil & gas will increase as will the demand for overall energy.

As shown in Figure 3.3 , the energy use per capita is increasing from 1971 to 2015. Together with research by *International Energy Agency*, the global energy use will continue to grow in the next decades, based on the population increase and industrial upgrading.

3.4. Historical Oil Price

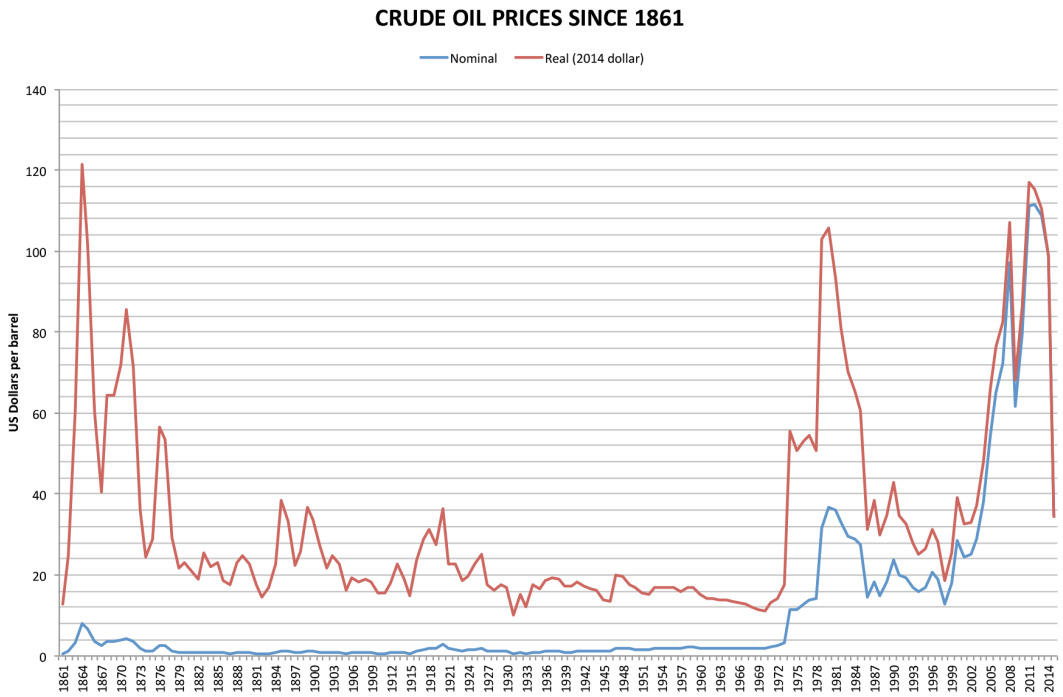

Figure 3.4: The nominal and real prices of crude oil, 1861-2014, (US dollars per barrel) *Source: BP Statistical Review of World Energy*

[3]The Group of 7 (G7) is a group consisting of Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. These seven countries are the seven major developed countries as reported by the International Monetary Fund.
[4]In this research, due to lack of data, China is excluded from the research.

Undoubtedly, the oil price is one of the most important indicators in the energy market. It is also a complex indicator. This is because the oil price is influenced by so many other factors, including, but not limit to, geopolitical factors, global energy demand, currency exchange rates, and technological development.

Thus, the forecast of the oil price will not be done in this project but reviewing some trustworthy forecasts from investment banks or energy administrations like *U.S. Energy Information Administration* and *International Energy Agency*. Reviewing the historical data of oil price and analysing the link between oil price and the offshore activities will contribute to the analysis.

As shown in Figure 3.4, from 1861 to 2014, the crude oil price fluctuated violently. Besides, after the peak in 2013, the oil price dramatically dropped which resulted in less offshore projects.

On the one hand, the oil price is too changeable and complicated to analyse. On the other hand, analysing the link between the oil price and offshore projects data is much easier and useful for the upstream players. Studying the historical crude oil prices and the historical data of the offshore projects will contribute to the study of the influencing mechanism of oil price and offshore equipment market.

Obviously, the current oil price and the historical data is known, which is enough for a short-term forecast using trend extrapolation. For a longer term market forecast, due to the accuracy issue and the practical usage, future scenarios will be compiled based on different oil price forecasts, applying the results of the data analysis.

Together with the influencing mechanism and the time lag from the analysis, the offshore projects demand pattern can be analysed. Due to the fact that the offshore installation projects come from new offshore oil & gas platforms, the market demand for installation equipment can be extrapolated as well.

3.5. The Demand for Oil & Gas Outlook

As shown in Figure 3.5, according to the research from the *International Energy Outlook* by U.S. Energy Information Administration, the overall global energy demand is growing from 2012 to 2040 based on the global population and economy, over the 28-year period. Furthermore, the increase of the global energy demand mainly come from non-OECD countries.[43]

To derive the energy demand outlook, the *U.S. Energy Information Administration* examined the patterns of the energy consumption delivered to the end users in different sectors including building, industrial and transportations.

The demand drivers for the *Residential and commercial buildings* include the rising standard of living, strong economic growth in the non-OECD countries and population growth.

In terms of the energy consumption by region, the Non-OECD countries account for an increasing demand for energy as they have relatively strong and long-term economic growth drives. Another reason is that the industrial structure of non-OECD countries is mostly energy-intensive. Though there is a global trend that the industrial structure is moving to more service-oriented, the energy demand will not be lowered as there are other energy consumption drivers in the world.

Based on the economy growth globally and other factors, as forecast by many banks and energy agencies, the demand for oil & gas will still increase until at least 2040. However, there will still be some economic cycles meaning some fluctuations can be expected. The trend stated above is a general trend. To conclude, though there will be economic cycles, the energy demand will increase in the long term.

3.6. Oil & Gas Industry Value Chain

Oil & gas are conventional but still important energies in the coming decades. This industry is complicated and so many companies involved in the whole process from *exploration&production* to *refining&marketing*. To analyse the market demand for the equipment which is used in one stage of the procedure, a thorough analysis of the industrial value chain is needed.

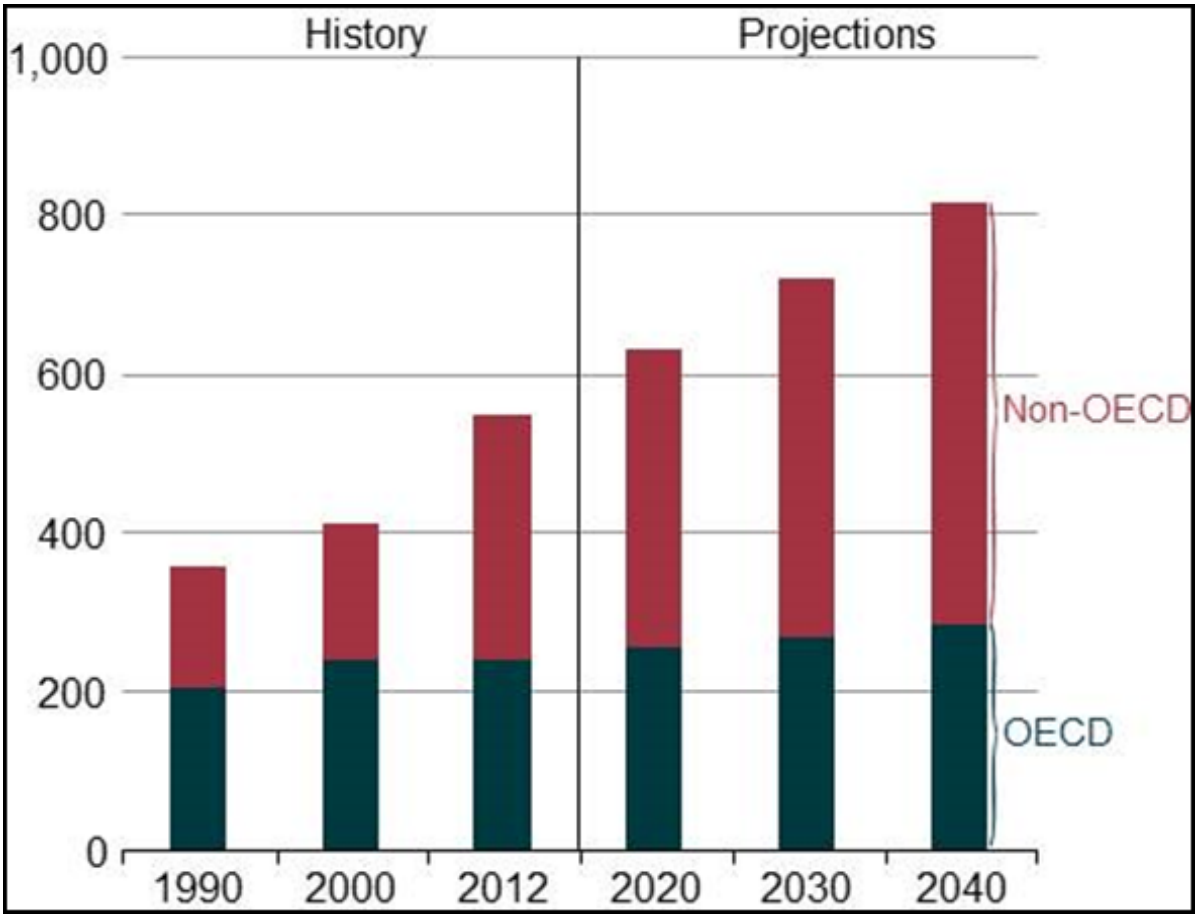

Figure 3.5: Global Energy Consumption 1990-2040, quadrillion BTU (Source: EIA)

Like other industries, the oil & gas industry has various activities which play a role in different stages of the value chain.[5] All industries have upstream and downstream segments, which are close to raw materials and close to the customer respectively.

As shown in Figure 3.6, there are upstream, midstream and downstream segments in the global oil & gas value chain. IHC IQIP is playing a role in the upstream of the oil & gas industry as a supplier for the offshore installation contractors.

Products of IHC IQIP are used in the *Development and Production* stage in the upstream of the oil & gas industry, precisely in the offshore installation sector.

Furthermore, the *Development and Production* sector is the upstream sector of the oil & gas industry and the offshore equipment market is also an upstream sector of the *Development and Production* projects. The clients of IHC IQIP are the offshore contractors, e.g. *Subsea 7, Technip, Saipem, McDermott*. These contractors need to purchase or rent the offshore equipment before they start working on the offshore projects installation.

Since the oil companies are the ultimate clients of the equipment suppliers like IHC IQIP, the upstream CAPEX [6] of the oil companies are essential for the oil & gas equipment market analysis for IHC IQIP. Offshore equipment has a long design life and relatively high prices, which belong to the fixed assets of the oil companies.

According to *Andrew Inkpen and Michael H, Moffett*, the long-term investment plans (CAPEX) vary among different oil companies, which is mainly a function of oil fields, other costs and commodity prices. For example, the oil producers in Saudi Arabia could make a profit even if the oil price fell to $10/barrel. North Sea oil producers could be profitable at $25/barrel in 2011. Some Canadian oil companies need at least $50/barrel to make a profit. Apparently,

[5]A *value chain* is a term describing the independent economically viable segments in one specific industry. [17]
[6]CAPEX: Capital Cost

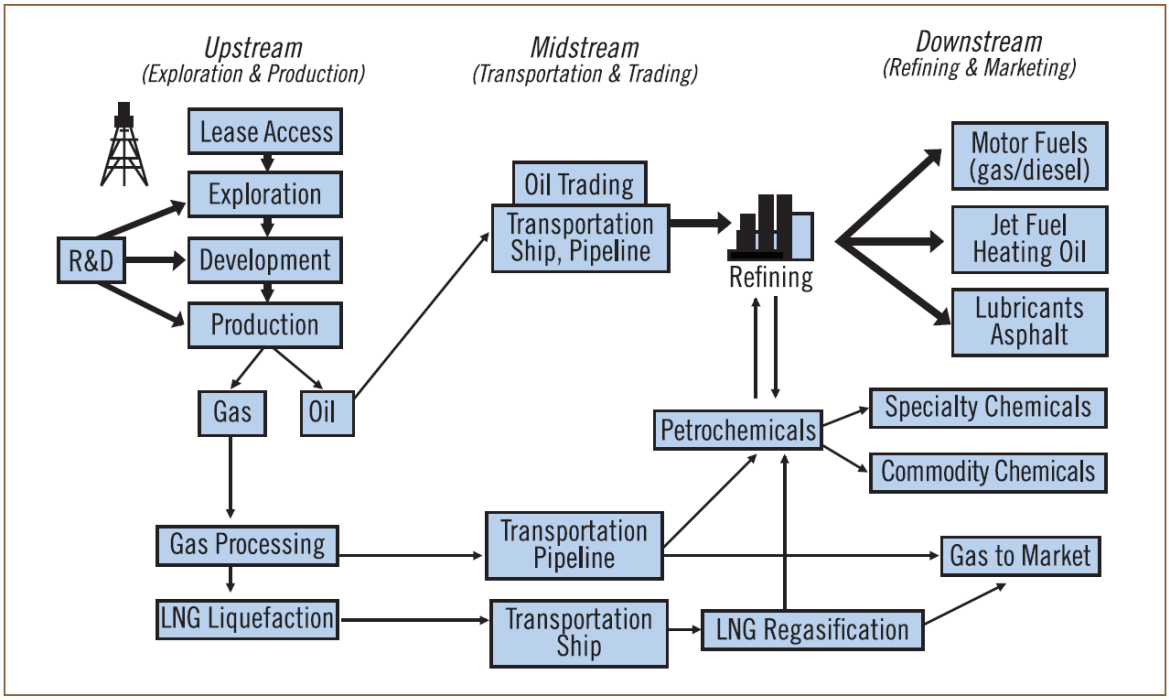

Figure 3.6: Global Oil & Gas Value Chain (*source: The Global Oil and Gas Industry, Andrew Inkpen Moffett and Michael*)

with the same oil price, different companies have different profit margins. Together with the oil & gas market forecast, the oil companies will make different plans in exploration and production.

Importantly, if more offshore oil & gas projects are executed, there will be a higher demand for the offshore installation projects. Then, the offshore contractors may need to purchase or rent more offshore equipment from the equipment suppliers like *IHC IQIP*.

