

CRITICAL SUCCESS FACTORS OF THE
FLOATING, PRODUCTION, STORAGE AND
OFFLOADING (“FPSO”) PROJECTS

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**CRITICAL SUCCESS FACTORS OF THE
FLOATING, PRODUCTION, STORAGE AND OFFLOADING
("FPSO") PROJECTS**

By

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ABSTRACT

CRITICAL SUCCESS FACTORS OF FLOATING, PRODUCTION, STORAGE AND OFFLOADING PROJECTS

Johnny Ong Shou Yee

Various oil and gas projects have been initiated to source for the natural resources at onshore locations in the deep forest, desert region or towards the cold Arctic sector. As some onshore oil wells are maturing, the Oil & Gas Operators and Exploration & Production companies are moving towards the shore and to some extent, the oil shale play and deep offshore oil fields.

The high demand will never with China expecting to import 75% of their need and such thirst for the oil and gas natural resources coupled with rapid development at the BRICS are pushing the International Oil Companies and National Oil Companies to deeper drilling at onshore wells and deeper parts of the wide ocean out there.

The Capex for Floating Production Systems spending will increase up to US\$68 billion within the next three (3) years from 2013. With the known deepwater oil field developments, the need for more sophisticated oil production facilities is required, not forgetting the skilled manpower too.

What motivates the research on this area is due to usage of the Floating, Production, Storage and Offloading (“FPSO”) vessel to venture into the deepwater oil field developments.

Secondly, the involvement of my goodself in the said offshore industry, whereby the FPSOs are being built at a fast pace to explore the deepwater oil wells, prompted me to find out what makes the FPSO industry ticks.

By 2017, an estimated figure of US\$52 billion is expected to be spent by International Oil Companies and National Oil Companies on FPSOs alone.

The Project Research will bring up the Critical Success Factors (“CSFs”) that will determine the success of the FPSO projects. If the CSFs are really that critical which will decide the outcome of the FPSO projects, how then do we ensure that such CSFs are being employed to see that the project finishes on schedule and within budget.

The main research will be on the CSFs that will assist the FPSO Contractors to execute their projects in a manner where time and cost are the priority. Apart from looking at the CSFs, certain journals and scholar articles look at Lessons Learned. This aspect will be looked into as well as it will also bring out factors that could determine the success of the FPSO projects.

In conclusion part of the Project Research, it will be able to determine the CSFs with recommendations which will assist the FPSO Contractors to complete their projects within the agreed schedule and budget.

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The world is very dependent on the natural resources in which the Project Research touched on and the very same fact, this Project Research depended on a number of people to make this research a success. If not for the responses, I can't be writing on the topic of achieving project success.

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Date: 16 December 2013

PERMISSION SHEET

It is hereby certified that JOHNNY ONG SHOU YEE (ID No: 12UEM01211) has completed this dissertation entitled “CRITICAL SUCCESS FACTORS OF THE FLOATING, PRODUCTION, STORAGE AND OFFLOADING PROJECTS” under the supervision of DR. CHIA FAH CHOY (Supervisor) from the Department of Built Environment, Faculty of Engineering and Science.

I hereby give permission to my supervisor to write and prepare a manuscript of these research findings for publishing in any form, if I did not prepare it within six (6) months time from this date, provided, that my name is included as one of the authors for this article. Arrangement of names will depend on my supervisor.

Yours truly,

JOHNNY ONG SHOU YEE

APPROVAL SHEET

This thesis/dissertation entitled “**CRITICAL SUCCESS FACTORS OF THE FLOATING, PRODUCTION, STORAGE AND OFFLOADING (“FPSO”) PROJECTS**” was prepared by JOHNNY ONG SHOU YEE and submitted as partial fulfillment of the requirements for the degree of Master of Science (Project Management) at Universiti Tunku Abdul Rahman.

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1.0 INTRODUCTION

1.1 Energy Supply

Our life is very dependent on the natural resources such as water, oil, gas and coal where shortage of it will generate unnatural reaction from fellow humans. Water itself is being used to generate power, produce drinking water, for transportation or source of food.

Coal is generally used to generate electricity or source of chemicals production (Tollefson 2008). As for gas, it can be used for cooking, heating, electricity or transportation. Last but not least, oil is the most sought after commodity in the world. People are willing to conquer another land just to have control over the supply of oil – where Iraq conquered Kuwait in 1990 (El-Najjar 2001).

Various oil and gas projects have been initiated to source for the natural resources at onshore locations at deep in the forest, desert region or towards the cold Arctic sector (Finer et. al. 2008 and Economides 2013). As some onshore oil wells are being depleted of its supply, the oil companies are moving towards the sea and to some extent, the oil shale play and deep offshore fields (Jaffe 2011).

1.1.1 Importance of Oil & Gas

The uses of oil and gas are so numerous and complex to a certain extent. The by-products that are being churned out from these two natural resources are humongous and it changes people's lifestyle throughout the whole world. With huge oil deposits, eleven (11) nations formed Organization of the Petroleum Exporting ("OPEC") to maintain the market behaviour including price stability for the oil industry but later the non-OPEC oil producing countries out-produced OPEC members. OPEC members tend to control their productions in order to preserve the natural resources over a longer period of time. Being the top oil and gas producers, their economy and GDP itself are already on the high end side.

Non-OPEC members produced more in order to improve their nations' GDP and this brings major impact to their respective economies. Foreign Direct Investments will increase for the oil and gas sectors thus improving the nation's economy and the economy multiplier effect can affect other supporting industries such as the steel industry and transportation. More investments will be poured into research and development to enhance the existing technology or to invest new technologies to improve on the oil and gas productions.

The importance of oil and gas led us to the tragic event of Iraq conquering Kuwait back in 1990 which then led USA to lead a

military intervention into Iraq to liberate Kuwait. Is it worth all the trouble to free Kuwait? For the hydrocarbons that will sustain the USA economy for years to come, of course (Wang & Kashi 2013).

1.1.2 What Drives Global Energy Demand?

The global energy demand is determined by the demand from developing countries. The world population will increase up to 9 billion by year 2040, an increase of about two (2) billion from current figure. The huge population will drive the transportation to use more of the energy and electricity usage will definitely increase. To support the electricity usage, energy supplies to power industry will be required. The population growth will be concentrated in Africa, India and other developing nations. By 2040, majority of the world's population will reside in Asia Pacific and Africa. The developing regions will utilise increasing energy per capita due to urbanisation, improved prosperity and technological process (ExxonMobil 2013).

1.1.3 Changes to International Oil Company / National Oil Company

With huge capital outlay towards each oil and gas production, the nature of how each International Oil Company ("IOC") / National Oil Company ("NOC") operates has changed tremendously. IOCs, with their huge resources, are able to invest in various oil and gas productions around the world in production sharing contracts together with NOCs. The IOCs' main objective is to capitalise and

maximise their investments but normally subject to NOCs' rules and regulations (Stevens 2008).

Meanwhile, NOCs are monitoring the development of their country's natural resources and with the higher crude oil price; NOCs have begun to take control of the oil production. With experience gained from earlier tie-ups with IOCs, NOCs are controlling about 90% of the oil reserves now (Tordo, Tracy & Arfaa 2011). NOCs from China have also moved on to takeover oil and gas fields to feed China's thirst for the natural resources.

1.1.4 Where is the Oil and Gas Industry Heading To?

The high demand for the oil and gas natural resources is pushing the IOCs and NOCs to produce more. The NOCs are opening up more oil and gas blocks to be developed further together with the IOCs. The rapid development is on-going where it is going to deeper parts at onshore wells, deeper parts of the ocean and with oil shale productions increasing it is changing the landscape of the oil and gas industry (Longwell 2002 and Fielden 2013).

The onshore and oil shale productions aside, this paper will proceed into the area of deep offshore or deepwater oil productions that has huge potential at the wide ocean out there. In the midst of the onshore and offshore developments as mentioned above, countries bordering the Arctic are already eyeing the potential 'hot

spots' where there is a potential of ninety (90) billion barrels (13% of world reserves), gas reserves of 1,669 trillion cubic metres (30% of world reserves) and gas condensate reserves of forty four (44) billion barrels (U.S. Energy Information Administration 2009).

1.1.5 Research on the Floating, Production, Storage and Offloading Construction Industry

FPSO system has the functions of Floating Production, Storage, and Offloading and it includes process equipment, ship system and mooring system. As the FPSO system has many features, such as adaptability for water depth, powerful resistance to wind, wave and current, little investment and fast return, movable and relocatable, and lower risk, it is widely applied to offshore oilfield developments. What motivates the research on this area is due to the need of high technology required to venture into the deepwater oilfields. A lot of the deepwater regions have not been thoroughly assessed yet.

Secondly, the involvement of my goodself in the said offshore industry, whereby the Floating Production Storage and Offloading vessels ("FPSO") are being built at a fast pace to explore the deepwater oil wells, prompted me to find out what makes the FPSO industry ticks.



Figure 1.1: SBM Offshore's Fleet of FPSOs
Source: SBM Offshore

It is a known fact that the FPSO industry is being controlled by a few FPSO Contractors in the market namely, SBM Offshore, MODEC, BW Offshore, Bluewater Group, Teekay Offshore and Aker Floating Production. Besides being the FPSO Contractors, they do provide Operations and Maintenance of the FPSO upon completion of the FPSO vessel. Most of the leading FPSO Contractors would build new FPSOs or convert existing tankers into FPSOs according to Clients' specifications. Thereafter, the Clients would either purchase the FPSO upon completion or opt for the lease option for a fixed period (Knight, Callanan & Podevyn 2009).

SBM Offshore has the honour in constructing the FPSO vessel whereby the Shell Castellon was built in Spain in 1977. The first-ever conversion of a Liquefied Natural Gas (“LNG”) carrier, Golar LNG, into an LNG floating storage and regasification unit was carried out in 2007 in Singapore. It is also known as Floating LNG (“FLNG”). An FLNG system works similarly as the FPSO but it produces gas instead.

1.1.6 Critical Success Factors

What is Critical Success Factors? It is defined as “the process of project implementation, involving the successful development and introduction of projects in the organisation, presents an on-going challenge for managers” (Pinto & Slevin 1987).

The paper will bring up the Critical Success Factors (“CSF”) that will determine whether the FPSO projects will be a success or otherwise. If the CSFs are really that critical that will decide on the outcome of the project, how then do we ensure that such CSFs are being employed to see that the project finishes on schedule and within budget.

1.2 Background of Research

1.2.1 Potential of Oil and Gas at Deepwater Sector

As the onshore oil productions are maturing coupled with the demand from the BRICS nations, the IOCs and NOCs are pushing for quicker oil productions. One of the sectors is at the deepwater fields. The oil exploration at the deepwater fields started back in the early 1990s.

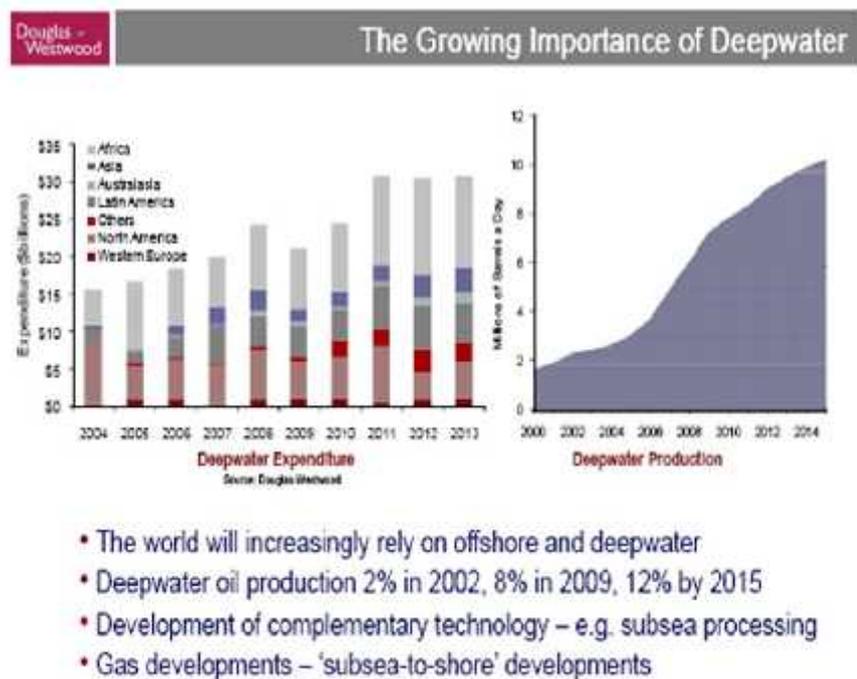


Figure 1.2: Growing Importance of Deepwater
Source: [Universiti Teknologi Petronas](#)

The contribution of oil production from the deepwater sector has risen tremendously with more extensive research and development efforts being done to develop the deepwater sector.

The deepwater sectors in Africa, Gulf of Mexico, Brazil and Asia-Pacific will be the main oil producing regions for the offshore oil productions as can be seen from Figure 1.2 as above.

In 2010, the three (3) main deepwater oil producing regions, namely, West Africa, Gulf of Mexico and Brazil contributed at least three quarters of the oil reserves (Sandrea & Sandrea 2008).

1.2.2 FPSO and FLNG's Potential

FPSO is a floating vessel mainly used by the IOCs and NOCs at deepwater offshore fields to receive, process and store the oil and gas. Thereafter, the oil and gas will be offloaded to a storage tanker to transport to destinations decided by the IOCs and NOCs who have contracted with end users (International Association of Oil and Gas Producers 2006).

As at end 2011, there are one hundred fifty two (152) active FPSOs that are in service at the deepwater sectors with twelve (12) FPSOs being engaged by Petrobras, Brazil. Petrobras alone is producing oil via FPSOs up to 13.5% of the global FPSOs' activities. Another twelve (12) FPSOs are to be commissioned by Petrobras by year 2015 (Oil & Gas Financial Journal 2012).

In the FPSO contract characteristics, a new contract could either be a newbuild, conversion (from other type of vessel, generally oil

tankers, into a FPSO) or redeployment (re-allocated from a deepwater oil field to another). Once a FPSO is built, converted or redeployed, the ownership could either be in the hands of the Clients or the FPSO Contractors. If it is owned by the FPSO Contractors, the FPSO Contractor will lease the vessel to the same client for a number of fixed years with options to extend.

The FPSO and FLNG vessels are so complex that technological advantages provided today might change in the following month. Suppliers to FPSO technologies are modifying and remodelling their equipment that will generate smoother operations, cost saving and more robust as it operates in the middle of the ocean.

The demand for FPSOs is so great till major shipyards are operating at full capacities in the rush for the black gold (Rigzone 2012). The oil and gas industry do prefer the FPSOs for the following reasons (International Quality and Productivity Center 2013):-

- a) Swift roll-outs = Quicker time to production;
- b) Lessened Investment = Diminished overheads;
- c) FPSOs do not have to be custom built;
- d) FPSO can evade harsh weather;
- e) FPSOs can hop from field to field;

- f) Abandonment costs are significantly less than for fixed platform;
- g) FPSOs are ideal for deepwater drilling;
- h) Asset integrity costs lessened with FPSOs;
- i) FPSOs eliminate the need for costly and sprawling underwater infrastructure; and
- j) FPSOs are more environmentally-friendly than rigs.

1.2.3 Reason for the Research on the FPSO Industry

The motivation the research on this area is due to the need of knowing the right CSFs to embark on due to the high occurrence of project cost overruns and delays, as shown in Chapter 2 earlier, to the construction of either conversion or newbuild of the FPSOs.

Secondly, the involvement of the researcher in the said offshore industry, whereby the FPSOs are being built at a fast-track pace in order for the Client to explore the deepwater oil fields, prompted the researcher to find out what makes the FPSO industry ticks.

1.2.4 Rationale of Research

Rationale of research is to obtain as many CSFs as possible and try ascertain whether the CSFs obtained from the structured interviews with respondents would provide the solution to FPSO Contractors operating at different oil and gas regions such as West Africa, South East Asia, Gulf Mexico, North Sea or Brazil region. The

researcher would like to identify which CSF would make a difference if its presence or absence in the success of the FPSO project. The intention is collate the information and data which would be useful for similar FPSO projects to embark and implement the relevant CSFs right from project commencement.

1.2.5 Research Questions

With the known major problems, the FPSO Contractors should work closely with the Clients to overcome any work deficiency, lack documentation or lack of coordination.

The following research questions have been prepared where responses from thirty (30) participants would be collated to determine the relevant CSFs related to the following areas:-

- 1) Reliance on Experience.
- 2) Reliance on Shipyards.
- 3) Co-ordination with Major Suppliers.
- 4) Co-ordination with Clients.
- 5) Handling Stakeholders.
- 6) Managing Project Schedule.

1.3 Research Aim and Objectives

1.3.1 Aim

The research has been undertaken to establish the CSFs that FPSO Contractors can adopt in order to achieve project success by completing FPSO projects within the agreed schedule and budget.

1.3.2 Objectives

With the intention to assist the Norwegian FPSO Contractors and operators, the Norwegian Oil Industry Association (OLF) has done, by creating a large database of lessons learned, critical success factors (“CSF”) and decisions taken during the design phase. OLF’s objective is to transfer lessons learned to existing FPSO vessels and future FPSO projects in order for the respective projects to progress without repeating mistakes which have resulted in schedule and budget overruns (Norwegian Oil Industry Association 2011).

In view of the above, this research is to be conducted with the objective of identifying and establishing CSFs for the FPSO construction industry as follows:-

- a) The research shall determine which CSF will make a difference for FPSO Contractors.

- b) To establish and ensure that CSFs that have been identified are able to guide and assist future similar projects to avoid the risks and/or problems faced previously relating to schedule deviation and cost overruns.
- c) The research shall identify any similarities between CSFs via literatures review and structured interviews with those CSFs identified in connected offshore construction activities and/or offshore oil & gas regions within the FPSO industry.
- d) The research shall also identify the lessons learned from previous FPSO projects and how such lessons can be successfully applied to other FPSO projects.

Once CSFs are established, FPSO Contractors would be able to confidently rely on same in order to manage the execution of FPSO projects and to ensure that the project is completed on time and within budget.

1.4 Scope of Research

1.4.1 Factors That May Affect the FPSO Industry

As an FPSO vessel could be a newbuild, conversion or re-deployment, different type of works will have different CSFs to ensure project success (Mierendorff 2011 and Parker 2009). It would be due to factors at deepwater works, fabrication yard or even suppliers.

1.4.2 Usage of Relevant CSFs

Regardless of the FPSO's location, the construction of a newbuild or conversion would require similar construction methods or same equipment to be installed but could differ in terms of size or pressure. With such similarity, will the information gathered or data collected from the research is useful for other similar FPSO projects to confidently rely and implement the relevant CSFs from project commencement.

1.4.3 Focus of the Research

The research will be mainly on the CSFs for the FPSO construction industry whereby the FPSO Contractors will be in total control of the shipyards, major suppliers, coordination with client's other major contractors that are supplying subsea equipment, integration of other major works at different shipyards and to finally complete the tie up with the offshore oil field for the oil production.

1.5 Significance or Expected Outcomes of Research

1.5.1 Reliance on Experience

Most FPSO projects rely heavily on the Project Management Team's ("PMT") accumulated years of experience to achieve project success. Often, the respective members of the PMT will have a different perspective on how certain works should be executed, resulting in disagreements between the PMT on the way to proceed to manage certain project success. Once CSFs have been communicated to the PMT, efforts should be concentrated on those CSFs that make the project successful according to the importance of which factors that will make or break the project.

1.5.2 Reliance on Shipyards

At present, shipyards in Asia are operating at near full capacity due to the healthy demand for FPSOs. FPSO Contractors need to monitor the integrity of the works being executed and ensure milestones are achievable in order to meet the overall project schedule and complete within budget. Utilising CSFs will assist the PMT to manage the areas that should be monitored more aggressively and prioritise some works over others to ensure successful project completion.

1.5.3 Co-ordination with Major Suppliers

Major suppliers will need to comply with various standards, checklist, quality assurance and regulations to manufacture

equipment that are of the quality required under the respective contract. With such compliance requirements, it is critical to monitor the suppliers' work progress and maintain the project schedule. Therefore, if CSFs are known it will be easier for the PMT to manage the project as a whole in a proper controlled manner, ultimately ensuring that the project is completed within schedule and budget.

1.5.4 Co-ordination with Clients

With the above outcomes of the research being identified, the research can target specific areas together with the Clients' co-operation to help to understand, identify and determine potential causes of delay and disruption in a project (Salama, El Hamid & Keogh 2008). The identified CSFs would help the PMT and its Clients to focus on managing weaknesses that would derail the project which would result in cost and schedule overruns and enable the PMT to take necessary steps to ensure the success of the projects being undertaken.

1.5.5 Handling Stakeholders

In the oil and gas industry, it is prevalent that FPSO Contractors, International Oil Companies and other major contractors will collaborate together or partner the National Oil Companies owing to local content requirements. It is known that different stakeholders would have different aims and/or objectives. The

importance in identifying CSFs will help the PMT to manage the relevant stakeholders by taking the necessary steps to which will ensure the success of the projects being undertaken.

1.5.6 Managing Project Schedule

The most critical part of any project for that matter is the schedule, if not the most significant process of a project. The project schedule will assist the FPSO Contractor in establishing the required works to be executed in a timely manner with proper sequential flow of the work activities to co-incide and interface with the Client's other major contractors' work activities.

1.6 Research Methodology

1.6.1 Primary and Secondary Research

The primary research will be through the literatures review of at least thirty (30) journals, scholarly articles, relevant thesis of same topic and thereafter, sub-questions will be formulated as it will form the basis of questions for participants in due course.

Secondary research approach would be to conduct literatures review on a minimum of sixty (60) professional articles and journals written by practitioners of the FPSO industry, to review related dissertation or thesis.

1.6.2 Sample Size of Research's Participants

As this research is based on qualitative approach, the Grounded Theory Method would be employed with the belief that the respondents chosen are able to contribute significantly to the research. The respondents' years of work experience is a resemblance of a bank vault full of monies waiting to be drawn upon by the researcher.

1.6.3 Flowchart

A flowchart will be shown to describe the process of setting the questions right up to obtaining the right information.

1.7 Dissertation Structure

1.7.1 Chapter 1 - Introduction

It will see the general introduction to the oil and gas industry in the current era of high demand from developing and developed nations. The general aspect of CSFs will be introduced too.

1.7.2 Chapter 2 – Literature Review

This chapter is to address the philosophy and background of the FPSO industry. It will show the huge potential it will generate for the oil and gas industry. The theoretical framework of the FPSO industry will be described herein. In addition, flowcharts and figures would be incorporated to explain in details on how the FPSO industry functions as a whole in the deepwater oil productions.

1.7.3 Chapter 3 – Research Methodology

The research has to set out its objectives. With this it will assist the end users to understand which area and the manner of the research was done. It will list down the procedures, steps taken and approaches to obtain the data or information required for the research.

1.7.4 Chapter 4 – Results

This chapter will show the information and data obtained from the structured interviews. A tabulation will be shown to identify the

steps to be taken and the CSFs required in order for the FPSO Contractors to achieve project success

1.7.5 Chapter 5 - Discussion

The FPSO industry has a number of problems that will need to be addressed in order for the people in the industry to respond with their solutions and recommendations to improve on the project execution.

1.7.6 Chapter 6 - Conclusion

In this chapter, it will conclude with recommendations for future FPSO projects with the corresponding CSFs. It will determine whether the research has met its initial and final objectives with the relevant information gathered.

2.0 LITERATURE REVIEW

There have been many studies or research on FPSO projects but majority of them concentrated on the technical layout aspects, structural and hull designs, construction methods, functionality of various equipment found in the FPSO vessel or on external factors such as metocean and geophysical, fluid characteristics, and subsea technicalities that may affect the FPSO vessel or its equipment.

Hence, this chapter attempts to provide the intellectual support from the view point of the academicians and practical literature. There is very little focus in the research on Critical Success Factors (“CSF”) for the FPSO industry as a whole. Even though there are many studies on FPSO projects as mentioned in the above, the studies on success factors will not be reviewed in depth, and only referred to when appropriate. In going through this chapter, it can be seen that academicians seldom conduct research or studies on the FPSO industry in terms of constructing the FPSO within the tight budget and agreed schedule. This can deduce from the fact that there are many technological advances or construction know-how knowledge that cannot be divulge to the public in the event the competitors might be able to develop an even better technology or knowledge.

Extensive literature review will be conducted on the viability of FPSO industry. Analysis on the CSFs will be done to assess the impact it has on the FPSO projects worldwide.

The review will also focus on whether CSFs will assist the FPSO Contractors to execute their newbuild, conversion or redeployment projects to be completed within schedule and budget.

Further review will also be done on other connected offshore works such as the drilling, subsea, installation, risers and flowlines, oil well productions on how such works will affect the CSFs for FPSO industry.

2.1 What Are The Major Problems In The Oil And Gas Industry?

Onshore oil wells and gas deposits are maturing and depleting faster than expected which have driven IOCs and NOCs to the deepwater to continue to source for the natural resource (Lesourne 2009).

A lot of the wells and gas deposits are facing oil peak situation where production rate have grown so much where a lot of the oil and gas fields are reaching its peak. Thereafter, the growth will peak and subsequently, the production decline may decrease at a much quicker rate compared to its increase till it is depleted (Poyrazoglu 2011).

High technical risks may affect future oil and gas supplies and overruns. It includes technological risk, environmental risk, geological risk and infrastructure risk. In view of all these technical risks, it could extend the oil field development's duration. When oil field development is extended, it would cause delay to the first oil supply and thus, cost overruns would happen.

The oil and gas industry usually executes huge and complex petrochemical plants to generate the suitable output for their buyers. Various sections of the oil and gas industry would have to get involved to plan and execute such huge capital expenditure. With such huge capital expenditure, the projects would take a considerable period to complete and this could affect the costing as prices tend to fluctuate a lot. Moreover, delivery of free issued items by Oil & Gas Operator may take longer than expected due to incomplete data or certain long lead items have too many design changes along the way. Contractual matters could be so legalistic at times till it affects the procurement strategies. Once the strategies are affected, it could cause delay to the project schedule.

2.2 What Are The Major Problems In The FPSO And FLNG Industry?

Majority of the FPSOs and FLNGs would be built for field specific that is a particular FPSO will be designed and constructed to suit the particular offshore oil well's oil characteristics and sea

condition. Once it is decommissioned from that oil well, it may have to be refurbished for the suitability of another offshore site (George, Le Cotty & Newport 2012).

Imposition of local content requirements as stipulated by the NOCs of the host nations would mean that inexperienced, unqualified or insufficient workforce and suppliers may cause delay and cost overruns due to low quality of products or services (Lesourne 2009 and Trade Council of Denmark 2009).

The technologies being adopted and developed for the FPSO and FLNG industry are getting more complicated and sophisticated day to day. Extensive research and development and engineering works have to be executed to meet the clients' requirements and specifications or the standards set by the Classification Society such as American Bureau Shipping or Lloyd's.

The offshore oil field development is getting more complex due to more deepwater oil fields being discovered. FPSOs being built have to cater for such high risk projects and potential cost overruns could happen due to longer assessment of the risks involved.

The life cycle of the FPSO vessel is also subject to its design engineering factor. The FPSO cannot operate beyond its design life for example fifteen (15) years. Beyond it has to go for further

structural and hull tests to determine the vessel's condition before any construction works commences.

A newbuild or a conversion FPSO model differs in terms of completion duration and the complexity due to the increasing size of FPSO and water depth.

2.3 Previous Studies on Major Problems with FPSO Industry

Marine risks which had caused major problems have been identified through previous FPSO projects which are being managed to ensure the respective risks are mitigated, delegated or totally removed (International Association of Oil and Gas Producers 2006).

In a number of FPSO projects, the following areas may be the most common source of problems (Wyllie & Johnson 2006):-

- a) Control of interfaces and inadequate communication;
- b) Combined engineering and project management team for hull, topsides and mooring system design, procurement, construction and commissioning;
- c) In-house fleet operations team;
- d) All engineering disciplines working on a common and unique 3D model space; and

- e) Detailed and comprehensive inspection procedures, coupled with extensive and rigorous hull analysis work before committing to final tanker purchase.

Engineering deliverables remain one of the critical parts of the FPSO project and it has discovered that the following challenges were presented to the senior management to resolve (Kim et. al. 2008):-

- a) Requirement for high flexibility of topside design for generic FPSO design;
- b) No flaring strategy of any small to medium gas leaking from topside process;
- c) Vendor Data Management; and
- d) Experience level of the detailed design engineering subcontractor.

The lessons learned for six (6) Norwegian FPSOs, namely Petrojarl1, Varg, Norne, Balder, Jotun and Asgard that operated at the Norwegian's North Sea area has been compiled for reference by future project teams (Norwegian Oil Industry Association 2011). Information and data on major problems for project and operations early phases were gathered for the benefit of other FPSOs.

FPSO construction costs rose in all offshore oil and gas regions rapidly in recent years and it doesn't help when incomplete engineering design, inefficiencies in contract structure, design development changes and delivery liabilities for long lead equipment or materials would occur and cause heavier impact on the FPSO projects (Parker 1999).

At times, the condition of FPSO vessel may deteriorate at a quicker rate than as expected or designed due to massive exposure to the environment. Structural analysis programmes and procedures with advanced and sophisticated numerical analyses would have to be implemented to deliver a safety oriented hull design project (Mikkola et. al. n.d.).

Environmentalists are worried about the green efforts being supported by the FPSO Contractors and Operators. Unprecedented exploration and production projects may threaten the biodiversity, ecosystem, environmental and social impacts (Finer 2008). The flaring system is one of those equipment on board that releases a lot of carbon dioxide into the atmosphere. The chemicals used to operate the FPSO vessel is contaminant if not treated or discharge of properly after its usage (Colby, Matos & Mony 2007).

The decision in fixing the turret equipment onto the FPSO vessel may not allow it to disconnect immediately, due to massive

technological affects, if there is an adverse weather coming along especially in the Gulf of Mexico. If disconnection from the turret is to be executed, it may require twenty four (24) hours' notice. Thereafter, the works to re-connect the turret or even the mooring system requires extensive works with immediate supports from the respective expertise. This technological situation has been resolved with the first FPSO in the Gulf Mexico where the main design criterion was the disconnectable turret (Ribeiro et. al. 2007). With this improved technology design, another FPSO based on similar design criteria will be deployed in 2016 i.e. the Stones FPSO.

2.4 Definition of Critical Success Factor

The Cambridge dictionary has defined CSF as "one of the most important things that a company or organization must do well in order for its business or work to be successful". This definition fits the aim of this research where it is to establish the CSFs that FPSO Contractors can adopt in order to achieve project success by completing a project within the agreed schedule and budget.

The main research will be on the CSFs that will assist the FPSO Contractors to execute their project in a manner where time and cost are the priority. Apart from looking at the CSFs, certain journals and scholar articles look at Lessons Learned. This aspect will be looked into as well as it will also bring out factors that could determine the success of the projects at hand. One of the best

ways in confirming CSFs would be to obtain the information from the horse's mouth. One of the prominent FPSO Contractors described the following points in their Q1 2012 presentation in an investors relations' event (BW Offshore 2012):-

- a) In-house resources and competency.
- b) Increase in bid preparation time which will improve accuracy of cost estimate.
- c) Enhanced project front-end loading and engineering resources.
- d) Co-location of project execution, engineering and construction.
- e) Suppliers and subcontracts control.
- f) Monitoring of performance measures.

The FPSO Contractor seems to be very confident that if the above points are followed properly, it will be able generate better prospects in the FPSO industry. Further research will show us. With the respondents' results on the CSFs that are important for an oil and gas project or FPSO industry, this will be compared against the CSFs gathered from and supported by various journals and articles. This is to strengthen the findings or to explain on the difference, if any.

In conclusion part of the paper, it will be able to determine the CSFs that are widely relied on. The paper will then assess whether the right CSFs can be the determining factor that will assist the project team to execute their project accordingly to meet the schedule and budget.

From some intensive reading and search throughout various search engines related to journals and articles, it was found that CSFs are for real. That the CSFs if adopted and followed upon with proper project management, it will certainly bring success to the project.

2.5 The Need for CSFs

The onshore oil exploration has been the main source of crude oil for many IOCs and NOCs. The competition for onshore oil blocks is getting crowded and pushes IOCs and NOCs to the offshore sector to source for the 'black gold'. The offshore frontier is not new but it is definitely more capital intensive and risky in terms of larger investment required to start with. Project success became even more critical.

With the IOCs and NOCs moving offshore in search for the natural resources, IOCs and NOCs, owners of the offshore oil blocks would usually contemplate to use which floating production system ("FPS") to suit their oil exploration areas. FPS such as FPSO, Floating Production Semi-Submersibles, Tension Leg Platforms and

SPARs would be taken into consideration. Although each of this FPS would have its own advantages and disadvantages, the FPSOs would be the preferred option based on key considerations in selecting production platform technologies (Guzman, Thuriaux & Carvajal 2013). Employing FPSOs have been well accepted by the IOCs and NOCs which has outweighed and dominated other FPSs (Offshore Technology 2008). Even though FPSOs are the preferred option, FPSO Contractors do face high risk in constructing an FPSO for deepwater oil field developments.

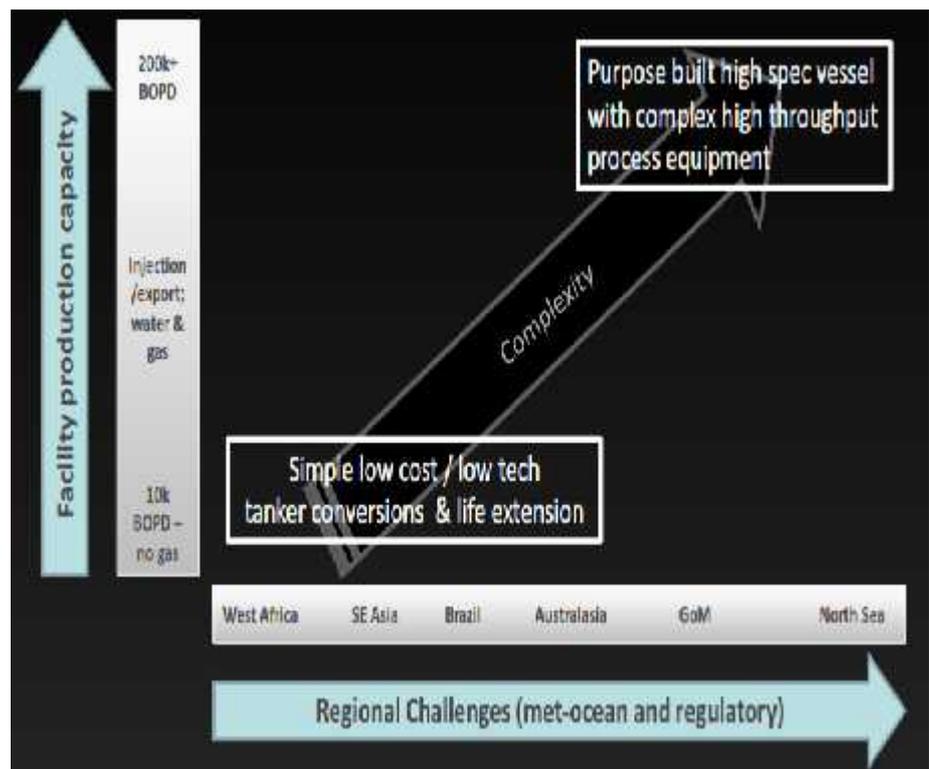


Figure 2.1: FPSO Complexity
 Source: [Institute of Engineers Australia](#)

As mentioned earlier, the FPSOs are going to be regarded as a mainstream solution to the deepwater oil field development

(Cochran 2013). As depicted in Figure 2.1, apart from the deepwater challenge, there are other challenges or higher risks faced by FPSO Contractors at the Gulf of Mexico and North Sea regions. With the higher complexity, the FPSO Contractors, IOCs and NOCs would have to learn to identify the challenges ahead and also the related CSFs (Palmer 2008). This calls for a greater measure of CSFs to be identified by the FPSO Contractors as the scope of works became more complex to execute the projects.

The deepwater exploration is usually executed by the IOCs or NOCs or together as joint venture partners. The deepwater oil production holds the main key to the FPSO industry as prior to the arrival of the FPSOs, the owner or operator of the deepwater subsea well is to ensure that the subsea well is drilled efficiently, proper tie-ins to flowlines to be connected to manifold and subsequently to risers that will connect to the FPSOs. Any delay or failure in this area will hold or delay the overall project. Therefore, it is also critical for FPSO Contractors and Operators to be aware of the development of the deepwater sector as subsequent delays may affect the FPSO's connection with the subsea equipment (Denni-Fiberesima & Rani 2010).

The preparation works at the deepwater field development holds a significant impact on the readiness of the FPSO. As the FPSO sets sail for the offshore site for mooring installation, the deepwater

field development works' success depends on the following tested CSFs (Denni-Fiberesima & Rani 2010) that will see the project being completed successfully:-

- a) Good project formulation.
- b) Project management capability.
- c) Good project implementation.
- d) Realistic project duration.
- e) Effective risk allocation.
- f) Resource availability.
- g) Access to secure finance.
- h) Communication.
- i) Innovative technology.
- j) Proper estimation of capital cost.

TOTAL MARKET 2007-2016										
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
TOTAL FPS MARKET	5,688	8,276	7,583	5,982	9,780	6,911	9,313	14,177	19,588	17,786

	2007-2011	2012-2016
Africa	9,165	11,908
Asia	5,330	7,496
Australasia	2,207	4,009
Latin America	12,199	33,916
North America	5,103	4,335
Western Europe	3,104	5,178
TOTAL	37,108	67,871

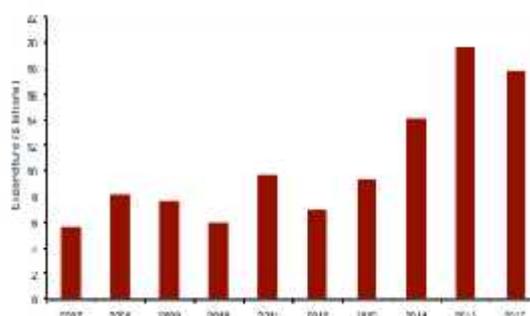


Figure 2.2: Global FPS Capex
Source: [Society of Petroleum Engineers](#)

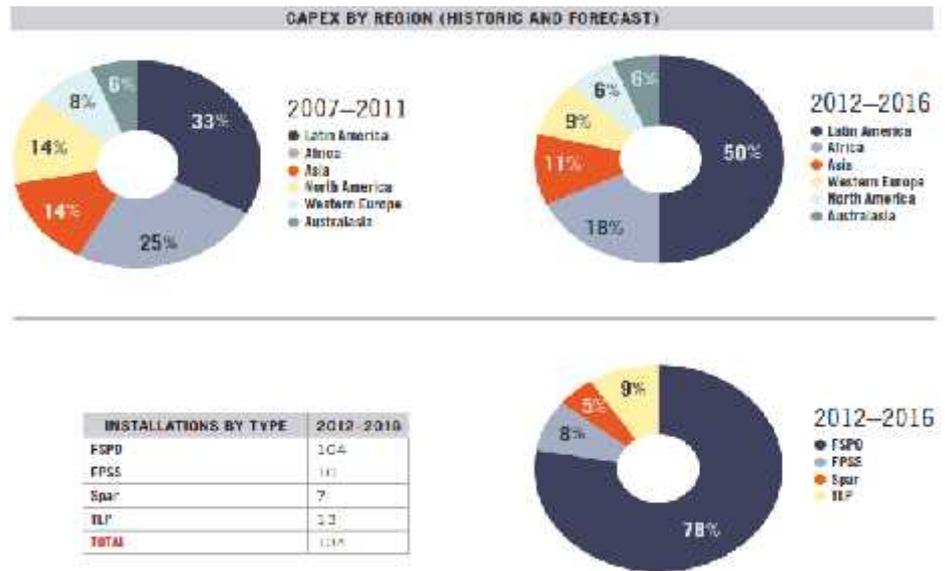


Figure 2.3: Capex by Region
 Source: [Society of Petroleum Engineers](#)

From Figures 2.2 and 2.3 above, FPSOs would contribute to about 78% equivalent to about US\$52.94 billion of the total FPS market of US\$68 billion. With the FPSOs moving on to become the mainstream solution for offshore oil exploration, many criteria have to be looked into to ensure that the project works move on as planned and within the allocated budget. With the huge capital expenditure being invested by IOCs and NOCs, these parties would also be interested to know about the relevancy of the FPSOs for their offshore oil blocks. With FPSO being recognised as the main solution to conduct the oil exploration and production, research or studies on the CSFs for FPSOs remain vital for the FPSO industry.

The Norwegian FPSOs faced more challenges operating at the rough North Sea region and it would be good to know how the

other FPSO Contractors have done previously in that rough weather. CSFs were collated from five (5) Norwegian FPSOs (Norwegian Oil Industry Association 2011) and this not only helped the five (5) FPSOs but FPSOs that would come into the same region and certain CSFs were applicable for use in other offshore oil and gas development. Different oil and gas regions would have different set of specification to be relied on to construct the FPSOs.

2.6 Limited Coverage by Research

Meantime, FPSO Contractors have been benefitting from the positive moves by the IOCs and NOCs. The FPSO Contractors are bracing themselves for more challenging orders as in constructing FPSOs for the deepwater oil exploration. In moving to this deepwater frontier, FPSO Contractors would need to be aware of many challenges that they may face in the process of the works. As mentioned earlier that most studies are conducted in microeconomics manner, it is not easy for the FPSO Contractors to learn from other parties on the lessons learned or to avoid repeating those mistakes which could be costly. The success factors are mentioned in various research or studies but it is quite specific for certain technical or process related works concerning the FPSO industry. The topic on CSFs is usually not the main focus for previous research done.

2.7 Previous Studies on CSFs

A recent research was conducted to identify the prevalence of CSFs for successful projects in the exploration and production deepwater oil and gas project portfolio management (Denni-Fiberesima & Rani 2011). The research has identified thirteen (13) CSFs and it even has close reflection of Project Management Body of Knowledge. Even though thirteen (13) CSFs have been identified, this is just based on respondents who have worked in the major oil and gas companies within deepwater exploration and production industry. There will be certain element of biasness as the FPSO construction industry was not taken into consideration. Can such CSFs be confidently relied upon by FPSO Contractors?

Although the identified CSFs sound familiar, it doesn't mention any interface management with the major contractors such as the FPSO Contractors or other major contractors such as the Risers and Flowlines Contractors, Umbilical Contractors, Drilling Contractors, Subsea Contractors and Installation Contractors as identified in Figure 2.4 below.

With the above-mentioned research done for the deepwater oil and gas projects and CSFs were identified, are the CSFs in mega construction projects similar to those in deepwater oil and gas projects. The researcher identified the following CSFs which are important for oil and gas mega oil field development that would

improve further the oil and gas project even better (Browning 2004):-

- a) Clear understanding achieved in the project team.
- b) Scope and latitude for performance by various participants (advisers, contractors and sub-contractor).
- c) Buy in to the project life cycle objective by the key contributors.
- d) With focus on key success factors, it has produced excellent results in many areas.

Mega oil field developments which are more complex in nature require clear definition of scope of works and all parties involved should clarify if unsure and to understand in-depth in order to execute the works according to the contract specifications.

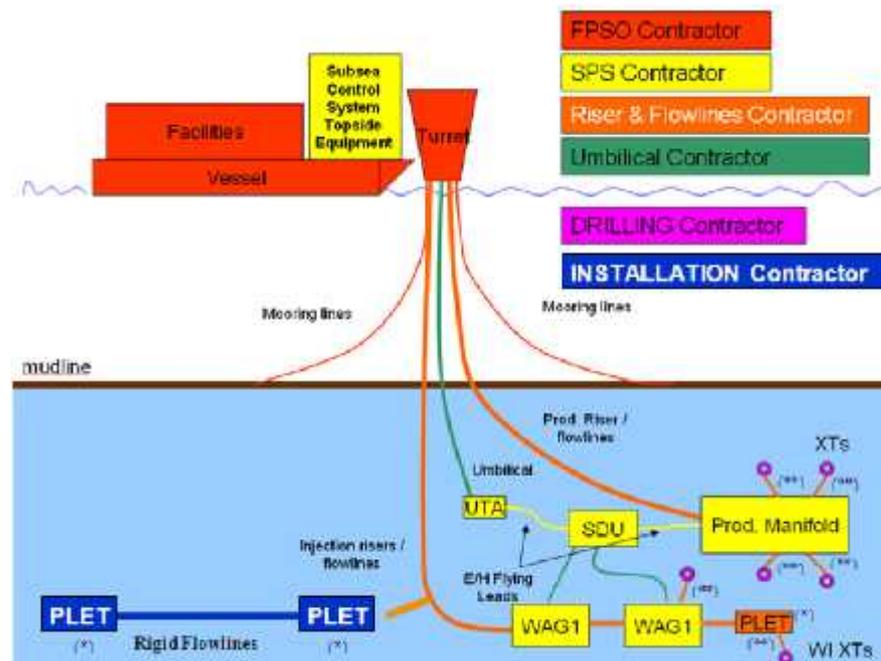


Figure 2.4: Typical FPSO Field Layout
 Source: SBM Offshore / ENI S.p.A.

As seen in Figure 2.4 above, the FPSO Contractor needs to be aware of their roles and contractual obligations amidst the various major contractors' roles for the same FPSO.

The research done for the deepwater oil and gas project (Denni-Fiberesima & Rani 2011) did not cover the area of high cost for production and drilling units which is a concern for deepwater exploration and production of late. For that matter, the research doesn't relate to any type of FPS to be employed for the offshore exploration and production. As the exploration and production are moving into the deepwater region, there is a lack of infrastructure and high cost involved for the mobilisation of drilling rigs. No matter how detailed is the project management procedure or good scheduling being adopted, the costs involved will derail the project.

Moreover, the same research (Denni-Fiberesima & Rani 2011) did not study on the complexity of the wells and need for future well intervention. However, this Research Project will conduct a study on the CSFs applicable to the FPSO industry and it can be compared to the CSFs of the exploration and production in the deepwater region to see the similarity. However, this research did touch on the subject of scope definition whereby different stakeholders need to know their respective responsibility in order for them to know what is or not to be carried out.

It is not easy to identify CSFs related to the FPSO projects on a chronological basis in the sense how did FPSO Contractors fare from the early days of FPSO development in the late 1970s till today. Different FPSO Contractors, other major contractors or major suppliers of FPSO equipment have executed their works on their own and rarely share their in-depth expertise, methods and knowledge as the FPSO industry remains very competitive.

Many FPSO Contractors or Operators for that matter have experienced and are experiencing increasing capital expenditure (“Capex”) for each FPSO being constructed and the total FPSO Capex for up to one hundred four (104) FPSOs are expected to increase up to US\$52.94 billion within the next three (3) years from 2013 as shown in Figures 2.2 and 2.3 above. This calls for the need of research on the CSFs for the FPSOs. With the increase in costs,

any further cost overrun will definitely cause financial hardship on the FPSO Contractors or the Oil & Gas Operators' budget may not be sufficient to cover those unexpected cost overruns. It has been noted that upstream oil and gas megaprojects have experienced cost overruns averaging 25% and schedule slippage averaging 22%. This may affect the project schedule and delay the completion of the FPSO projects. It would be good to implement the standardisation effects in stabilising the project costs (Kalligeros 2006) but only under the following conditions:-

- a) Reduction in operating expenses
- b) Reduction in FEED cost and time
- c) Reduction in construction cost
- d) Reduction in construction time

In order for the FPSO Contractors to achieve project success, it is more than items (a) to (d) as above. The reduction as described was purely based on various process systems and utilities that were constructed on both Kizomba A and Kizomba B FPSO for offshore Angola (Bybee 2006). The duplication of designs used for both FPSOs have generated considerable savings and reduced date of completion by six (6) months has proved to be workable for such an approach. However, the data on design and construction effects from the duplicating FPSOs used for illustration purpose requires is a matter of further research (Kalligeros 2006).