After the research of the global energy market and macro economy, the offshore technology will be elaborated on in next chapter to set a foundation for the market mechanism. This is because the offshore technology determines if the specific installation equipment can be used for specific offshore energy projects installation. In addition to that, the offshore technology study can contribute to the road map making for the research and development plan of *IHC IQIP*, which is the objective of this market analysis.

4

Offshore Technology Research

In addition to the energy economy, the offshore technology research is also important for the market analysis for IHC IQIP. This is because the offshore oil & gas installation market is very technology-intensive and will be effected largely by the technology development. In this chapter, the offshore technology and offshore installation technology will be studied to get an overview of the current technology of the offshore contracting activities including *Exploration, Production, Construction* and *Installation*[1], especially the offshore installation technology.

More specifically, understanding the offshore technology is one of the most important tasks to conduct this market analysis. The analysis of the offshore oil & gas technology development is vital for analysing the demand for installation equipment. In past decades, the development of offshore technology largely lowered the cost of offshore oil & gas exploration and production, which increased the demand for offshore equipment. Meanwhile, the trend of offshore oil & gas platforms contributed to the market change of the corresponding installation markets. For example, the market demand for deep sea installation equipment increased as deep sea platforms were developed.

4.1. Introduction to Offshore Structures

Offshore technology, also known as offshore engineering, is relatively young in the field of engineering. However, offshore technology was developed greatly in the past decades due to its importance in the exploitation of natural resources and public utility support. [6] [18]

As early as the beginning of 20th century, in Louisiana, oil wells were being drilled. Back then, the wooden derricks and wooden platforms were constructed on top of timber piles. Later, two types of fixed platforms were developed: the steel template and the concrete gravity type. The steel template was used a lot in the Gulf of Mexico and the concrete gravity platform was mostly used in the North Sea. As the development of offshore technology continued, a new type of fixed platform was invented to drill wells and develop projects in deep sea or deep water. This type of platform is the tension-leg platform. [7]

Due to the requirement for obtaining oil and gas in locations which have a bigger water depth, several types of offshore structures were developed. For example, Floating Production, Storage and Offloading systems are effective in a deep sea area. This is because the seabed pipelines are not cost effective for oil fields which are in deep sea. Floating Production, Storage and Offloading systems were created to eliminate the expensive cost for long pipelines from oil fields to onshore oil refinery locations.

As Figure 4.1 shows, from shallow water to deep sea, there are different types of offshore structures, as well as their functions and the range of water depths. The water depths in the figure may increase due to research and development of the offshore technology. In addition to these structures, there are also some other offshore structures such as semi-submersible platforms.

[1] Exploration, Production, Construction & Installation : EPCI

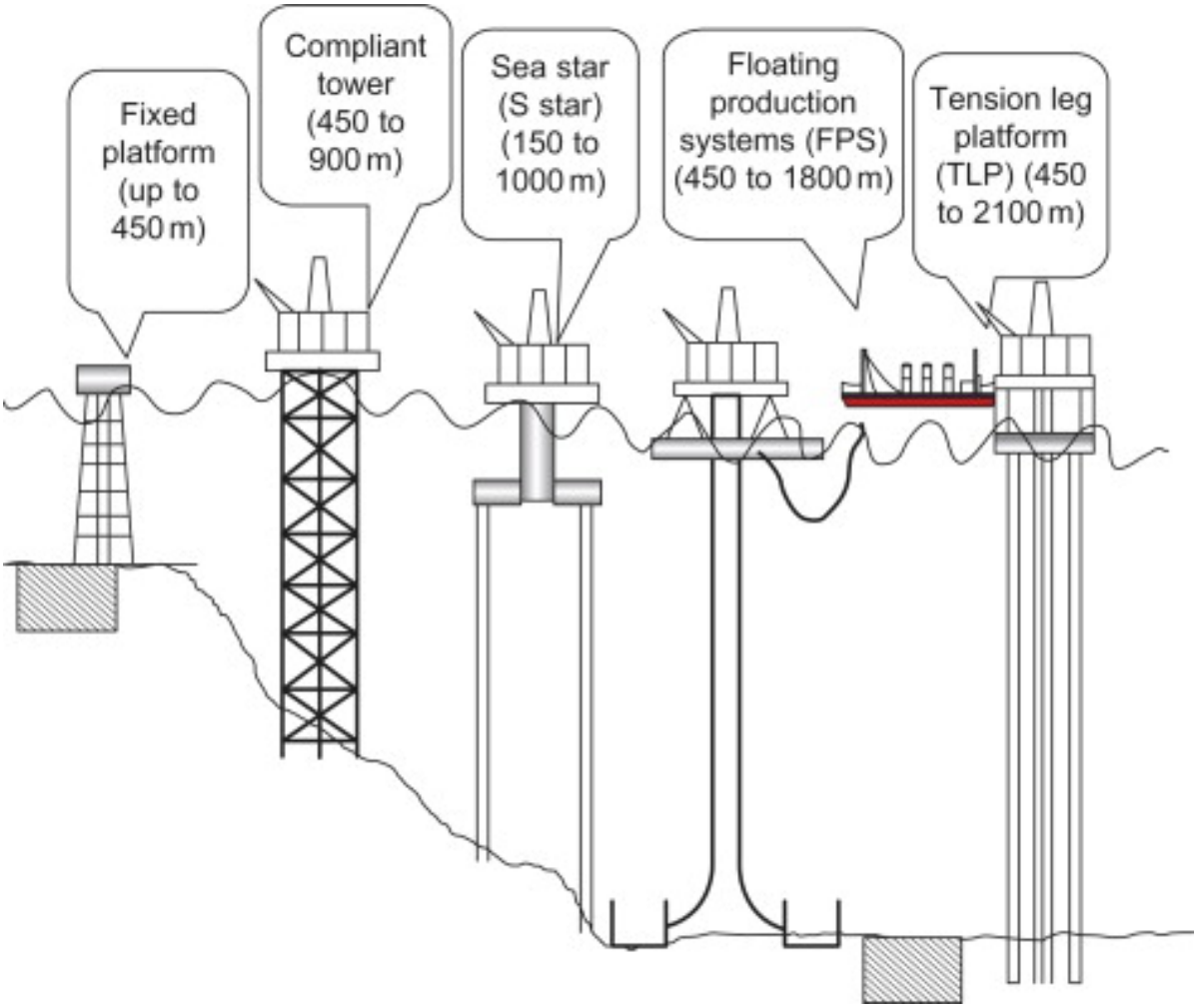

Figure 4.1: Different types of offshore structures (*source: Offshore Structures: Design, Construction and Maintenance, Mohamed Abdallah El-Reedy*)

4.2. Introduction to Fixed Offshore Platform

Among the varied offshore structure types, fixed platform is the mostly-used offshore platform type. Also, the offshore oil & gas project installation market is highly dependent on the fixed platform market because most installation projects are fixed platforms installation projects. Only a few installation projects are the FPS and subsea development projects. Apparently, the fixed platforms are the targeted market of *IHC IQIP*. Thus this research will also focus on the fixed platform.

In terms of the life cycle of offshore platforms, due to its high technology complexity and high investment, there is always a planning phase in the beginning, which is the start in life cycles of offshore structures. This is followed by *design, onshore fabrication, transportation, offshore installation, operation* and *decommissioning*. In some theories, *fabrication, transportation* and *installation* are concluded as 'construction' or 'execution'. Of course, *installation* is an important step in the life cycle of the offshore structures. This will be elaborated in the next chapter.

4.2.1. Introduction of the Substructure of Platforms

As the fixed platforms are the focus of this market analysis and the substructures are the sections which need the installation equipment, further study of the types of fixed platform substructures will be helpful for the overall market analysis.

Substructure is the part of an offshore platform and it sits on the seabed. It is rigidly

connected to the seabed by using foundation piles or the weight of itself. The examples are the jackets and the gravity base structure. [35]

4.2.2. Introduction to Jackets

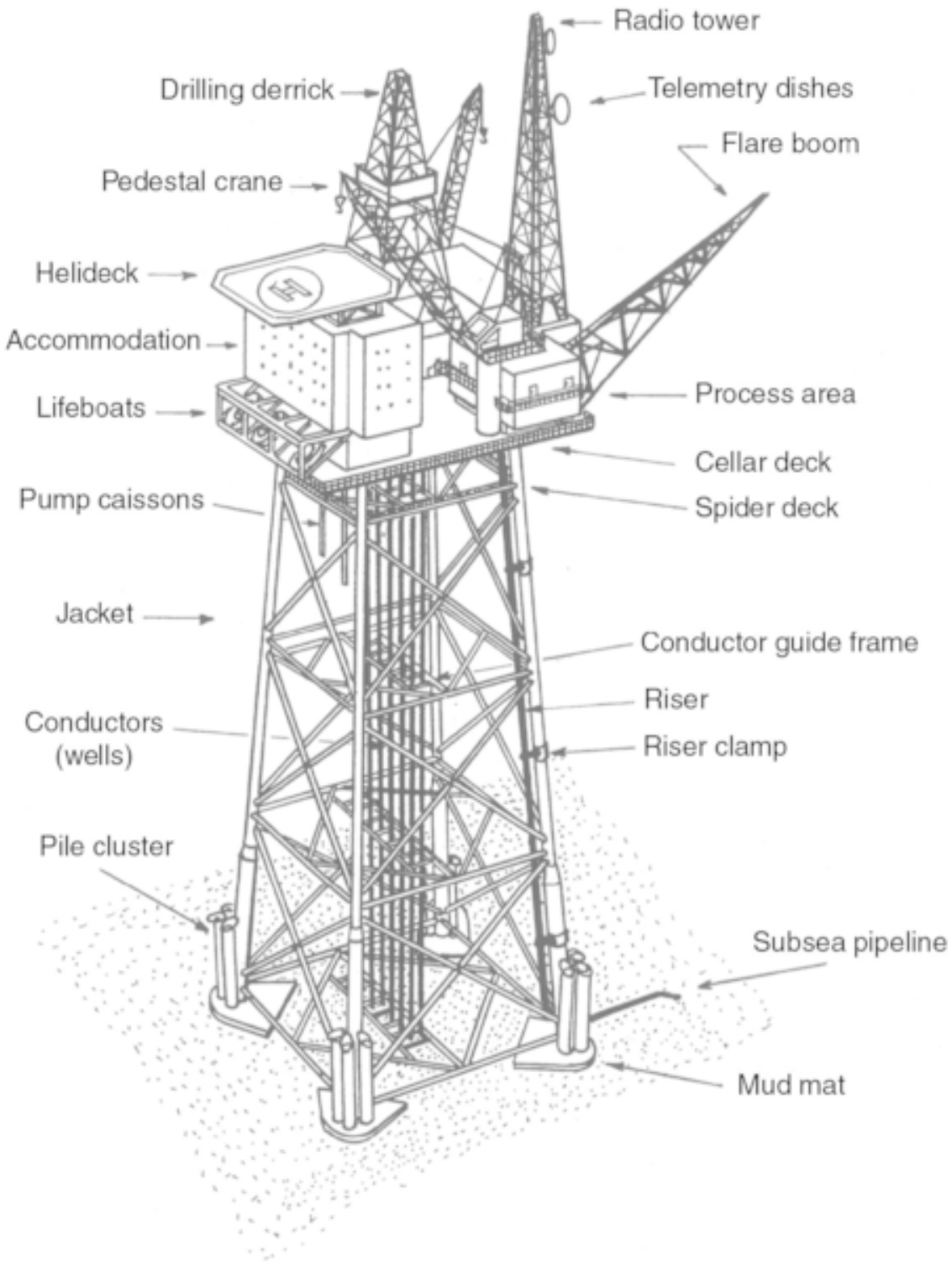

Figure 4.2: Jacket Offshore Oil & Gas Platform(*source: Handbook of the Offshore Engineering*)

As discussed above, the jacket is one of the most important offshore fixed platform type.

The jacket is a frame structure made of tubular steel members, as shown in Figure 4.2.

It usually has four, six or eight jacket legs which will transmit all external and topsides loads to the piles and eventually to the seabed. Sometimes it can also have three legs or even one caisson type leg. Jackets with one caisson are called *monopods*.

One important thing should be noted: The installation of *Jackets* needs pile driving equipment, which is the focus of this market analysis. There are two ways of the pile installation for different jacket platforms. Piles can be installed through the legs or through the pile sleeves. The pile sleeves are connected to the jacket legs.

4.2.3. Introduction to the Gravity Base Structure

In addition to the jackets, there is also another type of fixed offshore platform: Gravity Base Structures(GBS). They are widely used in the North Sea.

The Gravity Base Structures resist the forces from wind, current, wave and other kinds of loads by the soil bearing capacity and friction. This is because they are very large structures which directly sit on the seabed. Most Gravity Base Structures are made form concrete and can be installed in the sea areas which are not deeper than three hundred meters. [7][35][18]

The installation of this type of platform is different than other types of offshore structures. After completing the construction phase, the GBS will be towed by multiple tugs to the desired offshore position. By filling sea water to the tanks according to the predetermined ballasting plan, the GBS will be sunk down on the seabed.

4.3. Offshore Oil & Gas Platforms Installation

Regardless of which type of offshore platforms, there are some general rules of the installation. There are some *temporary phases* in the offshore projects, including the load-out, transportation and installation operations. Regarding these phases, the engineering work associated with them is called "*Installation Engineering*". Depending on the kind of offshore platform, the installation method will be largely different. Different installation methods can be applied in the same type of offshore platforms as well.[30]

As with the categorising of the offshore platforms, the installation methods could also be divided, including the fixed platforms and floating structures. For floating structures, only so few types of structures need piling installation such as piled anchors. Most installation projects are installing fixed platforms projects. The jacket platforms are the most common fixed platform type in terms of need of the offshore installation equipment since concrete gravity platforms do not need installation equipment, which has been researched in last section above.

4.3.1. Introduction to Foundation Types

The offshore platform needs a foundation to resist the external and internal loads and there are different kinds of foundations. Naturally, different kinds of foundations require different installation procedures.

There are four main foundation types: driven piles, drilled and grouted piles, suction embedded anchors and drag embedded anchors. In this market analysis project, driven piles foundation is the main market.

Driven Piles

The driven offshore piles are steel tubular members. The length, diameter and the wall thickness will vary from case to case.[35][18]

Piles need to be transported to the offshore location by barges , as well as other installation equipment. Lifting and hammering the piles into seabed are the main steps in driven pile installation, which will be further elaborated on at 4.3.2.