The above-mentioned reductions under items (a) to (d) will no doubt happen under the “design one, build two” approach as it would generate greater economies of scale. The important part is the details on how the FPSO Contractors have dealt with various other contractors are missing in the research (Kalligeros 2006). It was mentioned that such discreet preliminary data that detail the effects are found in focussed studies commissioned to both FPSO Contractors, namely Hyundai Heavy Industries Co. Ltd and Daewoo Shipbuilding & Marine Engineering Co. Ltd. Although the CSFs are not divulged, where the research (Kalligeros 2006) did mention did mention the following benefits under the “design one, build two” approach:-

- a) Capital expense (Capex) reduction mainly due to repeat engineering
- b) Contracts with preferred suppliers
- c) Discounts for material and services
- d) Integration efficiency
- e) Reduced operating expenses (Opex)
- f) Reduced FEED effort requirements, fewer mistakes and increased productivity
- g) Accelerating the receipt of cash flows from operations
- h) Skilled human resources cycle-time minimization
- i) Reduced risk in start-up efficiency and improved uptime; and
- j) Commonality of spares and training.

The above benefits are as a result of the “design one, build two” approach (Bybee 2006) and can be regarded as the objectives for FPSO Contractors but the FPSO Contractors would not be able to capitalise on the above benefits unless their projects are of similar approach. It is very unusual for the oil and gas operators to award FPSO Contractors to construct two (2) FPSOs simultaneously. In spite of this, SBM Offshore has been awarded to deliver two (2) FPSOs for Petrobras, i.e. the Cidade de Maricà and Cidade de Saquarema to be delivered early 2016. With larger FPSO projects to be executed, it is even more important for the CSFs to be identified and developed in order for the FPSO project teams to have a similar concept on which factors to concentrate on.

In order to achieve the research’s aim i.e. to establish the CSFs that FPSO Contractors can adopt, further structured interviews should be arranged with the FPSO industry’s major players. Owing to patented designs, technology know-how and nature of the industry, certain information and data are not shared to the public. This has also limited the researcher’s quest for additional supporting information.

One of the most extensive research coverage would be the “10 Years Operability Survey of Norwegian FPSOs” (Norwegian Oil Industry Association 2002) where information such as key project and operating lessons learned were gathered over the last ten (10)

years from five (5) Norwegian FPSOs. However, the information and data again related to technical aspects in operating the FPSOs:-

- 1) The problem of corrosion and how this has been managed;
- 2) Cost effectiveness of Norsok standards regarding material selection;
- 3) Meeting Integrity requirements;
- 4) Mechanical handling;
- 5) Process systems and power generation;
- 6) Marine systems -turret, hull and accommodation;
- 7) Modifications and upgrades; and
- 8) Factors that dominate Opex.

Besides the above technical aspects, the information and data were obtained from FPSOs that operated in the North Sea area only. The research coverage did disclose the following limitations:-

- 1) Lessons learned are related to project and operational start-up phases;
- 2) Operating lessons learned over the last ten (10) years; and
- 3) Decisions made in the design phase which have influenced the overall success of the project.

In a research on historical operational data on FPSOs worldwide, the oil spill risks under the FPSO Environmental Impact Statement

2001, organised by US Department of Interior, did not receive compelling data from a number of individual operators, companies and governments. Thus, the data collected was limited for the analysis (Ribeiro et. al. 2007).

2.8 CSFs in Line With Local Content Requirements

Foreign companies intending to commence business in developing countries are normally requested to employ local people as part of the organisation apart from allowing the expatriates work in the said developing countries.

This will open doors for employment for the local people and improves the livelihood of the local citizens. Angola and Ghana do have such Local Content Requirements and certain minimum percentages are imposed for the relevant industry. In the case of Ghana (Ablo 2012), local Ghanaians are employed by local recruitment companies and thereafter, they are posted to the offshore facilities. Prior to the postings, local training companies are supposed to prepare and train these local Ghanaians for them to work on the offshore facilities like the rigs. This opened up the avenue for more local companies to be set up to be involved in the recruitment and training of local Ghanaians.

2.9 CSFs Adopted by Shipyards

A local Malaysian fabrication shipyard, that includes FPSO fabrication works, has adopted the following Operational Excellence whereby Objectives are being set in order to improve on the respective Workstreams. Their determination and effort paid off when an international EPC company came to set up several joint venture companies to further enhance both parties' core businesses. The company is known as Malaysia Marine and Heavy Engineering Holdings Berhad ("MMHE") and their foreign partner is Technip.

Operational Excellence 3	
Workstream	Objectives
Construction	Improve Productivity & Optimize Resources
Project Management	Standardise Processes. Improve Change Order
Supply Chain Management	Optimize Price Agreements. Streamline Processes
Bidding	Enhance Bidding Win Rate Enhance Database
Engineering	Track Performance. Improve Engineering Capabilities
Marine Repair	Increase Efficiency & Productivity. Focus On Energy Vessels
Culture	Inculcate Culture Of High Performance
Communication	Promote Communication Transparency
Human Resources	Enhance Performance Management Process

Figure 2.5: Operational Excellence
Source: MMHE

Figure 2.5 has identified a number of Operational Excellence that could bring success to their projects. Under Construction Workstream, the resources have to be sufficient to carry out the projects. It was noted that Project Management Workstream should standardise its processes and improve on change management which the researcher acknowledged that this is a fact for the industry. Supply Chain Management Workstream remained a challenge for many FPSO Contractors too and MMHE's objective is to streamline the supply chain processes and with that it could standardise the pricing agreements. Communication, though a simple, carries a significant effect on projects and it has to be promoted and encouraged.

The construction and conversion of the FPSOs at fabrication shipyards are vital as it will determine whether the overall project will meet its agreed schedule and completed within budget. The CSFs will assist the FPSO Contractors to monitor their work progress that is being executed in the right manner accordingly (Mierendorff 2011). Lots of shipyards are being utilized to build or refurbish FPSOs or for conversion works to FPSOs. Shipyards in Asia such as those located in South Korea, China, Malaysia and Singapore are receiving large book orders to meet the supply gap existing in the deepwater field development (Rigzone 2012).

In order for the construction planning to be accepted in a shipyard culture, the FPSO Contractor's senior management would have to believe in the project schedule (Parker 1999). When it states that a certain work activity would happen on a particular day in a particular week that work activity would actually be carried out as per schedule.

European offshore fabricators have identified (Parker 1999) the following criteria which are regarded as the CSFs for business sustainability purposes:-

- 1) Engineering capabilities;
- 2) Good fabrication quality systems;
- 3) Reliable schedule achievements; and
- 4) Effective hook-up and commissioning.

The above CSFs are related to the respective job scope in the FPSO projects where a good understanding of the engineering deliverables would assist the fabricators Contractor to execute the correct method of construction. If the fabricators understood the contractual obligations, they would also carry out the works according to the quality systems that is part of the contract.

On the other hand, during the selection of fabrication contractor for Shell and BP's semi-submersible Floating Development System

which is to be moored at Gulf of Mexico's deepwater region, Shell took the following steps (Fairburn et. al. 2004):-

- a) Solicited interest worldwide from seventeen (17) contractors and thirteen (13) responded with interest on either the hull or deck;
- b) Prequalification was sent to the thirteen (13) contractors that came with a questionnaire requesting information on work experience, resource availability, work commitments, quality systems and HSE systems;
- c) Further input was solicited on contract structure preferences, owner furnished equipment schedule, engineering deliverables and potential local suppliers;
- d) During the bidding stage, contractors were requested to provide detailed costs, fabrication and erection methods, work plans, updated resource availabilities and updated work commitments. Further input was required on proposed method and cost components to adjust price for change orders purpose post AFC.
- e) During bidding stage, yard tours were conducted by Shell and replies to queries were provided. Replies to queries were generic and provided to all bidders.

Eventually Hyundai Heavy Industries ("HHI") was awarded the fabrication work. Even though Shell was careful with their

selection process, the following events were not expected which cause the FDS to be delayed for about five (5) months:-

- a) Contractor workload and resource availability – HHI was awarded with additional projects during the start of Shell's project and HHI's resources were fully stretched;
- b) Delay in engineering deliverables – underestimated complexities and further re-design was requested by the US authorities.
- c) Shell's specifications – HHI didn't agree with certain specifications which were caused additional costs and schedule pressure.

The following lessons learned was compiled by Shell in view of their fabrication work at HHI:-

- a) To establish comprehensive unit rate schedule and a process to quickly identify new unit rate requirement as the design progressed;
- b) Cost and schedule established did not capture the overall complexity of the project;
- c) HHI fabrication processes was based on their industry specification standards which does not align with Shell's specification and HHI was not used to Shell's active site team who has to verify and enforce compliance with Shell's

specifications. Misalignment happened which affected cost and schedule;

- d) Emphasis on commissioning performance is critical for a large scale fabrication project; and
- e) Fully realised equipment maintenance and preservation programme is essential to commissioning and start up success.

2.10 Causes of Delays in FPSO Projects

Increasing delays are happening in turnkey projects and newbuilds of FPSOs and a study was done on at least twenty five (25) FPSO projects (Rosenberg 2009) where delays were caused by the following:-

- a) Incomplete project definition;
- b) Schedule commitments were made disregarding project realities;
- c) Clients provided functional specification package only to Major Suppliers;
- d) Late changes to process design after start of detailed design;
- e) Aligning FPSO Contractors' capabilities with schedule expectations; and
- f) Unexpected additional works in converting the hull.

The experience gained from numerous FPSO projects being carried out by SBM Offshore has allowed them the advantage over their competitors. The construction phases for newbuild FPSOs (Le

Cotty 2003) should always be prepared for the following situations in the event shipyards are not available as per schedule:-

- 1) Generic design made available and subject to further review by Client;
- 2) Basic design is readily available and works can proceed immediately with the basic design to be approved once project is finally awarded; and
- 3) Construction possibilities can be reviewed and revised even when basic design together with the project schedule are being finalised.

Oil & Gas Operators tend to rush the FPSO Contractors based on fast-track project and potential cost growth being unpredictable or sail away date for the FPSO could be affected tremendously (Rosberg 2009).

2.11 Causes of Cost Overruns in FPSO Projects

In an independent analysis based on twenty five (25) FPSO projects (Rosberg 2009), the following works were found to have caused cost overruns:-

- a) Late engineering deliverables;
- b) Cost growth in engineering leads to growth in fabrication works;
- c) Incomplete project definition;

- d) Incomplete FEL and FEED; or
- e) Late changes to process design after commencement of detailed design;

A case study was initiated on an offshore field at North Western Australia is compared against a fictional offshore field at Gulf of Mexico but based on several identical terms, for example reservoir size / depth / characteristics, gas and condensate production rates, formation of water production rates, distance from shore, water depth and all wells were subsea with tiebacks to a floating facility (Business Council of Australia 2012).

In this case study comparison, with other factors *pari passu*, the capital expenditure at North Western Australia cost about 85% higher than the development at Gulf of Mexico due to the following reasons:-

- 1) Metocean influence;
- 2) Transportation cost;
- 3) Installation and vessel mobilisation cost;
- 4) Criticality of supply;
- 5) Supply Chain; and
- 6) Regulatory environment.

The above case study could be related to the FPSO industry where it depends on the location of where the FPSO is being converted or newly built.

A number of articles that have been reviewed dwelled on how various FPSOs have been constructed and completed within the agreed schedule and budget or otherwise owing to the CSFs. There are other factors as well that may determine its completion within budget and time as well. Cost overruns and project completion exceeding the agreed schedule are common scenarios in many FPSO projects throughout the world (van Dijk et. al., 2012 and Merrow 2012). In order to overcome the cost overruns or even to avoid the late delivery of the FPSO, SBM Offshore has discovered a number of CSFs through the Aseng FPSO project. The Aseng FPSO project team has discovered the following CSFs which are vital to project success:-

- a) Extensive schedule development
- b) Well-resourced and experienced contractor PMT
- c) Personnel
- d) Contractual set-up and contractor's Corporate Engineering Standards
- e) Communication
- f) Successful change management
- g) Focus on critical deliverable processes

- h) Procurement strategy
- i) Proven construction strategy

The Aseng FPSO project employed the guidelines from Project Management Institute (PMI) to set up their project schedule. Aseng FPSO was constructed within budget and finally sailed off to its offshore site within the contracted schedule period (van Dijk et. al., 2012).

2.12 Current State of the Research in Similar Field

The literature review has shown that there are limited published materials on the CSFs topic especially for and it has to rely on articles and conference proceeding papers from major offshore industry conferences. CSFs that are being referred to in the research of topics linked to FPSO have been observed and gathered for comparison. Majority of the CSFs are related to technical aspects of the FPSO such as:-

- 1) Success factors for sustainable deepwater concept development.
- 2) Green water loading on a FPSO.
- 3) Overview of the FPSO fatigue capacity.
- 4) Deepwater FPSO and subsea facilities-installation, hook-up and commissioning in Schiehallion on the UK Atlantic margin.

- 5) Understanding through experience-key findings from the FPSO structural performance joint industry project.
- 6) Safety climate, safety management practice and safety performance in offshore environments.
- 7) Greater Plutonio-Real time reservoir management in a high cost, deepwater environment.
- 8) Major technical and regulatory issues for Monohull Floating Production Systems in the Gulf of Mexico.
- 9) Mapping factors influencing the selection of subsea petroleum production systems.
- 10) Integrated riser and mooring design for the P-43 and P-48 FPSOs

Review of various literatures such as FPSO Industry's Conference Paper, FPSO Industry's Major Magazine, FPSO Industry's Major Articles, FPSO Industry's Journal, FPSO competitors' Investor Relation's presentation have been done to ascertain the related CSFs.

2.13 Further Research to Address These Gaps or Build on the Existing Research

The Critical Success Factors is not an unfamiliar sentence and people do recognize the meaning of it but FPSO Contractors and Operators seldom publish their findings publicly due to the stiff competitive FPSO industry.

Further researches should capitalize on Lessons Learned database that have been developed by certain parties for the benefit of the FPSO industry (Norwegian Oil Industry Association 2011). More researches should be conducted on FPSO projects being executed in different oil and gas regions such as West Africa, Brazil oil basin, South East Asia / Australia and North Sea to note the differences, if any.

Currently, lessons learned and CSFs were being provided by the practitioners, industry players, companies involved in the FPSO industry and on rare occasions, the FPSO Contractors and Operators. In reading further on the industry players' input, it was found that not only the physical work could cause cost overruns and delay but in fact, wrong adoption of contracting strategy could cause severe delay to the FPSO project (Stewart 2008). With this, one should be fully aware of commercial and contractual strategies of the FPSO industry and academic research should be performed on this matter.

The establishment of the CSFs for FPSO projects would make the authorities to change their mind to accept FPSOs due to severe hurricanes destroying oil rigs or platforms in the Gulf of Mexico region. Researches should be conducted on how best the FPSO projects, encompassing all areas of the works, could be the next best replacement of technology to explore and produce oil and gas

in the Gulf of Mexico region. FPSO industry players are keen to see the success of FPSOs in the Gulf of Mexico region and have provided feedback or factors that would bring success to the FPSO projects (Ribeiro, Palagi, Mastrangelo & Corte 2007 and Colby, Matos & Mony 2007).

Robert Gordon University (Offshore Management Centre RGU, 2002) and Norwegian Oil Industry Association have graciously produced database on FPSO projects that are available for FPSO Contractors and Operators and the Oil & Gas Operators to utilize and capitalize on it. In future, researchers should approach these two (2) parties to proceed further with such database and combine more databases from the region of West Africa, Brazil oil basin, South East Asia and Australia.

The researcher would recommend that future research be conducted on the supply chain management process. The FPSO project's PMT may be gung-ho about the project and pushed for a robust schedule to meet the Client's expectation but unknowingly, the supply chain team may not be capable or the vendors and suppliers have executed similar package before. At times, the vendors and suppliers do not understand the Client's specification in the areas of design, material procurement, equipment supply, testing processes (Fisher Maritime 2008).

Further research could be to assess the stakeholders and the local content requirements in those oil and gas regions of West Africa, Brazil oil basin, South East Asia / Australia and North Sea (Salamonsen 2009).

Apart from the above, FPSO Contractors should be aware of the treatment of legal and regulatory to avoid unnecessary non-work related issues to cause delay to the FPSO projects (Holman Fenwick Willan 2012).

An area where future research could be done is in the area of risk management for the FPSO industry as technological risk, environmental risk, geological risk and infrastructure risk (Trade Council of Denmark 2009) could derail the Oil & Gas Operators plans and due to such risks, it took Oil & Gas Operators longer nowadays to push ahead with the deepwater oil field developments.

3.0 RESEARCH METHODOLOGY

3.1 Introduction

The research for this project is to establish the CSFs for FPSO Contractors to confidently rely on when they approach the project works especially to achieve project success by completing the works within agreed schedule and allocated budget. However, the research has been limited by the little research or studies done previously on the same topic. The topic of CSFs was not the main concern for various research or studies found thus far but concentrated on technical layout aspects, structural and hull designs, construction methods, functionality of various equipment found in the FPSO vessel or on external factors such as metocean and geophysical, fluid characteristics, and subsea technicalities that may affect the FPSO vessel or its equipment during design stage or operations.

3.2 Qualitative and Quantitative Approaches

In conducting the literature review, it can be adduced that the topic on CSFs is not a profound subject matter by other researchers and CSFs are usually not the main topic in an article, journal or research.

The researcher is of the opinion that sharing the real life work experience is one of the most conducive methods to understand

someone's viewpoint or descriptive nature of an event (Guest, Namey & Mitchell 2013). Practitioners will find it hard to understand academicians' figures, tables and formulas to derive an outcome based on some fantastic statistics collated. Through the qualitative approach, respondents could share their stories or experiences related to the topic. As the researcher needs to know the detailed situation of the respondents' knowledge and experience, it is advisable to allow the respondents to relate their previous events which the researcher is unable to source for in a literature review. Due to the above reason, the best approach to obtain or source for the right information and data for this research is via qualitative method. This is considered the Grounded Theory Methodology (Glaser & Strauss 1967) whereby this method is one of the several qualitative research approaches that could assist in an exploratory research in which the researcher is adopting (Lopes, A 2010). Through the qualitative method, pilot survey and structured interviews with senior management would be conducted on face to face basis. With such data collection method, observations can be made at the same time when interviewees relate their true experience or encounters. The data collected is more realistic, accurate and related directly on the research aim and objectives as explanation would be provided to interviewees to understand the intended nature of the structured interviews.

The researcher's role would be to gather, obtain and collate the data from the structured interviews, to observe respondents' replies in order to draw up tables and produce analysis from the responses received.

3.3 Structured Interview

This research will be undertaken through the qualitative approach and interviews have been put in place to help the research further by obtaining specific information. There are few types of interview, namely structured or unstructured coupled with questions that are open-ended or closed (Creswell 1994).

The researcher has intended to adopt the structured interview with open-ended questions. The questions would be forwarded to the interviewee in advance in order for the interviewee to be prepared. It is better in this manner as answers provided are going to be different if the interviewee is surprised with an unexpected question.

3.4 Primary Research

The primary research will be through the literature review of at least thirty (30) journals, scholarly articles, relevant thesis of same topic and thereafter, sub-questions will be formulated as it will form the basis of questions for participants in due course.

Prior to the questions being set, a pilot survey was conducted with three (3) persons who are well-versed in the FPSO and offshore oil and gas industry and it was to ascertain the main hot topics for today's FPSO Contractors. The pilot survey was to validate the main hot topics which had been obtained during literature review. Subsequently, the six (6) main topics were picked after the pilot survey with the three (3) persons where these main topics were considered critical for the FPSO Contractors to be aware of and naturally to master if the FPSO Contractors intend to be successful in the FPSO industry. Eventually, the structured interviews would be drafted based on the six (6) main topics. This is to obtain the confirmation that the questions set would be of relevance to the industry and the right approach to obtain the information intended (University of Reading).

Thereafter, the structured interview format was drafted upon completion of the pilot survey with two (2) of the three (3) persons as mentioned above where in this case a Contracts Department Manager of SBM Offshore based at Kuala Lumpur Execution Centre, who is a former claim consultant from Trett Consulting, and a Senior Associate Director based at Houston, USA, a Commercial & Contracts Consultant from Driver Trett. The third person is an Operations Director of SBM Offshore.

Approximately twenty two (22) specific open ended questions related to FPSO works will be set. Potential participants from the related FPSO industry and oil and gas industries will receive the questions which are open ended to allow the experienced and professional people in the said industry to share their knowledge.

Respondents would be informed of the researcher's availability to ensure targeted participants will not answer out of topic and stick to within certain range of the research proposal's title.

The following research questions have been prepared where responses from respondents would be collated to determine the relevant CSFs:-

- 1) What is the level of working experience required to undertake a newbuild, conversion or re-deployment FPSO projects?
- 2) Is it more cost effective for the Project Management Team to be involved in the FPSO projects from the onset and if so, why?
- 3) In order to meet local fabrication content in terms of staff in certain countries, how will FPSO Contractors respond while maintaining cost and quality for the FPSO projects?
- 4) Does FPSO Contractor plan and schedule workshops in reviewing work procedures over the project life cycle in

ensuring minimum changes to the works for the purpose of reducing cost?

- 5) What are the Critical Success Factors required in order to make the (1) decisive engineering decisions, (2) meet budgets in executing projects and (3) hand over projects within the agreed schedule?
- 6) How are project staff being trained to capitalize on the known Critical Success Factors for the betterment of the FPSO projects?
- 7) How dependent are FPSO Contractors on the relationship with shipyards? Why?
- 8) How do FPSO Contractors ensure that the shipyards' workers are competent and having the right experienced to execute the works?
- 9) What are the Critical Success Factors at the shipyards that are required to complete projects within time and budget?
- 10) How do FPSO Contractors ensure that major suppliers are consistent in their product or service qualities, which need to be supplied within project budget and deliver by agreed dates?
- 11) What sort of cost effective strategy (if any) has been implemented together with the major suppliers to achieve successful delivery of products or services that are compliant with the Client's quality requirements?

- 12) What are the Critical Success Factors required for Major Suppliers in order to make the (1) decisive quality decisions, (2) meet budgets in executing projects and (3) to achieve schedule success?
- 13) With the project responsibility matrix identifying the respective roles and responsibilities of the FPSO Contractor, Client and Client's other major contractors, will this assist in reducing discrepancy or potential changes (drawings, interface data, specification) which may cause additional time and costs to execute the project?
- 14) How do FPSO Contractors manage potential changes from Client's other major contractors to ensure that it delivers a project within budget and schedule?
- 15) How do FPSO Contractors communicate on the subject of change management which could affect the project cost and schedule?
- 16) What are the Critical Success Factors that are required to be implemented when integrating the works with the Client to meet the project's delivery dates and within the project cost?
- 17) What sort of stakeholder analysis is being undertaken that will allow the FPSO Contractor to accept or mitigate the risks involved in dealing with developing nations or demanding International Oil Companies and National Oil Companies that may derail the project's costing and schedule?

- 18) Who are the specific personnel / team assigned to look into communication with all stakeholders during project execution and if so, what is the sort of communication strategy?
- 19) What are the Critical Success Factors in handling demanding stakeholders and to ensure Projects decisions are accepted by stakeholders?
- 20) How do FPSO Contractors maintain works in accordance with the agreed project schedule?
- 21) Will the project schedule be the main driving force in determining how the construction works are to be executed and if so, why?
- 22) What are the key Critical Success Factors in order for the project schedule to affect and control the rate of success for FPSO projects?

The above questions form part of the empirical research whereby further analysis would be conducted on the actual experience of the respective respondents. The information or data obtained through this manner may differ from the theories developed by academicians or authors who may have different work experience previously.

3.5 Secondary Research

The Research Methodology continued with the secondary research through literature review of more than sixty (60) industry journals, scholarly articles, relevant thesis of similar research, conference papers and proceedings, the internet and various publications from the related offshore industry professions or associations. The literature review has contributed substantial information which assisted the researcher to complete Chapters 4 (Results) and 5 (Discussion). The limitation on the scope of research is that FPSO Contractors seldom share their secrets of success owing to commercial confidentiality.

Thereafter, CSFs that are being identified through literature review will be compared against the respondents' response or information. In this manner, researcher would be able to distinguish the difference between the CSFs obtained from literature review to those provided by the respondents. Would the respondents' information be similar to those found through the literature review?

Subsequently, these data are then collated to determine which CSFs are related to achieving project success by completing a project within the agreed schedule and budget.

3.6 Sample Size of Research's Participants

At least eighty (80) participants will receive the questions to obtain a stable sample size of response. This will minimise or reduce the distortion of responses. This is to ensure the right information and data are being obtained to help with the research's aim and objectives.

The researcher would follow up personally with the respondents, estimated about twenty (20) of them, to ensure that the respondents were comfortable with the structured interviews. This exercise will be done over a period of one (1) to two (2) months. This is to reduce any misunderstanding on the questions posted to the respondents.

3.7 Flowchart

The flowchart shown below, Figure 3.1, described the process of sourcing for the information and data through the primary and secondary approaches.

Thereafter, open ended questions were being drafted and reviewed with professionals from the FPSO industry whereby the questions were re-drafted to suit the aim and objectives of the research.

Flowchart for Research Methodology

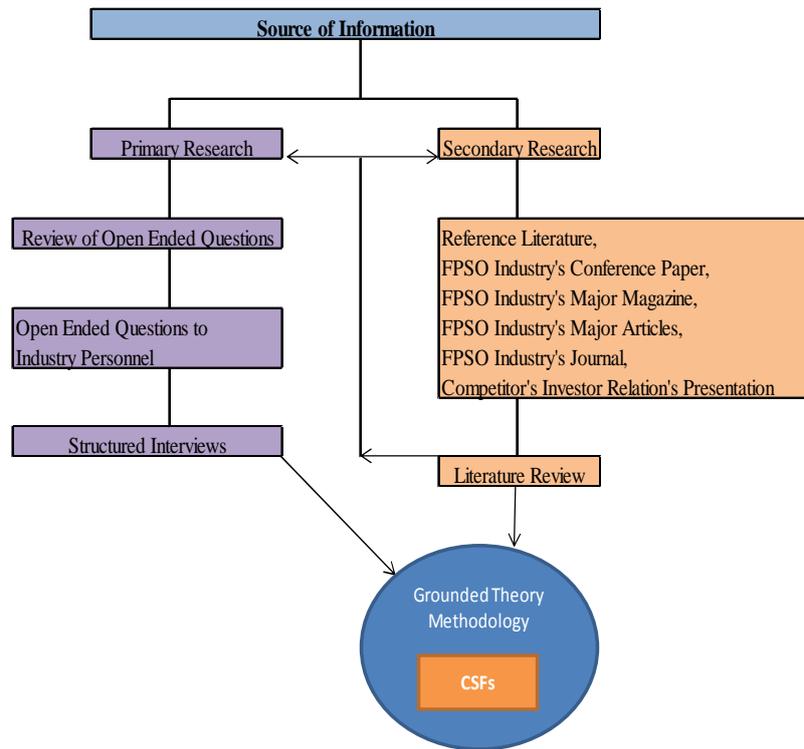


Figure 3.1: Flowchart for Research Methodology

3.8 Selection of Respondents for Structured Interviews

Although there are many FPSO Contractors in the market, the researcher's information and data was obtained from only one (1) FPSO Contractor. The research's result could have been more accurate if each FPSO Contractor in the market has contributed to this research. Knowing the high competitiveness in this FPSO industry, a respondent would not have revealed much to protect their knowledge or advantage over their competitors. Even though this research's information and data was mainly obtained from one (1) main source, the information and data is quite stable and reliable as the FPSO Contractor is the leading contractor in the

industry. The total number of years of experience as seen in the Respondents' Data listing is up to four hundred (400) cumulative years from just thirty four (34) respondents only. This shows the maturity level of the respondents with the extensive experience in the FPSO industry. People who wanted to enter a new business venture or seek employment in another unfamiliar industry would usually seek advice from the people who have seen it all and done it as it would give greater assurance owing to the experience and knowledge. The same applies to this research. The researcher believes that this research would be sought after by other FPSO Contractors, FPSO Owners/Operators and even the Oil & Gas Operators who wanted to know more about the FPSO Contractors' strengths and weaknesses. This is similar to the survey conducted by Norwegian Oil Industry Association where it has been sought after even though it concentrated on the CSFs in the operability phase of FPSOs.

3.9 Data Collection

Respondents would be mainly from FPSO Contractors with a few from the Oil & Gas Operators. The respondents' backgrounds are from Engineering, Project Control, Contract Management, Project Management, Cost Engineering, Interface Management, Delivery Manager and Construction. The respondents' accumulated years of working experience easily added up to four hundred (400) years with all of them having experience in offshore oil and gas industry

and in particularly the FPSO industry. More than twenty (20) respondents have previous work experience in other parts of the world apart from Malaysia.

The data collected would be extracted from the structured interviews sent out to around eighty (80) respondents. Twenty (20) respondents who have indicated their readiness to do the structured interviews would receive further explanation to ensure that respondents understood the purpose of the structured interview. The response to the structured interviews would be filled up by the respondents for record purposes.

Upon collection of the information and data, further analysis would be conducted to identify the themes or concepts and to observe and understand the respondents' CSFs that would be written in their own words.

Readers can see in Figure 3.2 how Cost Overruns & Schedule Deviation, being Independent Variable, can be improved with the Moderating Variables obtained from various sources. Upon analysing the Moderating Variables, it would be used to bring a change to the Independent Variable to become Intervening Variable as Critical Success Factors. Thereafter, the Intervening Variable would cause an effect as Successful FPSO Projects, the Dependent Variable, happens.

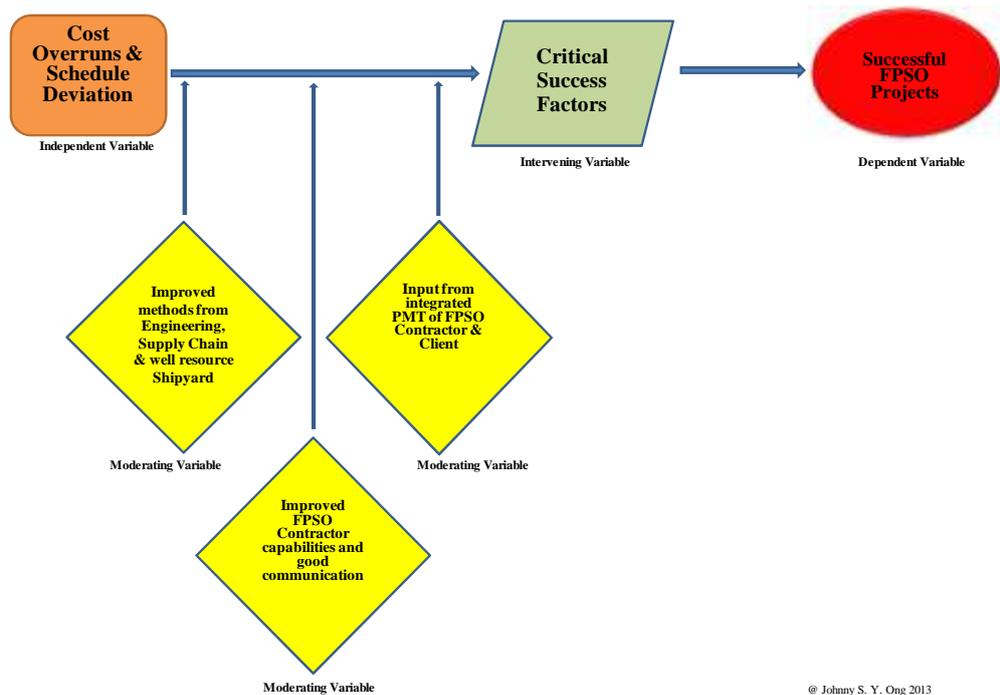


Figure 3.2: Flowchart for Project Research

3.10 Determination of Information and Data Collected Through Structured Interviews

The researcher will determine the findings based on grounded theory methodology where the emergence of new theories or knowledge could be obtained from the structured interviews with the respondents. From there the researcher will cross examine the findings with the literature review and re-construct the stories with the additional feedback from the respondents. Such grounded theory methodology has relied upon on researches related to the oil and gas industry (Matos & Hall 2007, O'Dea & Flin 2001, Malmquist 1990) but not on the FPSO industry specifically.

3.11 Grounded Theory Methodology

The grounded theory methodology was determined by the researcher as being suitable for this research due to the fact that data was provided in relation to the respondents' data and information. The grounded theory provided for the generation of a theory of actions, interactions, or processes through inter-relating categories of information based on data collected from individuals (Glaser & Strauss, 1967). The approach towards the grounded theory employed in this research was to gather data from respondents via structured interviews and to saturate the model through at least thirty (30) structured interviews. Eventually thirty four (34) structured interviews were completed. There is limited theory available on CSFs for the FPSO industry and this grounded theory employed by the researcher was to explain to readers that through previous FPSO project experiences, a theoretical framework could be developed. The researcher had differentiated the data under various topics such as Reliance on Experience, Reliance on Fabrication Shipyards, Co-Ordination with Major Suppliers, Co-Ordination with Clients, Handling Stakeholders and Managing Project Schedule. Within each major topic, through the process of data collection and analysis, the researcher could see common matters being brought up by the respondents and through literature reviews. Owing to the respondents' years of working experience within the offshore oil and gas industry, respondents were able to provide 'story lines' through their observations,

perception and opinions for the researcher. From the 'story lines', the researcher was able to determine certain emerging theories which have been generalised. The researcher relied on Charmaz's (2006) approach as it was less structured and easily adaptable to researcher's limited data and information. The constructivist grounded theory (Charmaz 2006) was adopted as it has flexible guidelines where theory being developed depends on the researcher's as follows:-

- a) View;
- b) Learning about the experience within embedded;
- c) Hidden networks;
- d) Situations;
- e) Relationships; and
- f) Making of visible hierarchies of power, communication and opportunity.

One of the researcher's reasons for writing this project title was due to observe the views, values, beliefs, feelings, assumptions and ideologies of individuals (Creswell 2006).

4.0 RESULTS

In the previous, the method of collecting the data for the research has been discussed. The data collected was based on the major topics such as Reliance on Experience, Reliance on Fabrication Shipyards, Co-Ordination with Major Suppliers, Co-Ordination with Clients, Handling Stakeholders and Managing Project Schedule. This chapter will present the results of the research on the information and data received from respondents.

This chapter will also show the respondents' demography such as job title, their company's nature of business, where are they based at, nature of their work, the largest project they have executed previously and the number of years of experience in the offshore oil & gas industry.

The information and data gathered from literature review will be mentioned in comparison with those obtained from the respondents. It will examine the differences between researches' information and data from literature review and those from respondents.

From the information and data obtained from the respondents, this research will show which of the CSFs are being regarded as the 'must have' in order for FPSO Contractors to achieve project

success. Subsequently, these CSFs will be compared against CSFs sighted during the literature review which will be described in the next chapter.

4.1 Respondents' Demography

4.1.1 Response Rate

The structured interview format was distributed to eighty one (80) respondents with various job responsibilities in the offshore oil and gas industry. More than 80% of the respondents hold senior or managerial positions which would make the qualitative research method a better research. The outcome would be of true account of respondents' number of years of experience gained at the offshore oil & gas industry. Out of the eighty one (80) structured interviews distributed, a total of thirty six (36) respondents have responded which represented a response rate of 45% as shown in Figure 4.1. However, the researcher had decided not to include two (2) respondents' data and CSFs as only two topics were completed out of six topics in the said structured interviews.

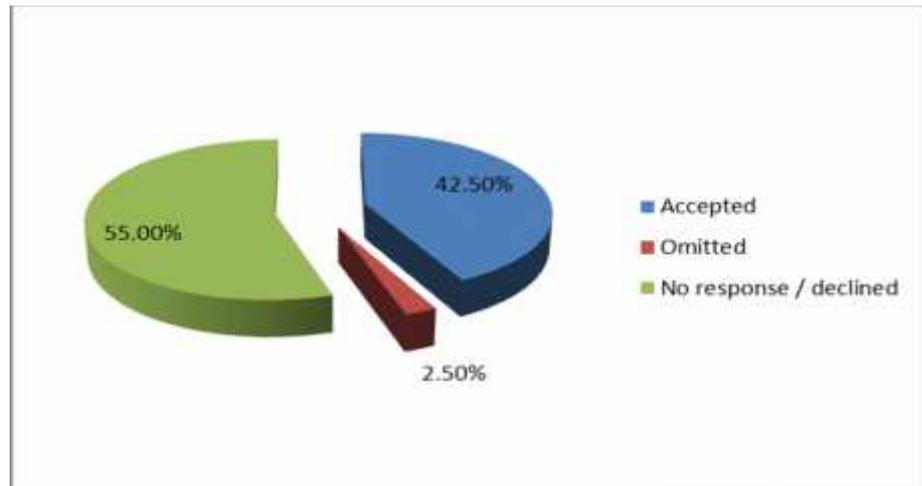


Figure 4.1: Response Rate for Structured Interviews

The researcher found it necessary to highlight that seven (7) out of the thirty four (34) respondents did not complete Section 5- Handling Stakeholders. In checking with these respondents, a few respondents mentioned that their works do not need to interact with stakeholders in which the researcher doubted. Another few respondents have stated that it is not their part of their work responsibility to handle stakeholders' demand or request.

4.1.2 Respondents' Job Title

The respondents were required to state their job title and with this data, the respondents' job title have been categorised into Managers, Seniors and Engineers as shown under Figure 4.2. Under the Managers' category, those job titles with the word Manager would be taken into consideration including the Consultant and Site Representative. Respondents with the title of Principal Engineer and Senior Engineer have been categorised

under Seniors. The remaining respondents with the job title of Project Engineer, Cost Engineer, O&M Engineer, Construction Engineer and Contract Engineer have been taken into consideration under the Engineers' category.

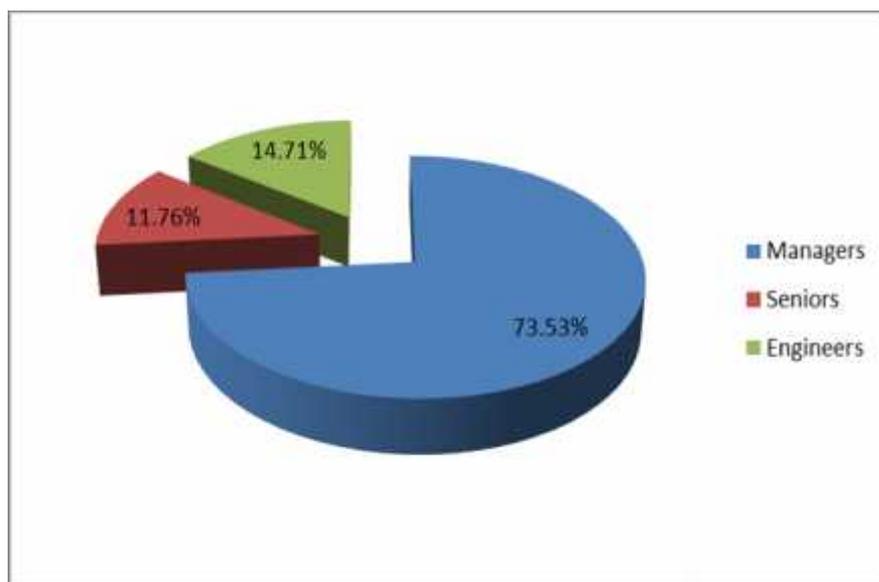


Figure 4.2: Respondents' Job Title

A number of respondents were holding similar job titles such as Project Manager, Engineering Project Manager, Project Controls Manager, Project Engineers, and Delivery Managers or from same stream of work such as Contracts, Engineering and Construction. The respondents that have responded represented an overall coverage of important roles in a FPSO project. There was a good response from the Managers category, numbering up to twenty five (25) or 73.53% of the respondents with the Seniors category has response rate 11.76% followed by the Engineers category at 14.71%.

4.1.3 Respondents' Company's Nature of Business

The respondents were also requested to provide the details of their employers' nature of business as per Figure 4.3. This data would help the researcher in obtaining the information required to meet the research objective. It is important to obtain the information and data from the horse's mouth, as the saying goes, as it would truly reflect the actual situation that has happened at construction site or certain events have occurred over a number of projects.

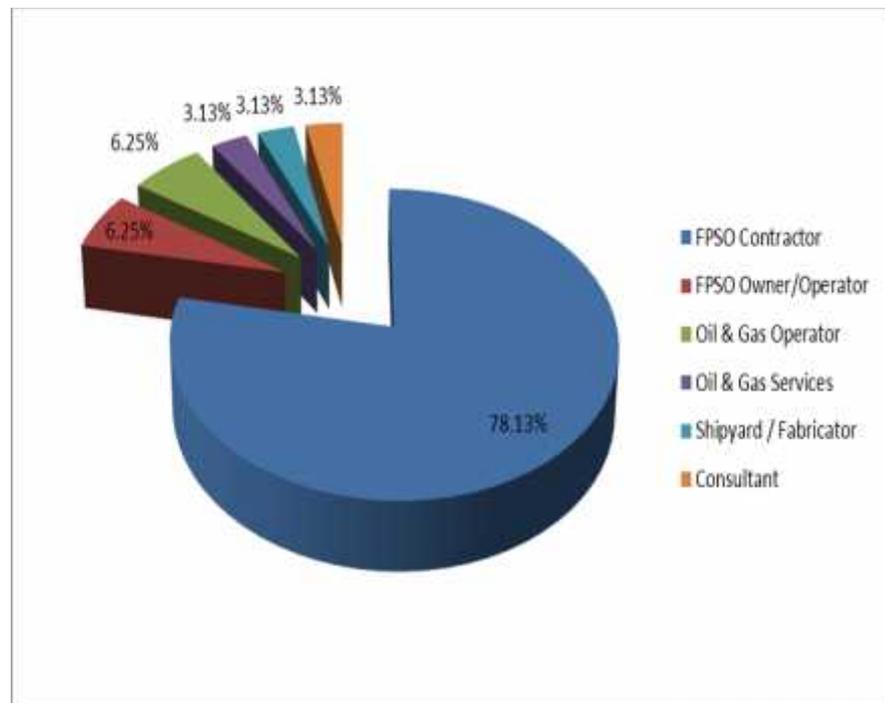


Figure 4.3: Respondents' Company's Nature of Business

Researcher was able to obtain responses from respondents who came from background of FPSO Contractor, FPSO Owner/Operator, Oil & Gas Operator, Oil & Gas Services,

Shipyards/Fabricators and Consultants. All these respondents have extensive dealings in the FPSO industry.

The accuracy of the information and data obtained through the structured interviews from the respective respondents could be highly regarded with the fact that approximately 78.13% of the respondents were directly involved with the FPSO Contractors.

This is followed closely by respondents from the FPSO Owner/Operator and Oil & Gas Operator categories who are direct FPSO end users. With such relevant respondents having contributed to the research, comprising 6.25% of the respondents, it has strengthened the reliability of such perception or opinions obtained. Apart from the FPSO Owner/Operator and Oil & Gas Operator categories, the Consultant has a contribution percentage of approximately 6.25% as well. The Oil & Gas Services and Shipyards/Fabricators categories have contributed approximately 3.13% each to the number of respondents. These two (2) categories play a big part in today's FPSO industry and the input provided would be valuable towards the research.

4.1.4 Respondents' Nature of Work

Under this column of Nature of Work in the Respondents' Data, the wide variety of respondents' job titles and nature of work have covered a large aspect of the FPSO project works which have made

this research well represented. This allowed respondents from different working environment to contribute to the research and made this research rather unique. The figure below would see the respondents' years of work experience in their respective field with the FPSO Contractors, FPSO Owner/Operators, Oil & Gas Operators, Oil & Gas Services, Shipyard / Fabricator and Consultant.

As shown in Figure 4.4, the respondents came from a wide range of work within the FPSO industry.

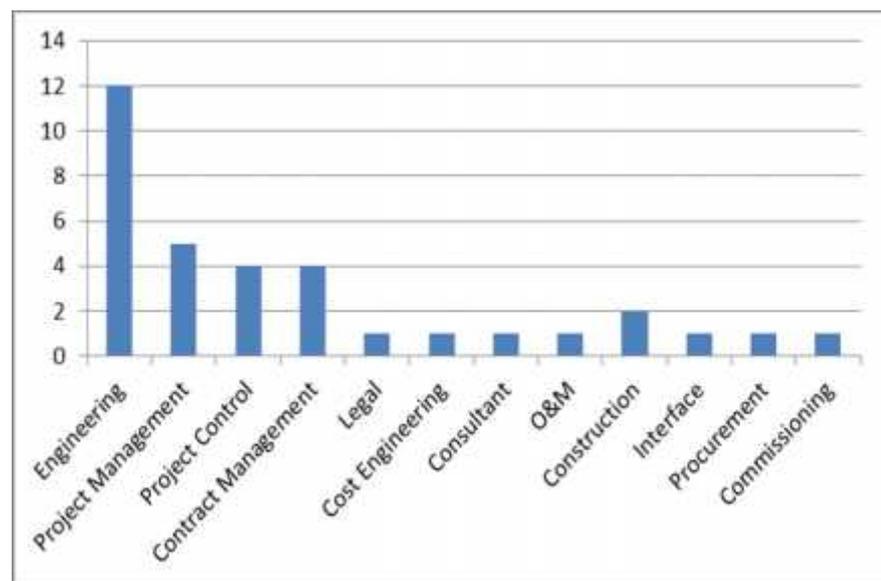


Figure 4.4: Respondents' Nature of Work

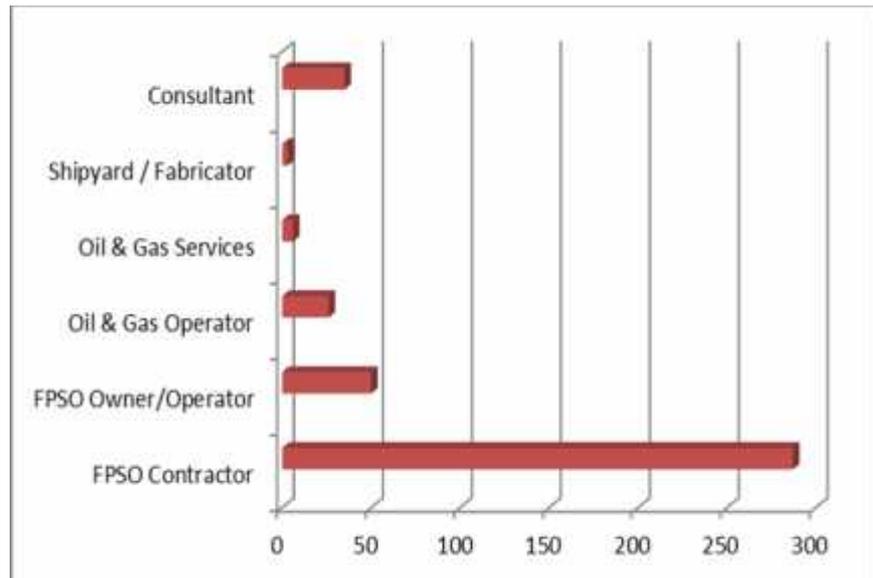


Figure 4.5: Respondents' Years of Work Experience

In reading from Figure 4.5, respondents having worked with FPSO Contractors have approximately two hundred eighty seven (287) years of work experience. With their years of working experience, the CSFs or advices obtained from them would have been the answers or the most practical for the said FPSO industry or the FPSO Contractor itself.

4.1.5 Respondents' Largest Project Executed

The purpose of this section was to show the capability and extensive work experience of each respondent as stated in Appendix 1 of the Respondents' Data. This has highlighted the fact that each respondent has handled project of tens of thousands right up to billions of dollars. This shows that each respondent had handled large projects previously and they are in a position to contribute to the structured interviews / research.

4.1.6 Respondents' Offshore Oil & Gas Experience

As stated in the Appendix A-Respondents' Data, all of the respondents have considerable offshore oil & gas experience and some with onshore experience. The cumulative total number of years of experience of three hundred eighty five (385) showed the strength and depth of this group of respondents' working experience.

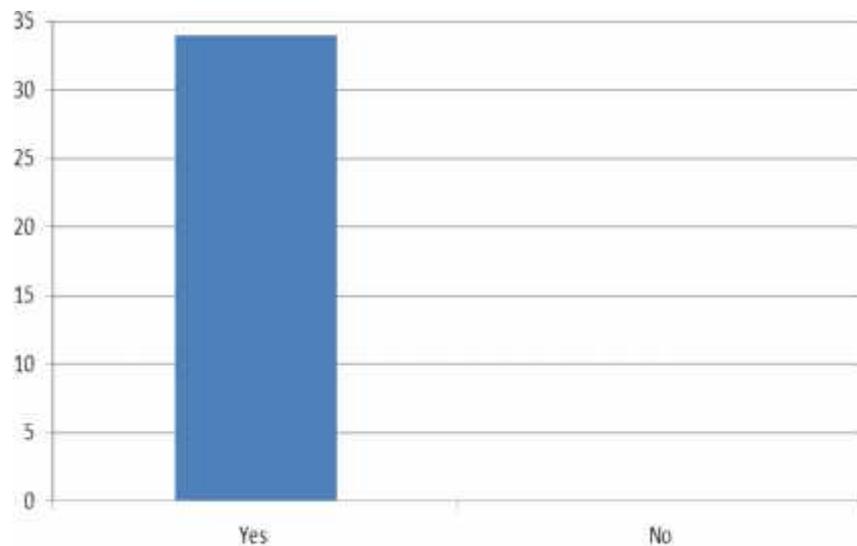


Figure 4.6: Work Experience in the Offshore Oil & Gas industry

It is noted under Figure 4.6 that all thirty four (34) respondents have considerable working experience and all respondents are currently working in the Offshore Oil & Gas industry.