Drilled and Grouted piles

This concept has been successfully used in the offshore installation. To install the piles, in the desired location, one hole is drilled into the seabed. Next, the pile is put into the jacket leg and is lowered into the hole. In the end, enough cement will be pumped into the gap

between pile and hole. Steel casings are expected to be used to ensure the stability of the hole. The drilled foundations have an advantage when the installation needs to drill through rocks while pile driving is not suitable. This type of piles is not in the scope of *IHC IQIP*.

Suction Embedded Anchors

Suction embedded anchors are used in the soft cohesive soil area to install the floating platforms, especially in the deep sea. Because in the deep water area, other installation concept will require much more cost.

As shown in Figure 4.3, the suction pile is a cylinder with an open hole in the top. Once the pile is put on the determined location, suction pumps in the remotely operated underwater vehicle will connect to the suction valve and pump the water out of the open hole. Then the anchor pile will be driven into seabed by pressure from sea water.

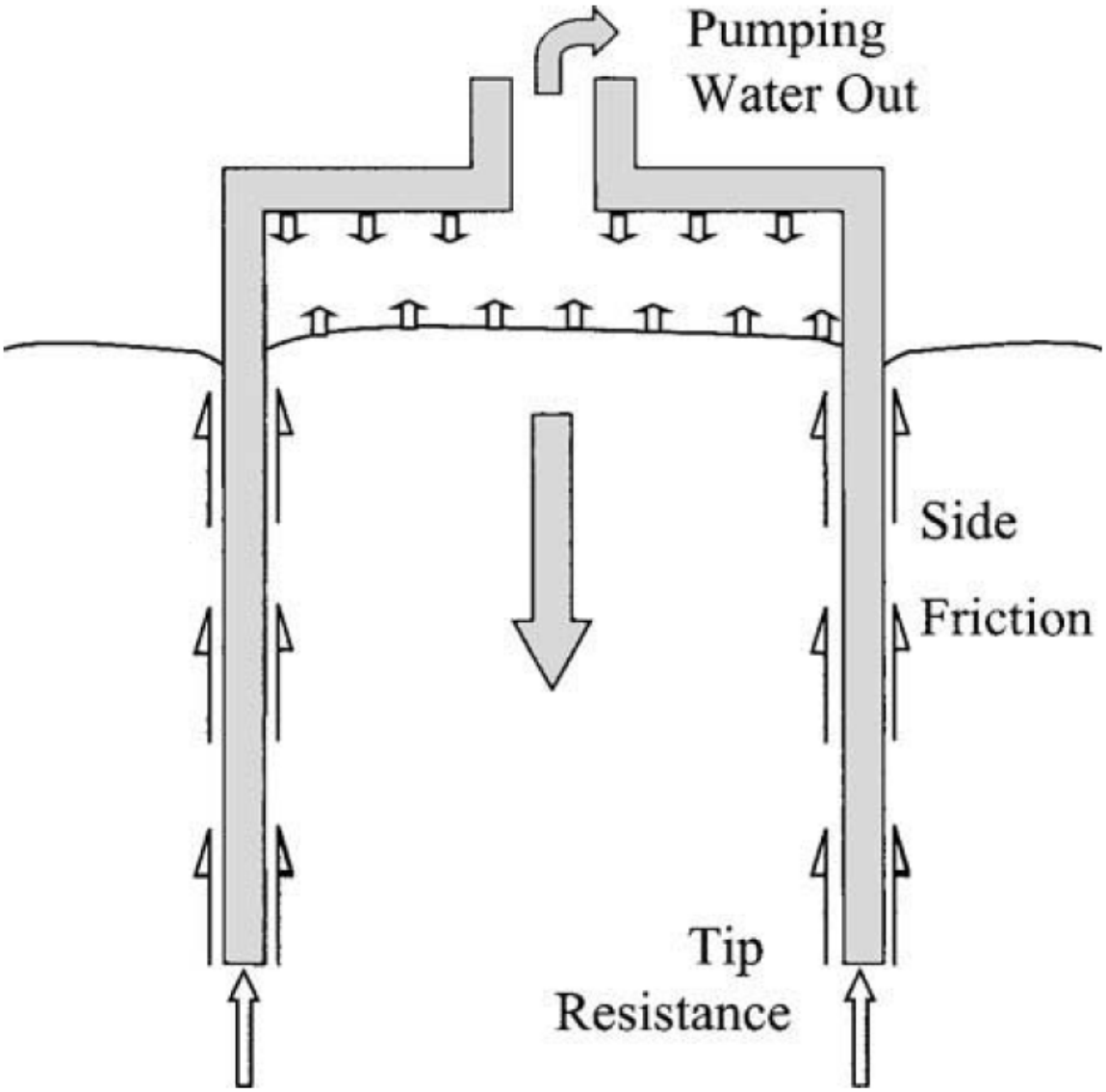

Figure 4.3: Suction Pile(*source: Handbook of the Offshore Engineering*)

Drag Embedded Anchors

Drag anchors are conventional anchoring methods which has been used for a long time by ships. They are also been used in mooring the floating platforms or installation vessels.

The anchors will generate the holding forces by embedding in the fixed location on the seabed. Anchors handling tugs, which are also known as AHT, normally handle and install the anchors to the desired location.

4.3.2. Driven Pile Installation

During the step of *installation*, several phases are defined, including *launching, upending, setting on bottom, founding, lifting* and *commissioning*.[18] Launching is a critical process in the installation of platforms. This is because during launching, the jacket will be affected by different stresses during transfer from barge to the sea. [7]

After launching the jacket into the sea and upending its position, the next step is driving the piles into the legs of the jackets. As shown in Figure 4.4, the process of pile installation includes 8 steps. This process starts from lifting the pile from barge and rotating crane with the pile. Then, the next step is rotating the pile to the jacket leg position and inclining the pile to inset in the leg. Lifting hammer from the barge deck and positioning hammer over the pile is the fifth and sixth step. The process ends with inclining the hammer to the pile and hammering the pile.

Obviously, the installation process needs to be designed to prevent bending or other failure. When the hammering starts, the pile will be driven into the legs and to the seabed until the pile refusal. Refusal is reached when the hammer blow no longer causes penetration. Also, it is not always necessary to drive piles to refusal. Sometimes the soil is very soft, meaning a considerable length is enough to support the structures stably. Furthermore, the hammering is better to a continuous procedure and an interruption may cause temporary refusals in some types of soils.

4.4. Offshore Oil & Gas Installation Equipment of *IHC IQIP*

As discussed above, the offshore oil & gas installation equipment is important for offshore oil & gas project installation. Thus, a better understanding of the installation equipment will contribute to the market analysis later.

4.4.1. Installation Equipment of *IHC IQIP*

As the goal of this market analysis is to contribute to the roadmap of *IHC IQIP* about the oil & gas installation market, the installation equipment of IHC IQIP and the general market information of *IHC IQIP* will be studied.

IQIP is a new organization which is a merger of four business units in Royal IHC. They are *IHC Hydrohammer, IHC Sea Steel, IHC Handling Systems, IHC FUNDEX Equipment* and the products from these companies always closely correlate with each other. Thus, after this merger, IHC IQIP could supply products and services to the clients in a more integrated offer, which covers the full scope of the installation equipment for offshore oil & gas projects. The integrated offer does not only include the equipment sales but also rental service, maintenance and repairing services. In other words, it could help the clients to decrease the lead time and cost of the project.

According to the interview[2], instead of only supplying the equipment, *IHC IQIP* is changing to supply a full service package, including sales, renting, advisory, maintenance and services. Also, the oil & gas industry also has a trend to shift from CAPEX-dominated towards more OPEX-dominated. The main clients of *IHC IQIP* are oil & gas corporations, installation contractors, engineering agencies and government authorities. Understanding the company will help the research find and solve the problem which the company needs to solve most urgently!

In this market analysis project, the offshore oil & gas project installation equipment is the analysis focus. The main equipment and the further technical characteristics will be studied in this sector.

[2] Interview with Jan Albert Westerbeek, CEO of *IHC IQIP*, Sliedrecht, March, 2017

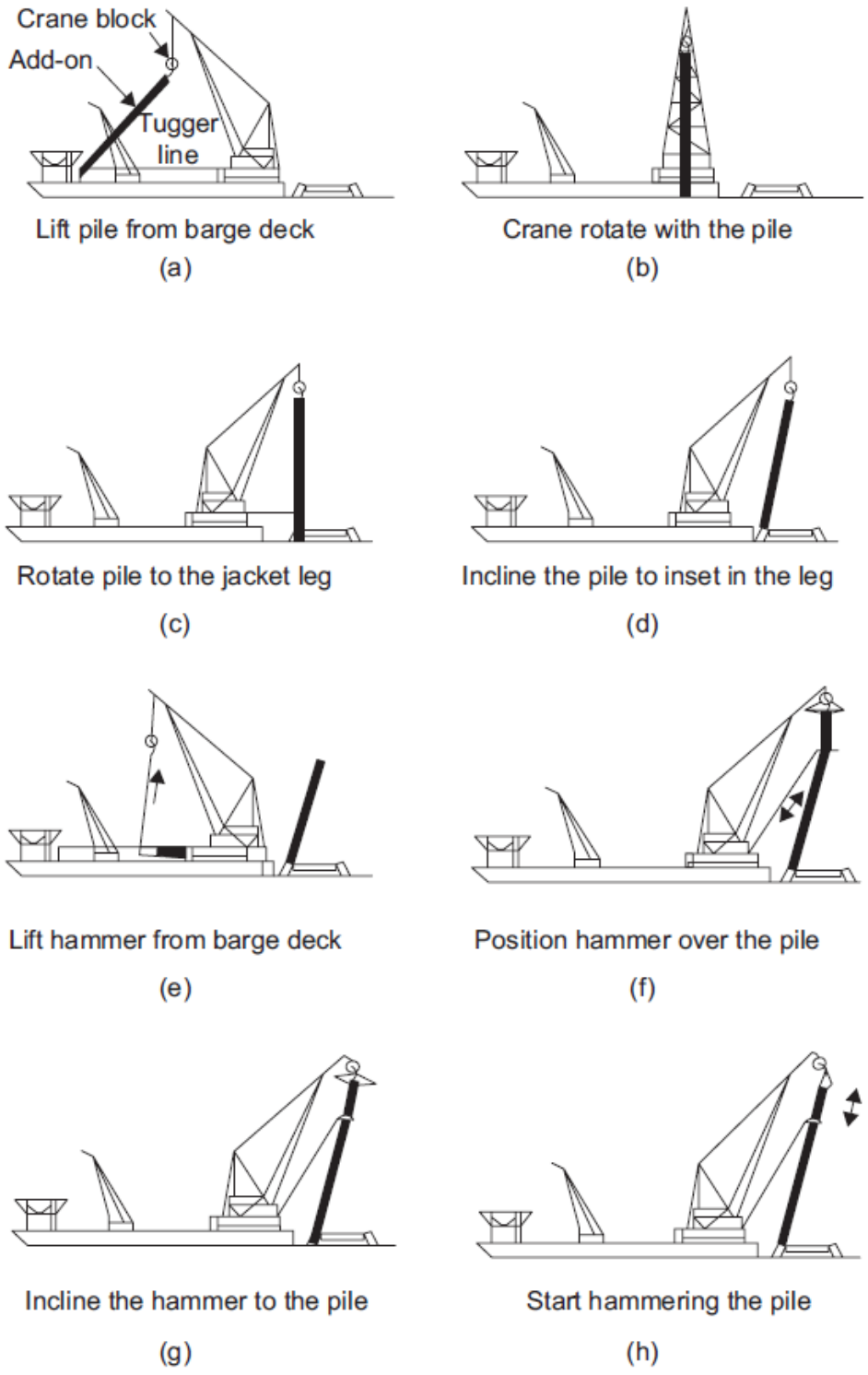

Figure 4.4: Pile Installation Process (*source: Offshore Structures: Design, Construction and Maintenance, Mohamed*)

IHC Hydrohammer

IHC Hydrohammer is a widely used equipment in the offshore oil & gas industry. As discussed above, the hammer is used for driving the piles into the seabed and is vital for the overall offshore installation process.

More specifically, IHC Hydrohammer is a hydraulic piling hammer for driving steel piles for conductors, jackets, tripods, mooring systems, monopiles and starter piles for pipe laying. [15] Due to the high technological complexity and speciality, the price of IHC Hydrohammer is very high.

Similar to vessels and offshore rigs, the design lifetime of Hydrohammer is 25 years but according to the interview with *Joop van Dijk* who is the technical manager of IHC IQIP, the real life time was largely extended because the design of IHC Hydrohammer is over-designed. According to clients, there are IHC Hydrohammers are still working well which were built more than 60 years ago.

There is some auxiliary equipment required to assist Hydrohammer and the design life time is 15 years for this auxiliary equipment. Based on the long lifetime and high price of IHC Hydrohammer, the market behaviour of selling IHC Hydrohammer is similar as new-building vessel market. Clients often take a long time to negotiate and make a final decision. Due to the long lifetime, the repeating order for replacing old IHC Hydrohammer is low.

IHC Waterhammer

Waterhammer is an environmentally friendly hydraulic piling hammer. Instead of using hydraulic oil, Waterhammer uses seawater as hydraulic material. It was designed especially for deep water and strict environment protection policies.

The Waterhammer is operable in ultra-deep water and has some advantages because it uses water as hydraulic material. For example, there is no hydraulic oil spill risk and it only needs a single hose because there is no need to design a return hose for oil circulation.

Fast Frame

Fast frame is used to support, level and orientate free standing impact driven piles. It is widely used in FPSO, FSO and FLNG anchor arrays installations, as well as single point moorings for offshore loading systems. It also has many specialized features. For example, Fast frame is able to level the frame up to 5 degrees if the seabed is inclined.

Other auxiliary installation equipment

There is some other auxiliary installation equipment which works together with the equipment above. For example, Chain clamp is used for the positioning of mooring chains. The Internal lifting tool is used for the upending of piles, conductors, and lifting and decommissioning of jackets, templates, buoyancy tanks and modules.

4.4.2. Market Segmentation of IHC IQIP

As discussed above, there are different types of installation equipment. Some equipment is specifically for certain market sectors due to its specialized function. Thus, in this sector, the market segmentation will be discussed. Additionally, dividing the market into smaller market segments will help analyse the offshore oil & gas market more accurately.