4.2 Shortcomings of the Structured Interviews

The research is based on qualitative approach. Therefore, subjective questions were posted to respondents in the FPSO

industry who are well versed with the daily activities and presumed to be well aware of the pros and cons of the industry too.

Majority of the structured interviews were posted to Managers and Seniors who would be able to provide the insights to the FPSO industry, letting us know based on their extensive knowledge and years of experience in seeing the FPSO industry growing at current level. Although the researcher's result could have been better represented if respondents from all working levels such as from the lower level to the supervisory level, right up to the seniors, principals or managers and the board of directors level. It is presumed that people at different level will face different challenges and their view on success factors is different from the other working levels. In the FPSO industry, the PMT members are the people that made decisions and execute the FPSO projects together with the Clients' PMT members. Hence, the researcher's decision to post the structured interviews to Managers and Seniors who are the movers and shakers of the FPSO projects and considered as the front liners in executing the FPSO projects.

As this research is based on qualitative approach, statistical results are not computed to interpret the results with well accepted formulas or tests. The research would only present an analysis of frequently mentioned theme or concept such as realistic schedule, experienced manpower, good communication, proper planning,

good change management or quality engineering works where this would determine the respondents' perception or opinions.

In the process of determining the concept, one has to have sufficient knowledge or experience in the same industry in order to interpret the respondents' information and data. It is also a skill to interpret respondents' perception and opinions but human judgement could occur which would affect the accuracy of the research.

The researcher's information and data was obtained from only one (1) FPSO Contractor but the result would have been well represented if each FPSO Contractor has participated in this research. With strict confidentiality in this high technological industry, the know-how is extremely valuable information too. Due to this, a respondent from another FPSO Contractor would not have differed much from the information and data obtained with the same set of structured interviews. The disadvantage in obtaining the research's information and data from one (1) main source is overcome by the stability and reliability of the information and data as the FPSO Contractor is the market leader in the industry. The total number of years of experience as stated in the Respondents' Data listing is up to four hundred (400) cumulative years from just thirty three (33) respondents only which depicts the depth of the respondents' experience in the FPSO industry.

4.3 Analysis of the Respondents' Responses to the Structured Interviews

One of the objectives of the research was to understand and observe the respondents' major perception and opinions, as per the grounded theory methodology, on the FPSO industry in terms of reliance on experience, reliance on fabrication shipyards, co-ordination with major suppliers, co-ordination with Clients, handling the important stakeholders and last but not least, managing the project schedule. The researcher has extracted a number of critical responses provided by the respondents in the following six (6) tables which would assist future researches.

Table 4.1: Respondents' Perception and Opinions on Reliance on Experience

Issues	Respondents' Perception and Opinions
Reliance On Experience	<p data-bbox="715 1218 1418 1339">What level of work experience is required by staff to successfully undertake FPSO newbuild, conversion or re-deployment projects?</p> <p data-bbox="715 1373 1418 1554">“With previous experience on FPSO projects, there is no special experience required for newbuild, conversion or re-deployment projects – as familiarity with the uniqueness of FPSO projects will have been gained.”</p> <p data-bbox="715 1592 1418 2027">“We find that people suitably qualified and having undertaken roles in other sectors (civil etc) and a good commercial mind can perform a Contracts role in FPSO projects. Of course, they need to understand the process, technology and sector to become leaders. From a Scheduling point of view, the situation is different. An appreciation of planning and planning tools is essential, of course, but also is the process of shipbuilding (for new build) but critically for conversion work as it is a much more complex engineering and construction process.”</p>

	<p>Is it more cost effective for the Project Management Team to be involved in the FPSO projects as soon as the award of a Contract is immanent and if so, why?</p>
	<p>“It is more effective for the project mgt team to be involved prior Contract award during the bid phase and to establish the project execution plan.”</p> <p>“It takes 3 months to organize a job but at the same time, we have to be getting on with the execution. In fact, the PMT crucial disciplines MUST be involved prior to start.”</p> <p>“I don’t believe that there is a direct relation between cost effectiveness of the project to the PMT involvement at the beginning of the project. The cost effectiveness of the whole project relates more towards the quality of the deliverables in meeting the contractual obligations.”</p>
	<p>In order to meet Contractual requirements for local fabrication content in certain countries, how should FPSO Contractors respond in terms of staffing arrangements in order to maintain cost and quality for the FPSO projects?</p>
	<p>“They also need to train the local staff to understand the FPSO Contractor’s structure and way of working. Team work and full integration between home and local staff must be encouraged and nurtured.”</p> <p>“A full assessment of the locally available expertise including presence of the recognized vendors / subcontractors needs to be made in order to first assess what part of the work scope can actually be executed in country with manageable risk levels.”</p> <p>“Depends on location and its culture and also its level of experience. In Singapore, the culture tends to be less contractual, more focus on production. In the Middle East, it is far more contractual, ahead of production. For quality, this is primarily experience and less so culture. China has little FPSO experience and so the level of supervision has to be x2 to x4 more than you would put into somewhere like Singapore.”</p>
	<p>Do FPSO Contractors plan and schedule workshops to review work procedures over the project life cycle in order to ensure minimum changes to the works for</p>

	<p>the purpose of reducing cost?</p>
	<p>“This was done Piping Isometric Production and Pipe Support design. These are two activities which are exceptionally problematic to achieve in a timely and efficient manner as they require data from a multitude of sources at a time when the Process design is not frozen and construction has already commenced.”</p> <p>“Workshops are usually held to discuss project execution and operations related matters for example design and constructability workshops, etc. These workshops will ensure that the execution /construction part of the project is coherent with the design and specifications. Some design parameters may have not been identified during the pre-FEED or FEED.”</p> <p>“FPSO Contractor, PMT and Corporate members should try to prepare a set of tailored work procedures during the early phase of the project. After this phase regular workshops must be planned.”</p>
	<p>How should project staff be trained to capitalize on the known Critical Success Factors for the betterment of the FPSO projects?</p>
	<p>“Staff should be progressively moving to different execution positions within the project organization to understand each critical phases of the project.”</p> <p>“These CSFs should be widely available in written form to team members as they join the project. In addition, offsite training can be introduced and some form mentoring of junior or less experienced staff by experienced staff should be encouraged.”</p> <p>“Staff needs to be fully trained and exposed to these procedures to ensure that the tasks can be performed with minimal supervision. Most importantly the contractual obligations/requirements of the project must be clearly cascaded to the project staff. This information must be made readily available through an online portal accessible by all at any time.”</p>

Table 4.2: Respondents' Perception and Opinions on Reliance on Fabrication Shipyard

Issues	Respondents' Perception and Opinions
Reliance On Fabrication Shipyards	How dependent are FPSO Contractors on the relationship with fabrication shipyards? Why?
	<p>“Their ability to mobilise resources and complete the works has a direct impact on the overall schedule.”</p> <p>“Absolutely crucial because capacity is limited and schedules are so tight we need really good relationships so that we both focus on delivery, not commercial. Trust is key.”</p> <p>“With good working relationship it is much easier to negotiate claims and agree incentives/acceleration matters.”</p>
	How do FPSO Contractors ensure that the shipyards' workers are competent and have the necessary experienced to execute the works?
	<p>“Usually an audit of the yard will determine the suitability of the yard for the intended fabrication works. Prior to physical fabrication work commencement, welding procedures are qualified and welders need to be qualified as well. These causes a lot of re-work in the process and prolong the intended fabrication schedule.”</p> <p>“Regular monitoring and inspection of the yard post Contract. Again, Contract administration, QA/QC and reporting procedures are important to ensure success.”</p> <p>“Previous experience – usually is an easy decision due to the fact that FPSO contractors tend to award contracts to previously tried and tested shipyards.”</p> <p>“Meet with the contractors proposed PM let him explain how the job project will be executed and why it will be a success.”</p>

Table 4.3: Respondents' Perception and Opinions on Co-ordination with Major Suppliers

Issues	Respondents' Perception and Opinions
Co-ordination	How do FPSO Contractors ensure that major

With Major Suppliers	suppliers are consistent in their product or service qualities, which need to be supplied within project budget and deliver by agreed dates?
	“Previous experience executing similar package. Understanding expectation and requirement of FPSO Contractors.”
	“Regular QA/QC audits with site visits during manufacturing of equipment.”
	“Schedule of execution shall be benchmarked from similar product/project.”
	What sort of cost effective strategy (if any) has been implemented with the major suppliers to achieve successful delivery of products or services that are compliant with the Client’s quality requirements?
“Quality plan at the beginning of project to be approved by company and client.”	
“Long term agreement with manufacturer or supplier.”	
“FPSO Contractors should establish with major suppliers for critical item (i.e. long lead equipment) JVs or frame agreement to reduce the risks of schedule extension or cost overrun.”	

Table 4.4: Respondents’ Perception and Opinions on Co-ordination with Clients

Issues	Respondents’ Perception and Opinions
Co-ordination with Clients	The project responsibility matrix identifies the respective roles and responsibilities of the FPSO Contractor, Client and Client’s other major contractors / vendors, will this assist in reducing discrepancy or potential changes (drawings, interface data, specification) which may cause additional time and costs to execute the project?
	“It will provide clarity in term of respective roles and responsibilities. However, need to make sure that the matrix is clearly defined.”

	<p>“A clear responsibility matrix will help to solve many disputes.”</p> <p>“Transparency to Client in execution of activity could allow client to be more flexible and be update for rapidly answering queries and changes.”</p>
	<p>How do FPSO Contractors manage potential changes from Client’s other major contractors / vendors to ensure that it delivers a project within budget and schedule?</p>
	<p>“Management of Change procedures built into POs and subcontracts. “</p> <p>“By having a clear change management procedures have contractual protection for additional cost and schedule impacts.”</p> <p>“Joint Risks Analysis/workshops can help in identifying risks linked to potential scope changes. Dedicated contingency plan can be developed to mitigate the identified risks.”</p> <p>“Is there any value in contractors uploading their interface data to a common ftp site to ensure that all project participants have the earliest possible opportunity to review and base their design on it, to avoid bottlenecks while Client postboxes interface data between its various contractors?”</p> <p>“FPSO Contractor must be able to demonstrate to the Client how the works done by “others” are impacting the critical path of its project.”</p> <p>“Any changes must be identified and reported to the client as soon as possible. The change must then be assessed and any critical changes must be managed on a daily basis. The change must be incorporated into the schedule and the schedule may have to be revised to allow activities to be rearranged to prevent delay.”</p>
	<p>How do FPSO Contractors communicate, both internally and with the Client, on the subject of change management which could affect the project cost and schedule?</p>
	<p>“Two levels – informally, through personal contact between say PMs and by Supervisory</p>

	Boards; formally, through formal correspondence.”
	“Everyone in the Project Team is responsible to identify potential changes. Upon early identification, formal notification should be given to the Client indicating both cost and schedule impact.”

Table 4.5: Respondents’ Perception and Opinions on Handling Stakeholders

Issues	Respondents’ Perception and Opinions
Handling Stakeholders	What sort of stakeholder analysis is being undertaken that will allow the FPSO Contractor to accept or mitigate the risks involved in dealing with developing nations or demanding International Oil Companies and National Oil Companies? Will this derail the project’s costing and schedule?
	“Insufficient focus is given, when a project is first targeted as a commercial prospect, to screening and evaluating the Client, its Co-Venturers (including national oil companies) and the political and country risk presented by the project.”
	“The risks dealing with developing nations are much greater than with the International Oil Companies and National Oil Companies. These risks can have a detrimental impact on the cost and schedule for a Project.”
	“Corporate Risk Assessment programs (leading to stronger T&Cs to protect the FPSO Contractor against risk).”
	Who are the specific personnel / team members assigned to look into communication with all stakeholders during project execution and if so, what is the sort of communication strategy?
	“Project managers and line management. Communication strategy is based on regular information sessions / meeting to focus on progress milestones and budget follow up.”
	“Interface with Client: discipline leads, project manager and project sponsor interface with their

	<p>counterparts within Client organization.”</p> <p>“Interface with national oil company, co-venturers and in-country regulatory authorities: Project manager or designees, but in practice Client may act as the interface between FPSO Contractor and these in-country agencies.”</p>
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Table 4.6: Respondents’ Perception and Opinions on Managing Project Schedule

Issues	Respondents’ Perception and Opinions
Managing Project Schedule	<p>How do FPSO Contractors maintain works in accordance with the agreed project schedule?</p> <p>“Segregation of works in manageable pieces (delivery managers, mini-projects).”</p> <p>“Put in place various indicators based on physical quantities.”</p> <p>“Project schedule is agreed and use to monitor the project daily each project team member is following the relevant part of the schedule to make sure that the part which fall into his responsibility is in line with the schedule.”</p> <p>“On new build, the schedule is quite rigid but on conversion jobs, the construction sequence can be adapted to overcome delays. You have to work the plan to deal with changing circumstances.”</p> <p>Will the project schedule be the main driving force in determining how the FPSO construction works are to be executed and if so, why?</p> <p>“In theory yes – but construction in shipyards is an activity that by nature cannot strictly adhere to the project schedule due to the number of variables such as manpower availability, weather, material availability, delivery of equipment etc.”</p> <p>“It determines works that are required to be executed in a sequence and logical manner. A good schedule is easily understood for proper advance planning by all parties involved.”</p> <p>“All these milestones have been captured and agreed in the contract. Any delay from these milestones will</p>

	<p>cause massive cost lost to the project.”</p> <p>“Yes to large extent. The construction works still need to be carried out in a particular sequence but there may be more parallel activities if the schedule is tight and less if the schedule is less demanding.”</p>
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The responses provided tally with the literatures review and issues related to the scope of work stood out as one of the main reasons for the cause of a number of events. The responses related to CSFs have not been included under Tables 4.1 to 4.6 due to the fact that it will be described under item 4.6 below.

4.4 Analysis of the Interview Conducted with FPSO Contractor’s Senior Management

The researcher has the opportunity to conduct a face to face interview with Mr. Ivan Replumaz, the Managing Director of the market leader of the FPSO industry, SBM Offshore of the Kuala Lumpur Execution Centre since 2006. He worked for the Bouygues Group over a twenty four (24) year period in various divisions and became CEO then Chairman; in 2002 he joined Technip as CEO of the Offshore Branch. The researcher believed that the interviewee background would have a good understanding of the FPSO industry as a whole.

Interviewee was formally informed of the reasons for the interview and on why the interview is required. The interviewee

was briefed on the CSFs that were required at the end of the interview where the CSFs would be of assistance to any FPSO Contractors in terms of cost and schedule basis.

The interviewee was willing to wait for the researcher to list the words being mentioned to ensure that the interview was fully captured. The researcher has managed to capture all issues brought up by the interviewee with the help of the pre-prepared questions provided earlier. The detailed interview transcript has been listed under Appendix B-Interview Transcript.

Table 4.7: Analysis of the Interview Statements

No.	Analysis of the Interview Statements
1	Easier to employ engineers will mean that it is easier to commence a project at a quicker manner as well as it is nearer to other clientele's project areas. This will assist the projects in meeting the schedule.
2	Lower operating cost compared to European offices.
3	Good relationship with shipyards will lead to better work arrangements which will generate lower cost in getting the works done.
4	Such strategy will bring proper control over the cost and thus, the project schedule will fall in place.
5	With cost of financing settled (Catherine 2011), it won't affect the overall construction cost.
6	With the other aspect of FPSO industry, SBM Offshore would have leveraged against other competition. In this manner it will not affect the cost in operating the FPSOs or building the FPSOs.

7	With years of experience it has allowed SBM Offshore be the leader in various areas of the industry. This will allow them to save costs in certain areas compared to their competitors.
8	With plentiful of advantages in the FPSO industry, the senior management has no doubt that to stick with same industry.
9	SBM Offshore is still ahead in terms of its engineering design and therefore, cost wise, it is not viable for shipyards to move into this area of the business.
10 to 12	SBM Offshore's is rather unique compared to IOCs and NOCs. With FPSO technologies tend to be more complicated with deepwater oil fields, IOCs and NOCs will leave it to the FPSO Contractors to deal with such construction works. With enhanced technologies, Capex growth is also critical and this will increase the risk and cost factors.
13	SBM will no doubt comply with the regulatory rules in all areas of operations and local laws of countries that they operate in. This will build reputation and avoid any penalties that will increase cost.
14 & 15	With good stakeholders' management, SBM Offshore will be able to gauge the IOCs or NOCs' next move and to facilitate its preparation for any decision made.
16	When SBM Offshore is able to provide the resources as stated, it will be able to manage the FPSO projects with ease at lower cost too.
17	With these CSFs, FPSO Contractors will be able to monitor and operate their works in an affective manner which will lead to shorter completion date for the project.
18 & 19	Lessons learned is taken very seriously by SBM Offshore as mistakes will cause more money to re-execute the works again which will also cause the project to be delayed.

20	CSFs are being developed by SBM Offshore through the lessons learned from other projects and it is already in the process.
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The above-mentioned analysis will help FPSO Contractors to monitor the relevant steps prior to deciding any moves for certain FPSO projects. It will remain as a guide as different FPSO Contractors may have different means of tackling each subject. Different FPSO Contractors may have worked on certain strategies for a number of years before finally embarking on the moves. It is very rare for FPSO Contractors to share their strategies as the FPSO industry comprises only a few big players and a few other smaller FPSO Contractors.

4.5 Analysis of Common Themes or Concepts

The researcher has listed the top ten (10) themes / concepts that are being mentioned frequently by respondents based on the CSFs submitted or quoted. The top ten themes have commanded 70.56% from respondents' answers based on five hundred eighty eight (588) CSFs. The five hundred eighty eight (588) CSFs were tabulated by adding up all the respondents' CSFs listed in the structured interview.

4.5.1 Schedule / Planning / Project Control

The ‘Schedule / Planning / Project Control’ has taken the top spot overwhelmingly, as per the Table 4.8 below, of more than twenty (20) themes / concepts being provided by the respondents. Obviously, any simple mistake in ‘Schedule / Planning / Project Control’ could cause consequential losses to the project’s bottom line. Respondents were concerned mainly with this ‘Schedule / Planning / Project Control’ theme where 19.90% of the responses were related to this.

For example, the wrong sequence planning of a particular work activity due to non-clarity of scope of definition could jeopardise a particular module in the FPSO whereby rework, additional man-hours and costs are required to amend the situation. If additional man-hours are required, this will cause the project to be delayed and thus, cost and schedule. If not careful, it could be part of the statistic where upstream oil and gas megaprojects, in which FPSO projects are part of it, around the world are experiencing cost overruns and schedule slippage at an extreme extent at an average of 25% and 22% respectively (Merrow 2012).

Table 4.8: Analysis of the Themes and Concepts

Themes and Concepts	Total	Percentage
Schedule / Planning / Project Control	117	19.90
Engineering Deliverables	50	8.50

Clear Scope of Work	43	7.31
Clear Communication	42	7.14
Adequate Resources	35	5.95
Experienced PMT	31	5.27
Stakeholder Management	29	4.93
Prompt Delivery of Equipment and Materials	27	4.59
QA/QC Processes	22	3.74
Experienced Workforce	19	3.23
<i>*Percentage is based on the Overall Total of 588 CSFs quoted</i>		70.56

4.5.2 Engineering Deliverables

This is followed by the ‘Engineering Deliverables’ theme which had garnered about fifty (50) mentions in the research equivalent to 8.5% of the respondents’ CSFs. Any slight overlook or calculation by a Project Engineer could cause the particular module to be reworked and tested again. This is most probably caused by not having a clear understanding of the contractual obligations or scope of works required. As such, this may cause additional time as in man-hours and costs that are required to be incurred in order to align with the contractual requirements. The mistakes in engineering could be detrimental as in procurement of equipment may be wrongly designed due to unclear definition of the job scope and thus, may have to re-design and re-built. This will delay the

equipment to be delivered to the shipyard for integration into the FPSO.

4.5.3 Scope of Work

Where 'Scope of Work' is concerned, any misunderstanding will cause certain parties to miss out certain works and upon realisation, it may cause delay to build the particular equipment or to provide the relevant service. If there is a delay, certain works must be accelerated to catch up with the lost time. Such acceleration will usually cause additional amount to be paid as additional man-hours will have to be put in to finish the work as soon as possible. The FPSO Contractors could be selling products to the Clients which is not what the Clients had expected as the Clients would have expected more or something different. At times, the problems arose due to Clients' poor understanding of the job scope, do not know what to expect or what they wanted or when they wanted it. Another example could be the delay caused by Client's other major contractor could derail the whole project as their understanding of the scope of work was poor and unable to rectify according to the contractual obligations. Mutual understanding of the scope clarification must be ensured so that no gray area remains. Only when the scope of works matter is resolved, the project schedule can be prepared accurately.

4.5.4 Clear Communication

As for the 'Clear Communication', it is definitely a major issue within other industries. The subject communication itself can be studied or research as a thesis itself. This proved how critical 'Clear Communication' is all about. It is not just plain letter writing but how the FPSO Contractors communicate with Clients, major suppliers, employees and relevant stakeholders in order to convey the right message to carry out the project works in an efficient and effective manner. Failure to do so will eventually lead to delay in the project schedule and thus, incurring more cost to catch up with the lost time.

4.5.5 Adequate Resources

If ever a project is short of resources, be it manpower, equipment or tools, it will lead to massive delay as project works could not commence or unable to continue due to inadequate resources. The planning for such resource is of utmost importance with timeliness of deliveries of the relevant resources has to be exact and accurate.

4.5.6 Experienced PMT and Experienced Workforce

The principal for 'Experienced PMT' and 'Experienced Workforce' works are the same i.e. inexperienced staff could lead to mistakes, delay in making proper decisions, delay in executing the works in a correct method, . While the salaries and wages continued to be paid, the project works may not be in tandem. This

means to say that even though cost outlay is increasing, the project work may not progress in line with the cost outlay. Therefore, FPSO Contractors have to be careful in appointing the right staff to the right positions.

4.5.7 Stakeholder Management

Stakeholder Management at times is not important but it will be too late to seek their understanding when it is critical to do so. It is one of the main prerogatives to maintain close relationship with all of the project stakeholders at all times and to understand each other's responsibility matrix or scope clarification is required. Stakeholders in this case would be as follows:-

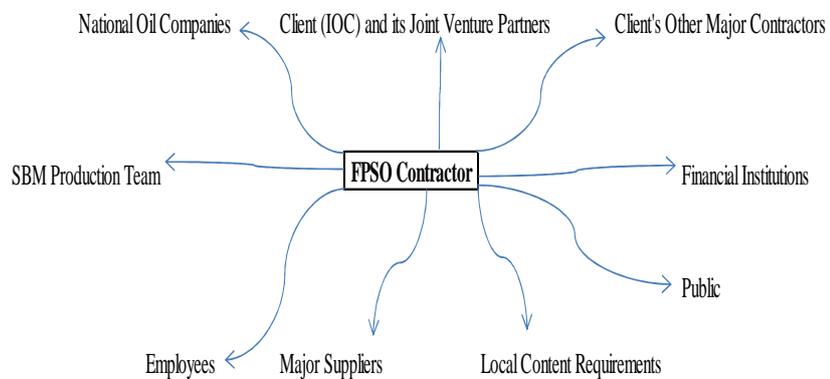


Figure 4.7: FPSO Contractor' Stakeholders

When the stakeholders as identified in Figure 4.7 are managed and the project decisions' reasons are made known to them, it would be easier for stakeholders to make informed decisions at a shorter period. This will enable to project to progress further with the approvals from the stakeholders and cost savings could happen

when stakeholders are willing to work together for the benefit of the stakeholders.