Structure installation

Structure installation is a basic activity in the offshore oil & gas market and *IHC IQIP* has a long history in this market segment. Under this market segment, the demand for equipment includes: Hydrohammer, Waterhammer, Hydraulic release shackle, Internal lifting tool, External lifting tool, Jacket pile gripper, Leveling tool, MaXine, Skidding system, Upending frame, Bear cage, Pile anti running clamp and Pile plug.

FPS mooring

Floating Production Systems (FPS) often work in deep water and remote locations far from other infrastructure in extreme climates. Naturally, there is a market demand for mooring. In the Floating Production Systems mooring projects, the equipment used is similar to normal piling installation.

(Ultra)deep water

Over the past few years, offshore projects in the oil & gas industry have moved from shallow to deeper water. This trend also continues to the ultra-deep water. There is a higher capability and reliability required for the equipment used in deep water. Some equipment needs special design and material. For example, the normal offshore oil & gas projects, the lifting tools are also essential in deep water. *IHC IQIP* supplies the *internal lifting tool* and it is crucial as well.

Conductor installation

Conductor is a large diameter steel pipe which is driven into the ground to provide the initial stable structural foundation for oil well. In offshore oil & gas industry, the conductor installation is also vital for the installation in certain areas due to the soft soil. *IHC IQIP* has been involved in this specialized market segment since the 1970s. The main equipment used in this segment is the Hydrohammer, as well as *IHC Waterhammer*, *Fast Frame, Internal Lifting Tool* and *Pile Lifting Tool*.

Subsea field development

This market segment is relatively small compared with the other four segments. However, due to the technological development and the natural oil field distribution, the number of subsea infrastructure installation projects is increasing. [15] Specifically, subsea development projects were developed and have increased the productivity of certain oil & gas projects. To install the subsea infrastructure, the hydrohammer or waterhammer is needed.

Thus, Hydrohammer is the widely-used equipment in offshore oil and gas installation projects. Other equipment of *IHC IQIP* is needed in different market segments.

After the research of the offshore technology and installation equipment, the market model can be built up based on a solid understanding of the market need and the technology trend. The market model of *IHC IQIP* will be elaborated in next chapter.

To conclude, the pile installation is very important in the overall offshore platform life cycle and it is also complex which requires many well-designed solutions and specialized equipment. Through the analysis of this chapter, the link between the installation equipment of *IHC IQIP*, offshore technology and regarding markets was identified, which will support the following quantitative market analysis. The quantitative market analysis will be elaborated on in the following chapters.

5

Model of Market Potential of *IHC IQIP*

5.1. Market Research Overview

To maximize the profit and gain more market shares in the oil & gas market segment, the decision makers of *IHC IQIP* want to know the potential market demand for certain equipment in the future and more specific information including the market value chain, the factors influencing the sales and the time lags from energy market to the offshore oil & gas platform installation equipment market of *IHC IQIP*.[1]

In addition to the conventional decision model based on the work experience and the original sales record, instead of actively analysing and using the market data, the statistical market analysis will contribute to the decision making process as a solid reference.

Generally, a good decision making process requires the tools that can quantify and qualify markets. [21] If the quantitative analyses result in same or similar conclusion as the conventional decision model which is based on experience and the original sales data, then the decision model is more convincing. Currently *IHC IQIP* does not have a clear quantitative information on the offshore oil & gas installation market. This is why the market research on the offshore oil & gas installation market segment was launched.

5.1.1. Market Research Methodology

There are several kinds of market research including exploratory research, descriptive research and causal research. The objective of exploratory research is to explore a problem whereas the descriptive research is about describing certain market phenomena, characteristics or functions. Descriptive research can also be built upon on the exploratory research. Causal research is used for analysing the effects of one variable on another variable. The ultimate objective of causal research is to reveal causality, which is a relationship between a first event and the consequence of the first event. [29]

There are four requirements for causality research including relationship between cause and effect, time order, control for other factors and the availability of theories. The third requirement could almost only be fulfilled in experiments to control other factors or some strictly controlled environment, which is called *field experiment*.[29] For example, the environmental factors should be constant in the research. However, this requirement could not be fulfilled in the oil & gas market.

Concerning the objective of this market analysis project, this market analysis will need *Exploratory Research* and *Descriptive Research* to set up the basic structure of the market. However, this analysis will also cover the quantitative research to reveal the time lags between the sales of *IHC IQIP*, oil price and the offshore oil & gas installation project data. From another perspective, the *Exploratory Research* and *Descriptive Research* are mainly qualitative research, whereas the *Causality Research* is mainly quantitative.

The scope of this market analysis project does not include a *Causality Research*. However, there exists some quantitative research: the analysis of the time lags. Thus, the market

[1] Interview with Mark Aelmans, Innovation Specialist of IHC IQIP, February 2017, Sliedrecht

research phases will be categorized into *Qualitative Research* and *Quantitative Research*. The reason for such categorization is that qualitative research inputs the market information and basic sales procedure, market structure and value chain. Upon this qualitative foundation, the quantitative research is needed for a more specific analysis.

5.2. Qualitative Research on the Market of *IHC IQIP*

In this market analysis project, qualitative market information was gathered by interviewing the experts and literature research. In the market research theory, this part will cover the phases of *Exploratory Research* and *Descriptive Research*.

The qualitative market information would contribute to establish an *Offshore Supply and Demand Model* to explain the offshore oil & gas industry value chain, as well as identify the variables which influence the market demand for the installation equipment produced by *IHC IQIP*.

IHC IQIP has four main market segments including *Offshore Wind Farm, Oil & Gas, Coastal & Civil and Decommissioning*. *IHC IQIP* supplies the installation equipment and related auxiliary equipment for offshore and onshore installation.

As *IHC IQIP* is located in the upstream sector of the oil & gas industry, the market demand for oil & gas influences the demand for the upstream investment plan for offshore oil & gas platforms and related equipment. Thus, analysing the influencing mechanism of the market will contribute to the equipment market demand analysis. To reveal these influencing mechanisms, the qualitative research needs to be done.

5.2.1. Overview of the Offshore Installation Equipment Market

The offshore oil & gas platform installation equipment is used to install the offshore platforms which produce oil & gas to supply energy and other chemical products.[15][30] Thus, it is important to analyse the whole market value chain to find the influencing factors to the sales of the offshore oil & gas platform installation equipment.[17][28]

There are different oil & gas wells in the world and some of them locate in the offshore areas. Thus, there are needs to design, produce, install and maintain the offshore oil & gas platforms to extract the oil & gas in the sea. These form the offshore oil & gas industry. From the macro-level, roughly 30% of the overall global oil & gas supply comes from offshore oil & gas wells.

There are two reasons why there is need for offshore oil & gas production in addition to the onshore oil & gas production. The first reason is the natural distribution of the oil & gas reservoir. There are many offshore oil & gas reservoirs which could also supply the increasing energy demand in the world. The second reason is that technological development decreases the cost level of offshore oil & gas production and increases the technical capability in terms of the offshore oil & gas exploration and production. Currently, more than 1600 offshore oil & gas fields have been found in the world but only 200 of them have been used in production according to the data in 2014. Even in this case, the annual output has reached roughly 1/3 of the global oil output. [8] Thus, the offshore oil & gas industry is vital for the global energy supply.

Unlike the onshore oil & gas projects, the offshore oil & gas projects normally have a higher cost. The cost will increase depending on water depth and climatic severity. This also applies to the development and production phases in offshore oil & gas projects. Considering the pipe-laying cost, the distance from shore is another important factor of the cost. [34][32]

Since the target market of *IHC IQIP* is the installation market, the *development* phase of the offshore oil & gas projects is more important than other phases in this analysis. Generally, the *development* cost includes all costs incurred to delineate a field and to install equipment and facilities necessary for production of that field, as well as the transportation facilities and terminals required to bring the oil & gas onshore. [10]

To drill wells and produce oil & gas in the offshore areas, there are different types of offshore oil & gas platforms and different corresponding installation procedures. Fixed platform installation is one of the main sectors in the oil & gas market of *IHC IQIP*, which is mostly in relatively shallow water. However, even in the deep sea areas, there are subsea systems in

the portfolio of *IHC IQIP*.

Furthermore, as the easy-oil-field is almost gone, the oil and gas projects are moving to deeper water and more complex environment. This will also contribute to the demand for the high-technology oil and gas equipment. [16]

5.2.2. Expert Interviews in *IHC IQIP*

To collect the market information such as the sales process, the influencing factor on sales, the information of the clients and the value chain of offshore oil & gas installation equipment market, a series of expert interviews have been arranged.

The interviewed experts list includes but is not limit to: Sales Manager, Account Manager, Technical Director, CEO, Manager of Back Sales Office, Innovation Specialist, Market Analyst, and Manager of Engineering. The detailed interviews will be elaborated in the appendices. The interviews last for at least 1 hour, which are one-to-one meetings with the exception of those with the senior management board members.

In terms of interview methodology, there are three types of interviews including *Fully Structured Interviews, Semi-structured interviews, and Unstructured Interviews*. *Fully Structured Interviews* use a series of prepared questions in a fixed order. It has the advantage of being easy to be executed for analyst. This is because the interviewees are asked the same questions in the same order and the answers can be grouped based on different groups. [23]

In addition, there are the *semi-structured interviews* which generally start with a set of questions. Unlike the fully structured interviews, the semi-structured interviews allow the interviewer to ask for additional information if new questions come up during the interviews. This is not allowed in the fully structured interviews, which is regarded as an interfering action.

The last method is the unstructured interview, which may simply be based on a list of topics or questions.[33] Generally, there is no fixed question but a topic. The main benefit of using unstructured interviews is that it is beneficial for exploring topics in a depth and breadth which may be harder to achieve in a fully structured interviews. [23]

In this project, the objective of the interview is to gather information and exploring research on the oil & gas offshore installation equipment market. Thus, the unstructured interviews were chosen to finalize the research. While the advantage of the unstructured interviews is convenient and easy to use, the disadvantage is that they cannot analyse one specific question in depth. However, since there is not a clear overview of the current offshore oil & gas installation equipment market, the unstructured interviews are suitable for this analysis project.

Moreover, the interview questions are mainly about the clients information, sales process, market value chain, the product development of *IHC IQIP*, etc. Thus, the ideal interviewees are sales managers, sales account managers, managing directors, market analyst or who have in-depth knowledge of the market.

For examples, the technical specialists have little knowledge about the sales process and the market intelligence. However, the interviews with technical specialists are used to collect the related technology information to contribute to the offshore technology research.

5.2.3. Information Flow in the Market of *IHC IQIP*

According to the interviews and the literature research, the installation equipment market follows the clients' installation projects market, just as in other industry. Since this industry is highly competitive and complex from a technology perspective, the lead time of project in offshore installation project can last from six months to 2 years.[2]

The long duration of the information flow of the oil & gas installation projects market is important for the market analysis. The specific information flow of the order intake in *IHC IQIP* is shown as figure 5.1.

The common procedure is: the offshore contractors, which are the clients of *IHC IQIP*, get enquiries from the oil companies concerning specific installation projects and then the contractors start to send the enquiries to the equipment suppliers such as *IHC IQIP*. Af-

[2]Interview with Michael Schaap, the Technical Director of IHC IQIP, May 2017, Sliedrecht

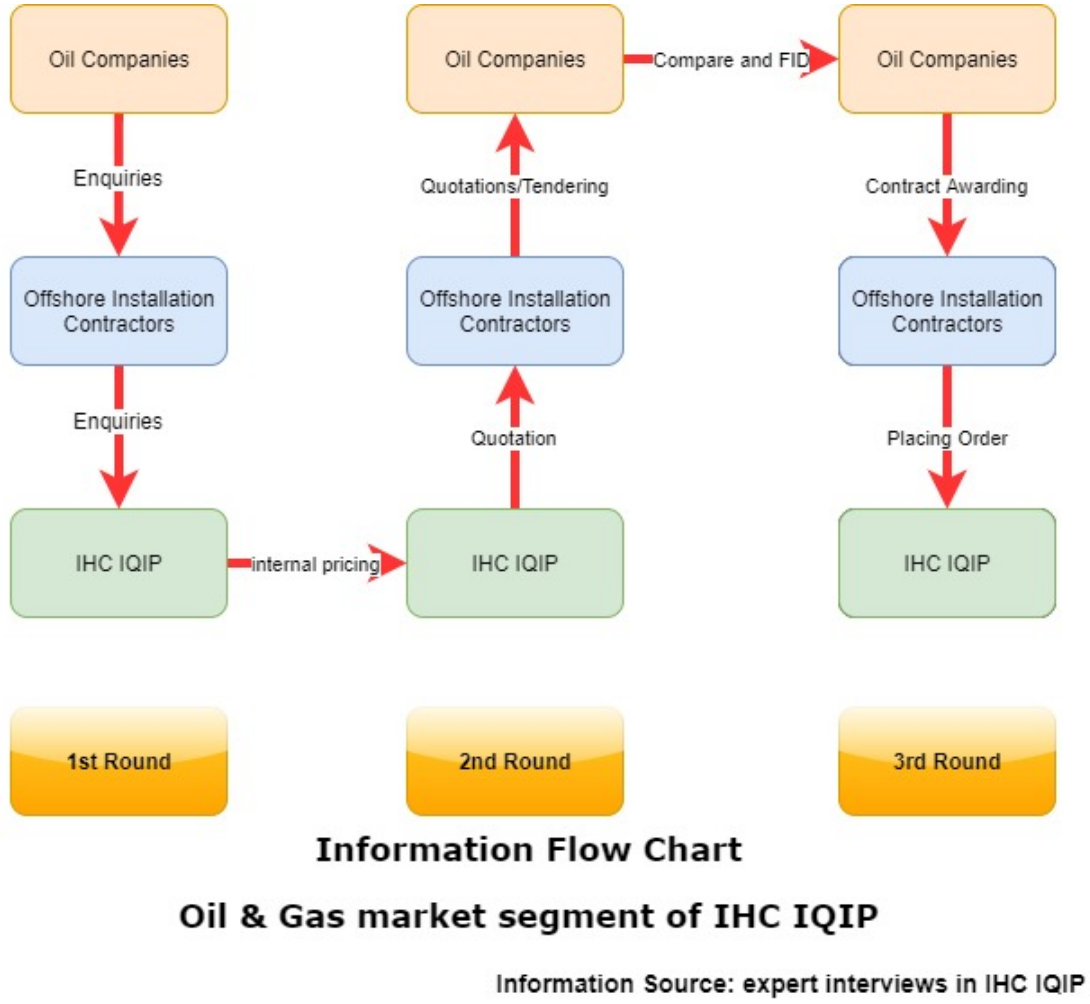

Figure 5.1: Information Flow Chart about Oil & Gas market segment of *IHC IQIP* (*source: expert interviews in IHC IQIP, compiled by Mark Xiaoming Ma*)

ter gathering enough information including technology qualification, delivery time, cost and other related terms, the contractors will come back to bid for the installation projects from the oil companies. These loops will restart once the contractors are awarded the contract from the oil companies.

As shown above in figure 5.1, there are three layers in the information flow including *Oil Companies, Offshore Installation Contractors* and *Equipment Suppliers*. In this case, *IHC IQIP* is the equipment supplier. There are three rounds of information flow consisting of enquiries, quotation/tenders, contract awarding and placing orders. This information flow is indicated by the red arrows in the figure 5.1.

Naturally, due to this information flow and the special market feature in offshore oil & gas sector, which is capital-intensive and long investment cycle, the quotations from the suppliers to contractors may be laid idle when the oil companies cut the upstream cost.

In the perspective of the information flow shown as figure 5.1, the quotations from the suppliers to the contractors are laid idle in the second round information flow. Furthermore, it may be laid idle in the contractors level, but it is also possible that it ends up in the oil companies level. For example, the offshore installation contractors have already sent the tenders to the oil companies but the oil companies did not award the contract to any contractor due to the changing market.

When oil prices fluctuate and the oil companies start evaluating the upstream projects, offshore platform installation contractors may lose orders from the oil companies. Thus, the

offshore platform installation contractors would cut costs in the long-term investment plan including purchasing heavy assets like Hydrohammer or the handling systems.[3] Obviously, the long lead time of the information flow will cause a time lag between the upstream market cause and the downstream market effect.

5.2.4. Basic Structure of Offshore Oil & Gas Installation Market

As discussed in Chapter 3, *IHC IQIP* is located in the upstream sector of the oil & gas industry. However, there are many players in such an industry. To make an analysis, the more important factors should be chosen for analysis.

Based on the expert interviews in *IHC IQIP* and the economics theory of the global oil & gas market, the value chain of the offshore oil & gas installation market is shown as figure 5.2. As shown in Figure 5.2, considering the industry structure and available data sources, there are four main sectors in the value chain including global economics, global oil & gas market, offshore installation contractors, and IHC IQIP, which is a supplier of the offshore oil & gas project installation equipment.

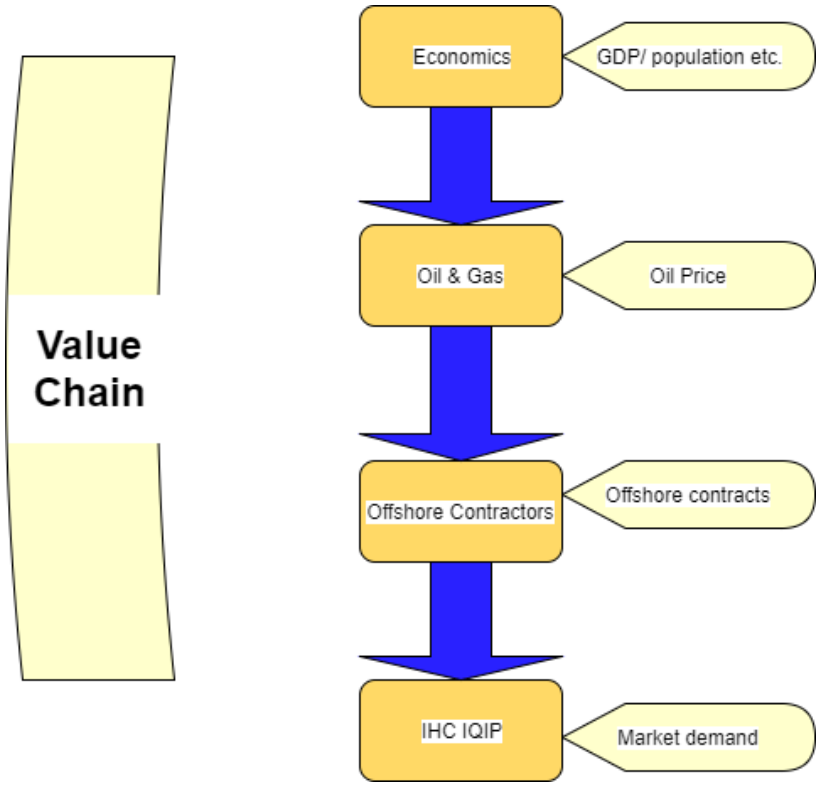

Figure 5.2: Value Chain of the Offshore Installation Market

The dependent variable is the market demand for the offshore equipment in oil & gas sector, which is also the analysis focus of this market analysis project. The GDP, oil price and the gained offshore installation projects number are the explanatory variables. Specifically, the crude oil price and the GDP are influencing each other and in this case they are not independent variables.[12]

There is a time lag between the order intake data of offshore installation and the oil price fluctuation.[37] [45] This means another analysis objective is to figure out if there is any influencing mechanism or time lag between the energy market, installation project market and installation equipment market.

The sales data from other offshore installation suppliers are highly confidential and *IHC IQIP* does not have in-house data base either. Thus, the sales data from *IHC IQIP* will be the

[3]Interview with Max van de Kemenade, Account Manager of IHC IQIP, February 2017, Sliedrecht

data source for 'the supplier'. There are actually more suppliers in the market. However, due to limitation of the data sources, analysing the link between the contractors data and the data from *IHC IQIP* is the best possible option.

Understanding the energy market structure and the influence of the economy, together with the oil & gas industry value chain, the quantitative data analysis can be done upon an economic foundation. Based on this value chain, the varied variables are defined for the analysis afterwards.

5.3. Offshore Supply and Demand Model

Based on the qualitative research above, including the value chain and the information flow, as well as the economics research in chapter 2, the *Offshore Supply and Demand Model* was created.

There are two main sections which are *Supply* and *Demand*. The model could be used to explain the market mechanism and the related factors which influence market demand for the offshore oil & gas platform installation equipment.

In addition to that, several different layers and segments of the market and the important variables are defined for the quantitative analysis later. The model will be elaborated below with more explanations.

5.3.1. Overview of the Model

As shown in the *Offshore Supply and Demand Model*, there are different companies, different data and different economic segments. Thus, the *Offshore Supply and Demand Model* has three dimensions. These dimensions include the companies dimension, data dimension and the economic dimension. In each dimension, the market can be divided into different sectors which are easier for the market analysis.

The first dimension is the company dimension. As Figure 5.1 shows, there are varied company levels which have equipment suppliers, offshore contractors and oil companies. *IHC IQIP* is one of the equipment suppliers in the market. The clients of these equipment suppliers are mainly offshore contractors.

From the economics point of view, energy demand is the ultimate market driver of installation equipment. This is because the target market of the installation equipment is the installation market of oil & gas platforms or subsea production systems. These oil & gas platforms or subsea systems serve the energy market.

From the data point of view, according to the different layers of the market, the important variables for the later quantitative analysis are the sales data of *IHC IQIP*, the offshore project installation data, oil price, and GDP as an indicator of the global economy.

From the market point of view, there is a clear chain from global economy to the sales of *IHC IQIP*. When global economy grows, there will be more energy demand. Then the market will react and the energy price will go up when the demand is larger than the supply. However, there are different types of energy such as oil, natural gas, shale gas, wind energy, coal and other renewable energy types. Thus the oil and gas market will be influenced by these other market segments as well.

5.3.2. The Value Chain in Offshore Installation Market

Due to the increasing population, development of the economy and the increasing living standards, the demand for derivative products of oil & gas such as gasoline, diesel, jet fuel, natural gas and lubricants will increase. Thus, the demand for oil & gas will also increase. This increased market demand for oil & gas could be supplied by: new oil & gas platforms, new offshore subsea development wells, new onshore production plants, or increasing the production capacity per well in the existing oil fields.

Naturally, when there are new offshore oil & gas platforms or new offshore subsea development, there will be market demand for the offshore oil & gas platform installation equipment. The market for offshore installation equipment comes from the installation market of the *new oil & gas platforms* and *new offshore subsea development*.

For the new platforms, there are two sectors including the *Fixed Platform Installation* and

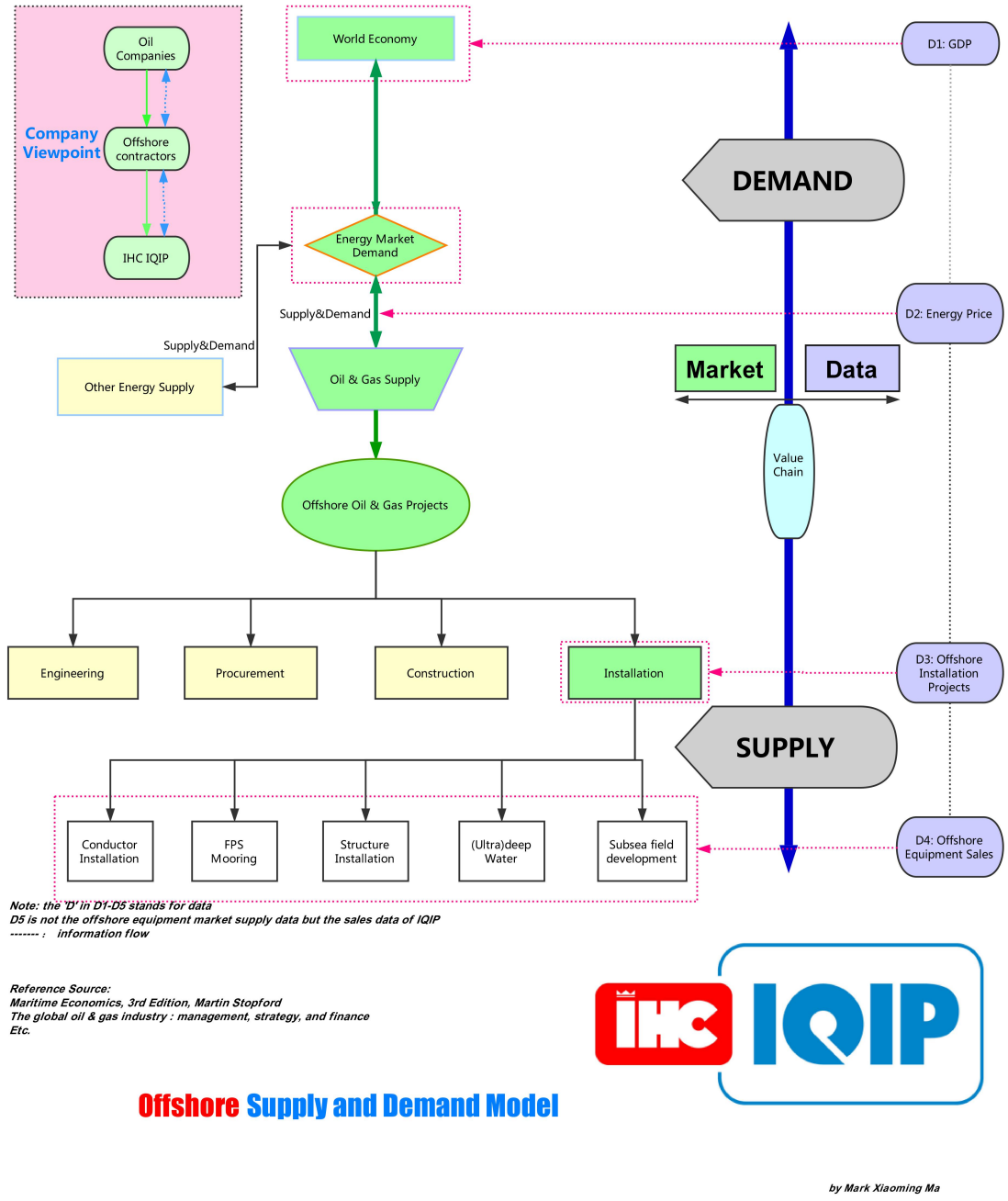

Figure 5.3: Offshore Supply and Demand Model

Floating Platform Installation. The subsea development could use tieback systems to transport the oil & gas to the existing oil & gas platforms, so there is no need for the platform installation, only the installation for the subsea infrastructure, such as templates, manifolds and pipelines. [15]

The market demand for new platforms or new subsea development comes from oil companies. The oil companies will analyse the oil price, natural gas price and related political issues, as well as the cost of the new development projects. When there are potential offshore development projects, the oil companies will ask quotations from the potential projects.

Meanwhile, they will make a financial analysis for the potential projects considering the cost and benefit.

When the financial analysis of investing in a new offshore oil & gas platform is positive, the new offshore development projects will be launched. This mostly happened at a time when the energy demand is greater than the energy supply. In this case, the oil companies will expand the upstream investment plan for exploration and development and increase the production to maximize their profits.

Also, the oil companies have the exploration and development projects which were laid idle. When the energy price is low and the project is not profitable according to the updated financial analysis, the oil companies will 'freeze' the oil & gas projects to avoid bigger losses, which means the projects will be stopped at wherever it is. Obviously these projects, which were partly completed, will enter the market sooner than the totally new projects. To maximize the profit, the oil companies will restart these idle projects when oil price increases from a slump.

In terms of the actual procedure and phases of oil & gas projects, the exploration and development activities in the *Offshore Supply and Demand Model* include the activities of *Engineering, Procurement, Construction* and *Installation*. Before these activities, the oil & gas projects also require seismic research, test drilling and financial analysis before their execution. [17]

Either it is a new offshore oil & gas project or a restarting project, it will need installation service, which is the last step in the macro-overview. To complete the installation, the offshore installation contractors will need the offshore oil & gas installation equipment. Thus, the demand for the offshore installation equipment will be influenced by the oil price in reality. [22] [2]

Now the whole value chain and market structure relating to offshore oil & gas platform installation market is complete. From the value chain shown in Figure 5.2 and the market model shown in Figure 5.3, there is a clear value chain from crude oil market to the offshore installation equipment market.

5.3.3. The Time Lag Effect of the Market

Concerning the information flow shown in Figure 5.1, there is a complex influencing mechanism between oil price change to the sales market change of *IHC IQIP*. The oil companies make upstream investment plans based on their forecast of the future prices instead of the current price. Additionally, the oil & gas projects need a relatively long time to finalize the engineering, procurement, production and installation procedure.