4.5.8 Prompt Delivery of Equipment and Materials

In any FPSO projects, it is important for 'Prompt Delivery of Equipment and Materials' be it free issued by Client to FPSO Contractor or by FPSO Contractor to shipyards or fabricator yards. Good understanding of the contractual obligations would help in meeting the respective datelines. Only when people are not clear of the contract's scope of works, delay of such deliveries of equipment and materials would occur and definitely cause massive delay to the schedule. Work sequence would be affected as well which will cost for if reworks are required.

4.5.9 QA/QC Processes

The last item in the top ten listing is 'QA/QC Processes'. It is critical for all parties to monitor the quality of the works being produced, manufactured, built, constructed, and processed from the commencement of the FPSO project. Failure to do so will incur reworks, additional time and cost to correct the mistakes.

4.6 Analysis of the Critical Success Factors

Another aim of the structured interview was obtain the respondents' views on the relevant CSFs for the FPSO project in six (6) major areas identified as below. The respondents were

requested to list as many CSFs as they can. The thirty four (34) respondents provided five hundred eighty eight (588) CSFs in the end with an average of seventeen (17) per respondent. It must be noted that rankings were not given but respondents were informed to provide the CSFs based on their knowledge and work experience. The researcher has compiled the top five (5) CSFs for each of the major areas:-

4.6.1 Critical Success Factors Mentioned By Respondents (Reliance on Experience)

Table 4.9: CSFs on Reliance on Experience

No.	Critical Success Factors Mentioned By Respondents (Reliance on Experience)	Number of Respondents
1.	Proper planning & scheduling during project execution	12
2.	Experienced workforce and lead staff	11
3.	Clear understanding on Client's scope of work	10
4.	Good engineering design & deliverables	9
5.	Strong PMT	7

It is clear cut that 'Proper Planning & Scheduling during Project Execution' is done right from the commencement of the FPSO project. At least twelve (12) agreed to that. With the planning & scheduling done properly, the 'Experienced Workforce and Lead Staff' will be able to execute the works according to the schedule and keeping the schedule throughout the project. In order for the

planning & scheduling to be executed properly, one must first understand the Client’s scope of work or specification that is required of the FPSO Contractor. Once everyone is clear about the scope of work, it will be easier to control the workflow and cost will be maintained due to lesser reworks. With the clear understanding on the specification, the engineering team will be able to produce detailed engineering designs which can be issued for construction purpose. A ‘Strong PMT’ team is required to ensure that all the works are carried out according to the schedule.

4.6.2 Critical Success Factors Mentioned By Respondents (Reliance on Fabrication Shipyards)

Table 4.10: CSFs on Reliance on Fabrication Shipyards

No.	Critical Success Factors Mentioned By Respondents (Reliance on Fabrication Shipyards)	Number of Respondents
1.	Experienced workforce	15
2.	Sufficient manpower & materials	13
3.	Reliable schedule	10
4.	Quality of engineering deliverables	10
5.	Free issued materials to be issued according to schedule	8

When it comes to Reliance on Fabrication Shipyards, the CSFs have changed to those related and relevant to fabrication shipyards. Fifteen (15) respondents have quoted that ‘Experienced Workforce’

at the shipyards hold the key to success factor for the FPSO projects as this factor will lead to works being completed within budget and agreed schedule. This is followed closely by the ‘Sufficient Manpower & Materials’ factor which is a must to meet the project schedule. The first two CSFs should also fit into the ‘Reliable Schedule’ as however experienced or sufficient; the moment the schedule is not followed it will cause the project to be delayed. To ensure that the project schedule is maintained, the ‘Quality of Engineering Deliverables’ are as important as this will also determine whether the ‘Free Issued Materials’ can be delivered on schedule by the Clients or FPSO Contractors.

4.6.3 Critical Success Factors Mentioned By Respondents (Co-ordination with Major Suppliers)

Table 4.11: CSFs on Co-ordination with Major Suppliers

No.	Critical Success Factors Mentioned By Respondents (Co-ordination with Major Suppliers)	Number of Respondents
1.	Understanding Client’s specification	12
2.	Regular progress meeting	11
3.	Regular quality control inspection	8
4.	Project control mechanism in place	7
5.	Quality of engineering deliverables	7

From the above table, it can be deduced that Major Suppliers tend to deviate from the ‘Client’s Specification’ as twelve (12) could have experienced similar situation. This will definitely cause delay as Client may not approve the changes without their approval. Even if the Client was to approve, the Client would have taken additional time to approve the deviation. It is important that ‘Regular Progress Meetings’ and ‘Quality Control Inspection’ are held at Major Suppliers’ premises during their work execution. This is to ensure that the Client’s specification is met accordingly. Once the Client’s specification is fully understood, the ‘Project Control Mechanism’ has to monitor and control the delivery of the products or services. The ‘Quality of Engineering Deliverables’ is one of the major factors as it is being mentioned by the respondents in this topic too.

4.6.4 Critical Success Factors Mentioned By Respondents (Co-ordination with Clients)

Table 4.12: CSFs on Co-ordination with Clients

No.	Critical Success Factors Mentioned By Respondents (Co-ordination with Clients)	Number of Respondents
1.	Good communication	10
2.	Interface management	10
3.	Clear definition of project scope	9
4.	Integrated and solution orientated teams	8
5.	Change management	5

It is the obvious when dealing with the Clients that is 'Good Communication' is required to put forward the right information or to seek for Clients' approvals. Poor communication will lead to misunderstanding and will lead to unclear direction or misguided in the work execution which will lead to costly mistakes in the project. 'Interface Management' is another aspect of passing the accurate information and data between related parties and any slight misinterpretation due to miscommunication will lead to certain works being totally missed out. Frequent delay in 'Interface Management' will cause the project to be delayed as work cannot proceed due to missing information and data. Alternatively, works may proceed but if there is a misalignment subsequent reworks may be very costly as the project schedule may be affected as well. Therefore, 'Clear Definition of Project Scope' has to be understood from commencement of project to avoid clashes during project execution. To avoid the above-mentioned, an 'Integrated and Solution Orientated Team' must be set up to overcome miscommunication and delays. If the 'Interface Management' requires a variation to the works, the 'Change Management' process has to kick off immediately to avoid delay to the project schedule. With such arrangements, the project will benefit as the CSFs are made known.

4.6.5 Critical Success Factors Mentioned By Respondents (Handling Stakeholders)

Table 4.13: CSFs on Handling Stakeholders

No.	Critical Success Factors Mentioned By Respondents (Handling Stakeholders)	Number of Respondents
1.	Prompt awareness of project decisions	9
2.	Effective communication	8
3.	Understand stakeholders' decisions and interests	8
4.	Regular meetings to provide latest updates	5
5.	Transparency on issues that affects the project	5

Stakeholders have interests in the project due to their investments, supply of products, provision of services, as employees, granting of approvals due to national interests. Various stakeholders will have different reasons linked to the project. Therefore, 'Prompt Awareness of Project Decisions' is critical as stakeholders may alter their strategy or decide to exercise another option due to certain project decisions made. To ensure that stakeholders are aware of project decisions, 'Effective Communication' is critical to the success of the project. The FPSO Contractors will have to learn to 'Understand Stakeholders' Decisions and Interests' and work on alternative approaches to overcome any hindrance or if different directions are given. In any given situations, it is highly recommended that 'Regular Meetings' are to be held to provide

latest updates to the stakeholders. This is a form of good communication too. If there is any negative event that may affect the project's profitability, it is of utmost importance that FPSO Contractor has to be 'Transparent' on such issues.

4.6.6 Critical Success Factors Mentioned By Respondents (Managing Project Schedule)

Table 4.14: CSFs on Managing Project Schedule

No.	Critical Success Factors Mentioned By Respondents (Managing Project Schedule)	Number of Respondents
1.	Reliable schedule	11
2.	Proper planning and regular review	10
3.	Identify critical path and key milestones	8
4.	Detailed schedule of engineering deliverables	6
5.	Prompt delivery of free issued materials	4

Based on the responses, this group of respondents has picked 'Reliable Schedule' as the main CSF for this related topic. This is no doubt one of the main concerns under the analysis of Themes or Concepts. Another related CSF that is 'Proper Planning and Regular Review' came in as the second most important CSF. Proper planning is vital to the FPSO projects as the right sequencing of work activities may just turn the project execution

around with 'floats' in healthy balance. 'Detailed Schedule of Engineering Deliverables' will determine the reliability of the schedule if the engineering deliverables can be issued on schedule and with correct designs. Upon issuing the engineering designs, Major Suppliers or the Client can rely on them to build the relevant equipment. With the engineering progress maintained, 'Prompt Delivery of Free Issued Materials' will materialise. Reliable schedule is important in the fast track FPSO projects due to the urgency of IOCs and NOCs to bridge the supply gap in FPSOs (Mosley 2012).

It must be mentioned that the responses provided were based on each respondent's job designation, company's nature of business, job responsibility and number of years of working experience.

4.7 Established Critical Success Factors

In the respective analysis as described above, the researcher has established the CSFs for each of the major topics and ensure that CSFs that have been developed or to be developed are able to guide and assist future similar projects to avoid the risks and/or problems faced previously relating to schedule and budget overruns.

This chapter has analysed the results obtained from the thirty four (34) respondents through Respondents' Demography, Analysis of the Respondents' Response to the Structured Interview, Analysis of

the Interview Conducted with the Managing Director of FPSO Contractor, Analysis of Common Themes or Concepts and Analysis of the Critical Success Factors. The following chapter shall interpret the results and compares it with other literature findings. Further discussion shall be made on lessons learned.

5.0 DISCUSSION

The research has so far obtained results from the structured interviews together with a face to face interview being conducted. The results from the structured interviews have been validated by comparing with the literatures review which was found to be consistent throughout the research process and this would eventually confirm the existence of grounded theory for this research. In this particular chapter, the researcher would be discussing and comparing the results obtained against other forms of research done, for example, the literature review. The researcher's own opinion from personal work experience in the onshore and offshore oil and gas industry would be presented too.

The discussion begins with the pilot survey conducted and then followed by the respondents' perception / opinion on the Reliance on Experience, Reliance on Fabrication Shipyards, Co-Ordination with Major Suppliers, Co-Ordination with Clients, Handling Stakeholders and Managing Project Schedule Thereafter, the discussion would move on to the structured interviews conducted and respective analysis done based on the CSFs.

5.1 Pilot Survey

The pilot survey was necessary to ascertain the right topics to be put into the structured interview. Prior to selecting the right topics, it is important to select the right persons to enquire about the topics. The pilot survey was done with people who are recognised in the FPSO industry. Before conducting the pilot survey, the researcher read up a few articles (van Dijk et. a. 2012, Meek, Cariou & Schier 2009 and Mierendorff 2011) to obtain possible main topics that could be used for the researcher's structured interview. Thereafter, the researcher proceeded with the face to face pilot survey with both the Operations Director and Contract Department Manager from SBM Offshore of the Kuala Lumpur Execution Centre and the Commercial & Contracts Consultant, via email. The researcher conducted the pilot survey to validate and verify the current main topics in the FPSO industry to compare against the literature review and ensure that the main topics were in line with the practitioners in the FPSO industry. This gave assurance on the correct main topics to put forward to the respondents in search for the results that are in line with the Project Research's aim and objectives.

5.2 Respondents' Perception and Opinions

Even though the respondents, numbering thirty four (34) of them, came from various backgrounds, the respondents have provided the research with grounded theory methodology responses. It has been

stated that “there should not be any expectations about what might be happening in an area of interest” (Kwok, McCallin & Dickson 2012). With the approximate four hundred (400) accumulated years of working experience, the respondents’ perception and opinions can be regarded as the practitioners’ current and existing manner or method to execute the FPSO projects in South East Asia, Europe, USA and Angola. The responses provided were through the years of work experience, knowledge, the specific know-how, leadership, technology development and FPSO experiences that could be shared, used in and knowledge being transferred to other regions as well. With the years of experience and such bountiful knowledge, the responses were actually “saturated” as through the years respondents have identified certain ‘theories’ and knowledge in the FPSO industry and through this research, the responses provided were similar in nature.

The Grounded Theory Method is like of a partnership between the researcher and the respondents with mutual understanding and meaningful reconstruction of stories into a grounded theory model (Lopes 2010). Based on this model, the researcher would extract the perception and opinions from the structured interviews. The researcher noticed and observed that a majority of the respondents provided ideal situations but it can be read that the following issues need to be avoided:-

- a) Inexperienced PMT;
- b) Delay in delivery of free issued materials to fabrication shipyards;
- c) Failure to understand Clients' specification;
- d) Breakdown in communication with Clients;
- e) Insufficient information provided to stakeholders; and
- f) Unrealistic project schedule.

Responses are almost similar although the same words were not used but many responses for the relevant main topics carried the same meaning or favourable to certain theme / category. The researcher could see from the CSFs that the responses would be centred within the top ten (10) themes or concepts which were proven in Chapter 4. The top ten (10) themes or concepts were mentioned / stated by the respondents up to 70.56% of the twenty plus themes or concepts. The researcher did inform twenty (20) other respondents, who were either slow in responding or too busy to respond to the structure interviews, that they could opt not to respond with the reason being given to them that the targeted number of respondents has been met.

The following discussion is on the six (6) main topics where respondents' perception and opinions are compared against the practitioners preferred method of executing the FPSO projects and

also with other researches, articles and journals that were sourced from the literature review.

i) Reliance on Experience

The respondents have highlighted the need for an experienced PMT or workforce for FPSO projects even from the commencement of the FPSO projects. For example, a respondent has stated “With previous experience on FPSO projects, there is no special experience required for newbuild, conversion or re-deployment projects – as familiarity with the uniqueness of FPSO projects will have been gained.” This has been concurred during the Sanha LPG FPSO development led by SBM Offshore in order to achieve project success (de Ruyter, Pellegrino & Cariou 2005). Furthermore, it calls for an integrated PMT together with the Client’s PMT from ChevronTexaco. In the employment of team members for the LNG FPSO project development (Meek, Cariou & Schier 2009), the following criteria have been set to aim for project success:-

- a) Individual team members must have the accumulated experience from concept design right through actual operation;
- b) Extensive experience in designing and building complex offshore oil and gas facilities;
- c) Operational experience; and

- d) Hands-on experience on projects that come closest to an LNG FPSO.

Another respondent opined that “Critically for conversion work as it is a much more complex engineering and construction process.” where experience for the PMT and workforce would be critical for the project success which is similar to the points brought up in literature review. From the above, the researcher could see that owing to non-clarity of the Client’s specification, only a team that could work together could overcome it by working together and towards the same goal.

- ii) Reliance on Fabrication Shipyards

The number one concern with the respondents in shipyards dealings was related to the Client’s specification or contractual obligation related to the scope of work. If the initial part of the project could not be agreed mutually we could foresee major commercial problem that could stall the FPSO’s project works and erupt into a legal battle between the FPSO Contractor and shipyard owner (Parker 1999, Cassidy 2001).

A number of respondents have also indicated that fabrication shipyards’ ability to mobilise the required resources to complete their portion of the works is critical (Fairburn et. al. 2004). Respondents through the structured interviews have indicated that

deliveries of equipment and materials must be as per agreed schedule as any delay would surely cause impact on time and cost. This applies to free issued equipment and materials from FPSO Contractors and Clients and it is confirmed with the practitioners who executed similar FPSO projects (Bybee 2006) where this happened for the Kizomba A and Kizomba B FPSO projects. In analysing further on the Kizomba A and Kizomba B FPSO projects, the method of Design One, Build Two Strategy will generate the following benefits (Wyllie & Johnson 2006) that will bring success to the FPSO projects:-

- a) Cost savings from reduced engineering and project management man-hours.
- b) Supplier discount from repeat orders of identical equipment.
- c) Shipyard discount from repeat construction contracts.
- d) Schedule savings from reduced engineering and procurement time, and shipyard familiarity with scope of work.

An interviewee stated that even though the FPSO industry's competition is tough, SBM Offshore has decided to forge partnerships with shipyards for the FPSO industry purpose. Hence, the participation in the setting up of both Brasa and Paenal shipyards located in Brazil and Angola. Although the operating costs of these shipyards could be on the higher side, an interviewee mentioned that SBM Offshore has taken into consideration of

meeting the local content requirements. With the top management's nod, SBM Offshore has transferred their experienced staff to manage the shipyards initially. This was to stabilise the both operations and leadership. The interviewee believed that once leadership has been developed properly, managing the shipyard would be easier especially with local Angolans and Brazilians being appointed and promoted to senior positions. Such high costs could not be viewed as negative but in fact it would contribute to the success of future projects in the West African and South American / Gulf of Mexico regions on a long term basis. With the shipyards in hand, SBM Offshore is a step ahead of their competitors in these regions. In keeping up with the competition, Technip has made similar move whereby they have tied up with Malaysian fabrication shipyards and McDermott International Inc. has ventured to Indonesia to source for a local fabrication yard too. In order for SBM Offshore and Technip to churn out more FPS such as FPSOs and FLNGs, both SBM Offshore and Technip have decided to forge partnerships with fabrication shipyards in China and South Korea respectively.

From an interview, an interviewee did mention that fabrication shipyards' work rate and experience have improved tremendously in the FPSO industry but they were not ready to venture on their own to build FPSOs as a whole. Besides that, it is more risky for shipyards to move into the FPSO industry where they not

accustomed to the complex scope of works required from an established FPSO Contractors.

How much does FPSO Contractors rely on fabrication shipyard? A respondent from FPSO Contractor background said “Absolutely crucial because capacity is limited and schedules are so tight we need really good relationships so that we both focus on delivery, not commercial. Trust is key.” The researcher managed to get a response from a respondent with Fabricator / Shipyard background who mentioned “FPSO Contractors have to trust the fabrication shipyard and assess the work done by them on previous projects including weld fail rates and the likes.” The researcher would say that the shipyard is actually one of the main factors to achieve project success. A respondent from the Oil & Gas Operator background has agreed with the researcher on this. Any delay or failure on works being carried out at the shipyard would definitely hamper the project completion within agreed schedule. But how do you trust them? Two (2) other respondents did state as follows, “Previous experience – usually is an easy decision due to the fact that FPSO contractors tend to award contracts to previously tried and tested shipyards.” and “Review previous projects executed at the yard and understand if the work is really comparable to the new project to award.” However, another respondent from the FPSO Owner background mentioned “More could be done to keep these suppliers competitive by tendering each project rather than

inducing complacency by repeat business to the same fabrication yards regardless of their performance on previous projects.” In other words, detailed checks on the shipyard’s capability should be conducted in case of what has happened with Shell’s FDS development (Fairburn et. al. 2004). As the FPSO industry is growing fast, it is vital to ensure that dealings with the shipyards are executed accordingly with the right commercial and contractual approach to avoid schedule, quality and cost overruns (Parker 1999). The researcher is of the opinion that the FPSO Contractors should be aware of the followings in dealing with fabrication shipyards:-

- a) The previous experiences in handling the similar FPSO specification.
- b) Capability in handling new FPSO projects with their current workload.
- c) Are there any new projects to be undertaken in the near future?
- d) Fabrication shipyards’ capability in handling additional works in view of changes to delivery of free issued items from FPSO Contractors or Oil & Gas Operators.

A respondent mentioned “Proactive approach to early warning signs of schedule or cost overrun: monitoring the shipyard resources allocated to the work and increasing resources where necessary to maintain schedule and budget.” This respondent is

well aware of shipyards' situations and would look into the availability of shipyards' resources available.

iii) Co-Ordination with Major Suppliers

Few respondents agreed that early placement of purchase orders for equipment and materials would enable those suppliers to commence their works. Such arrangements would be easy on the suppliers as other FPSO Contractors could be in the midst of placing similar purchase orders too. This is to avoid late delivery of the equipment and materials to the shipyards which are usual worksite for the integration of the equipment and materials (Shimamura et. al. 2006). In order to place the correct purchase orders with sufficient scope definition available depends on FPSO Contractors' understanding of the Clients' specifications. Clients must be able to inform what they wanted, when they wanted it and according to which applicable operational methods. In conducting the structured interviews, at least six (6) respondents had mentioned the following in similar statements:-

- a) audit and inspection before, and at regular intervals to maintain, approval of suppliers as authorized vendors;
- b) investigating track record on previous projects before approving suppliers;

- c) regular inspection, monitoring and management during execution of each project, including monitoring resources allocated to the project; and
- d) active management at project manager level; escalation of serious problems to senior management of FPSO Contractors and suppliers; regular (every 3 months?) sponsors' meetings of those senior management representatives to ensure the project remains on track and address issues before they become serious problems.

iv) Co-Ordination with Clients

FPSO Contractors should collaborate with the Clients or Oil & Gas Operators through positive channels for instance at conferences or forums, for example at the annual Offshore Technology Conference held in Houston, USA. Major FPSO Contractors and Operators, Production Contractors and Oil & Gas Operators would deliver and share their experiences about the offshore projects challenges and CSFs to overcome the complexities of the deepwater and ultra-deepwater oil field developments (Vardeman et. al. 2005). Co-ordination with the Clients is important which was seen in the Greater Plutonio FPSO's contracting strategy. Upon further discussion on the strategies to construct the FPSO, the Client decided to split the contracts for various six (6) major works and adopted mixed contracting strategy that would ensure that the schedule and cost are protected (Stewart 2008). Communication

with Clients and FPSO Contractors need to take into account of Clients' perspective due to them knowing their oil field's data better and that they would have executed similar FPSO projects previously (Adhia 2004). All the above measures were taken to ensure that the relevant scope of works was carried out according to the specific contracts. The researcher would like to extract a few sentences from a literature written by an author from the FPSO Contractor's background (Loez 2002):-

“The art of war is to deploy one's troops in such a way that they are everywhere at the same time, all the time – Napoleon”. The same is true for an FPSO project. One has to be everywhere at the same time. And the battle to be fought is all the harder for the enemy is ill-defined. The enemy is not, as one might think, the client. Quite the opposite, it is better to consider the client as the main ally. The enemy is the disorder, inefficiency, internal friction or, to use a term from thermodynamics, “entropy”.

The researcher could relate the above statement to the clarity of scope of works amongst all stakeholders involved.

v) Handling Stakeholders

SBM Offshore's vital accumulated years of experience through the six thousand (6,000) plus workforce does provide them an edge which is taken into consideration by financial institutions being one

of those major stakeholders of SBM Offshore's projects. The interviewee is of the opinion that financial institutions found it easier to provide huge banking facilities to SBM Offshore due to their FPSO experiences, track records and being the market leader in the FPSO industry. With favourable response from the financial institutions, SBM Offshore has been able to source for banking facilities at favourable interest rates which is considered a CSF. One of the respondents said "The FPSO Contractor should have an in-country sale representative who builds a relationship with the client personnel through-out the pursuit of an award to develop and thorough understanding of the client drivers and motivation. Understand whom the client reports to and what are the deliverables / facilities required to ensure a successful project at the highest level." This is truly one method to understand the stakeholders and it would make it easier to handle their requests and get to "bring behind-the-scene benefits" as mentioned by another respondent. To understand the stakeholders, partly the FPSO Contractors would have to listen to the stakeholders' perspective for the particular FPSO projects (Adhia 2004) and that the stakeholders must understand FPSO Contractors' decision and subsequent consequences on quality, cost and schedule, if any. As what one of the respondents had stated "On a scale from proactive/informative to reactive/combative: Daily/weekly/monthly progress meetings and reporting; interface meetings; submission of engineering documents; technical and interface queries; site

instructions and queries; variation requests, proposals, instructions and orders; non-conformity reports; formal correspondence; dispute resolution at various levels of management; mediation; arbitration, litigation and other formal dispute resolution.”

Interface management is an important factor in the FPSO industry. A respondent from the Oil & Gas Operator stated that Project Sponsors and Managing Directors should meet on regular basis to resolve differing understanding and opinions on the scope of works and to agree on a common goal which could lead to smooth execution of the works. The respondent did mention also that clear definition of the project goals are to be shared with the IOCs and NOCs in order for everyone to be clear of their respective responsibility matrix of scope of works.

vi) Managing Project Schedule

Most of the respondents are in agreement that as long as the project schedule are in place with the engineering deliverables finalised within the agreed schedule, the project would be heading the right directions. Although these two factors were recognised as critical success factors, FPSO Contractors and Oil & Gas Operators are still finding cost overruns a handful issue to overcome. A schedule is important which is considered an important overall strategy to meet the project objectives (Pinto & Slevin 1987). The schedule is categorised as part of the planning stage whereby the strategic

objectives was to achieve the intended project goals. Project teams should adopt strategic and tactical implementation in a systematic manner, where schedule is a major factor (van Dijk et.al. 2012 and Pinto & Slevin 1987). The project schedule could be managed as stated by one of the respondents “On new build, the schedule is quite rigid but on conversion jobs, the construction sequence can be adapted to overcome delays. You have to work the plan to deal with changing circumstances.” Another respondent gave his reason on why the schedule should be the main driver for the FPSO project, “A project is either cost or schedule driven. They normally start with an equal level of importance but at some stage one driver will lead. If schedule becomes the main driver then the cost will rapidly increase. Equally, if the schedule is not the main driver the cost will also increase as extended project durations increase cost. Therefore the schedule should always be the main driving force.”