More specifically, the installation equipment is needed in the later phase of the *Exploration & Development* of offshore oil & gas projects. These factors will influence the time lag between the oil price change and offshore installation market. Furthermore, the time lag could contribute greatly to the business strategy for the offshore installation contractors and the installation equipment suppliers.

However, there is no available clear information about the time length between the oil price change and the installation market change. In contrast, this time lag is very useful for the offshore installation equipment suppliers. For example, if the time lag is known as 2 years, a supplier of installation equipment such as *IHC IQIP* could change marketing strategies once the oil price changes or some other market indicators change. Then, based on the time lag, the oil price could be used as a forward indicator of the offshore installation equipment market. If the time lag is 0 or even negative, apparently there will not be a forward indicator but simple relationship between the market fluctuations.

In addition to that, with the help of a known time lag, the management board of *IHC IQIP* could make the business plan, research and development plan, and other business activities to maximize the profit and lower the risk.

Thus, based on the information flow and the development phases of the oil & gas projects, the hypothesis is set: there is a time lag between oil price change and the offshore oil & gas installation projects market change. There are some tasks following this hypothesis. The first task is to verify the existence of the time lag and the second task is to examine the length of the time lag by the quantitative analysis. After that, the decision makers can use

this information to better forecast the market demand for the offshore installation equipment to maximize the profit and lower the risk.

To conclude this chapter, the market research overview and methodology contribute to set up the analysis process. The qualitative research contributes to set up the basic structure of the market model of IHC IQIP. Then to overview the market and the relationships among the varied market segments, the offshore supply and demand model was established. This model will support the quantitative research as a foundation.

Next the research topic came as the time lag between the oil price change and the installation equipment market demand change. To examine the length of the time lag accurately, in the next chapter, the quantitative research will be used to further analyse the time lag effect. Then the result could help the decision makers of *IHC IQIP* to understand the market better.

6

Quantitative Research, Data Pre-processing and Data Analysis

6.1. Quantitative Research on the Market of *IHC IQIP*

To analyse the offshore oil & gas market, both the qualitative analysis and the quantitative analysis need to be included in the market research. The objective of the qualitative analysis is to establish a solid theoretical foundation from the economic point of view as well as the practical point of view, which can be done by means of the literature research and the expert interviews.

After the qualitative analysis including the *Offshore Supply and Demand Model*, the quantitative analysis of the market data should be done to reveal a clear specific mathematical relationship between the different market sectors. The quantitative analysis is important for the understanding of the offshore oil & gas installation equipment market and is able to contribute to the decision-making process as well. For example, from the quantitative analysis, there is a hypothesis that there are time lags between oil price changes to the offshore oil & gas projects market fluctuation. To verify the existence of the time lags and to calculate the length of the time lag, the quantitative analysis is needed.

In terms of the quantitative analysis, using an econometric model is the ideal method to forecast the market demand considering multiple factors. The introduction of econometrics will be elaborated in the next section. Briefly, the three key ingredients of econometrics are economic theory, economic data, and statistical methods. In this market analysis project, the economic data includes but is not limit to crude oil price, offshore projects data, market demand, and market supply of the offshore oil & gas installation equipment market.

However, considering the limited database in this project, the econometric model realistically can't be used, though it would be the best if there is a large enough suitable database. For example, there is no available data about the sales data of all suppliers in offshore oil & gas project installation equipment market. Instead, based on the available data and the hypothesis from the qualitative analysis, the lagged correlation will be used to analyse the time lag between oil price change and the offshore oil & gas project market, which will be elaborated below.

6.1.1. The Use of Econometrics

As mentioned above, to better forecast the market demand for the offshore oil & gas installation equipment considering multiple factors, using an econometrics model is the ideal and the most accurate way. For example, using an econometric model, there would be a function of the market demand for the offshore oil & gas installation equipment based on varied explanatory variables. Then, using the input of varied explanatory variables, the market demand can be calculated.

Briefly, the demand for the offshore oil & gas installation equipment depends on the offshore installation contracts market and the competitive level in this market segment. The

offshore oil & gas installation project market demand depends on the explanatory variables including *crude oil price, GDP*, as well as other factors such as *natural gas price, renewable alternative energy price, weather conditions, etc.*.

However, to build such an econometrics model, the data source has to include the sales data of all offshore oil & gas installation equipment suppliers in this market segment.[38] In addition to that, related factors including alternative energy price, GDP per region are needed as well.

In other words, all the suppliers who produce and sell the offshore oil & gas platforms are part of the *Offshore Supply and Demand Model*. Unfortunately there is no access to the data of the whole offshore installation equipment industry supply.

In different kinds of applications, examples of time series analysis have been used in the forecasting in such fields as economics, engineering, business and sciences. Time series analysis is one of the basic econometric model. However, the adjacent observations of a time series must be dependent, which is also the feature of time series. [4] [27] The three data sets in this analysis, which are oil prices, offshore oil & gas platform installation projects and the order intake of the suppliers, are time series data based on the definition above.

However, one fact which should be noted is that the one proper econometrics model based on correct and sufficient data is the best way to forecast the market demand. Due to the limit of the data access, there is not enough data to build up an econometric model. A usable econometric model can only be made with enough and right data. Instead of an econometric model, time lag analysis is chosen to reveal the market influencing mechanism due to it is relatively fast analysis when compared with building an econometric model.

6.1.2. The Use of the Time Lag Analysis

To verify the existence of the time lags and examine how long the time lag is, the lagged correlation analysis technique could be applied to reveal the time lags. [19] [31]

Currently, the companies in marine industry suffer from the low oil prices, shipping freight, and more competitive market. Thus, the decision-makers have to be more efficient to keep the market share and even increase the profit. This is also the aim of *IHC IQIP* right now, to lower the risk and win more profit. Due to the low energy price, the upstream cost of the oil & gas industry was greatly decreased. There are much less offshore projects to be installed and clients of *IHC IQIP* have less orders which influences their investment plan. The market demand of the offshore installation equipment has decreased as well.

However, as discussed in Chapter 3, there is still a lot of market demand for the conventional energy like oil & gas. When there are new offshore oil & gas *Exploration & Development* projects, the offshore installation contractors will get more orders from the oil companies which will persuade them to purchase or rent more equipment from the installation equipment suppliers. However, due to the long and complex information flow, the time lag between the oil price, installation projects market and installation equipment market is not clear for *IHC IQIP*. It is important for the management directors to know when and how the market demand for the installation equipment will react when the oil price rises again.

Thus the time lag analysis could contribute increasingly to the decision making based on different data sets. For example, the time lag between oil price and offshore installation market could be revealed based on the time lag analysis between the data sets of oil price and installation contracts number. Efficiently using the time lag could help the players in this industry to catch the market opportunity and contribute to the decision making in a relatively short time and with a better prediction.

6.2. Time Lag Analysis

As discussed above, the market demand for the offshore oil & gas project installation equipment comes from the new increased offshore installation projects. This will also be influenced by the contractor's own fleet. If the installation market does not change, the contractor will be able to complete the installation projects without purchasing new installation equipment.

For example, if the demand for offshore oil & gas increases, the oil companies will invest more in the new offshore oil & gas platforms or more subsea production system. Then

these installation projects will require more equipment and the contractor will need more installation equipment.

However, in the offshore installation industry, the period of investment return is long and offshore contractors also have some offshore installation equipment as their fixed assets. [32] [34] Thus, the purchasing or renting order intake might not be simultaneously follow the pattern of the oil price. Then to better understand the market and forecast the market, one hypothesis can be set: there are time lags between oil price, offshore installation project market and the installation equipment market.

Furthermore, the number of the installation projects is the vital variable for the installation contractors and subcontractors to make purchasing or renting decisions. Thus the time lag between oil price and installation project data is important.

Concerning the difficulty to get the sales data from other competitors, the time lag between oil price and market demand for the installation equipment will be skipped. However, the time lag analysis will be done between oil price and the sales order intake to see if there is a correlation and if there is also a time lag.

6.2.1. The Lagged Correlation Analysis

Based on the expert interviews and literature research, the market fluctuations have time lags between the oil & gas market, offshore installation market and the installation equipment market. To maximize the profit and lower the risk, *IHC IQIP* has to know the market mechanism and especially the time lags. To reveal how long the time lag is, the cross-correlation test need to be made to compare the different correlation coefficients under varied time lags.

The time lag with the biggest correlation coefficient obviously is the most possible time lag in reality, though the accuracy may be limited by the data source. For example, the installation time of the offshore oil & gas platforms is only as accurate as a specific year instead of a date. This would be another recommendation for the future data mining and market analysis.[19] Increasing data accuracy could help to increase the analysis accuracy. The further recommendation will be elaborated in the last chapter.

Intuitively, two sequences have a lag correlation of l if they look very similar but one is delayed by l time-ticks.

Correlation coefficient [31] between two stochastic variables X and Y is defined as

$$\rho(X,Y) = \frac{\mathbf{Cov}(X,Y)}{\sqrt{\mathbf{Var}(X)\mathbf{Var}(Y)}}$$

Here, the

$$\rho(X,Y) = R(0) = \frac{\sum_{i=1}^{t}((X_t - \overline{X})(Y_t - \overline{Y}))}{\sigma(X) * \sigma(Y)}$$

However, in many cases, there is time lag between different market data. Thus, the lagged correlation analysis formula is:

$$R(l) = \frac{\sum_{t=l+1}^{n}(X_t - \overline{X})(Y_{t-l} - \overline{Y})}{\sqrt{\sum_{t=l+1}^{n}(X_t - \overline{X})^2}\sqrt{\sum_{t=1}^{n-1}(Y_t - \overline{Y})^2)}}$$

Here,

$$\overline{X} = \frac{1}{n-l}\sum_{t=l+1}^{n} X_t$$

$$\overline{Y} = \frac{1}{n-l}\sum_{t=1}^{n-1} Y_t$$

The *R(l)* is the correlation coefficient when X is delayed by l. The high absolute value of *R(l)* is the judgement basis. [36] However, there is a limit of the time lag. When the lag l is

larger than *n/2*, the original sequence time series data and the shifted time series data will have too few overlapping time-ticks. Following the time series analysis recommendations[4], the maximum lag is restricted to be *n/2*. [36]

6.3. Data pre-processing

As discussed, there are 3 types of data including: crude oil price, offshore installation number per year and the original order intake data of *IHC IQIP*. However, some data needs to be prepared for further analysis due to different data formats, different unit, different time frequency, etc.

6.3.1. Order Intake Data Pre-processing

Ideally, the sales data of all suppliers in the market would be the best for such a market analysis. However, the sales data of other suppliers in this market are not accessible. Thus the time lag analysis will be done under the assumption that the market share of IHC IQIP is stable during this time period.

To apply the lagged correlation analysis technique, the data is supposed to be in the same time frequency. The sales data and oil prices data have to be prepared in the same time frequency. Thus, the order intake should be mined from the original data from ERP system of *IHC IQIP* and count the orders per month or quarter. Then the oil price should be pre-processed to a monthly average oil price or quarterly average oil price. [26]

Due to the reason that *IHC IQIP* has varied market segments including *Oil & Gas, Offshore Wind Farm, Coastal & Civil and Decommissioning*, the original data from the ERP system *ISAH* is supposed to be filtered. After filtering, the orders belonging to Oil & Gas market segment can be used for further analysis.

Since the financial data is not accessible currently, the turnover per month or quarter could not be calculated based on the prices and order intake. The product portfolio in the sales kept relatively stable, which means this analysis will use the order intake as the market demand indicator. However, the ideal analysis is supposed to be analysed based on the financial numbers, which is a recommendation for the future analysis.

The original data includes *Order number, product code, description, product number, planned sending date, client code, Order type etc.* However, some information in the original sales record data were missing. Some dates are missing, meaning these sales record could not be counted in the time series data. The incomplete data, which does not have specific date information, is removed from the original sales record data set. 23 out of 1358 records were removed and it accounting for 1.69% of the entire sales record. The market analysis will be done based on the filtered 1335 sales records in *Oil&Gas* market segment.

In total, from 2010 to 2017, there are 1335 effective orders in the *Oil&Gas* market segment according to the ERP system of *IHC IQIP* including the sales orders and orders for renting services. However, the order intake data is not a prepared time series data but only different orders on certain dates.

Furthermore, since the time used in the data analysis is the planned sending date, one thing should be mentioned is the lead time between planned sending date and order-placing date is roughly 104.5 days, based on the Handling tools sales data from 1992-2014. About the lead time of hydrohammer, there are different lead times in sales and rental business, which will be explained later.

Since the objective of the data analysis is to further analyse the time lags and the time path. Thus, the sales data is needed to be pre-processed to a time series order intake data. The original sales data is a list of orders received by *IHC IQIP*, which dates back to the second quarter in 2010. Considering the time window is relatively short, to do the lagged correlation analysis, a list of quarterly order intake has to be prepared, which will give 27 data points.

6.3.2. Oil Price Data Pre-processing

There are two main crude oil types including WTI and Brent. As defined by the U.S. Energy Information Administration, WTI stands for West Texas Intermediate, which serves as a reference or ”marker” for pricing a number of other crude streams. Brent crude is a combination

of crude oil from 15 different oil fields in the Brent and Ninian systems located in the North Sea. Since the clients of IHC IQIP come from all over the world, together with the stakeholder from IHC IQIP, this market analysis will use WTI crude oil price as oil price parameter.

The data source is the daily crude oil spot price from U.S. Energy Information Administration. The unit is *Dollars per Barrel*. To analyse the time lag between crude oil price and offshore projects installation number, because the offshore installation number is yearly data, the oil prices have to be pre-processed into yearly average spot price, which will be shown in the next section.

Since the oil price is influenced by currency inflation, this will cause some effects in the market analysis. In other words, the nominal crude oil price from U.S. EIA is calculated by the past US dollar's value instead of today's US dollar's value. To analyse the correlation between oil price and offshore installation market, the oil price has to be the real price based on the exact same buying power of the US dollar instead of the nominal oil price.

From the *International Labour Organization (ILO)*, CPI is the Consumer Price Index, the best and most well-known indicator of inflation. It is the barometer of the performance of the economy and a key indicator in evaluating the results of the monetary and fiscal policy in a country.

The oil prices have to be adjusted for inflation, based on CPI. In this project, the base year is 2017 and every crude oil price will be calculated based on the CPI of 2017 and the CPI of the year it belongs to. For example, to calculate the adjusted oil price in 1986, the CPI in 1986 will be used together with the CPI in 2017.

Real Price(t) = (Nominal Price(t)) x (Adjustment Factor)

The adjustment factor is formed using the CPI measures, and the the foumula of the *Real Price(t)* is:

Real Price(t) = (Nominal Price(t)) x (CPI(2017) / CPI(t))

The adjusted oil price and the original price is shown in Table 6.1.

6.3.3. Offshore Installation Project Data Pre-processing

The offshore platform installation number is counted on the unit of year, instead of exact dates. This will cause some limit of the forecast accuracy, which is another point for future improvements. In addition to this, there are two other types of offshore installation projects including *Floating Platforms* and *Subsea Production Systems*, which will be explained in detail in the next Chapter.

Using Python to filter and pre-process the installation projects database, a time series data base can be created of the installation number per platform type. There are three types of offshore installation contracts including *Fixed Offshore Platforms Installation, Floating Platforms Installation* and *the Subsea Production System Installation*.

The overview of the offshore installation projects and the adjusted oil price are shown as table 6.2. It is the adjusted crude oil price based on CPI for inflation and the yearly number of 3 different types of offshore installation projects, from 1986 to 2016. The number of the offshore installation projects is counted by the installation time instead of the time when the oil companies made the decision.

Another feature that should be considered is that the offshore installation time of the projects is when they are installed on the seabed, instead of the time when the oil companies made the decision. Also, the data on when the energy companies started processing the new offshore oil & gas projects is not available. Otherwise that would be the better data to be used.

According to the technical director of *IHC IQIP*, the normal lead time of the installation project preparations is roughly six months to one year, depending on its complexity and specific project conditions. [1] More precisely, the installation project starts from tendering, after selecting and technical negotiation, the supplier will be selected and supply the equipment

[1] Interview with Michael Schaap, the Chief Technical Director of IHC IQIP, 4th September 2017, Sliedrecht

Table 6.1: Adjusted Crude Oil Price for Inflation

Year	Oil Price	Adjusted Oil Price
1986	15.05	33.74
1987	19.2	41.42
1988	15.97	33.09
1989	19.64	38.76
1990	24.53	46.19
1991	21.54	38.83
1992	20.58	35.96
1993	18.43	31.34
1994	17.2	28.46
1995	18.43	29.67
1996	22.12	34.59
1997	20.61	31.53
1998	14.42	21.69
1999	19.34	28.48
2000	30.38	43.16
2001	25.98	35.94
2002	26.18	35.69
2003	31.08	41.49
2004	41.51	53.81
2005	56.64	71.17
2006	66.05	79.69
2007	72.34	85.27
2008	99.67	111.25
2009	61.95	70.63
2010	79.48	89.51
2011	94.88	103.11
2012	94.05	100.79
2013	97.98	102.98
2014	93.17	96.01
2015	48.66	50.06
2016	43.29	44.17

Table 6.2: Platform Installation Numbers & Adjusted Oil Price for Inflation

Year	Fixed Platform Number	Floating Platform Number	Subsea Development Well Number	Adjusted Oil Price for Inflation
1986	316	5	11	33.74
1987	223	10	14	41.42
1988	285	8	18	33.09
1989	289	6	17	38.76
1990	297	12	19	46.19
1991	263	6	25	38.83
1992	227	12	23	35.96
1993	269	13	28	31.34
1994	294	10	36	28.46
1995	233	9	40	29.67
1996	251	11	31	34.59
1997	260	18	60	31.53
1998	277	28	70	21.69
1999	207	27	58	28.48
2000	206	22	54	43.16
2001	220	11	73	35.94
2002	190	21	68	35.69
2003	191	15	83	41.49
2004	219	26	57	53.81
2005	199	20	63	71.17
2006	239	23	74	79.69
2007	241	25	83	85.27
2008	230	29	104	111.25
2009	242	29	89	70.63
2010	139	29	69	89.51
2011	147	34	89	103.11
2012	190	23	75	100.79
2013	189	25	86	102.98
2014	179	34	65	96.01
2015	200	27	78	50.06
2016	129	25	84	44.17

to the offshore contractor to do the installation projects. The installation projects themselves are much shorter, which only take two days to two weeks. This would contribute to the understanding of the market analysis and market demand prediction.

Furthermore, the normal lead time of the offshore installation work is 1 to 2 days, while the total lead time of the project could last for 1 to 2 years from the tendering phase to the end of the project.[2]

6.4. Time Lag Between Oil Price and Offshore Installation Market

After the market research above, the market structure of offshore oil & gas installation equipment market is researched as a solid qualitative foundation of the quantitative market analysis.

Since the offshore installation projects number is a yearly record, the daily oil prices are supposed to be averaged to a yearly oil price. Also, since there are three kinds of offshore installation projects, the correlation analysis between oil price and the offshore installation project market will be done accordingly.

The first type of the offshore installation project is fixed platform installation. Fixed platform installation platforms are the main market of *IHC IQIP* because the installation equipment is largely used in the fixed platform installation such as Hydrohammer and handling tools.

The fixed platform installation projects account for the biggest proportion of all the installation projects. From 1986 to 2016, there are averagely 224 fixed platform installation projects per year while only 19 floating platform installation projects and 56 subsea well development projects.*(Source:IHS Database)*

6.4.1. Fixed Platform Installation Market

To visualize the relationship between these two data sets, the graph of these two series of data is shown as Figure 6.1.

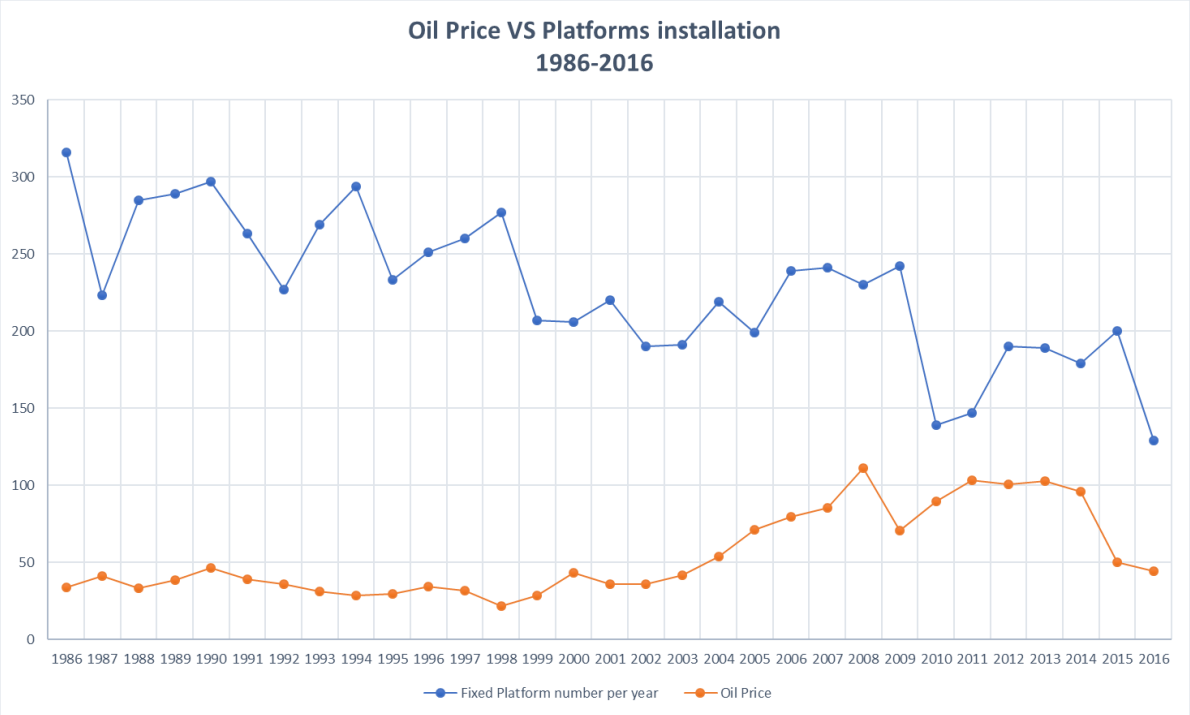

Figure 6.1: oil price and fixed platform installation number, 1986-2016 (*source: IHS Database*)

From first visual impression, after 2002, these two series of data have similar fluctuation

[2]Interview with Griedo Bel, Engineer of *IHC IQIP*, 13th Oct 2017, Sliedrecht

Table 6.3: Correlation Coefficients between Oil Price and Offshore Projects Data

Lagged Correlation Analysis	Fixed Platform	Floating Platform	Subsea Development
-3	-0.36	0.059	0.23
-2	0.27	0.09	0.079
-1	0.04	-0.27	-0.18
0	-0.49	0.25	0.004
1	0.71	-0.10	0.24
2	-0.27	-0.21	-0.36
3	-0.17	0.46	0.40
4	0.33	-0.18	-0.42
5	-0.12	-0.27	0.34

patterns. Precisely, the increase or decrease of oil price has its own feature but the pattern of oil price change is similar as the fluctuation of the number of fixed platform installed. However, to prove it quantitatively, data analysis needs to be applied to demonstrate the correlation relationships.

From 1986-2016, there are 31 pairs of data including the oil price[3] and installation number of the fixed offshore platforms. After second order differencing to stabilize the data, there are 29 pairs of data. Then, the cross-correlation coefficients will be calculated according to different time lags.

6.4.2. Results of the Lagged Correlation Analysis

Based on the pre-processed data, the correlation coefficients are calculated by the formula *R(l)*. The results are shown in the Table 6.3.

In the lagged correlation analysis, when the lag length is 1 year, the correlation coefficient reaches 0.715 which is the highest correlation coefficient in the group. Based on this, the correlation lag between oil price change and the offshore fixed platform installation is 1 year. More specifically, limited by the data accuracy, the time lag can fluctuate from 6 months to 18 months, which can be rounded to 1 year.

The second installation sub-market is the floating platforms installation market. And the correlation coefficient between oil price change and the floating platforms installation market is 0.462 in the time lag of 3 years, which is the highest in the analysis. Thus the time lag is 3 years for floating platforms installation market.

The last installation sub-market is the Subsea Production System. This market segment is smaller than the other two segments. During the time between 1985 and 2017, there are only 1470 subsea production systems which were installed.

The lagged correlation coefficient between subsea production system order intake and oil price is also calculated. From Table 6.3, the highest correlation coefficient in the time lag of 3 years is reached. Thus the time lag for this market is 3 years. The reason behind this time lag comes from different perspectives. The technology is more complex than the normal fixed platforms and the project lead time is longer as well. Furthermore, the overall market size of the subsea development project installation is relatively small. Thus the contractors' own equipment could complete the projects without purchasing new installation equipment.

6.5. Time Lag Between Oil Price and the Installation Equipment Market

The lagged correlation analysis between the oil price and the installation equipment market of *IHC IQIP* could be used to test the correlation relationship between oil price and the order intake of *IHC IQIP*.

As discussed in Chapter 5, there is no available data about the installation equipment sales from other companies. Thus based on the assumption that *IHC IQIP* kept a stable market share during the time window of the analysis, the order intake of IHC IQIP will be

[3]The oil price refers to the spot price of WTI crude oil.

Table 6.4: Adjusted Oil Price and The Order Intake of IHC IQIP

Time	Adjusted Oil Price	Order Intake
2010 Qtr2	77.79	35
Qtr3	76.05	66
Qtr4	85.10	52
2011 Qtr1	93.54	46
Qtr2	102.23	136
Qtr3	89.72	67
Qtr4	94.01	82
2012 Qtr1	102.88	31
Qtr2	93.43	44
Qtr3	92.18	57
Qtr4	87.96	33
2013 Qtr1	94.34	57
Qtr2	94.10	27
Qtr3	105.84	35
Qtr4	97.34	34
2014 Qtr1	98.75	34
Qtr2	103.35	11
Qtr3	97.78	46
Qtr4	73.16	13
2015 Qtr1	48.54	33
Qtr2	57.85	66
Qtr3	46.42	46
Qtr4	41.95	31
2016 Qtr1	33.18	13
Qtr2	45.41	36
Qtr3	44.85	56
Qtr4	49.14	34
2017 Qtr1	51.77	4
Qtr2	48.24	56

used to analyse the time lag between the crude oil price and the installation equipment market.

As shown in the table 6.4, the two datasets are pre-processed to one time frequency. Just as the analysis above, the lagged correlation analysis is used in this time lag analysis. Given different time lag length, there are different correlation coefficients.

The lagged correlation analysis of these 2 datasets shows that the correlation coefficients reach its highest point at the time lag of 0 quarters. However, the correlation coefficient with 0 quarter time lag is 0.24 which is too small and can not prove if there is any correlation relationship between these 2 data sets.

To conclude, from the qualitative research in last chapter, the basic market structure and the direction for quantitative research were defined. In this chapter, the quantitative analysis and the whole process of the data analysis were discussed, including the data pre-processing and the lagged correlation analysis. With the lagged correlation analysis, the correlation relationship between oil price and the equipment sales was analysed. This analysis will also contribute to the offshore equipment sales forecasting. However, there is still potential for improvement for future analysis, which will be elaborated on in the next chapter.

7

Conclusions and Recommendations

7.1. Conclusions

The offshore installation equipment market is a complicated market and has many influencing factors, including oil price, offshore technology development, market competition and so on. Among these factors, oil price is the most important factor. The focus of the analysis is the correlation relationship between offshore installation equipment market and crude oil price. The crude oil price could then be used as an indicator of the offshore installation equipment market.

Additionally, to set up a foundation of the quantitative analysis of the correlation relationship, this analysis finalized the research in global energy market, offshore technology development and the market mechanism of the offshore installation equipment market.

7.1.1. Global Energy Market and the Energy Demand

The offshore oil & gas installation market belongs to the oil & gas industry which is part of the energy market. Thus, the research of the energy market and the value chain of the overall oil & gas industry is essential for the further analysis of the offshore oil & gas installation market.

Generally, though there is not any clear economics equation of the nexus between energy and global economy, the correlation between world GDP and world primary energy is very clear, based on the information from the World Bank. Based on this information and other research, *U.S. Energy Information Administration* forecast the total world energy consumption will rise 48% from 549 quadrillion Btu in 2012 to 815 quadrillion Btu in 2040. Though there are some other factors influencing demand for oil & gas, based on the data from EIA, the demand for oil and gas will continue to grow at least until 2040.