5.3 Analysis on Themes / Concepts

Even the traditional audit firms (Ernst & Young 2012 and Deloitte 2009) have been drawn into the Oil & Gas industry with consultants or specialized team catering to the specific oil and gas clients’ needs. An audit firm’s Oil & Gas Performance Improvement practice has a number of experienced oil and gas team members who together are of the opinion that companies in the oil and gas industry should place importance on the following

capabilities which could determine boom or bust for the companies:-

- a) Effective project management.
- b) Supplier performance management.
- c) Risk assessment and reduction.
- d) Safety.
- e) Regional execution.
- f) Governance, controls, policies and procedures.
- g) Contracting strategy.

Meanwhile, traditional audit firm giant has branched out into oil and gas consultancy, understood that the oil and gas industry is facing tough challenges in meeting the consumption requirement of the world at large particularly from the BRICS nations. With the foregoing challenges, it is always good to find a firm footing on some best practices which leads to certain level of success factors along the way. And in reality check, the audit firm's best practices for the oil and gas companies are as follows:-

- a) a rigorous and relentless approach to capital cost management.
- b) robust performance management processes.
- c) on-going talent management and recruitment.
- d) building alliances.

e) strategic collaboration.

Referring to Table 4-8: Analysis of the Themes and Concepts, it came to a conclusion that the structured interviews confirmed the grounded theory methodology the top ten (10) themes and concepts are similar with the traditional audit firms' best practices.

The 'Schedule / Planning / Project Control' is definitely one of the main drivers for the FPSO project and as described in the sub-title of Managing Project Schedule. And when it is schedule driven, all parties involved in that particular schedule has to respect each other's schedule to meet the completion dateline as agreed (Soeters 2002).

5.4 Analysis on CSFs

In an interview, the interviewee did mention that knowing when to rely on reimbursable or lump sum basis for certain main contracts or subcontracts is vital to the success of the FPSO projects. It all depends on which party is in control of the said contract or the project works. With this knowledge, cost wise would be manageable and the project could concentrate on the physical works itself without much on the sustainability of the projects.

SBM Offshore's current direction is solely on FPSO, FPSO, FPSO but as the FLNG is being developed it could develop additional

source of income for the company in the future. The interviewee also believed that its FPSO projects would continue to grow despite the high cost of investment which would be due to the following factors (International Quality & Productivity Centre 2013):-

- 1) Swift roll outs = Quicker time to production
- 2) Lessened Investment = Diminished overheads
- 3) FPSOs do not have to be custom built
- 4) FPSOs can evade harsh weather
- 5) FPSOs can hop from field to field
- 6) Abandonment costs are significantly less than for fixed platforms
- 7) FPSOs are ideal for deepwater drilling
- 8) Asset integrity costs lessened with FPSOs
- 9) FPSOs eliminate the need for costly and sprawling underwater infrastructure
- 10) FPSOs are environmentally-friendly than rigs

The above factors are mostly related to cost and schedule reasons which made FPSOs the darling of offshore oil & gas industry. These created more CSFs for FPSOs.

SBM Offshore would be hard to match if, according to the interviewee, it continued to maintain its good reputation, deliver the FPSOs within the agreed schedule and ensure that uptime

during FPSO operations is kept high all the time. IOCs and NOCs would find this hard to match as it is not their core business and would not be feasible for them to venture into the FPSO industry. Keeping teams of engineers solely for the purpose of constructing FPSOs may be redundant at the certain periods and such costs could be too high to maintain. Hence, SBM Offshore has to keep improving on the good reputation which made it as CSF.

The offshore oil & gas industry has numerous regulatory compliances to adhere to and therefore, it would be critical to ensure that local laws or regulations in other countries are clearly understood in order to be compliant. Failure to follow such simple guideline may cause the FPSOs to be impounded which would lead to down time on the oil production. Such loss of revenue may be costly to the IOCs and NOCs together with the FPSO operators too. It would to be a CSF when laws or regulations were adhered and coupled with the good reputation, the FPSO Contractor's name would continue to catch the FPSO industry's attention.

The interviewee's response on the CSFs is almost similar to the answers obtained from the structured interview. Although the interviewee's seniority and job responsibility differs a lot from the PMT members, there were similarities in the following CSFs:-

- a) Resources in terms of workforce;

- b) Right access to major suppliers;
- c) Partnerships with international fabrication shipyards; and
- d) Local partnerships for local content purposes.

From the above-mentioned CSFs, it can be seen that with the right resources in terms of workforce would allow the FPSO Contractors to commence and execute the FPSO projects on the right track right from the commencement of the project. This CSF would fall under the main topic of 'Reliance on Experience'. The major suppliers have been a major concern to a number of respondents too where good co-ordination with them would see engineering and procurement deliverables executed on schedule and within budget. Another CSF related to the fabrication shipyards is similar to the main topic of 'Reliance on Fabrication Shipyards'. Once the fabrication shipyard's management works favourably with SBM Offshore owing to clear definition of scope of works, half the battle has been won already. Finally, the stakeholders' interests have been listed as well which agreed with the main topic of 'Handling Stakeholders' found in the structured interview. When the stakeholders are aware of the project's scope definition, subsequent requests brought to them were usually agreed to or approved without much hassle. Stakeholders' participation is very important when it comes to major decisions on the scope of works that could affect the FPSO project.

Last but not least, the interviewee was a strong proponent to the idea of lessons learned and to standardise the practices or methods if it was good to be maintained. SBM Offshore has developed the Corporate Engineering Standard whereby all engineering designs or concepts are stored online accessible by any staff who are located all over the world. With SBM Offshore taking the stand that lessons learned from previous projects ought to be remembered and taken seriously, the researcher's topic related to CSFs would be of beneficial to SBM Offshore and hopefully the CSFs that have been listed or obtained from all respondents would be of good reference in the various FPSO projects.

In a published thesis that concentrated on the CSFs for the conversion of oil tankers to FPSO (Mierendorff 2011), the closest literature reference to the researcher's Project Research, that particular researcher identified CSFs through literatures review and confirmed via structured interviews where the respondents provided the following as CSFs (not in any preference order):-

- a) Project Manager;
- b) Project Management Team;
- c) Interface Manager;
- d) Communication;
- e) Customer Input;
- f) Finance & Cost Management;

- g) Front End Engineering and Design (FEED);
- h) Scope of Work;
- i) Change/Variation Management;
- j) Whole of Life Cost Concept;
- k) Safety Case Regime; and
- l) Standardisation.

The Project Manager's role was eventually identified as the most important CSF as it stated that the Project Manager would be responsible for the success of the FPSO project. The above-mentioned CSFs under items (a) to (l) have all been listed by the thirty four (34) respondents in the researcher's structured interview. The above structured interviews were conducted with respondents who have work experience in the conversion of FPSO where the researcher's selected respondents had work experience in either newbuild, conversion or re-deployment of FPSOs. This showed us that the CSFs deemed critical for the success of FPSO projects were similar whether the FPSO is a newbuild, conversion or re-deployed.

In order to evaluate the relevancy of CSFs on deepwater oil development project (Denni-Fiberesima & Rani 2011), further studies and analysis were conducted through the one-sample t-test, two tailed test and Cronbach Alpha Value, the following can be deduced:

- 1) The listed CSFs greatly influence deepwater project success.
- 2) Portfolio management strategy will influence the CSFs for deepwater project success.
- 3) Total project budget is highly dependent on the listed CSFs.
- 4) CSFs will influence project schedule for deepwater project success.

A similar study was conducted to determine the CSFs for an offshore oil field development (Browning 2004) right up to the first oil day that took three and half years to reap the reward. The following CSFs are important for oil and gas field development to improve further:-

- a) Clear understanding achieved in the project team.
- b) Scope and latitude for performance by various participants (advisers, contractors and sub-contractor).
- c) Buy in to the project life cycle objective by the key contributors.
- d) With focus on key success factors, it has produced excellent results in many areas.

6.0 CONCLUSION

6.1 Introduction

This research began with the aim of establishing the CSFs that FPSO Contractors can adopt in order to achieve project success by completing FPSO projects within the agreed schedule and budget which was stated in Chapter 1. In Chapter 2, literature review was done to extract more information and data to test the validity of the subsequent responses from the structured interviews. The Research Methodology has been described under Chapter 3 where it would explain how the research was conducted. Chapter 4 was mainly the results from the structured interviews and the researcher had to go through numerous pages to observe and understand where the respondents stood. Chapter 5 was written to evaluate the respondents' perception and opinion comparing against the list of literature reviewed. Finally, Chapter 6 is here to bring readers to read about whether the literatures review and structured interviews have achieved the research aim of this Project Research. Not forgetting the research objectives too. The outline of the research objectives are as follows:-

- a) The research shall determine which CSF will make a difference for FPSO Contractors.

- b) The research shall establish and ensure that CSFs that have been identified are able to guide and assist future similar FPSO projects to avoid the risks and/or problems faced previously relating to schedule deviation and cost overruns.
- c) The research shall identify any similarities between CSFs via literatures review and structured interview with those CSFs identified in connected offshore construction activities and/or offshore oil & gas regions within the FPSO industry.
- d) The research shall also identify the lessons learned from previous FPSO projects and how such lessons can be successfully applied to other FPSO projects.

6.2 Will this research proposal succeed in its aim and objective?

As the structured interview format was distributed to participants involved in the FPSO industry, it was able to generate good responses with the right information aimed for in this research. With the FPSO industry's seasoned professionals involved, the outcome of the research has resulted in outcomes which were similar to the real challenges being faced daily at worksites.

6.2.1 The research shall determine which CSF will make a difference for FPSO Contractors

The findings in this Project Research were gathered from thirty five (35) participants, including a full face to face interview, who responded well with up to five hundred eighty eight (588) CSFs being provided. Further analyses were done to determine the themes or concepts or the CSFs that were regarded as important and critical. In the analysis on themes or concepts, the top ten has covered approximately 70% of the total CSFs. This proved that the respondents were in agreement on a number of those themes or concepts.

As the respondents had described their work experience in the related offshore oil and gas industry, 78% of the respondents came from the background of FPSO Contractors. The CSFs provided by this group of respondents would be reliable owing to the number of years of work experience numbering up to two hundred eighty seven (287) years where majority of them are PMT members. These lessons learned or CSFs obtained from the respondents on the handling of the works related to the FPSO industry are definitely valuable and would make a lot of difference for FPSO Contractors.

The respondents have highlighted the need for an experienced PMT or workforce for FPSO projects. If the PMT lacked experience it could derail the project schedule and cost may not be managed properly. The Sanha LPG FPSO and LNG FPSO development conducted by SBM Offshore has discovered that an integrated project team of an experienced PMT or workforce is highly critical in order to achieve project success. The integrated team in the Sanha LPG FPSO comprised SBM Offshore's experienced staff working in an integrated PMT together with ChevronTexaco instead of each company having to form their own PMT with different agendas. This integrated team would avoid any differing opinions on scope of works as all parties were working towards the same goal. This shows that the PMT's input and feedback in this research should be well regarded. From my experience, the lack of experience relates back to the poor understanding of the scope of work and unsure of the scope definition. This would lead to poor execution of the FPSO project itself. From the various literature review and discussion in previous chapters, the scope of work or scope definition is an item that came up in more than 90% of the literatures or respondents' perception and opinions.

6.2.2 To establish and ensure that CSFs that have been developed or to be developed are able to guide and assist future similar projects to avoid the risks and/or problems faced previously relating to schedule deviation and budget overruns

The rankings of CSFs, in terms of its frequency have allowed end users to see which CSFs would have the most impact on a particular main topic. This would direct the project team members to put in more efforts to ensure those CSFs are further discussed and new procedures or policies implemented to achieve project success by relying on those CSFs. The rationale of research was to ascertain the relevant CSFs for the FPSO projects in terms of cost overruns, delays that affect the project schedule and on methods to manage the project schedule. Thereafter, the project team members would have to carry out their works with those CSFs in their mind. The data were from respondents who have worked all over the world with various FPSO projects with their proven working experience the CSFs obtained would be useful for other similar projects in other oil and gas regions to embark and implement the relevant CSFs right from project commencement.

The five hundred eighty eight (588) CSFs have been categorized under various themes or concepts and whenever there are issues related to those themes or concepts, the FPSO Contractors or end users should zoom into those related themes or concepts to find the

best solution in the related CSFs. Alternatively, this research would have referred to or reviewed certain literatures that would have contained write-ups on solutions which would be of help to the end users. Through the themes and concepts, the ‘Schedule / Planning / Project Control’, ‘Engineering Deliverables’, ‘Clear Scope of Work’ and ‘Clear Communication’, ‘Prompt Delivery of Equipment and Materials’ and ‘Experienced PMT and Workforce’ have been the main issues brought up by the respondents. It is clear that if the scope of works and deliverables were not identified or understood accurately, it would cause subsequent major problems and mistakes which would lead to schedule deviation and cost overruns.

6.2.3 The research, through literatures review and structured interviews, would also identify any similarities between CSFs used for connected offshore construction activities and/or CSFs used in the offshore oil & gas regions within the FPSO industry

The literature review was done with more than sixty (60) professional articles, journals, scholarly articles and relevant thesis being reviewed for the offshore oil and gas industry and FPSO industry respectively. Next, the structured interviews conducted had doubled up the effort in searching for the relevant CSFs for the FPSO industry. In reading Chapters 2, 4 and 5, readers would be able to pick up the related CSFs for their own industry or work activities. With the high number of literature reviews and structured

interviews done with respondents who have tons of working experience, the research was able to pick up similarity of the CSFs.

Based on Chapter 4's evaluation on the identified themes or concepts and Chapter 5 moved on to discussed on the significant findings on each main topic, this research would have led the readers through various assessment of the CSFs and assist the readers in understanding the CSFs' strength and also the contribution it could bring to the Project Research and finally to the industry players.

No matter how strict is the PMT on following the project schedule, there would be some gaps appearing between the shipyard practices and offshore standards on the scope of works. The industrial culture at shipyards would largely depend on the senior management's direction. The standards implemented by Keppel Shipyard Limited's ("KSL") senior management have led the shipyard to be awarded with numerous projects that the docks are all occupied till early 2015. Appointing such shipyards would bring assurance to FPSO Contractors where the works were always on tight project schedule. KSL's would also be having the experience working on complicated FPSOs which is one of the CSFs being mentioned in the structured interviews. With good experienced workforce and gung-ho senior management, the shipyard would then be able to comprehend the complexities of the contractual

obligations and understand the scope definition of the newbuild or conversion projects. When the scope of works is fully understood, letter reworks would occur and this would keep the costs at bay and lead to a project success. But one has to bear in mind on what has happened with HHI who was appointed by Shell as described in Chapter 2. The HHI situation arose out of different opinions on the scope of works or method to carry out the works.

6.2.4 The research shall also identify the lessons learned from previous FPSO projects and how such lessons can be successfully applied to other FPSO projects

The research has managed obtain a number of lessons learned from various FPSO projects from a number of literature review. These literatures were generally from the related industry and professional magazines, articles and journals respectively. If not for this research, all these lessons learned or CSFs would not be collated for a single purpose to allow it to be applied for future FPSO projects. In terms on how such lessons can be successfully applied, the researcher provided the information under the Research Implications as below.

As made known in the interview conducted by the researcher, SBM Offshore did conduct lessons learned sessions with the PMT member and senior staff in order for them to be aware and kept

well abreast of what caused the failure of or delays in certain projects.

Through literature reviews, it has been suggested that recording systems should be set-up and critical checklist should be monitored. Though tedious initially but on subsequent projects, such systems would be very helpful towards implementing new projects.

6.3 Research Implication on the Authority

It is a fact that NOCs control approximately 90% of the world's oil reserves and 75% of production (similar numbers apply to gas), as well as many of the major oil and gas infrastructure systems. Of the top twenty (25) oil and gas reserves holders and producers, eighteen (18) are NOCs." With this information, NOCs would be more receptive towards the CSFs about the FPSO industry. As more offshore oil fields are moving into deepwater regions, NOCs would want to be more prepared in this offshore works.

The NOCs would benefit from the FPSO industry as the FPSO Contractors would have the capacity to assist in providing the FPSOs in a quicker manner by converting tankers to FPSOs at a lower cost compared to constructing an oil platform. The FPSOs could see quicker first oil supply from clearly identified responsibility matrix between the FPSO Contractors & Operators

and the NOCs' other main contractors such as the Subsea, Drilling, Transportation and/or Riser & Flowlines. By having scope of works identified at the early stage it would enhance the work performance which would lead to the project being completed within the agreed schedule and budget.

To keep the exploration and production lower, leasing arrangement could be executed to lease for a fixed number of years and it is the preferred amongst the Oil & Gas Operators as the FPSO Contractors and Operators would be responsible for the operations and maintenance of the FPSOs which is not the core business of the Oil & Gas Operators. This leaves the NOCs PMT to concentrate on completing the FPSO project only. At the same time, the Oil & Gas Operators need not assume higher liabilities by owning FPSOs. The Oil & Gas Operators could pay the FPSO Contractors & Operators from the oil proceeds in due course. This reduced the risk of non-completion of FPSOs.

The NOCs should take up the joint venture options with the FPSO Contractors and Operators as this would also assist the economy via the local content requirements. The NOCs could participate in the ownership of the FPSOs and could request the FPSO Operators to include local nationals or companies to be involved in the operations and maintenance of the FPSOs. Brazil has been employing this method and it has greatly brought the standard of

living up for those involved in the oil and gas industry. Moreover, this has drawn more local people to join the oil and gas industry to boost the supply of manpower which is truly lacking.

Concurrently, the NOCs are assured of the environment protection as FPSOs are definitely more environment friendly than oil rigs. Upon maturity of the oil wells, the FPSOs could be mobilized to another oil field development. The NOCs' assigned local people or companies would benefit with the continuity of the FPSO. This would improve their skills and greatly enhances the technological knowledge in the oil and gas industry.

As mentioned above, NOCs would be the main contributor to the oil and gas industry. FPSO Contractors would re-define their strategies in collaborations with NOCs, not forgetting the IOCs. With Brazil being the leader in Latin America and Angola expected to lead the Africa's oil production by 2014, leading FPSO Contractors would be maintaining strong relationship with Petrobras (Brazil) and Sonangol (Angola). However, local content requirements were expected to be harsher in these two (2) key markets. With the strict local content requirements in Brazil, it has caused certain oil and gas development projects to be delayed due to shortage of high-skilled workforce. SBM Offshore is willing to invest in Brazil's economy mainly due to its robust maritime industry that encourages and support shipbuilding, construction of

off-shore platforms and ship repair. As a result of the local content requirements, the Brasa yard was set-up in Brazil.

In the same aspect of meeting the local content requirements in Angola, the Paenal yard was set-up by SBM Offshore under a joint venture partnership with Sonangol too. But it does not stop there as more extensive requirements would be expected as in local bank accounts, local residence of funding and local currency for local goods purchasing.

6.4 Research Implication on Current Issues and Problems in the FPSO Industry

The FPSO industry is attending to the issues as follows:-

i) Oil & gas deepwater discoveries

IOCs and NOCs are discovering new deepwater oil fields at Gulf of Mexico, Brazil, Angola and Nigeria. With more deepwater oil fields, the IOCs and NOCs would take longer period to sanction such investments as it would cost even more. FPSO Contractors should collaborate with IOCs and NOCs to develop new technological ideas in view of the complexity in exploring for more natural resources at deepwater regions. With such complexity in the oil field development, both PMTs from FPSO Contractor and Client have to learn to identify the CSFs. The following factors are keys to achieve the project success where 'Reliance on Experience'

would help for both the oil field development and FPSO production:-

- a) Experience & professionalism and ability to assess specialist resources.
- b) Generous delegation of authority and short Operator/JV decision chain.
- c) Function as extension of the organization.
- d) Good communication.
- e) Project Leads assigned work packages with continuity of responsibility.
- f) PMT management concentrated on contingencies and interface issues.

Liaising with the stakeholders is of the utmost importance. The collaboration between the FPSO Contractors and Operators and the Production Contractors in the Deepwater and Ultra-Deepwater Fields is of utmost importance. Failure to agree on even non-pertinent matters between the stakeholders may lead to complications later on in the project life cycle.

FPSO Contractors and Operators, Production Contractors and Oil & Gas Operators should continue to hold conferences or forums to share their knowledge as what it is done during the Offshore Technology Conference held in Houston, USA annually. At this

conference, almost all major FPSO Contractors and Operators, Production Contractors and Oil & Gas Operators would gather together to produce white papers to address the complex issues found in the deepwater and ultra-deepwater fields. The complexity would be due to the differing opinions on the scope of works. The FPSO Contractors would be selling products, methods or services which were not required by the Clients. The parties would have to discuss and agree on issues to avoid situations that could jeopardise the offshore industry and worked on collaborative approaches for the benefit of all parties involved especially in the following areas:-

- 1) inherent risks and uncertainties in the field development process;
- 2) ownership of deepwater hub platforms and pipeline infrastructure;
- 3) leasing and operating vs. ownership of FPSOs;
- 4) subsea tiebacks and supply chain management; and
- 5) ownership and implementation of technology.

ii) Technical risk and preventing overruns

Technical risk such as technological risk, environmental risk, geological risk and infrastructure risk could derail the Oil & Gas Operators plans and it would take longer nowadays for the Oil & Gas Operators to push ahead with the field development with the much higher risks in tow. Reason being more studies and tests

would have to be conducted to mitigate the foreseen risks. Oil & Gas Operators in upstream megaprojects throughout the world are already experiencing cost overruns averaging 25% with slippage in schedules averaging 22%. These average figures were made known publicly but the respondents believed that actually more than 70% of FPSO projects worldwide have experienced / are experiencing schedule deviation and/or cost overruns. One of the major increases in cost is normally due to Major Suppliers. From the structured interviews, majority of experienced respondents have provided the following responses to control Major Suppliers' costs:-

- a) Previous experience in executing similar package;
- b) Understand expectation and requirement of FPSO Contractors' specification;
- c) Clarity during negotiation and before placement of purchase orders (especially on scope of work, price, exclusion, turnaround time);
- d) Scheduled monitoring of progress report;
- e) Penalty or reward for respective delivery dates;
- f) Existing workload.

The issue with Major Suppliers boil down to having the experience to understand and know the exact specifications for the works. Failure to arrest the lack of knowledge of the scope of work or

scope specification would lead to heavy consequences on the schedule and budget.

In view of the above, a few respondents' have suggested that the FPSO Contractors should implement the critical risk system on the monitor major components by having stricter procurement and management process. FPSO Contractors should consider increasing resources when it monitors process equipment and lesser resources for management of bulk materials. The FPSO Contractors must consider building long term relationships with Major Suppliers in which it is not being done very well. This is to improve communication and understanding with transparency in the business dealings. On long terms basis, costs could be maintained owing to close relationships.

Increase in costs could also be due to project works exceeding the agreed schedule. The project schedule issue is always one of the critical aspects. In finalising the project schedule, it is usually governed by the commercial and contract's terms and conditions set by external consultants during negotiation stage which didn't steer the project schedule according to the scope of works. To avoid or to minimise variation orders during project execution, the project schedule has to be drawn up according to the detailed scope of works and specifications.

iii) Complex Oil Fields with Higher Risks

The deepwater oil field development has a lot of potential for growth but somehow the risks were getting too high too. In this manner, the CSFs identified or proposed by the respondents could help out in the area of Handling Stakeholders. If the risks could be passed on or mitigated by jointly resolving the issues, it would bring benefits to all stakeholders involved. The FPSO Contractors would have to go through this process thoroughly and respondents proposed that FPSO Contractors should start with the following:-

- a) Risk assessment on country risk.
- b) Risk assessment on political and cultural issues.
- c) To screen and evaluate potential clients, clients' co-venturers (including NOCs) on business ethics standing, corporate standards, nationality, ownership and identity;
- d) Work on the relationships; and
- e) Sales and service team to be involved that may bring behind-the-scene benefits.