The global energy market is the source of the market demand for the offshore installation equipment, which is explained in chapter 3.

7.1.2. Market Mechanism of Offshore Installation Equipment Market

To maximize the profit and even gain more market shares in Oil & Gas market segment, the decision makers of *IHC IQIP* want to better understand the offshore oil & gas platform installation equipment market of *IHC IQIP*.

To assist the quantitative market analysis afterwards, solid qualitative research has to be done. The main objective is to set up a market model of the offshore installation equipment of *IHC IQIP*. According to the time lag analysis and the market research, the market data analysis shows that there is 1 year time lag between oil price change and the fixed offshore platform installation market fluctuation.

7.2. Recommendations for future analysis

7.2.1. Recommendation 1

In this market analysis, the contract price per order is not available due to confidentiality. Instead of the financial data, the research used the order intake as the market indicator. For future analysis, adding the price or at least the estimated price level into the analysis will contribute to better accuracy.

Generally, the ideal analysis is supposed to be done based on the financial numbers, instead of the order intake. By using the financial numbers, the actual value of the sales or market supply can be better estimated.

7.2.2. Recommendation 2

In terms of the data source, the sales data of the offshore oil & gas platform installation equipment suppliers is not available. Thus the relationship between the oil price and the market demand for the offshore oil & gas platform installation equipment is difficult to analyse.

If the sales data from other suppliers could be collected, the supply-demand model of the installation equipment can be based on this additional data. Also, since this is a niche market and the equipment is very complex, the barrier for newcomers entering into this market is high. The benefit of such a supply-demand model will be even bigger for *IHC IQIP*.

If the data source is better, then the research will be able to use econometrics methodology to analyse the offshore oil and gas installation market.

7.2.3. Recommendation 3

As researched in the market data analysis, the time lag between oil price change and the fixed offshore platform installation market fluctuation is 1 year. The time-frame of 1 year is relatively short for decision-making in oil and gas industry. This means using the current crude oil price is not ideal.

However, the forecast from oil companies will be useful for an installation equipment supplier such as IHC IQIP. This is because the oil companies will make an upstream investment plan based on their forecast of the oil price in the future, instead of the current oil price. Because the Capital Expenditure[1] plan from oil companies was not used well in IHC IQIP. Using the CAPEX plan from oil companies will bring more market intelligence for the decision makers at *IHC IQIP*.

[1] Capital Expenditure: as known as CAPEX.

Appendices

A

Expert Interview List

The interviewed experts list includes but is not limit to: Sales Manager, Account Manager, Technical Director, CEO, Manager of Back Sales Office, Innovation Specialist, Market Analyst, Manager of Engineering. The interviewed expert list is shown below:

- Tim van Erkel: Sales Manager in Oil & Gas market segment, IHC IQIP
- Kevin Jongkind: Account Manager in Oil & Gas market segment, IHC IQIP
- Max van de Kemenade: Sales Manager in International Sales, IHC IQIP
- Michael Schaap: Technical Director, IHC IQIP
- Jan Albert Westerbeek: CEO, IHC IQIP
- Koen Vonk: Manager of Back Sales Office, IHC IQIP
- Mark Aelmans: Innovation Specialist , IHC IQIP
- Daan Uiterwaal: Market Analyst in Offshore sector, IHC
- Xu Pengpeng: (former) Engineer, One of the clients of *IHC IQIP*
- Joop van Dijk: Technical Integration Manager, IHC IQIP
- Henk van Vessem: Technical Account Manager, IHC IQIP
- Bob Jung: Senior Vakspecialist (Senior Specialist), IHC IQIP
- Eric Hooijschuur: Manager of Engineering, Product Management, IHC IQIP

The interviews are at least 1 hour one-to-one meeting except the ones with the senior management board members. Though the interviews are not the structured interviews, they contributed to the market analysis from varied perspectives as well.

B

The interview Example

B.1. Interview with Mr. Max van de Kemenade, about the general sales information of *IHC IQIP*

Interview with Mr. Max van de Kemenade Regional Account Manager of IHC IQIP
20th April 2017
Sliedrecht

Introduction

- Max van de Kemenade: Max
- Mark Xiaoming Ma: Mark

Content

Here is the content of the interview and a conclusion about this interview.

00:00

Mark: First of all, thanks so much for this meeting! (The last one was done on 30th March with Mark, Max and Kevin) Here is the basic outline for our meeting.

So, this is the last question we ended in last meeting. We do have some regular package which our clients prefer to make such combinations, right? If they order Hydrohammer, will they always order ILT/fast frame or some other equipment together?

01:42

Max: So, basically the customer has a project in which several things should be done. Firstly, for the project, if they have the Hydrohammer, they could pile the hammer into the ground. However, the piles need to be lifted and be piled into the ground afterwards. For example, ILT is a bit more efficient. So we always try to, from the sales' point of view, of course sell as much as possible on this project. But also for the customer, they will calculate the cost and gains by using ILT. (e.g. Renting one more ILT could save some time for the client to finish the project but also the client need to pay the rent for the ILT. The saved time means the client could save the rent for other equipment and the offshore supply vessel, which is much more expensive.) So basically they could become more efficient by renting more equipment from us.

Mark: So they will count the different shares in the package?

Max: So for example, they translate the time into money. So they say, they saved half day in installation time by using our tool. Their ship, for operating a ship half-day cost 15,000 dollars. Renting our ILT cost,for example, 14,000 dollars. So they could save 1,000dollars by using our ILT. So it logical for them to use our ILT.

Mark: So to speak, if they like renting our equipment, will they ask for all the quotations of the equipment in one time or the orders phased in gradually?

Max:Usually they come all in one. Because they need to get their ship..

Mark: Prepared?

Max: Yes. If they (were) prepared and everything on there, they could start focus on the project rather than come back and forward.

Mark: Yes. That's a good one. Okay. This is a sub-question: Do you see any key equipment, like a bottleneck, to finish the project? Let's say, without this equipment, the client cannot finish the project.

Max: Yes, it basically depends on the project and the customer. Let's say, if you have a FPSO which needs to be moored, they need to lift up the piles and with the help of the frame on the seabed they could start piling the pile into the ground.

Mark: So for installation, a frame is an essential? Or hammer

05:37

Max: For installation of moor, the frame is essential. But installation of jackets, then basically hammer is definitely needed. You could not pile it with other solutions. ILT is just one of the solution, but it is not the only solution.

Mark: Up to now, what is the proportion IHC Hydrohammer accounts for in this sector? (about the competitors)

Max:in O and G?

Mark: Yes

Max: oops I am not sure.

Mark: Let's say, it is majority or not?

05:46

Max: I would say roughly even share compared with our competitors.

Mark: ok.

Max:I would say it is about 50 to 50.

Mark: Because in the last meeting we talked about the different sizes of the Hydrohammer. Let's say from S90 to S4000 right?

Max: Yes

06:46

Mark: I remembered we said there is a range for Oil and Gas...

Max: So for Oil and Gas, there are mainly S500 to S1200

Mark: So basically this part is main market O&G focus on?

Max: Usually from S280 to S1200, that's the full range I would say. You may not see any one bigger than S1200 for Oil and Gas. Smaller than S280, umm sometimes. (So this 280-1200 is the main market of the Hydrohammer in Oil and Gas)

Mark: So, basically there are some competitors. Umm More precisely, if we divide the Hydrohammer market into two parts: one is smaller size between S280- S1000 ,for example, and another one is bigger size market.

Is it harder to get the orders in the large size market? Let's say, in the bigger pile driving market we need to compete with Menck which is really competitive. But in the smaller one we have a much better track record than Menck. And there are many producers which are much smaller than us.

Max: Actually it is easier to get the orders of the bigger size Hydrohammers compared with the complete market of the smaller one.

Mark: So even we need to compete with Menck which is really strong, it is still easier compared with a smaller size market.

Max: It is my interpretation. Yes.

Mark: Yes Ok.

Max: YOU know, the larger hammers from S1200 to S4000 are mainly for offshore wind farms market, which we have a dominating market position.

Mark: Yes. And how is the smaller size Hydrohammers market?

Max: That's mainly for Coastal and Civil Sector. S280-S1200 is mainly for Oil and Gas.

Mark: Yes. So how about the Waterhammer?

09:00

Max: Actually we are using the Waterhammer right now on the offshore project in Norway.

Mark: Is it really deep or shallow?

Max: It's not deep. I think 15-16 meter water depth.

Mark: Oh It's that shallow

Max: Yes, it is shallow.

Mark: So from your point of view, the Waterhammer is mainly used in the shallow water or the deep water? If we look at the technical issues, one of the advantages Waterhammer has is really environment-friendly and has no possible pollution risk to the deep sea. So it could be used in the deep sea right?

Max: Yes. That's the main selling point. But the track record is not yet built.

Mark: So we need to convince the clients Waterhammer could help them to finish the project right?

Max: Usually they asked for a track record to see how it works. So we need to prove ourselves into deeper and deeper water depth.

Mark: But definitely it was used in O&G projects already, right?

Max: Yes Yes

Mark: And roughly, is it (used in) 15 meters? or?

Max: Umm

Mark: Let's say it is no more than 100 meter, right?

Max: Yes.

Mark: Thanks I got a perfect answer for this question. Here is the second question: Do we have a regular overview and analysis for our sales

Max: Like sales amount?

Mark: Yes and also the orders

Max: I'm sure we do. I also do it myself. Also, Tim (the manager of Oil and Gas sector) and Marc (Sales Director of IQIP) and maybe also other management board member from the financial point of view.

Mark: Good. Thanks.

Max: Yes and Marc has a overview not only O&G but also other sectors.

Mark: Is there any internal report, to get an impression, to show how much we sell?

Max: Yes There is a screen on the first floor about the weekly report.

Mark: Perfect. And did you experience any time lag from the oil price to our equipment market?

Max: Definitely. Though I'm not sure how much it is but I'm sure there is a time lag. If the oil price goes up, and companies see this going up, then there will more projects going to the contractors like Heerema and Subsea 7. And they start to asking for price of the installation equipment. And after 1 or 2 years they moved ahead with the projects and then the price went down again and less tenders are coming out.

Mark:Yes

Max: Definitely there is a time lag but it is difficult for me to provide the exact time.

Mark: Yes. This is part of my job. I will analyse this from the data but it is valuable to get the feedback from our front line colleague that we do experience the time lag in reality.

Max: Yes Yes

Mark: And last week Mark had a meeting with me. He brought up an idea about the time lag. Definitely the time lag is positive between oil price and offshore projects market. But Mark was interested to know if the time lag between offshore projects and our equipment market.

Max: Yes

16:10

Mark:So to speak, will the offshore contractors come to us before they get the orders? Or they always purchase or rent our equipment after getting their orders from the oil companies.

Max: After!

Mark: After?

Max: Yes. So we push our rental, of course. And when the installation contractors like Heerema, they got the inquiries from Shell for example. And they got the orders here. They will wait their orders confirmed before placing the orders with us.

Mark:Ok So they need to confirm their orders from the oil companies and then, they start the enquiry of our equipment?

Max: Well they can ask for the prices and they will not ..

Mark: Let's say, place the order?

Max: Umm No. I don't think they will do but to me it makes no sense for them to place the order before they have their own orders.

Mark:Yes.

Max: Let's say, if we didn't see a demand for a bigger hammer like S6000 for example, which we don't have yet, we will not make investments before we got confirmation from our customer.

Mark: Otherwise it is a risk.

Max: Yes, it is a huge risk.

Mark: Thanks, it is a really important one.

So, let me wrap up briefly: So the oil companies place the orders to the contractors and the contractors start placing orders to us.

Max: Yes, so the oil companies have the project and they come to the contractors like Heerema or other installation contractors and ask for pricing for the projects. Heerema these contractors start to enquiring with us, saying ok We need these piling hammers We need lifting tools. We need other drilling tools.

21:54 So we provide our price to them. And Heerema start to make their package price to the oil companies. The oil companies may say it is ok and they place the order to Heerema. Heerema then place the different orders to the different suppliers.

Mark: Ok Nice. So the first loop is a tendering process.

Max: Yes

Mark: And once it is confirmed then it will go back and back to place the orders, right ?

Max: Yes Yes

22:35 Mark: That's clear. Good. Here is the most important question: Our clients are mainly the installation contractors. That's for sure. For example, there are plenty of the projects coming but we will supply the installation equipment, right?

Max: Yes. We have do the decommissioning job.

Mark: So to speak, if we consider the life cycle of the projects, we only get orders when there is the new platforms getting into the market, right?

Max: Yes, and, when there is the old one which needs to be taken away. Decommissioning.

Mark:Yes. But now we separated them into the Decommissioning sector right?

Max: Yes Yes

Mark: So we only get the orders when there is new platforms right?

Max: Yes. Then it (the order number)is relying on the new rigs.

Mark: Okay. And when the platforms need to be relocated, like submersibles, is there new orders?

Max: It depends on the way of their mooring. If they need the piles then it would happen.

Mark: For piling

Max: Yes Sometimes they only use anchors.

Mark: If they use anchors then there is no business opportunity for us, right?

Max: Of course

Mark: Did we get any order from the re-locating business?

Max: Umm not at when I'm working

Mark: Okay. If there is the new rigs, the orders go up and this is the mainstream of our business, right?

Max: Definitely.

Mark: Good good. This is useful for the input of my model.

Ok Here is the last question and it is an open-question: Which part of the market analysis is useful for you?

Max: Ah Let me think.

Mark: This is a really open question.

Max: Yes. I believe there is a correlation between the oil price and the amount of the off-shore rigs installed and our equipment market. A graphic interpretation of the past projects which we took or we made our bids. And see which project we have won and which projects we have lost.

Also, why we won the orders we got and why we lost the orders would be really useful. So, the reasons we won or we lost the order.

Mark: Okay

Max: For example, we lost an order from the area. Is that because the competitor is more locally or their price is more competitive? And from the sales' point of view, you can work on that.

Mark: Yes

Max: So you see, ok, in the past, it happened in this area that we lost orders. If there is a new project comes and we could adjust our strategy to ..

Mark: To fight for more orders?

Max: Yes Yes But it is more based on the past projects rather than the upcoming projects.

Mark: Yes.

Max: That would be really valuable for us.

Mark: Thanks so much!

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