With this research, professional bodies could adopt the CSFs tabulated to conduct more comparisons and provide more guidance to the FPSO industry. Professional bodies such as American Bureau of Shipping (ABS), Project Management Institute (PMI), Oil and Gas Producers Association and Norwegian Oil Industry Association (OLF), marine associations or even FPSO conferences

such as Offshore Technology Center, FPSO Research Forum and FPSO Congress could conduct seminars and trainings based on the CSFs collated herein or to present papers on interface management between all stakeholders especially on the job scope.

As the FPSO industry is growing at a rapid pace and to bridge the supply gap, FPSO owners should concentrate on constructing a standard FPSO. A standardised FPSO will bring forth the following benefits and indirectly will lead to CSFs in the long term:-

- a) Reduced project risk.
- b) Improving project schedule.
- c) Making budgets more predictable.
- d) Able to negotiate better terms for leased FPSO.
- e) Standardised equipment and system solutions.

6.5 Research Implication on Academic World

This research would assist future researchers who are keen to find out more about CSFs generally. It provides guidance to a researcher looking for samples of CSFs in various industries and in particular the oil and gas industry, in this case the FPSO industry.

The academic world could tie up with the leading FPSO Contractors to conduct in-depth research of the CSFs as in how to achieve better project execution, understanding respective scope of

works, partnerships and sustainability and to include all parties involved in the FPSO industry. With this collaboration, the outcome of the research would be known by all parties and should encourage all parties to adopt the CSFs to prepare for future FPSO projects.

6.6 Limitations of the Project Research

With FPSOs becoming the mainstream product for the deepwater or offshore oil field development, the sensitivity of sharing information, data, or strategies were restricted due to the stiff competitive FPSO industry. There are gaps in terms of the know-how, technology and experience between parties involved in the FPSO industry. As there are limited articles, journals or research on the CSFs for the FPSO industry, this research is of good timing and it is not affected or influence by any literature or studies. With this impartiality, the researcher hoped that this research will be well accepted by all players in the FPSO industry. Although the research or studies are limited, the respondents, as seen in the Respondents' Data, that have responded were acceptable and experts in their relevant field of work. The depth of responses received has overwhelmed the researcher. The structured interview could be further improved in terms of requesting the respondents to provide the CSFs based on priorities or importance. As the researcher combined the perception or opinions to form the themes or concepts, some of the responses could be left be out due to

researcher's biasness and limited experience in certain areas of the offshore oil and gas industry. The researcher is of the opinion that the responses would not have provided a different analysis or outcome, if all the eighty (80) who have received the structured interview had responded, as the researcher believed that "saturation" has occurred due to similarity of the responses provided received from the thirty five (35) respondents. The "saturation" of responses has caused the emergence of theories where future research could put forward new journals or new theories based on these responses. On the other hand, the researcher has described that the research was based on the Grounded Theory Method where the responses received were sufficient to form a theory. Readers would have to note that most of the respondents came from SBM Offshore's in Kuala Lumpur with limited participants from other offices such as Monaco, Singapore and Angola. However, the researcher found out that a number of the SBM Offshore respondents in Kuala Lumpur office have worked on various FPSO projects located in other overseas offices before being assigned to Kuala Lumpur's office. The FPSO industry would welcome various stakeholders' opinions and further in-depth analysis should be conducted with the relevant stakeholders in future researches.

6.7 Recommendations for Further Research

The Critical Success Factors are almost similar from different business sectors in the offshore industry but somehow FPSO Contractors and Operators are still making the same mistakes even though lessons learned are captured.

Lessons learned need to be compared with different oil and gas regions such as West Africa, Brazil oil basin, South East Asia / Australia and North Sea to see the similarities or differences. This will help the offshore industry to be prepared for the potential factors that could assist in improving the offshore industry especially the construction of FPSOs. Or be aware of the downside of the industry if certain CSFs were not met. With more lessons learned being captured, it will lead to better management and preparedness of venturing into the FPSO industry and that both FPSO Contractors and Operators would be well aware of what to expect. This would reduce unexpected costs and delays in the FPSO projects. There isn't a comparison of CSFs between the oil and gas regions as above-mentioned. In the absence of such important data, FPSO Contractors and Operators would be venturing into a region with uncertainties and higher risk elements.

Future research could be aimed at collaborations with Robert Gordon University and Norwegian Oil Industry Association, both of them having huge database of lessons learned for FPSO projects,

together with Oil & Gas Operators and FPSO Contractors and Operators. For the benefit of all parties and the FPSO industry, one should put aside the ego and pride for a period to contribute to the society at large.

Extraordinary savings could be obtained from improved research on how to ensure all parties understand the scope definition or engineering scope of work. Thereafter, all parties should know their scope of work accordingly. A lot of the cost overruns were caused by blur definition of scope of works.

The researcher would recommend that future research be conducted on procurement strategies against current delays experienced for various equipment deliverables which would see an integrated team comprising procurement specialists from FPSO Contractors, FPSO Operators and Oil & Gas Operators contributing. Such a research would assist them in analysing the weak points during the placement of purchase orders and which area required frequent monitoring to ensure the product specifications are met at all time.

Another further research could be to assess the potential backlash from stakeholders that were not kept informed or abreast of the FPSO projects. As the FPSO projects is not the finished product itself for an oil field development, the FPSO Contractors should be ready to lend a hand to other stakeholders for the benefit as a

whole. Although all stakeholders are in it to benefit from one way or another, it would be nicer that all stakeholders are in it to help one another to pull through in hard times and bad times. A number of FPSO Contractors have gone bust due to the complexity of the FPSO industry. It could be due to the fall out with many stakeholders who were not prepared to assist. Was it due to senior management's inefficient manner in handling the various stakeholders?

An important future research should be done to review and assess the local content requirements that are being implemented as this is written. A research could be done to understand how the local content requirements can be incorporated into the projects and yet benefit all parties. High growth oil markets in Asia, West Africa and Brazil are demanding Oil & Gas Operators and FPSO Contractors to include many local content requirements into their projects. In a project that the researcher is working on, the Angolan authorities required the NOC to be the joint venture partners for the oil field development, part owner of the FPSOs, joint venture owner of the local fabrication shipyard and that their local staff be provided with overseas training at the Oil & Gas Operators and FPSO Contractors worldwide offices where various part of the Angolan oil projects were being managed from. Oil & Gas Operators and FPSO Contractors must be prepared to listen to the

local authorities if they are to continue expanding their respective businesses or projects.

Last but not least, another future research could be conducted in compiling success factors from each major supplier and Client's other major contractors. Many researches have been conducted on the vessel, topsides, instruments, electrical, project engineering, the external factors such as mooring, subsea, risers, umbilicals, offloading to tankers and sea condition. Combining all the above researches would be a good reference for many parties in the offshore oil and gas industry where the probability to enhance the know-how and keep the respective smaller scale projects to complete their works within the budget and agreed schedule. In turn, it would reduce the time taken to construct the FPSO and the Oil & Gas Operator would see the first oil into their production at a shorter span of time.

6.8 Conclusion

The traditional audit firms that major in corporate assurance, financial accounting and tax advice have moved on to provide consultancy services to companies involved in the oil and gas industry. In reading these audit firms' improvement practices, it could be seen that they do agree with the research's findings. These findings should be placed importance as it could determine boom or bust for the oil and gas related companies which are the effective

project management, supplier performance management, risk assessment and reduction, safety, governance, controls, policies and procedures, contracting strategy, building alliances and strategic collaboration. This research has been able to identify that to achieve project success, four (4) main criteria are to be met where failure to do so it is deemed failure for that particular project which 'On schedule', 'On budget', 'Meet all set goals' and 'Acceptance by end users'. Lessons learned and CSFs should be compiled into large database with ease of retrieving the information required to assist the project team in overcoming any problems or difficulties. When the FPSO Contractors keep such database, the project knowledge is priceless when it is properly managed and re-use for similar projects. A Scottish university has compiled a huge database for the benefit of the FPSO industry where they have listed the Lessons Learned & Challenges based on the Norwegian FPSOs and UKCS FPSOs. They have summarized the key issues, lessons learned and challenges in various categories for reference purpose. With such database, the FPSO industry will gain tremendously in being able to assess their technical and commercial issues in a well-informed manner. Based on the Literatures Review on the relevant journals, articles, thesis and relevant websites' main points on CSFs, with the identified CSFs and based on the available database collated, FPSO project staff will know what to aim for / avoid in their daily works to achieve the target completion set forth by the respective project teams or

FPSO Owners / Operators. The CSFs identified in this research could be analysed further to adapt to each Oil & Gas Operators and FPSO Contractors' operation manuals or company policies. Trainings and strict adherence should be adopted to remind the workforce that it is imperative to achieve success failing which the company could go bust due to the high investment cost involved in terms of billions for the oil field development or to build a FPSO. The aim of this research is to equip the FPSO industry with the necessary information and data to improve the FPSO Contractors' performance. CSFs related to Reliance on Experience, Reliance on Fabrication Shipyards, Co-ordination with Major Suppliers, Co-ordination with Clients, Handling Stakeholders and Managing Project Schedule should be adopted as FPSO Contractors' future reference for decision makers. The major finding of this research after all the literatures review, structured interviews, analysis of results and further comparisons made is that poor understanding of the scope of work; Client's specifications are not well defined; Major Suppliers' failure to comprehend the Client or FPSO Contractor's work specifications; stakeholders' poor knowledge of the FPSO project's contractual obligations; PMT's failure to interpret the contract requirements; and insufficient and late interface information and data, would eventually lead to major schedule deviation and subsequently, hit by cost overruns. Partly, to overcome such situation is to hold frequent and in-depth reviews to obtain more feedback from relevant disciplines in the company

and from all stakeholders involved. Stakeholders such as the Risers and Flowlines Contractors, Umbilical Contractors, Drilling Contractors, Subsea Contractors and Installation Contractors who have no direct contract dealings with the FPSO Contractors would pose the biggest hurdles in obtaining the interface data for the FPSO projects. In this scenario, the researcher proposed that further reviews and feedback are to be executed from day one of FPSO projects with specific team members from all stakeholders mentioned above, assigned to such task and who are not involved in the day-to-day project works. However experienced are the PMT members and how detailed a project schedule can be, all this would fail in the course of the FPSO project when the scope of works or scope definition are not understood accordingly. With the research objectives in mind, the research's collated information and data are of current era and would be relevant in years to come. To the researcher, hopefully this research would generate more interest amongst the professionals and academicians alike to conduct further researches that would enhance the oil and gas exploration and production for the limited 'black gold' natural resources for the benefit of the generations to come. Further improvement on this research would bring excellent benefits to the FPSO industry players and save the unnecessary wastages of resources in complying with the contractual obligations or regulatory requirements. The research believes that the research aim and objectives have been achieved and FPSO Contractors would find

various references to literatures that could further enhance the knowledge and obtain more information that could assist them in executing the complexities FPSO projects.

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**Appendix A
Respondents' Data**

No.	Job Title	Company's Nature of Business	Work Base	Nature of Work	Largest Project Executed (USD\$)	Offshore Oil&Gas Experience (No. of years)	Remarks
1	Engineering Project Manager	FPSO Contractor	Malaysia	Engineering Project Management	90M	8	
2	Engineering Project Manager	Oil & Gas, FPSO Contractor	Malaysia	Engineering	250M	10	*20 years experience in onshore O&G
3	Engineering Project Manager	FPSO Contractor	Malaysia	Engineering Project Management	1B	15	
4	Project Manager	FPSO Contractor	Malaysia	Project Management of Oil & Gas Projects	1.1B	18	
5	Project Controls Manager	FPSO EPCIC Contractor	Malaysia	Provision of project control services to project such as planning, cost control and estimating	4.5B*	18	*Onshore Pipelines project on Sakhalin Island, Russia
6	Principal Process Engineer	Oil & Gas, FPSO Contractor	Singapore	Construction	-	20	
7	Project Controls Manager	FPSO Contractor	Monaco	FPSO conversion specialist	2B	10	
8	Legal Manager	FPSO Owner/Operator	Malaysia	Legal*	1.2B	15	*Experience in Oil Shipping
9	Principal Instrument Engineer	FPSO Contractor / EPC	Malaysia	Lead Engineer (Instrumentation)	1B	13*	*14 years experience in onshore O&G
10	Engineering Project Manager	FPSO Contractor	Singapore	Engineering management	300M	12	
11	Cost Engineer	FPSO Contractor	Malaysia	Project control	150M	6	
12	Senior Project Engineer	FPSO Contractor	Malaysia & Singapore	FPSO Topside	1.1B	11	
13	Completion Department Manager	FPSO Contractor	Malaysia	Overall responsible of pre-commissioning & commissioning activities for all projects executed by Execution Centre	1B	15	
14	Head of Contract Management	Shipyard / Fabricator	Malaysia	Contract Management	-	3*	*6 years experience in onshore O&G
15	Procurement Services Manager	EPCIC and Operations of offshore oil and gas solutions	Malaysia	Procurement management	340M	1*	*13 years in downstream operations (oil major petrochemicals)
16	Interface Manager	FPSO EPC, Installation and Operation Contractor	Malaysia	Offshore Oil & Gas	700M	15	
17	Project Manager	FPSO Contractor	Malaysia	EPC / EPCI	1.1B	15	
18	Commercial/ Contracts Consultant	Commercial/ Contracts Advise and Claims preparation	USA	Commercial/ Contracts Advise and Claims preparation	1B	35	
19	Department Manager	FPSO Contractor and Operator	Malaysia	Engineering	1.2B	16	
20	Engineering Manager	Oil & Gas Operator	Malaysia	Engineering	300M	8	
21	Discipline Manager	FPSO Lease and Operate Contractors	Malaysia	EPCIC, lease, operate, full life cycle products	1B	11	
22	Senior Contracts Engineer	FPSO full product life-cycle	Malaysia	Project and Contract Management administration	174M	10	
23	Project Controls Manager	FPSO Contractor	Malaysia	Project Control	2.2B	15	
24	Topsides Delivery Manager	FPSO Owner & Operator	Malaysia & Singapore	Member of the Project Management Team responsible for Delivery of the Topsides Facilities	2B	35	
25	O&M Engineer	Oil & Gas Operator	Malaysia	Oil and Gas	1.5B	18	
26	Construction Engineer	FPSO Contractor	Singapore	Construction	800M	7	
27	Project Controls Manager	FPSO Contractor	Malaysia	Project Control	3B	10*	*5 years experience in onshore O&G
28	Contract Department Manager	FPSO Contractor	Malaysia	FPSO Sale and/or Lease	2B	7	
29	Site Representative	Oil & Gas Services	Angola	Site Construction Manager	40M	6	

No.	Job Title	Company's Nature of Business	Work Base	Nature of Work	Largest Project Executed (USD\$)	Offshore Oil&Gas Experience (No. of years)	Remarks
30	Vessel Delivery Manager	EPCIC Contractor	Malaysia	Delivery of vessel facilities	1B	12	
31	Project Engineer	FPSO EPC Contractor	Monaco	Project management	11.5M	9	
32	Project Engineer	FPSO Contractor	Malaysia	Project management	1.5B	7	
33	Contract Engineer	FPSO Contractor	Monaco	Contract management	650M	7	
34	Project Manager	FPSO Contractor	Malaysia	Project management	300M	15	
Total No. of Years of Experience						406	

APPENDIX B

INTERVIEW TRANSCRIPT

Interview Transcript with Managing Director of FPSO Contractor

- 1) Why did SBM Offshore choose to add Kuala Lumpur as one of the main execution centres?

One of the main reasons in having the Kuala Lumpur Execution Centre is due to the reservoir of engineers. It is not hard to source for engineers in Malaysia with a number of oil & gas companies operating in Malaysia. Geographically, it is nearer to a few projects at hand from Malaysia. It is also important to open an office in Malaysia as Petronas is one of the clients who leased Kikeh FPSO from SBM Offshore. Besides that, Malaysia is a stable country, politically too, and an investors' friendly nation.

- 2) Is it cost effective to have the operations office in Malaysia? Why?

The operating cost is lower in Malaysia as compared to SBM Offshore's office in Europe. Another good point is that Kuala Lumpur has good infrastructure in place. In terms of cost, the allocation for social security is lower in Malaysia. The medical charges are much lower if compared to European's medical charges. In Malaysia, you are able to place a limit on medical charges on each employee but not in a number of European countries.

- 3) How dependent is your company on the relationship with fabrication shipyards?

SBM Offshore needs to extend good relationship with shipyards who will determine the project cost and schedule for an FPSO. The Singaporean shipyards are reasonable with their pricing but in a certain European country, the shipyard took advantage of SBM Offshore and maximized the claim / charges on SBM Offshore.

In some cases, the local content requirement has to be adhered to and in order to sustain the said requirement, SBM Offshore has to place further investment in the local content such as the local fabricator shipyards in Angola or Brazil. With such investment and sound management, dependent on them is a big advantage towards SBM Offshore's businesses.

- 4) How flexible is your company on the type of contracts with the respective clients and major subcontractors?

If it is a brownfield contract, it makes more business sense to opt for the reimbursable basis which is currently being applied on three (3) FPSOs as the works are being handled by the Kuala Lumpur Execution Centre.

If it is a newbuild or full refurbishment contract, it is advisable to opt for the lump sum basis. The same goes for the shipyards where fixed rates have to be agreed up front to reduce unnecessary financial exposure.

- 5) Is the funding of FPSO projects very risky in the eyes of the financial institutions? Will this affect the cost of constructing an FPSO?

Financial institutions would have priced their risks into the interest rates of the financial package being offered to FPSO Contractors. If the financial institutions have priced the risks then it won't be a risky loan to them. SBM Offshore is currently being offered competitive interest rates in which the overall cost of constructing will not be affected by financing.

- 6) Will SBM Offshore face competition from the China and Korean shipyards in the long term?

Maybe but not much as they are still shipyards. Meantime, SBM Offshore is also an FPSO operator and doing well with FPSO conversion. With Total potentially accepting FPSO conversion, it will bode well for SBM Offshore.

- 7) What are the advantages SBM Offshore has over its competitors?

SBM Offshore is definitely much larger in terms of number of years of experience in the FPSO industry especially in operating and maintaining an FPSO. With SBM Offshore strong track records, it is easier to obtain finance to support its businesses. The accumulation of know-how, expertise, construction methods and engineering designs has put SBM Offshore at the forefront.

- 8) Is it still desirable for SBM Offshore to stick to FPSO industry?

Yes, the Senior Management's vision is very clear which is FPSO, FPSO, FPSO. Potentially, FLNG will be a major deal in the future.

- 9) Are the fabrication shipyards capable to construct the FPSOs, with their rich experience, in the long term?

Yes, they are capable in constructing the FPSO but they are still lacking in the area of engineering design which may affect the procurement process. It is too risky for them to move into the full fledge FPSO industry especially in operating the FPSOs.

- 10) Why should the International Oil Companies ("IOC") and National Oil Companies ("NOC") consider SBM Offshore? How is this compared over its competitors?

SBM Offshore has maintained good reputation for its FPSOs. Mainly it has delivered the FPSOs on time to the Clients. The other good aspect would be good uptime in operations where oil production is always in process.

SBM Offshore has confidence in the FPSO industry against its competitors. With its strength in the FPSO business in terms of number of people involved and years of experience, it is already a premium contractor in a sense.

- 11) When the International Oil Companies and National Oil Companies have gained sufficient knowledge and technology know-how, will they take responsibility for their own fields and deplete SBM Offshore's business opportunity by constructing their own FPSO?

The IOCs and NOCs will not go full fledged into the FPSO industry as it is not their core business. There is no added value for them and lack of expertise in their offices. They would need to hire a whole new business unit just to look into the engineering, procurement, construction, installation, commissioning and subsequently the operations of the FPSOs.

The IOCs' basic expertise is to find and source for the natural resources. They specialise in geophysics, soil condition, wave motion, drilling and delineate the oil reservoir.

The NOCs are set up to protect the national oil interest generally although some are moving into the direction of being an IOC.

The IOCs and NOCs are not experts in constructing the FPSOs and the process part of the FPSO is also delicate. They would require a lot of engineers at their offices. Moreover, they would need to maintain staff at shipyards to monitor the construction and trying to maintain good relationships with shipyards all over.

- 12) Do you think SBM Offshore has proven itself internationally, that SBM Offshore may be relevant also for any new market?

Yes, SBM Offshore has over the years gained a lot of experience and able to even evaluate geophysics data, sea condition, temperature, cost to build FPSOs and is able to keep good track record on local content requirements at various countries.

- 13) How difficult is it to establish a relationship with the government?

SBM Offshore seldom deals with the government directly. It is the IOCs who will have to deal with the respective ministries to obtain the necessary permits or licences. SBM Offshore generally deals with government departments due to regulatory rules and it is SBM Offshore's duty to comply with those rules and regulations.

- 14) How does SBM Offshore manage the negotiation process with the International Oil Companies and National Oil Companies? (SBM Offshore has to tender competitively with the IOCs being squeezed, cost wise, by NOCs)

The budget for a particular oil field development is approved by the relevant ministry. Thereafter, any cost to develop those oil field would be paid through the oil proceeds with the balance or profit being shared according to the oil field development's shareholdings or percentages.

SBM Offshore only need to negotiate with the IOCs whilst the NOCs establish the budget. The NOCs will have the right not to proceed with a particular offshore oil field development if the cost is not according to their expected plan or returns.

- 15) Are the International Oil Companies and National Oil Companies executing the works / managing an oilfield development, which involves FPSO, in a cost effective and schedule driven manner?

Yes, the IOCs and NOCs would decide on whether to purchase or lease a FPSO to develop their offshore oil field development. For example, Murphy Oil is very professional with their dealings and reliable. They have the know-how and knowledge within the company. They have a good management team in place.

- 16) What are the major challenges that an international offshore company, such as SBM, faces in the execution of projects in developing nations in terms of cost and schedule?

It is the right people resources. There are a lot of bases to develop in the company. Our Schiedam office was started due to additional Topside works and it became a full execution centre soon after. Houston and Kuala Lumpur's execution centres were opened eventually to meet the growing demand of the Clients. The future will see SBM Offshore expanding the existing four (4) execution centres.

SBM Offshore will need to organize its construction works in competent shipyards that will guard the cost and schedule with utmost importance. With this, partnership with shipyards is very important. To meet the local content requirements in places like Angola and Brazil, SBM Offshore has set up fabrication yards

there to capitalize on future FPSOs that will be developed in the West Africa and Brazil regions. Although the cost is much higher, SBM Offshore has gained a foothold in the two (2) countries with the strong local content set up and good relationship with local authorities.

Financing option in those local markets are still to be developed. If local content requirements require local financing, it would be challenging to source for a suitable financing package that is not of high interest rates.

- 17) What are the critical success factors that are required to achieve cost effectiveness and project completion within schedule?

The critical success factors after all these years in the FPSO industry can be summarized as follows:-

- a) Resources of people;
- b) Right access to suppliers;
- c) Partnerships with the international shipyards and fabrication yards;
- d) Local partnership for local content purposes;
- e) Organising finance for FPSO projects; and
- f) Recruit and train the right crew members for its FPSO operations.

- 18) How is the project team capturing the lessons learned throughout the project life cycle?

People at the operations have to provide feedback or proposals in order for the engineering and construction teams to improve further. This can be done through Close Out Report or Permanent Feedback Form from the SBM Offshore's Production teams. Feedback on the equipment and process with indicators will help a lot.

- 19) How much has the company relied on the previous lessons learned?

Not always but mainly due to the Corporate Engineering Standards that has been set up and every staff has access to it. These CES have been developed and accumulated over the years. Staff from the engineering, safety, supply chain, contract management, construction, commissioning and production teams will follow the CES that is accessible online anywhere anytime, be it onshore or offshore. But SBM Offshore definitely must learn from previous lessons learned. If SBM Offshore had relied on those lessons learned some of the incidents would not have happened in some cases. It is still not enough though.

20) Has the project staff been trained to capitalize on the known Critical Success Factors for the betterment of the FPSO construction works?

SBM Offshore has organised lessons learned workshops for its staff in all execution centres. In one of the most expensive lessons through the YME MOPU Project, talks and workshops have been organised recently with Q&A sessions for the staff to pose questions related to their field of work. SBM Offshore would also embark on safety and quality performance in the daily works around the world.